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SCHOLASTIC

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SPECIAL ISSUE:
STUDENTS ON A MISSION

- PLANTING A TRILLION TREES
- FIGHTING DROUGHT
- PERFECTING SOCCER KICKS
- DISPENSING FIRST AID

SPACE SCIENCE

DREAMING BIG

This teen plans to become one of the first people to set foot on Mars

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SCIENCE WORLD OCTOBER 9, 2017
VOL. 74, NO. 3 **Editorial Director:** Patricia Janes **Senior Editor:** Jennifer Barone **Associate Editor:** Jacob Batchelor **Contributing Editor:** Andrew Klein **Editorial Consultant:** Cody Crane **Intern:** Cici Zhang **Education Editor:** Matt Friedman **Online Editor:** Catherine Wilshusen **Senior Art Director:** Sarah Irick **Photo Editor:** Els Rijper **Production Editor:** Allan Molho **Senior Copy Editors:** Ingrid Accardi, Suzanne Bilyeu **Copy Editor:** Troy Reynolds **Digital Imager:** Vanessa Irena **Media Editor:** Marie Morreale **Executive VP, Scholastic:** Hugh Roome **Creative Director:** Judith Christ-Lafond **Design Director:** Felix Batcup **Executive Director of Production and Operations:** Barbara Schwartz **Executive Editorial Director, Copy Desk:** Craig Moskowitz **President, Chief Exec. Officer, and Chairman of the Board of Scholastic Inc.:** Richard Robinson. **POSTAL INFORMATION:** *SCIENCE WORLD* (ISSN 1041-1410; in Canada, 2-c no. 55948) is published 12 times annually; biweekly: September, October, March; monthly: November, December, January, February, April, May; by Scholastic Inc., 2931 East McCarty St., P.O. Box 3710, Jefferson City, MO 65102-3710. Periodical postage paid at Jefferson City, MO 65102 and at additional mailing offices. POSTMASTERS: Send notice of address changes to *SCIENCE WORLD*, 2931 East McCarty St., P.O. Box 3710, Jefferson City, MO 65102-3710.

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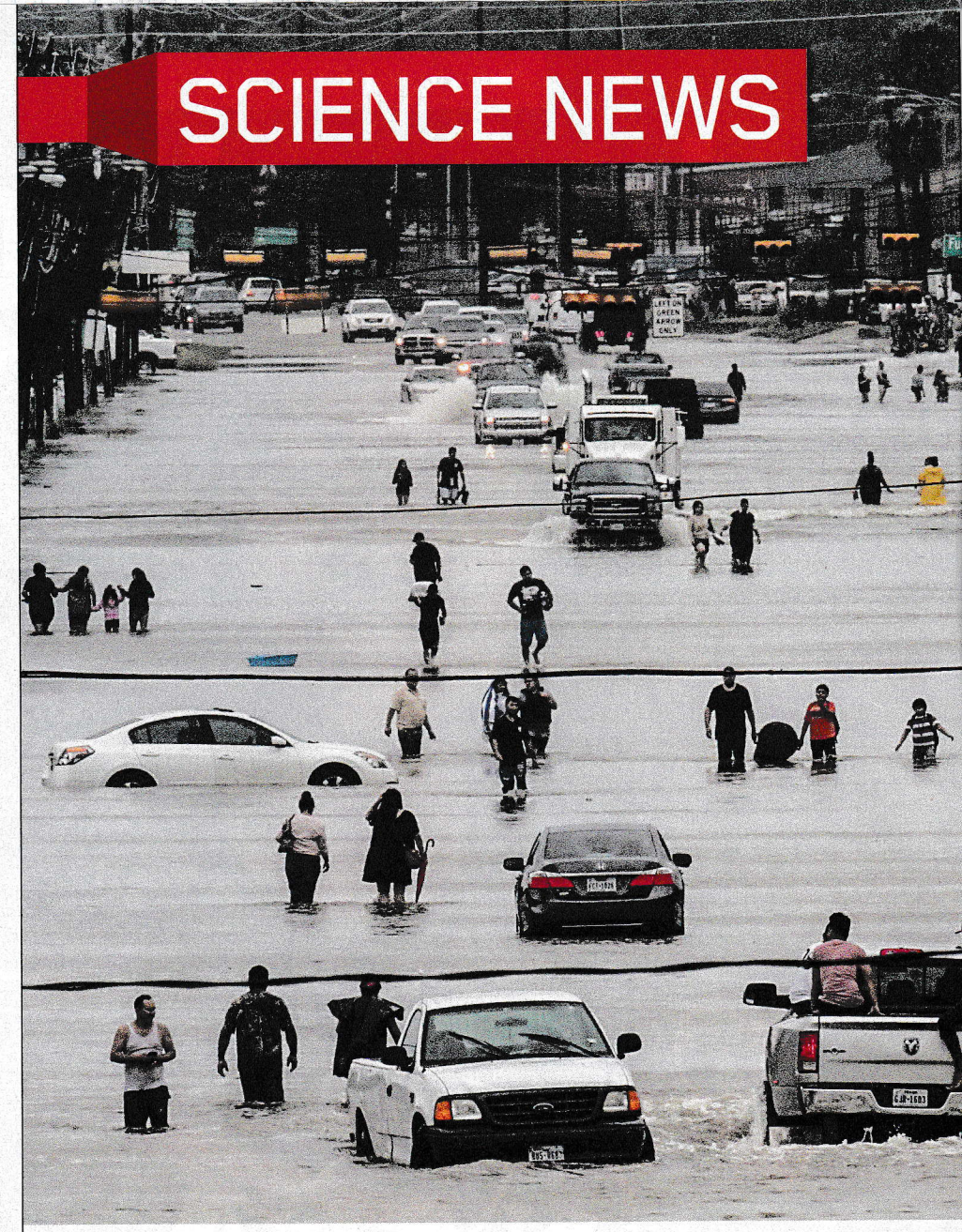
SCIENCE NEWS



HURRICANE HISTORY

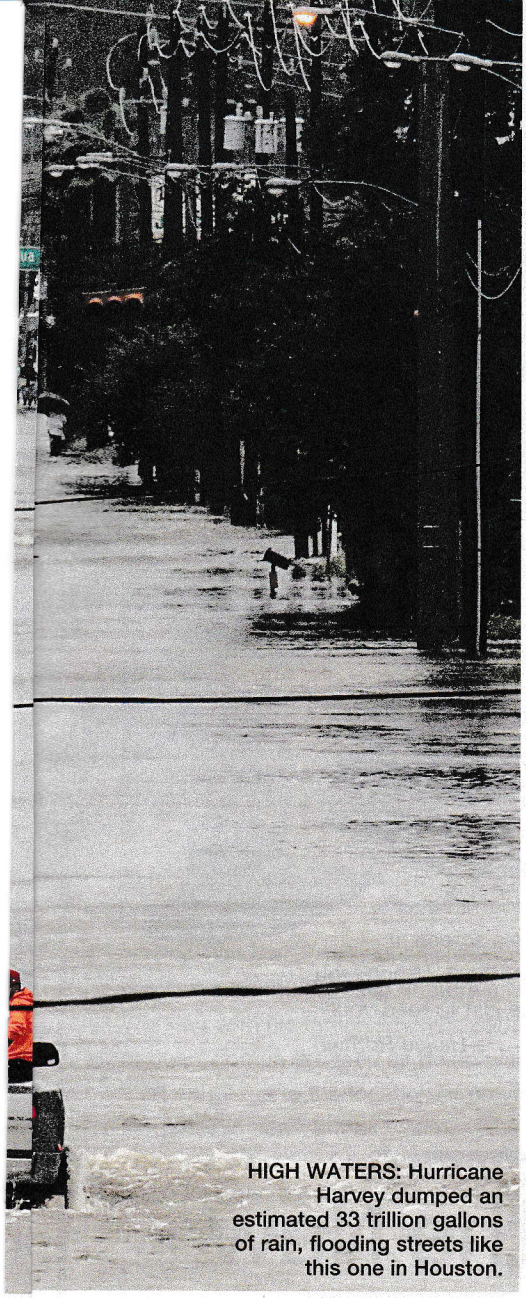
The timeline at right shows some of the most destructive storms to strike the U.S. in the past 25 years.

ANDREW (1992)

Andrew struck Florida, destroying more than 25,000 homes and killing 26 people in the U.S. As of press time, it was the last storm to strike the country as a Category 5 hurricane.

IVAN (2004)

Ivan hit Florida and Alabama with a 10- to 15-foot *storm surge*, or rising sea level due to wind and pressure changes. 25 died, and 2 million lost power. Another major storm, Charley, had struck the region earlier that year.



HIGH WATERS: Hurricane Harvey dumped an estimated 33 trillion gallons of rain, flooding streets like this one in Houston.

EARTH SCIENCE: CLIMATE & WEATHER

HURRICANE STRIKES

Late in August, Hurricane Harvey slammed into the coast of Texas, bringing with it heavy rains that caused devastating flooding. The storm was the strongest to hit the state since the 1960s. Dozens of people died, and thousands had to evacuate their homes as floodwaters rose.

AFTER HARVEY: A family rescued from floods in Spring, Texas

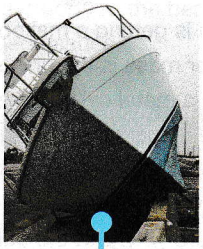
Harvey made landfall at the town of Rockport, which sustained significant damage. Houston, America's fourth most-populous city, saw record rains. While most storms keep moving and weaken once they reach land, Harvey got caught between other weather systems. It lingered in the same spot for days, dropping more rain than the area typically receives in a year. Climate change likely played a role in the heavy rainfall: Warmer air holds more water, so megastorms tend to dump more rain as global temperatures rise. Scientists predict that we'll see powerful storms more often in the future.

As this issue of *Science World* went to press, a new storm threat was emerging: Hurricane Irma was barreling toward the U.S. as a *Category 5* storm—the strongest class. Meanwhile recovery efforts in Harvey's wake will continue for months to come.

