SCHOLASTIC

FEBRUARY 13, 2017
VOL. 73 NO. 8
ISSN 1041-1410

# ScienceWorld®

## current science®

SCHOLASTIC.COM/SCIENCEWORLD

INSIDE



BIOLOGY

# SICKLY SWEET

How the sugar industry kept the link between sugar and heart disease quiet for decades

RECYCLE THIS PLEASE!

SCHOLASTIC
ScienceWorld
current science
FEBRUARY 13, 2017 VOL. 73, NO. 8



SCIENCE WORLD FEBRUARY 13, 2017
**VOL. 73, NO. 8 Editorial Director:** Patricia Janes **Senior Editor:** Jennifer Barone **Associate Editor:** Jacob Batchelor **Contributing Editor:** Andrew Klein **Editorial Consultant:** Cody Crane **Intern:** Shira Polan **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.

**TO ORDER *SCIENCE WORLD*, CALL 1-800-SCHOLASTIC.**

COVER: DAVID MALAN/PHOTOLIBRARY/GETTY IMAGES



# SCIENCE NEWS

**EARTH SCIENCE:** EARTH'S WATERS

## SAVING THE SEA

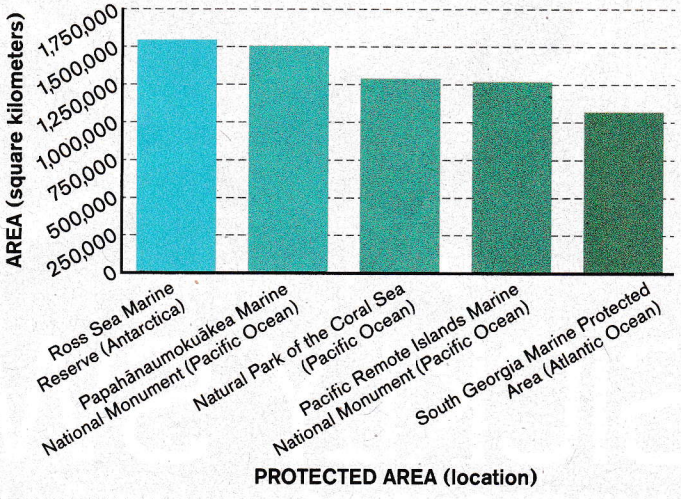
This past fall, 24 nations joined together to create the world's largest marine protected area. The 1.55 million square kilometer (598,000 square mile) zone, part of the Ross Sea, is located off the coast of Antarctica. It's home to vast numbers of fish, birds, and mammals, including leopard seals and orcas.

The agreement bans fishing and other human activities—except for some scientific research—in the protected area for the next 35 years. That will allow scientists to study the effects of climate change without the influence of fishing, says marine scientist Andrew Wright, one of the leaders who created the new reserve.

*—Shira Polan*

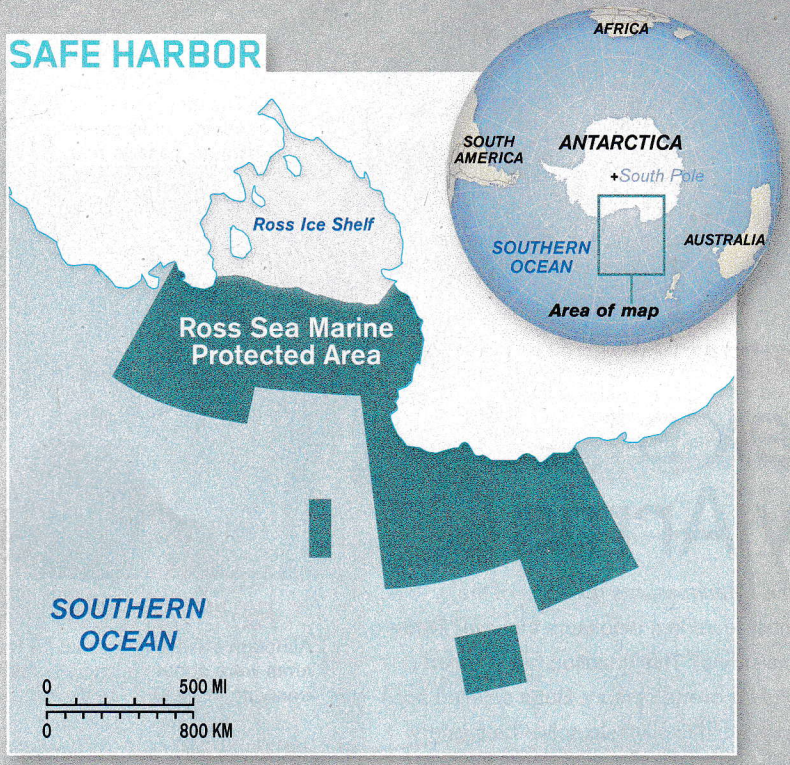
### PROTECTED WATERS

The new Ross Sea marine reserve is the world's largest. How much bigger is it than the South Georgia Marine Protected Area?