— Hailee Romain

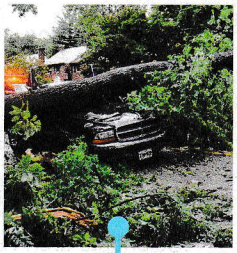
KATRINA (2005)

Katrina came ashore near the Louisiana-Mississippi border. It caused more than 1,800 deaths and $108 billion in damage. Two other intense hurricanes, Rita and Wilma, struck the South that season.



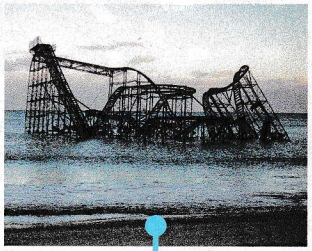
IKE (2008)

Ike battered Texas, Louisiana, and Arkansas particularly hard, killing 28 and knocking out power for nearly 3 million.



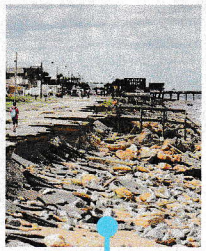
IRENE (2011)

Irene affected nearly every state along the U.S. east coast from Florida to Maine. More than 40 died due to the storm and nearly 6 million lost power.



SANDY (2012)

Sandy was the largest hurricane on record, at nearly 1,000 miles across. New York and New Jersey took especially heavy damage. Streets and subways in New York City flooded. 71 people died.



MATTHEW (2016)

Matthew struck the southeastern U.S., causing widespread flooding that devastated North Carolina. 47 people lost their lives.

FIGHTING GLARE
A texture like the surface of a moth's eye could make your phone easier to read.

ENGINEERING: DESIGN

Bug-eyed Tech

The glare from the sun can make it hard to read a cell phone's screen. Sunlight reflected off its surface can be brighter than the light emitted by the screen itself. A new material that borrows a trick from moths could make squinting at your phone a thing of the past.

Tiny structures cover moths' eyes, forming a mesh-like pattern. These nanostructures prevent light from reflecting off the insects' eyes at night, which helps keep them hidden from predators. Shin-Tson Wu, a physicist at the University of Central Florida, recently developed a thin film with a texture similar to moths' eyes. When applied to a phone's screen, it reduced reflected light by 89 percent. "Soon, you won't need to search for shade just to read your phone outside," says Wu. —*Hailee Romain*

PERFECT SPHERE
The new kilogram will be defined using the purest silicon object ever made, a reflective sphere with less than one atom in 3 billion of other elements.

CHEMISTRY: ATOMS

Meet the New Kilogram

The kilogram is getting a makeover. The metric measurement for mass is the only standard unit still based on physical object: a metal cylinder kept in France. Now scientists want to redefine the kilogram using a mathematical *constant*, a number that never changes.

The reason: Over time, the cylinder's mass has fluctuated. Scientists aren't sure why. But the subtle shift has made "all other measurements that are based on it inaccurate," says Ben Stein of the National Institute of Standards and Technology in Maryland.

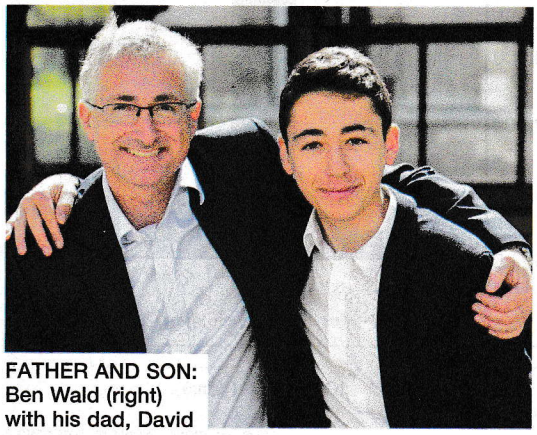
Scientists have created a sphere of the element silicon (Si) in a very pure form. It weighs the same as the original cylinder. Scientists will calculate the number of *atoms*—the smallest unit of an element—in it. They can then define a kilogram using the mass of that many silicon atoms. This "ensures people can accurately measure mass from anywhere," says Stein. —*Hailee Romain*

WHEN SECONDS COUNT: Coded wires embedded in patients' chests give surgeons critical information about their medical history.

LIFE-SAVING CODE

Ben Wald, a 16-year-old from England, has devised a method to help doctors save lives. Working with his father, who is a *cardiologist*, or heart doctor, the teen came up with a way to alert surgeons to the location of previous heart surgeries in heart attack victims.

Doctors need to know a patient's medical history so they can offer the best treatment. But in emergencies, there's often little time to discuss these details. Many people with heart problems have received a heart *bypass*. During this procedure, surgeons *graft*, or transplant, blood vessels from another part of the body to the heart to repair or go around damaged tissues.

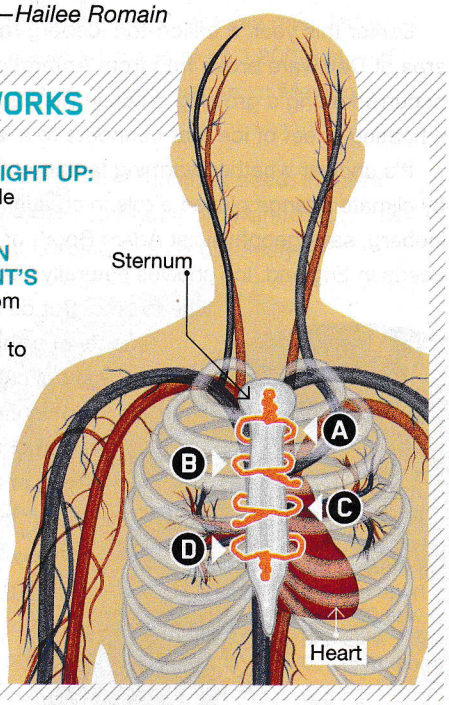


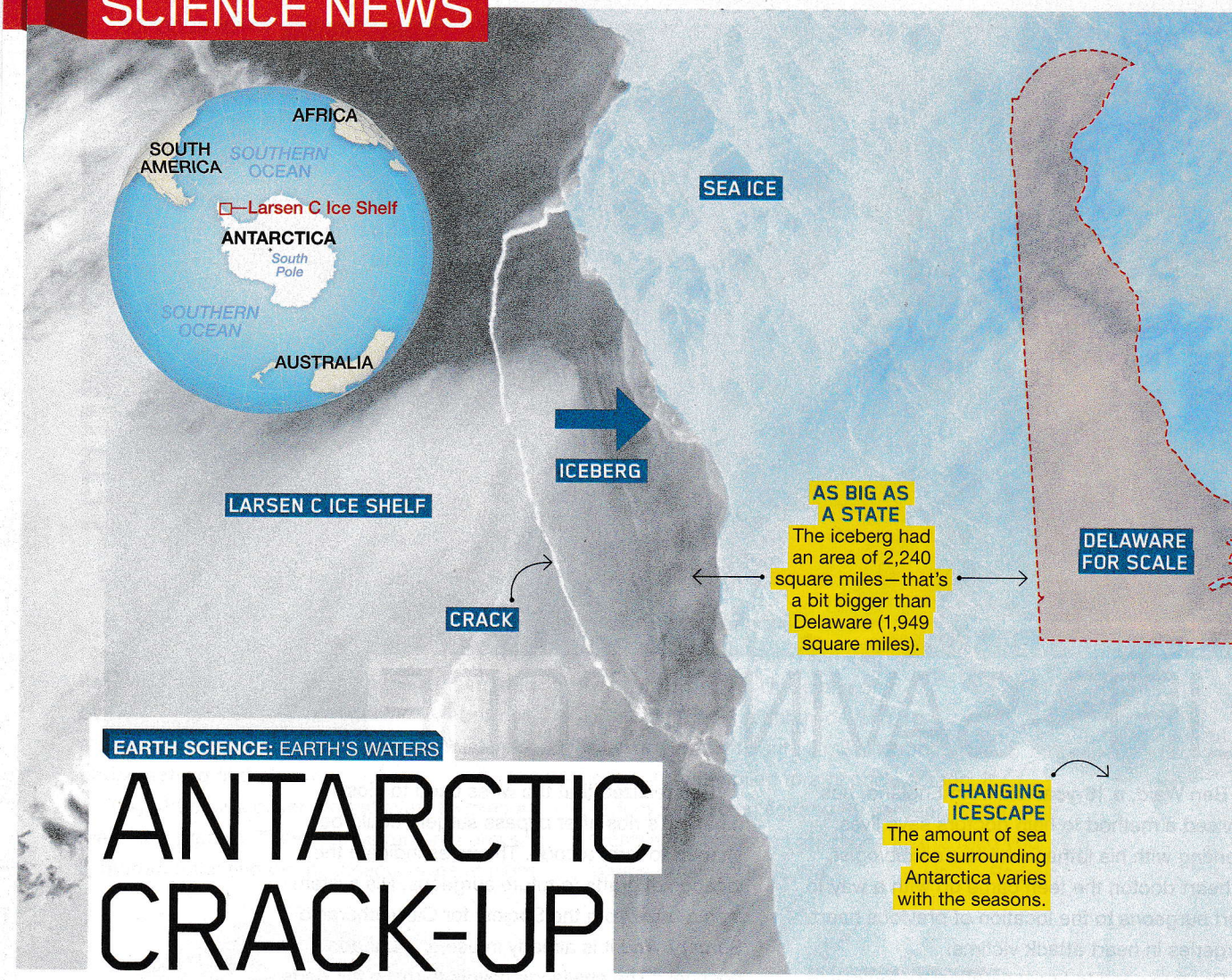
FATHER AND SON: Ben Wald (right) with his dad, David

Ben realized that the wires used to close a patient's ribs after bypass surgery could be shaped to form a code. The wires indicate the location of grafts to future surgeons. His system won a prize from the Society for Cardiothoracic Surgery. And it is already in use at a London hospital. "The challenge now is to make the code routine," says Ben. —*Hailee Romain*

HOW THE CODE WORKS

- **A WIRE POINTS STRAIGHT UP:** Indicates start of code
- **B WIRE POINTS DOWN AND TO THE PATIENT'S LEFT:** Graft starts from the *subclavian artery*, which supplies blood to the left arm
- **C WIRE POINTS DOWN AND TO THE PATIENT'S RIGHT:** Graft starts from the *aorta*, the heart's main artery
- **D WIRE POINTS STRAIGHT DOWN:** End of code





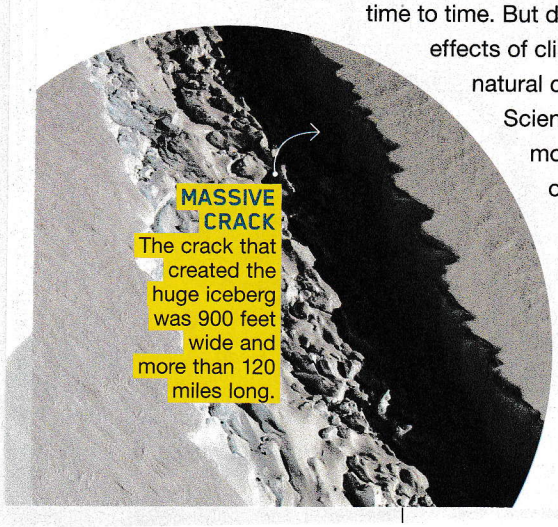
EARTH SCIENCE: EARTH'S WATERS

ANTARCTIC CRACK-UP

Earlier this year, a trillion-ton iceberg roughly the area of Delaware broke free from Antarctica. The break occurred along a growing crack in the Larsen C *ice shelf*, a floating sheet of ice that connects to a landmass.

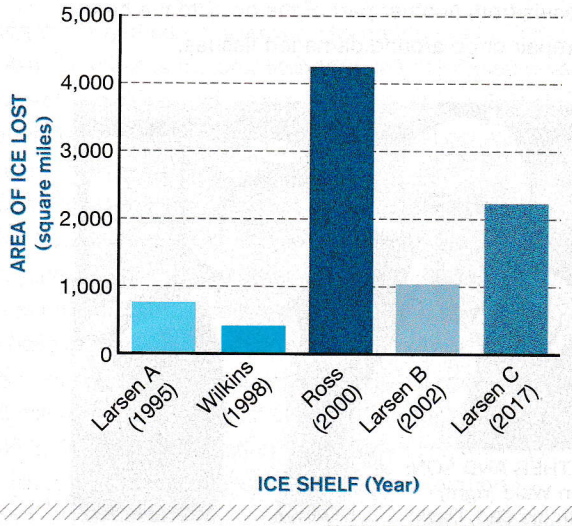
It's unclear whether warming temperatures caused by climate change played a role in creating the massive iceberg, says geophysicist Adam Booth of the University of Leeds in England. Ice shelves naturally *calve*, or split, from time to time. But distinguishing the effects of climate change from natural calving is tricky. Scientists are closely monitoring the rest of Larsen C, which could become more vulnerable to further breaks after losing so much ice.

— Cici Zhang

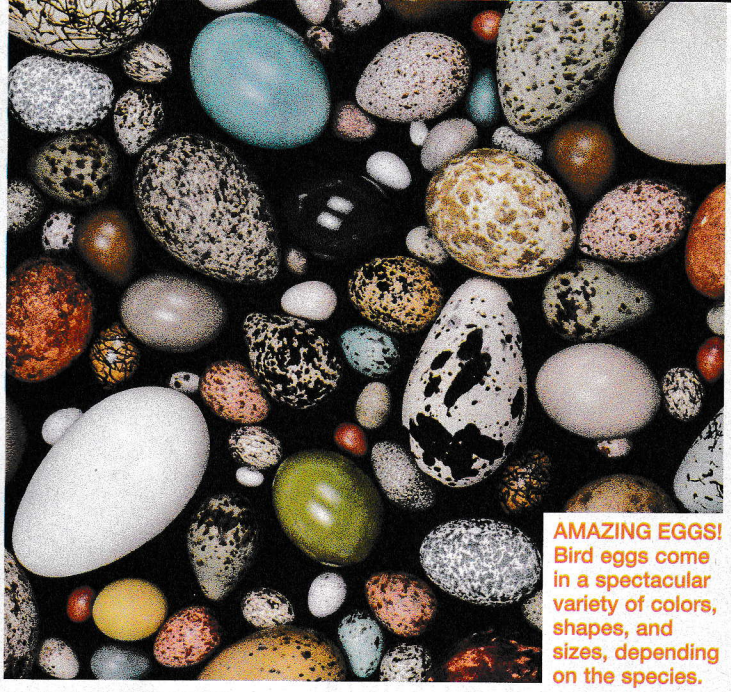


BIG BREAKS

The graph below shows several significant ice shelf breaks recorded in Antarctica. How did this year's Larsen C break compare with that of the Wilkins ice shelf?



SOURCE: NATIONAL SNOW & ICE DATA CEN



AMAZING EGGS! Bird eggs come in a spectacular variety of colors, shapes, and sizes, depending on the species.

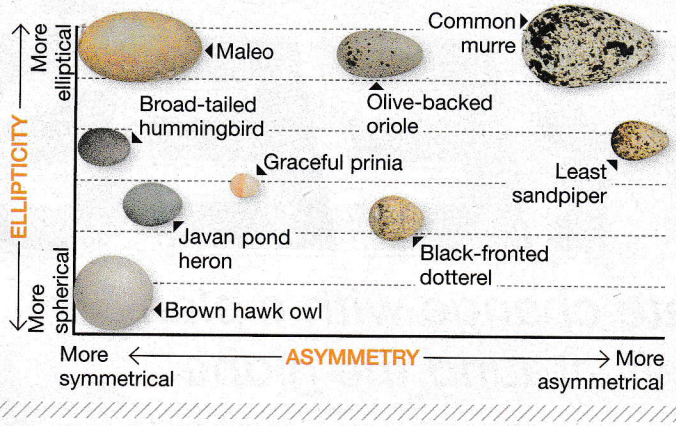
BIOLOGY: ANIMAL PHYSIOLOGY

Egg Shapes Explained

Why do bird eggs come in so many different shapes? To find out, a team of scientists analyzed nearly 50,000 eggs from 1,400 species. They looked at each egg's *symmetry* (how similar the two ends are) and *ellipticity* (how oval an object is). They discovered that the strongest fliers lay the pointiest and most elongated eggs. Compared with birds that don't fly much, like chickens and domesticated ducks, the bodies of fast or long-distance fliers are narrower and more streamlined. "That makes it difficult to lay a round egg," says Mary Stoppard, a biologist at Princeton University in New Jersey who led the study. —*Spenser Mestel*

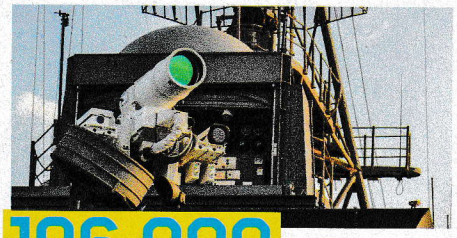
ALL KINDS OF EGGS

The graph below compares various egg shapes. How does the ellipticity of a common murre egg compare with that of a brown hawk owl? What can you infer about the flying abilities of the two birds?

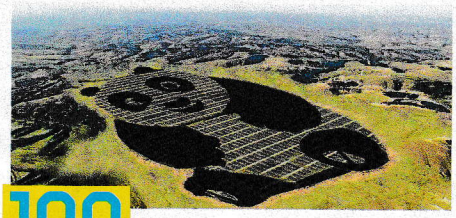


SOURCE: STODDARD ET AL./*SCIENCE*, 2017

NUMBERS IN THE NEWS



186,000 The speed of light in miles per second—and the speed at which light will travel from the world's first laser weapon system, designed for the U.S. Navy to target drones.



100 Power output in megawatts of a new panda-shaped solar power plant in China—enough to power tens of thousands of homes.

30 Length in feet of a secret tunnel recently revealed by electrical scans of an 1,800-year-old temple in Teotihuacan, in Mexico.

12 Top running speed, in miles per hour, of *Tyrannosaurus rex*, according to a recent analysis.

3 Number of Yangtze giant softshell turtles, native to China, known to be remaining on Earth. Scientists are looking for a fourth, which people claim to have seen in the wild.

POWER PLANTER
Felix Finkbein

CHAMPION FOR TREES

A teen battles climate change with a plan to plant a trillion trees around the globe

ESSENTIAL QUESTION: What actions can individuals take to help protect the environment?

When Felix Finkbeiner was in fourth grade, his teacher assigned a simple class project: Research climate change and give a presentation. The 9-year-old student from Germany focused on trees' role in protecting the planet. He concluded his presentation by challenging classmates to plant 1 million trees in their country.

Felix led the charge by planting a crab apple tree at his school in 2007. Other schools joined in to see which could plant the most trees. They set up a website to track their tree tally. German newspapers covered their progress. By 2008, Felix's idea had blossomed into a global movement, called Plant for the Planet.

Plant for the Planet organizes kids to plant trees in countries all over the world—a small step that could help in a big way. "Anyone anywhere can plant a tree," says Felix. "It's a beautifully simple and positive action."

So far, volunteers with the group have planted 14.2 billion trees worldwide. Now 19, Felix has set a mind-boggling new goal: Plant 1 trillion trees—about 150 for every person on the planet—to fight climate change.

SPEAKING OUT: Felix, 13, addresses the United Nations in 2011.