SOURCE: COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES, NOAA, CONSERVATION INTERNATIONAL, GOVERNMENT OF SOUTH GEORGIA AND THE SOUTH SANDWICH ISLANDS

## SAFE HARBOR




**GOING THE DISTANCE:** Conservationist and endurance swimmer Lewis Pugh completed a series of 300- to 500-meter swims in the 29°F waters of the Ross Sea while advocating for its protection.

KELVIN TRAUTMAN (LEWIS PUGH SWIMMING); JIM MCMAHON/MAPMAN® (MAP)


**BIOLOGY:** ANATOMY

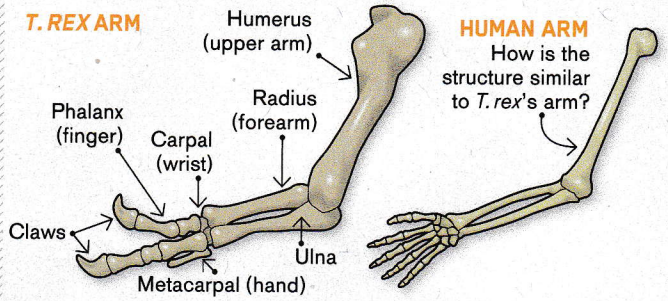
# *T. rex*'s Tiny Arms

Why did the *Tyrannosaurus rex*—one of the largest and most fearsome dinosaurs that ever lived—have such small arms? This question has puzzled paleontologists for over a century. But a detailed scan of a *T. rex* fossil could finally help solve the mystery.

Researchers analyzed the forearm of a *T. rex* nicknamed Sue, housed at the Field Museum in Chicago, Illinois. The 3-D image revealed the internal structure of Sue's arm bones. "This will tell us whether *T. rex* even used its arms," says Bill Simpson, a paleontologist at the museum. Early results indicate that Sue's bones don't show many signs of stress, suggesting the dino may not have used her tiny appendages very much. —*Jeanette Ferrara*

## T. REX VS. YOU

Although a *T. rex* was about 12 meters (40 feet) long, its arms were about the same length as a human's. See how the bone structure of a *T. rex*'s arm and a human's measure up.