PLANET IN PERIL

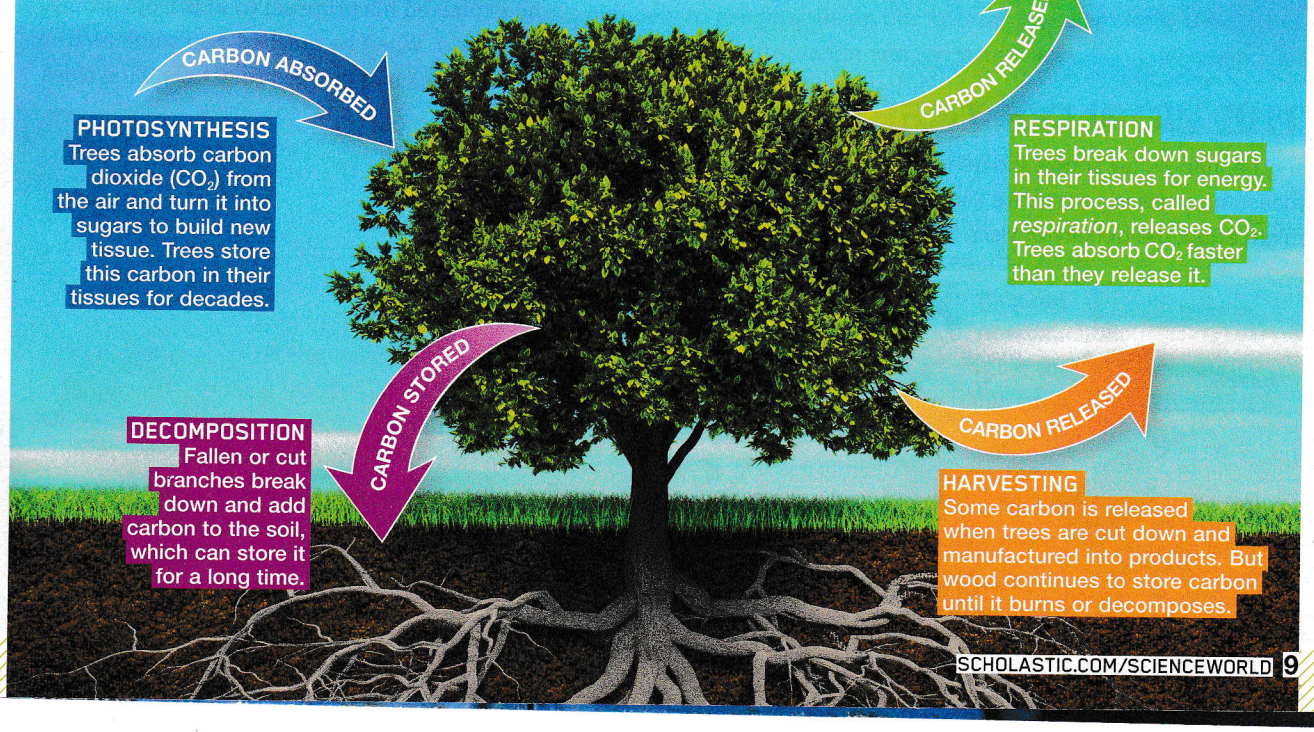
For the past hundred years, Earth's average temperature has been steadily increasing. Scientists have found that human actions are driving the planet's climate to change. Burning fossil fuels—such as coal, oil, and gas—for energy releases *greenhouse gases*, like carbon dioxide. These gases build up in Earth's atmosphere and form an invisible blanket around the planet, trapping heat from the sun.

Earth's rising temperatures can lead to heat waves and droughts. It can also cause ice caps and glaciers to melt. Meltwater flows into the

Continued on the next page →

SOAKING UP CARBON

Trees can store carbon for long periods, helping to keep it out of the atmosphere. Here's how carbon moves through forests.



TOBIAS HASE/PICTURE-ALLIANCE/DPA/AP IMAGES (LEFT); JOHN MCILWAINE/UN PHOTO (UNITED NATIONS); SHUTTERSTOCK.COM (DIAGRAM)

1


2

ocean, raising sea levels and increasing coastal flooding. To slow climate change, people must reduce production of greenhouse gases or find a way to remove them from the atmosphere. That's where trees come in.

LEAFY GUARDIANS

While researching climate change for his fourth-grade assignment, Felix came across the work of Kenyan environmentalist Wangari Maathai. She led a successful campaign to plant 30 million trees in parts of Africa that had been stripped of their forests.

Felix also learned that trees absorb carbon dioxide from the air and store it in their tissues (*see Soaking Up Carbon, p. 9*). Trees use sunlight to convert carbon dioxide and water into sugar and oxygen. Through this process, called *photosynthesis*, they make their own food.

Forests all over the world have been shrinking rapidly as people cut down trees for lumber or to make room for buildings or farmland. Inspired by Maathai, Felix decided to rally kids to restore their countries' forests and help protect the planet.

GOING GLOBAL

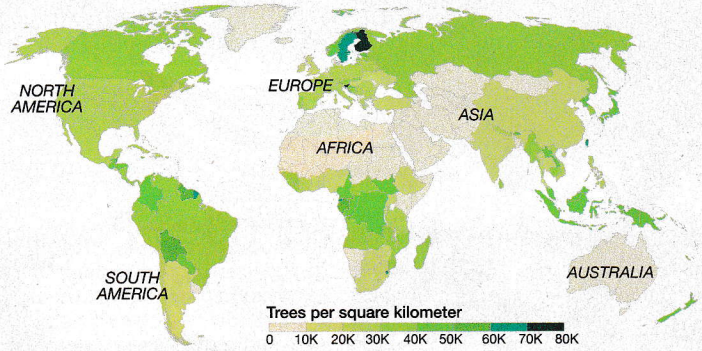
In 2008, Felix was elected to the junior board of the United Nations (U.N.) Environment Programme. At a conference in South Korea, he explained his proposal to kids from around the world. When he finished, 500 students from 58 countries had pledged to get a million trees planted in their home countries.

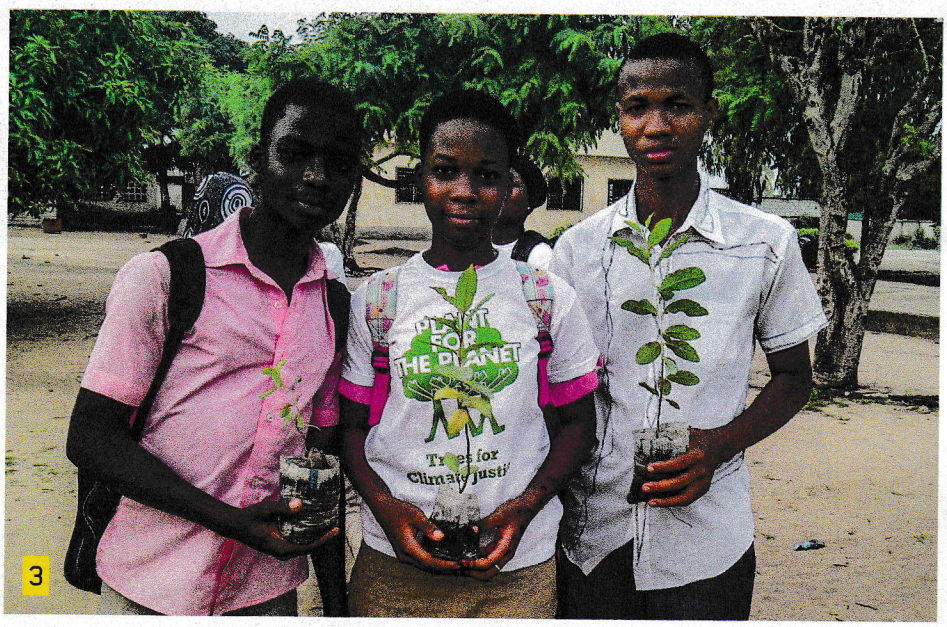
In 2010, Germany became the first nation to reach the 1-million-tree mark. The following year, Felix addressed the U.N. in New York City. He explained that many adults don't take climate change seriously enough because its worst consequences won't happen in their lifetimes. "For us children, it's a question of survival," he told global leaders. "We cannot trust that adults alone will save our future. We have to take our future in our own hands."

Felix's speech impressed U.N. leaders so much that they put Plant for the Planet in charge of the U.N.'s own tree-planting campaign, which had a goal of 1 billion trees.

THE WORLD'S TREES

The map below shows the density of trees in each country, measured in trees per square kilometer. What are some factors that might affect the density of trees in a particular country?





HOW MANY TREES?

The new goal was a big one. But would a billion trees be enough to make a difference in slowing climate change? To find out, Felix's organization needed to know how the number of trees on Earth changes over time.

Ecologist Tom Crowther, who was then based at Yale University in Connecticut, and a group of colleagues decided to help Plant for the Planet get some answers. "We thought this would be a quick project," says Crowther. "But then we looked and realized that nobody had addressed these questions reliably."

Crowther's team gathered data from studies in which people on the ground had counted trees one by one on more than 400,000 plots of land around the world, covering a total area of 4,300 square kilometers (1,660 square miles). They paired that data with satellite images to get detailed global estimates of tree density (*see The World's Trees, p. 10*). They determined that the planet has 3 trillion trees, and the number is dropping by 10 billion per year. At that rate, the world's forests will disappear in 300 years.

Crowther dreaded delivering the news to Plant for the Planet. "I thought it was going to be horrible, saying, 'I hate to tell you, but a billion trees isn't going to do anything,'" he says. It turns out he shouldn't have worried. "They said, 'Fantastic, finally we have reliable numbers to use to scale up our efforts.' The way they took the information and ran with it was inspirational," says Crowther.

Felix and his collaborators decided that slowing climate change would require not 1 billion new trees but 1 trillion. That number might soak up roughly a quarter of all the carbon dioxide emitted each year. Crowther is now working on precise measurements of how much carbon trees can store so that the project can make sure their latest goal is on target.

"Trees alone can't solve the climate crisis," says Felix, "but they can buy us more time. The more we make use of their abilities, the better off we'll be." —*Jennifer Barone*

INSPIRATION: Kenyan environmentalist Wangari Maathai led a campaign to plant 30 million trees.

GLOBAL REACH

1 Plant for the Planet's "Stop Talking, Start Planting" campaign encourages climate action.

2 The organization hosts workshops that train students to be climate justice ambassadors.

3 Students attend a workshop in Togo, a country in West Africa.

CORE QUESTION

How did Felix and his collaborators evaluate whether their project would be effective?

A WINNING BALL

A teen uses her love of soccer to create a tool to help people recover from injuries

ESSENTIAL QUESTION: Where do you think inventors get the inspiration for their ideas?

Amelia Day has been playing soccer since she was 4 years old. So when a teacher assigned a project asking students to develop a solution to a real-world problem, Amelia immediately knew what to focus on. She wanted to use her love of soccer to help others. The 15-year-old from Washington state came up with the idea for a soccer training tool, called the Press-Sure Soccer Ball.

Like many soccer players, Amelia often struggled with accurately kicking the ball. "When you kick a ball incorrectly hundreds of times, you never really improve," she says. Her solution was to create a high-tech ball that lets people know when they've properly landed a kick.

SOCCER SCIENCE: Amelia shows off her Press-Sure Soccer Ball.

Amelia soon realized that her invention could aid more than just aspiring athletes. It could also help people undergoing *physical therapy* to restore balance and muscle control after an injury. Amelia's idea landed her a place as a finalist at the 2016 Discovery Education 3M Young Scientist Challenge.

PRACTICE SHOT

Amelia created her device by attaching a soccer ball to a pole via a springy rubber tether (*see Finding the Sweet Spot, right*). The outside of the ball is marked with a square green target.

If you kick the target with enough force, you activate a pressure sensor inside the ball. That sensor sends an electrical signal through wires in the tether. A small computer detects the signal and triggers a beeping sound. The beep lets you know that your kick was a success.

HELPING PEOPLE HEAL

Amelia believes the real benefit of her invention could be as a therapy tool for people with physical disabilities, like those caused by a *stroke*. A stroke occurs when blood flow to the brain is cut off, damaging nerve pathways like those that control movement. The act of kicking the Press-Sure Soccer Ball could help rebuild those connections. The physical and sensory stimulation provided by kicking the ball and hearing the beeps can help rewire the brain and build new nerve pathways. Plus, says Amelia, it's more fun than typical physical therapy. —*Jennifer Marino Walters*

CORE QUESTION

How could you turn a hobby or pastime you love into an invention to help others?

FINDING THE SWEET SPOT

Here's how Amelia designed her Press-Sure Soccer Ball to ensure that a person lands a proper kick.

1 TARGET
If the target is kicked with enough force, a pressure sensor inside the ball is activated.

2 PRESSURE SENSOR
The sensor detects a change in the force exerted against the ball. It sends an electrical signal through wires in the ball's tether to a small computer.

3 TETHER
A springy rubber cord connects the ball and its wires to the pole so the ball doesn't go too far when kicked.

4 COMPUTER
A tiny programmable computer called the Raspberry Pi picks up the electrical signal from the pressure sensor and triggers a beeping sound.

5 BLUETOOTH
Bluetooth technology uses radio waves to send beeping sounds from the Raspberry Pi to earbuds worn by the kicker. The beeps signal a successful kick.

DREW PERINE/THE NEWS TRIBUNE (DAVI); SHUTTERSTOCK

SHOOTING FOR THE STARS

Fourteen-year-old Taylor Richardson dreams of becoming one of the first people to set foot on Mars

ESSENTIAL QUESTION: Why are the fields of science, technology, engineering, and math important in the modern world?

Taylor Richardson may be only in eighth grade, but she already has a long-term mission: She wants to be one of the first people to visit Mars.

NASA plans to send astronauts to the Red Planet sometime in the 2030s. That means it could be the kids of today who will be making the historic trip in the future.

Getting space explorers safely to Mars will be no easy feat. Becoming an astronaut takes years of education and training (*see The Right Stuff?, right*). But that hasn't deterred Taylor. The 14-year-old, who lives in Jacksonville, Florida, has had her sights set on space since she was 5.

"I read the autobiography by my idol Mae Jemison—the first African-American woman in space," says Taylor. "She looked just like me! I felt so inspired by what she had achieved." Jemison wrote about how studying science, technology, engineering, and math helped her overcome many of the odds she faced. Together, these fields are known as STEM.

Taylor saw herself in Jemison's story and has been following in her hero's footsteps ever since. She, too, has discovered a passion for all things STEM. Taylor is active in her community, sharing her love of space and science with others—particularly young women of color like herself. She hopes to motivate them to also shoot for the stars.

EMPOWERED BY STEM

Taylor may be young, but she's already faced her own share of obstacles. She has been diagnosed with *attention deficit hyperactivity disorder* (ADHD). The condition sometimes makes it difficult for her to concentrate. But she refuses to let that hold her back. She decided ADHD would instead stand for "Abundantly Different and Happily Divine." Taylor also had a tough time with bullying when she was little. "Older kids at school teased me for liking science—they called me a nerd and a geek, and I was discriminated against for being African-American," she says.

The more Taylor explored STEM, though, the more confident she became. When she was 9, she decided to attend Space Camp at the U.S. Space & Rocket Center in Huntsville, Alabama. There, kids train like real astronauts using *simulators*—training machines that imitate conditions in space. One, for example, gives the sensation of moving around in low gravity—like that found on the moon. Camp attendees also participate in missions aboard mock spacecraft, including one that resembles the International Space Station (ISS).

"All of these exercises teach students that astronauts can't be successful without working as a team," says Pat Ammons, a Space Camp spokesperson.

The program also focuses on future missions to Mars (*see Living on Mars, p.16*). One of Taylor's camp projects was to design a model of a Martian colony based on what astronauts might need while living on the Red Planet. It could take astronauts up to nine months to reach Mars. They'll need enough food, water, and air to survive the trip. Once astronauts land, they'll need to survive the planet's inhospitable environment. Mars has little water and no breathable air.

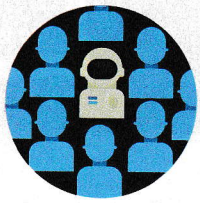
GIVING BACK

Taylor loved Space Camp, but it bothered her that she was the only African-American girl in her class. She wanted to help other girls of color discover a love of STEM. When she returned home, she held a book drive to collect STEM-themed

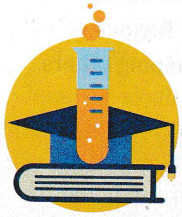
Continued on the next page →

THE RIGHT STUFF?

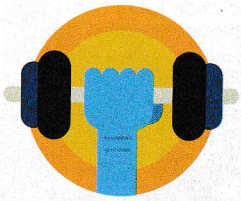
Brandi Dean, a spokesperson for NASA's Johnson Space Center, told us what it takes to become an astronaut.



About 18,000 people applied for the most recent astronaut class, and 12 were chosen in June 2017. The previous group was selected in 2013.



Any U.S. citizen with a bachelor's degree in a STEM field and three years of experience in a STEM career can apply.



Astronauts must be physically fit. A spacesuit weighs 300 pounds on Earth. It's heavy and hard to move around in—even in the low gravity of space.

Two years of general training are followed by another two years of training for a specific mission.

Taylor meets astronaut Scott Kelly, who lived aboard the ISS for a year.

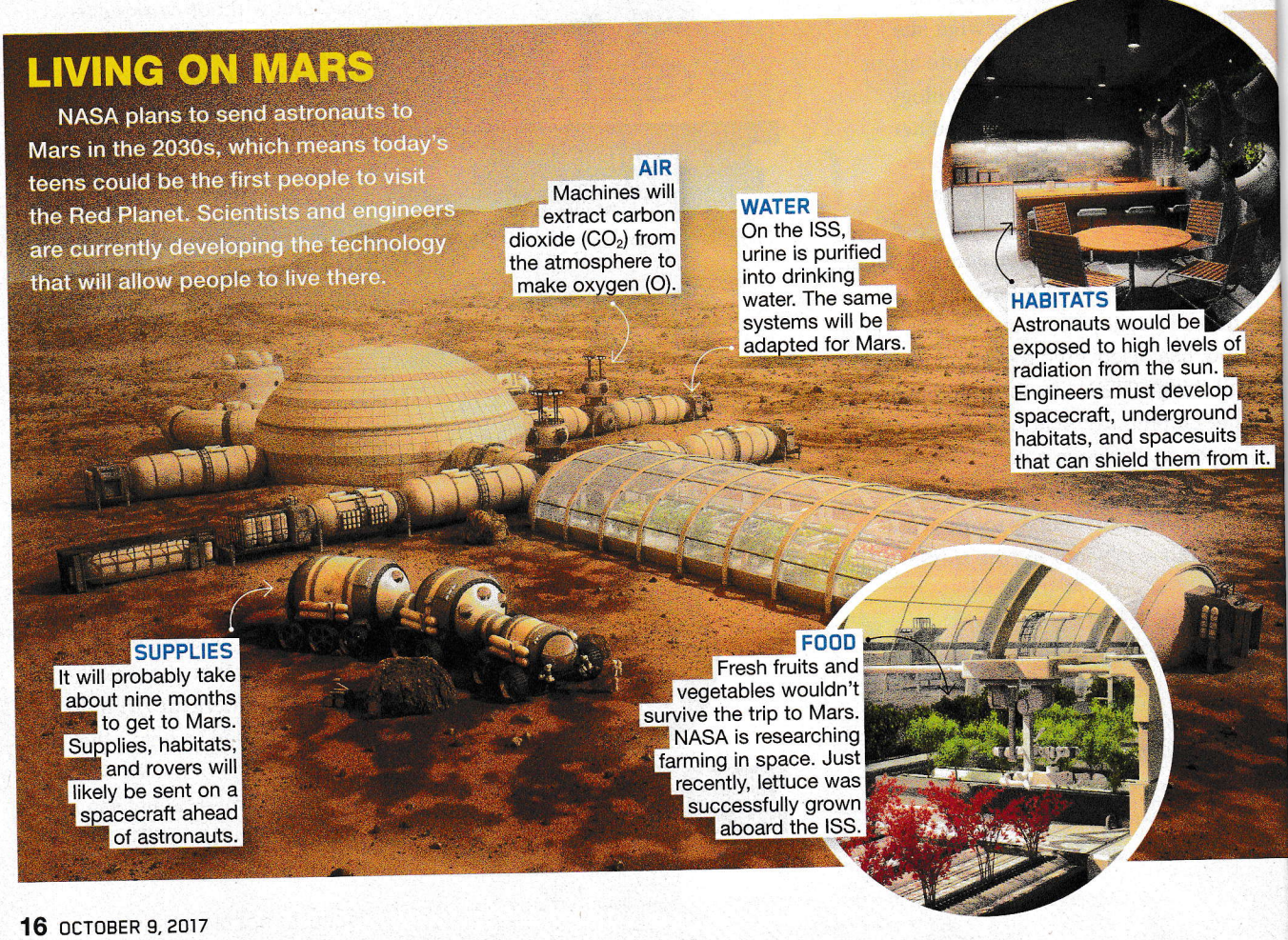
Attending the *Hidden Figures* screening at the White House

books for schools with students from low-income families. The idea grew into a program called "Take Flight with a Book," which has already distributed more than 5,000 books.

People began to take notice of Taylor's enthusiasm and commitment to helping others. In 2016, she received an invitation from the White House to attend the United State of Women Summit. The event celebrated the achievements of women and girls. Later that year, she was invited back to the White House for an early screening of the movie *Hidden*

LIVING ON MARS

NASA plans to send astronauts to Mars in the 2030s, which means today's teens could be the first people to visit the Red Planet. Scientists and engineers are currently developing the technology that will allow people to live there.



AIR Machines will extract carbon dioxide (CO_2) from the atmosphere to make oxygen (O).

WATER On the ISS, urine is purified into drinking water. The same systems will be adapted for Mars.

HABITATS Astronauts would be exposed to high levels of radiation from the sun. Engineers must develop spacecraft, underground habitats, and spacesuits that can shield them from it.

SUPPLIES It will probably take about nine months to get to Mars. Supplies, habitats, and rovers will likely be sent on a spacecraft ahead of astronauts.

FOOD Fresh fruits and vegetables wouldn't survive the trip to Mars. NASA is researching farming in space. Just recently, lettuce was successfully grown aboard the ISS.

Taking part in a simulated mission at Space Camp

Meeting her idol, astronaut Mae Jemison

Figures. It tells the story of a group of female African-American mathematicians whose calculations helped send the first U.S. astronauts to space. (*Read more about* Hidden Figures *in the 1/16/17 issue of Science World.*)

Inspired by the movie, Taylor started an online campaign (through the website GoFundMe.com) that sent more than 1,000 girls in the local Jacksonville area to see the movie. Her efforts went viral and sparked similar campaigns in more than 72 cities around the country, raising more than $120,000! With money left over from her campaign, Taylor set up a scholarship to send another girl from a low-income family to Space Camp this past summer.

A FUTURE IN SPACE?

Taylor plans to continue her charitable efforts while learning everything she can about space. In college, she wants to major in a STEM field, like physics or engineering—a requirement to apply for NASA's astronaut program. And since it's important for astronauts to be physically fit, Taylor competes on her school's track team. She's also currently studying Mandarin Chinese and Spanish. Learning different languages is an important skill for astronauts too. That's because they need to communicate with astronauts from all over the world while working aboard the ISS.

Even with all her studying and experiences, Taylor says it will be a long shot for her to make it to space. Only 107 people have ever visited the ISS, and just 12 have gone as far as the moon. But Taylor's astronaut idols continue to inspire her to achieve her goals—no matter how lofty.

Last May, Taylor's mom heard that Mae Jemison would be speaking at Clark Atlanta University in Georgia. She contacted Jemison and set up a surprise meeting so Taylor could finally come face-to-face with her hero. "When I met her, she told me to always dream big, follow my dreams, and bring more women to the STEM table," says Taylor. ⚛

—Andrew Klein

CORE QUESTION

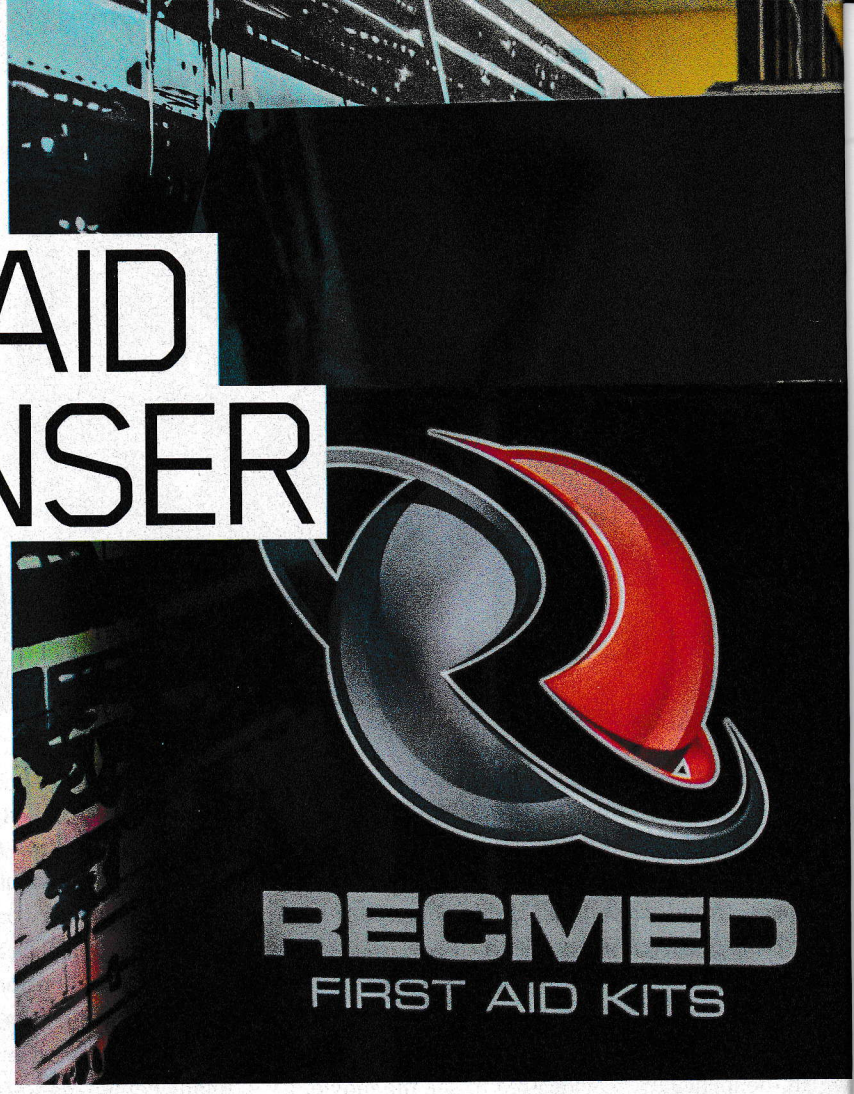
What goals do you have? How might you start preparing now for your career in adulthood?

MARS . . . HERE WE COME

Taylor isn't the only student dreaming of going to Mars. Each year, there are hundreds of kids who take part in Space Camp and hope to someday travel to the Red Planet. A new documentary on Netflix called *The Mars Generation* follows some of these kids. The film delves into the challenges astronauts of the future will face to travel to Mars and what it might be like to live there.

COURTESY OF TONI RICHARDSON (SIMULATED MISSION, TAYLOR & JEMISON); COURTESY OF SPACE CAMP® (SPACE CAMP)

FIRST-AID DISPENSER



Teen inventor Taylor Rosenthal created a vending machine that makes it easy to treat minor injuries on the go

Picture this: You and your friends are playing basketball at the park. As you take a jump shot, you collide with another player and land hard, scraping your knee. You realize you don't have any first-aid supplies on hand. What do you do?

That type of scenario bothered Taylor Rosenthal, a 16-year-old from Alabama. He wanted to make first-aid supplies readily available in locations where people might get hurt. Taylor came up with an invention: a vending machine that dispenses first-aid kits, called RecMed. Each machine has bandages, antibiotic ointments, and antiseptic wipes—everything you'd need to treat a minor injury.

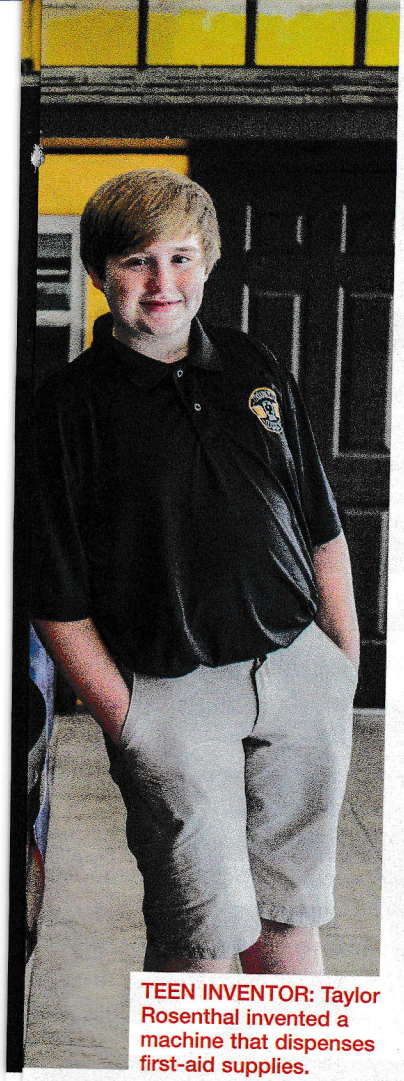
Taylor worked on the concept for 10 months. He then filed a *patent* for RecMed and was granted the exclusive rights to his invention (*see Patenting an Invention, page 19*). Taylor worked with local investors to fund RecMed's development and now has his own company. *Science World* spoke with Taylor to find out just what it takes to become an entrepreneur.

How did you come up with the idea for RecMed?

My original idea was a pop-up shop at sporting events that would sell customized first-aid kits for minor medical problems, like nosebleeds, sunburns, or scraped knees. I quickly realized that paying a person to staff the shop wouldn't be cost effective, so I changed my focus to a vending machine concept.

How did you develop your idea into a working design?

I partnered with a mechanical engineer to develop a *prototype*, or preliminary model. I told the engineer exactly what I wanted the machine to be able to do and how I wanted it to look. Together, we figured out what moving parts and computer software the machine would need. I hope to begin testing a working model by January of 2018.



TEEN INVENTOR: Taylor Rosenthal invented a machine that dispenses first-aid supplies.

PATENTING AN INVENTION

Science World spoke with the U.S. Patent and Trademark Office (USPTO) to find out the steps needed to patent an invention.

1. Identify a problem that you want to solve. Invent something completely new or improve a product that already exists.
2. You can't patent an idea. You must prove that your invention will work to solve a problem.
3. Make a prototype to prove that your invention works and that it can be reproduced. Identify any problems with the prototype and improve them during this step.
4. Apply for a patent with the USPTO. A patent prevents others from making or selling your invention.

What are your plans for RecMed?

We want to place machines at athletic fields and indoor sports complexes, but also in high-traffic areas, like airports and theme parks, where people may get injured and need fast, easy access to first aid. Customers can buy kits for specific injuries or choose to customize their own kits by selecting different supplies.

Right now, there are several prototypes of the machine. We also recently filed a patent on a new multipurpose design that can dispense differently sized items. It can sell everything from office supplies to snacks, not just first-aid kits.

Are you working on any other inventions?

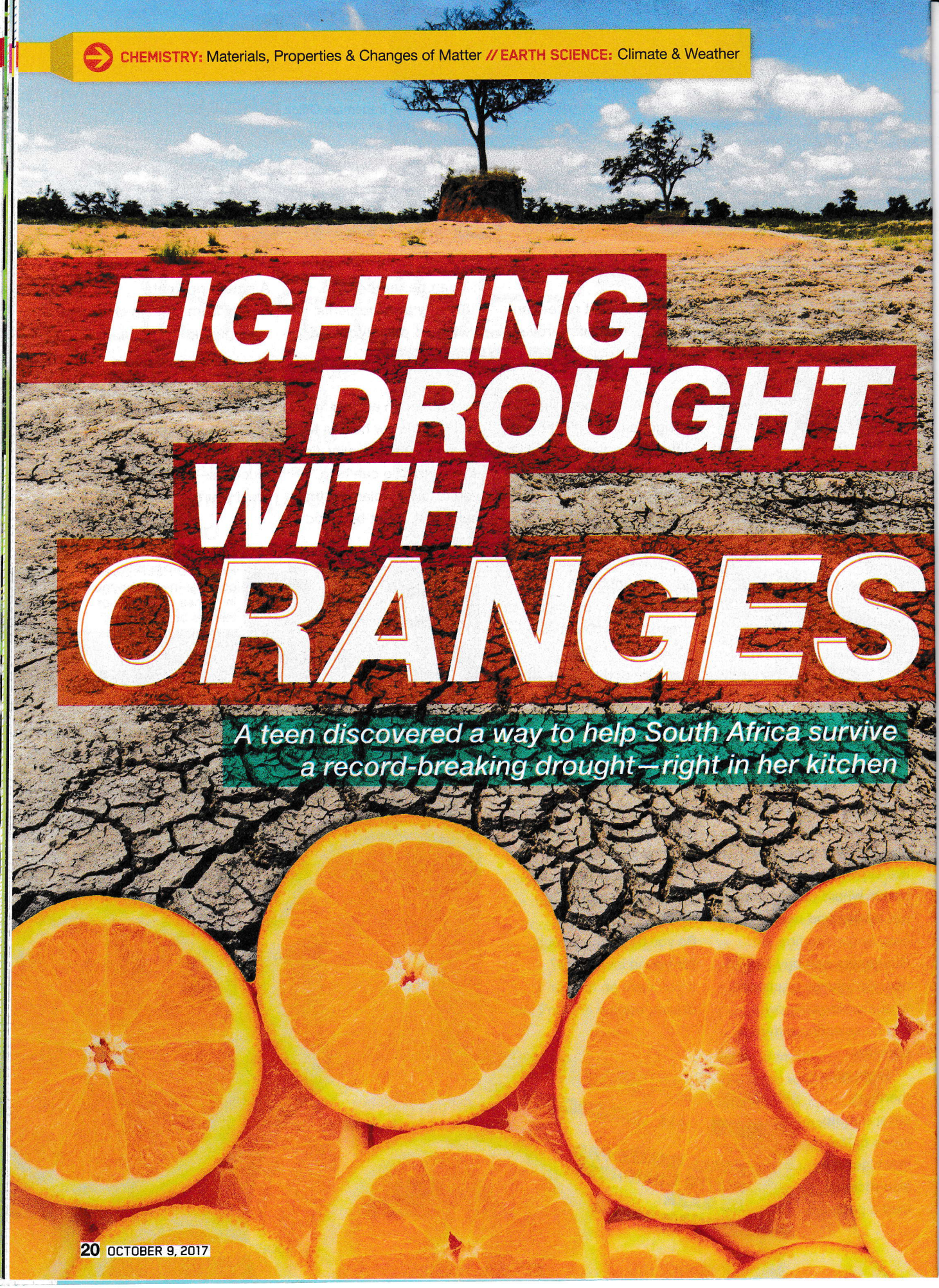
Yes, I'm also working on a medication dispenser, called RX Pill Machine, that a person can use at home. It's programmed to notify a person that it's time to take medication and to distribute the proper dosage. It can also send reminders to family members or caregivers. I have a working prototype built and have begun the patent process.

Do you have any advice for young inventors?

If you have an idea or a dream, pursue it. Don't just take no for an answer. If you don't know how to turn your idea into a reality, find someone who can help you take your plans to the next level. Don't be afraid that you're too young or that your idea might not be good enough to be a success—you'll never know until you try!

—Jeanette Ferrara

HERE TO HELP: RecMed could someday be found in places where minor injuries are common.



FIGHTING DROUGHT WITH ORANGES

A teen discovered a way to help South Africa survive a record-breaking drought—right in her kitchen

ESSENTIAL QUESTION: What problems affect the people in your community? How would you go about finding solutions to these issues?

A few years ago, South Africa began experiencing its worst drought in 30 years. The lack of frequent rainfall devastated crop production. And as the food supply withered, most people began to lose hope. Luckily, 17-year-old Kiara Nirghin isn't like most people.

Instead of being disheartened by the problem, the South African teen turned her attention to finding a solution. Kiara began studying the causes and effects of drought to see how she could help. "If you don't understand the problem fully, you won't understand whether or not your solution is effective," she says.

While researching, Kiara came across a class of super-absorbent materials. They are used in products like diapers to soak up liquid. The teen wondered if these substances could help soil retain the moisture from the little rain that fell. Then crops would have access to water even in dry conditions. Since most of these substances aren't good for the environment, Kiara developed her own nontoxic version made from a simple ingredient—orange peel.

DRYING UP

South Africa is located at the southern tip of Africa. Weather across the area is typically hot and dry. But there is usually enough annual rainfall to grow corn, wheat, and other crops. The recent drought, however, has caused a decline in the production of these important foods (*see Widespread Drought, right*). In 2015, for example, corn production dropped by almost 30 percent compared with the previous year. Wheat production was down nearly 20 percent.

Kiara watched this trend and worried for her community. When crops fail, food becomes more expensive. In South Africa, 20 percent of the population already lives in extreme poverty. *Famine*—the widespread scarcity of food—can quickly lead to starvation.

Kiara started thinking of a scientific way to tackle the issue. "There's not much science can do to improve rainfall," she says. "So I started looking at the research and found that even drought-stricken areas receive some rain—it just doesn't fall regularly." She wondered if there was a way to capture those precious drops of water and store them in the soil. That way, the water could be released slowly over time to nourish crops even during the driest times.

SCIENCE PRO: Kiara explains the science behind her invention.

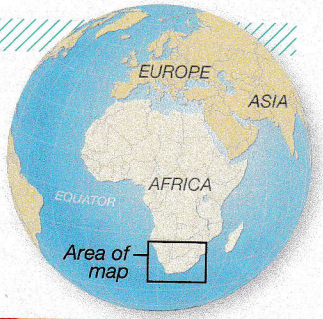
WATER SAVER

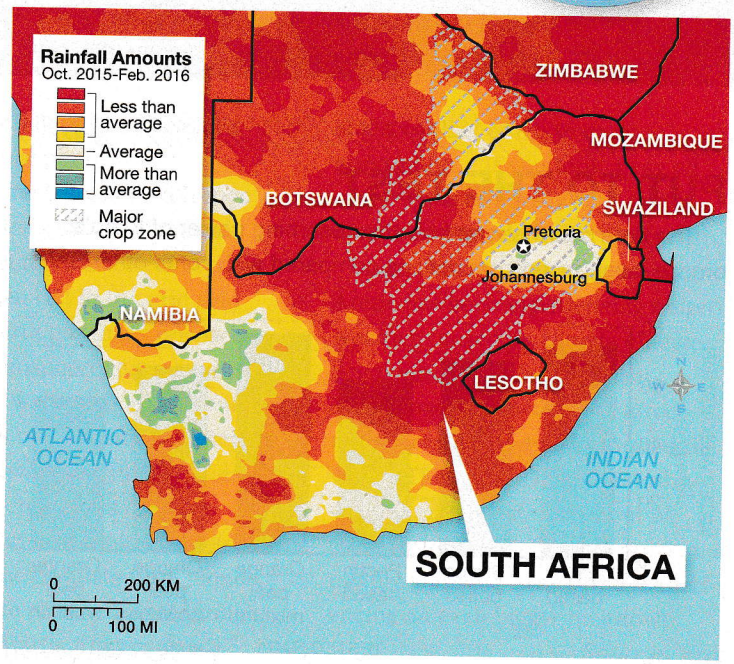
Kiara's curiosity led her to research *super-absorbent polymers*. The powder form of these

Continued on the next page →

WIDESPREAD DROUGHT

This map shows which areas in southern Africa were hardest hit by a recent drought. Where might Kiara's invention have been of most use?





GRAND-PRIZE WINNER: Kiara (*left*) and Shree Bose, a previous Google Science Fair winner, after the 2016 award ceremony.

chemicals can absorb hundreds of times their own weight in liquid. They do so by forming chemical bonds with water molecules.

A super-absorbent polymer, or SAP, spread in soil could theoretically absorb and hold rainwater for plants to use during periods of drought. Unfortunately, most SAPs are expensive and made with chemicals that are toxic to plants and animals. Kiara needed something that was cheap and safe to use. "It turns out you can find these kinds of molecules in a lot of natural sources," she says. "The most abundant option was something that I found in orange peel."

Orange peels contain *pectin*, a gelling agent often used to make jam. The peels also contain *polysaccharides*, a type of sugar molecule found in many SAPs. Kiara hypothesized that she could use these substances as the basis for a cheap and effective SAP. And it would also be *biodegradable*, or able to naturally break down without harming the environment.

CORE QUESTION

Why do you think Kiara chose the experiments she did to test the effectiveness of her orange-peel mixtures against drought?

KITCHEN LABORATORY

Kiara made three orange-peel-based mixtures and tested their absorbing power against that of three common SAPs. She performed three experiments. The first tested water absorption. The second examined the ability of the substances to maintain soil moisture over a three-week period. And the last looked at how well the materials helped an actual plant survive in drought conditions.

A homemade mixture of orange peel, avocado skin, and lemon juice came out on top. It beat Kiara's other mixtures, as well as commonly used commercial SAPs (*see Put to the Test, bottom left*).

"It's a very impressive result," says Vincent Remcho, a materials science professor at Oregon State University. He previously worked with a company developing its own biodegradable SAP for agricultural use. That company used *lignin*, a molecule found in the supporting tissues of plants. It is also a by-product left over from making paper and wood pulp.

"Her choice of the orange peel was spot-on," says Remcho. "So many industries have by-products that they'd love to use for something else. She really thought this through."

TAKING HOME THE PRIZE

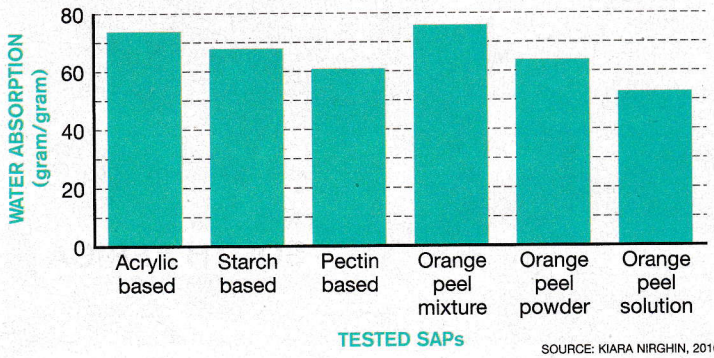
Remcho isn't the only one impressed with Kiara's results. Last year, Kiara submitted her project to the Google Science Fair, a global science competition for kids ages 13 to 18. She was invited to present her findings at Google's headquarters in Mountain View, California, along with other teenage scientists from around the world. The contest's judges awarded Kiara's project the grand prize, which included a $50,000 scholarship. She hopes to use that money to attend college in the U.S. next year.

Kiara's achievements may be extraordinary, but she says that anyone can do what she's done. All you need to do is believe in yourself, stay curious, and keep experimenting. "It's never too early to start doing science," says Kiara. "Even if you're young, you still have the ability to create something world-changing."

—Jacob Batchelor

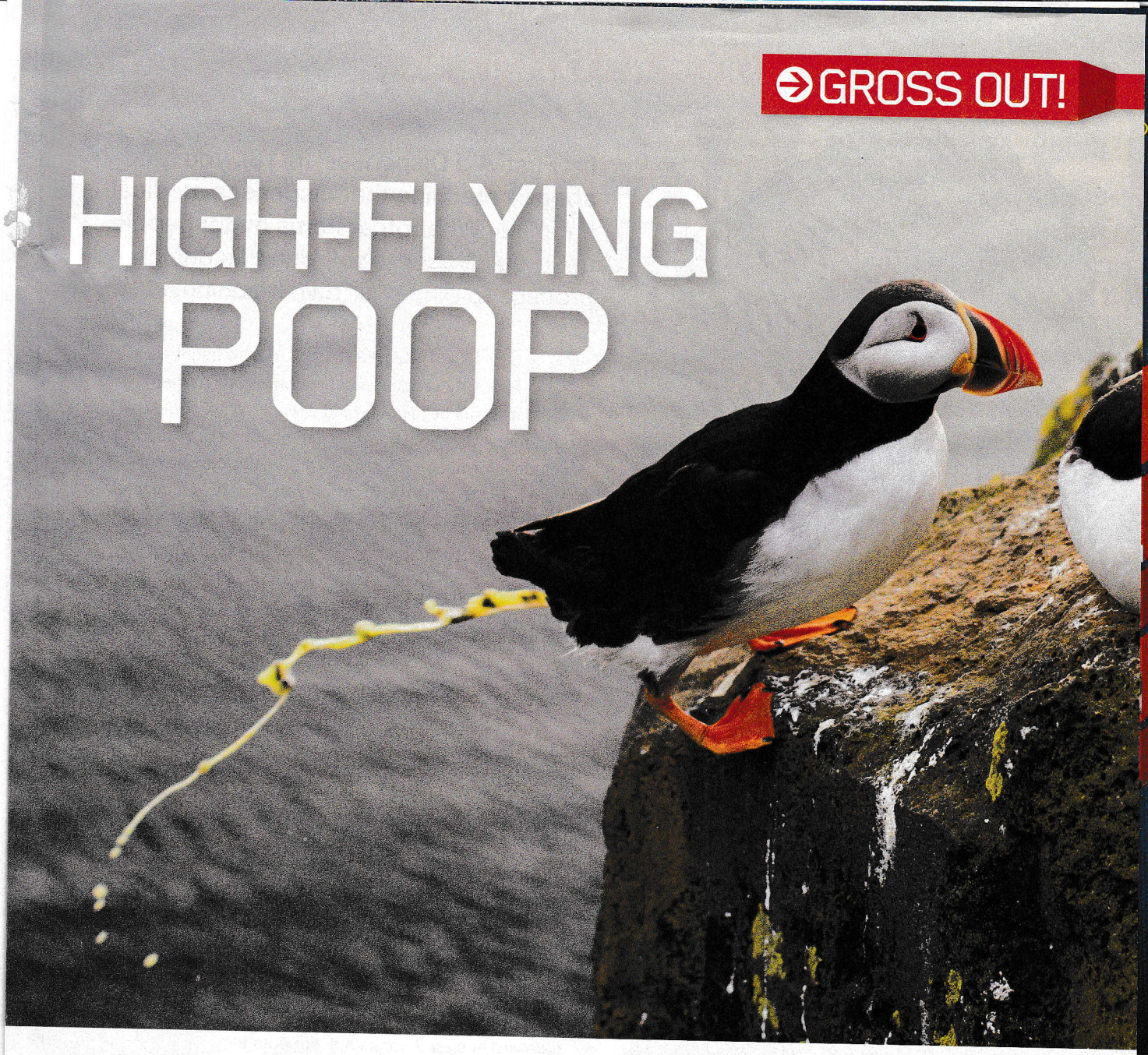
PUT TO THE TEST

The data below shows how the absorbing power of Kiara's orange-peel-based concoctions compared with some other SAPs.



SOURCE: KIARA NIRGHIN, 2016

HIGH-FLYING POOP



When it comes to making clouds in the Arctic, there's a surprising key ingredient: bird poop. Researchers believe that bird *guano*, or droppings, may help clouds form and may even cool the North Pole.

Every summer, tens of millions of birds travel long distances to the Arctic. "It's quite the migration," says Greg Wentworth, a scientist who works at Alberta Environment and Parks in Canada. Arctic terns, puffins (*pictured*), and other seabirds fly north to lay eggs and eat fish in the Arctic waters. After filling their bellies, they produce a whole lot of poop!

Bird guano is loaded with *uric acid*—waste created as animals break down food. Bacteria in poop turn nitrogen (N) in the uric acid into *ammonia* gas that's released into the atmosphere. Ammonia reacts with water vapor and other compounds to form small particles called *condensation nuclei*. Water vapor then condenses on these particles, forming liquid droplets. A lot of these droplets form clouds.

The white clouds reflect sunlight away from Earth. That causes a slight cooling effect in the atmosphere. "If you took away all of the birds tomorrow, the Arctic would be warmer," says Wentworth.

Like the rest of the planet, the Arctic has been experiencing hotter weather caused by climate change. Scientists are racing to understand how this change will affect ecosystems and weather around the world. Though the birds' contribution is small, what comes out of their bottoms is helping to prevent a rapidly warming Arctic from experiencing an even bigger meltdown.

—*Kathryn Free*

In "First-Aid Dispenser" (p. 18), you read about a machine that dispenses medical supplies. What other items might people need quick access to? Use this design process to plan your own machine.

1 DEFINE THE PROBLEM Where might a specialty vending machine be helpful? What items would it dispense? How would it work? Who would the customers be? Write a detailed description of your idea. Include information about the criteria and constraints you'd need to consider for your design to be successful.

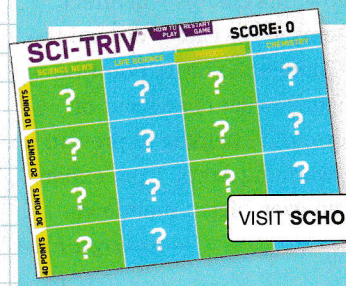
2 BRAINSTORM SOLUTIONS Think about how you could turn your idea from step 1 into a reality. Come up with several different design solutions for your vending machine. Write out step-by-step plans, draw diagrams, or make models for each design to help you envision how your machine would be used.

3 PLAN AND IMPROVE IT Pick your best solution from step 2. Use it to create a blueprint for your vending machine. Pair up with a classmate and discuss your designs. Offer each other ideas on design features that might need to be tweaked or added.

4 OPTIMIZE YOUR DESIGN Based on the feedback you received in step 3, make adjustments to your original plans. Keep going back to the drawing board until you're satisfied. Then enter our contest (*right*).

ENTER TO WIN!
Submit a 300-word essay describing your vending machine. Include information on why your machine is useful and the design features it needs to function. Five entrants will each win a collection of books on inventing and design. Go to scholastic.com/scienceworld for more details about how to enter.

ANALYZE IT Survey people to gauge their interest in your machine. Research to see if anyone has patented your design yet.



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