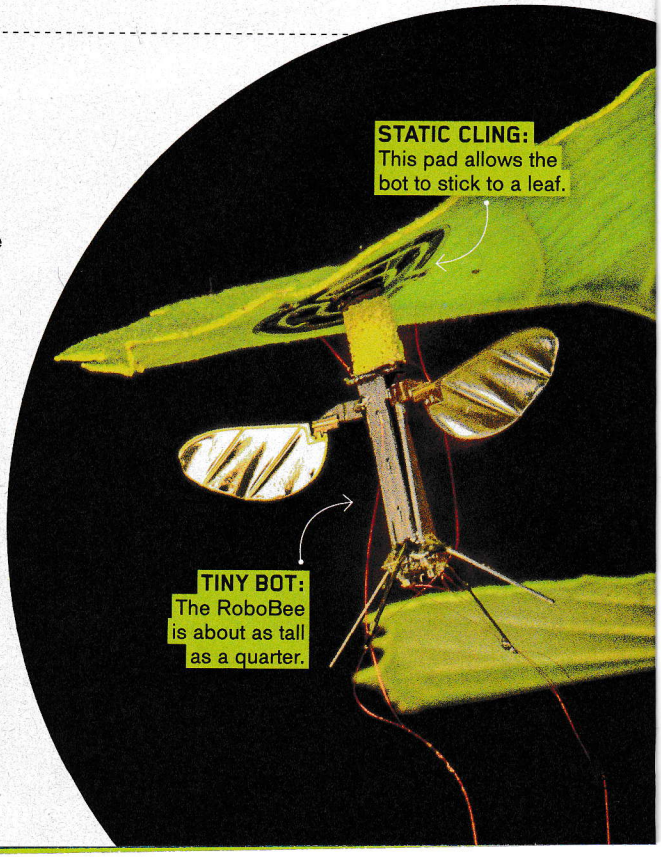

**PHYSICS:** ELECTRICITY

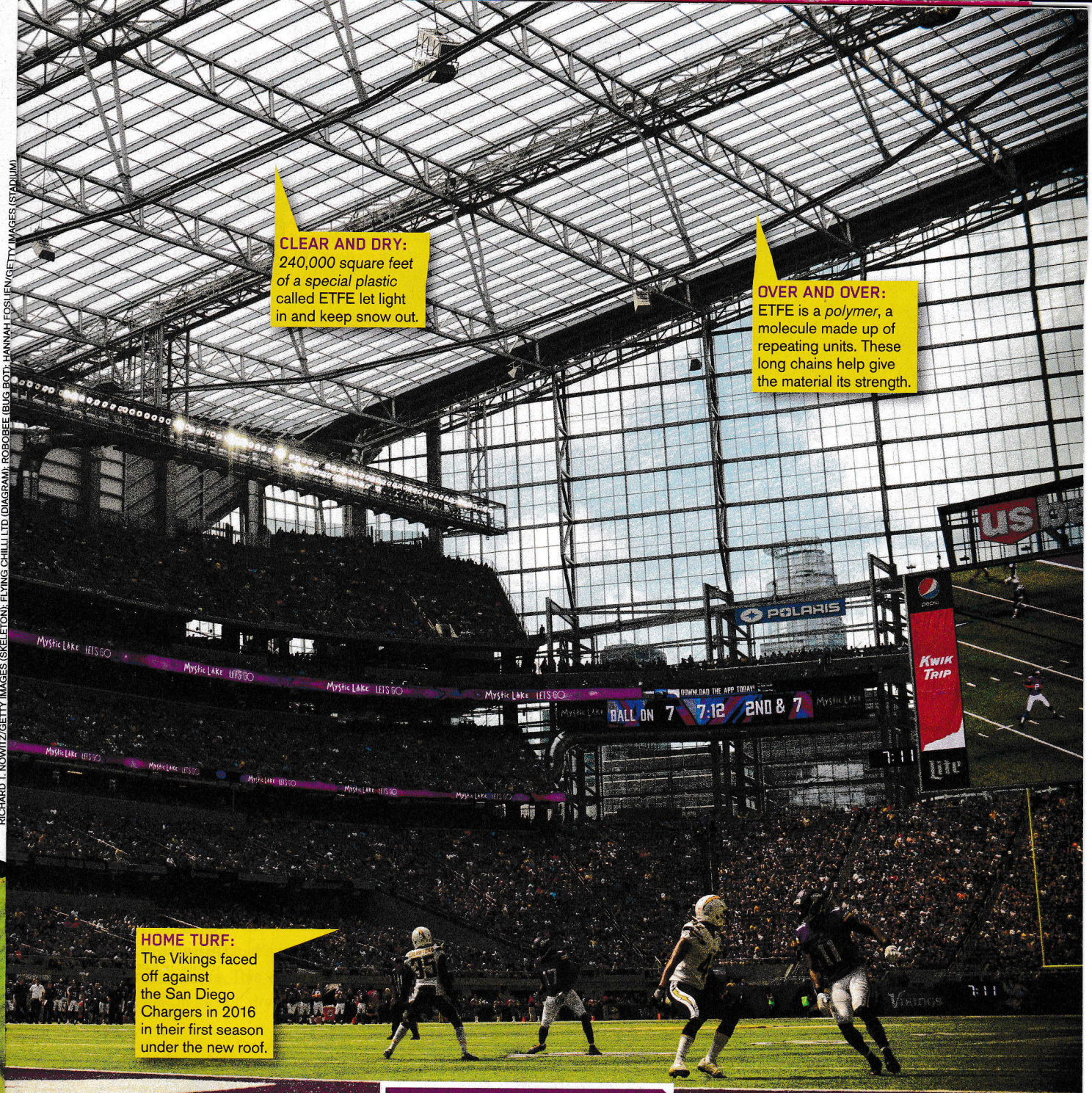
# Bug Bots

BUZZZ! Engineers at Harvard University in Massachusetts are developing tiny flying robots inspired by bees. The researchers have now created a way for these paper-clip-sized bots, called RoboBees, to perch on objects—just like real bugs. Instead of constantly remaining in flight, the machines can rest to save energy.

RoboBees land and stay put using *static electricity*—the presence of opposite electric charges on objects' surfaces. These opposite charges attract one another, allowing the robots to stick to objects.

A RoboBee creates static electricity by running an electric *current*—a flow of electrons—through a flat pad at the top of its body. Once charged, the pad will attach to any smooth surface. The robots could someday help with tasks such as weather monitoring and search-and-rescue operations. —*Shira Polan*






**CLEAR AND DRY:** *240,000 square feet of a special plastic* called ETFE let light in and keep snow out.

**OVER AND OVER:** ETFE is a *polymer*, a molecule made up of repeating units. These long chains help give the material its strength.

**HOME TURF:** The Vikings faced off against the San Diego Chargers in 2016 in their first season under the new roof.

RICHARD T. NOWITZ/GETTY IMAGES (SKELETON); FLYING CHILLI LTD (DIAGRAM); ROBOBEE (BUG BOT); HANNAH FOSLIEN/GETTY IMAGES (STADIUM)

**ENGINEERING:** CIVIL ENGINEERING

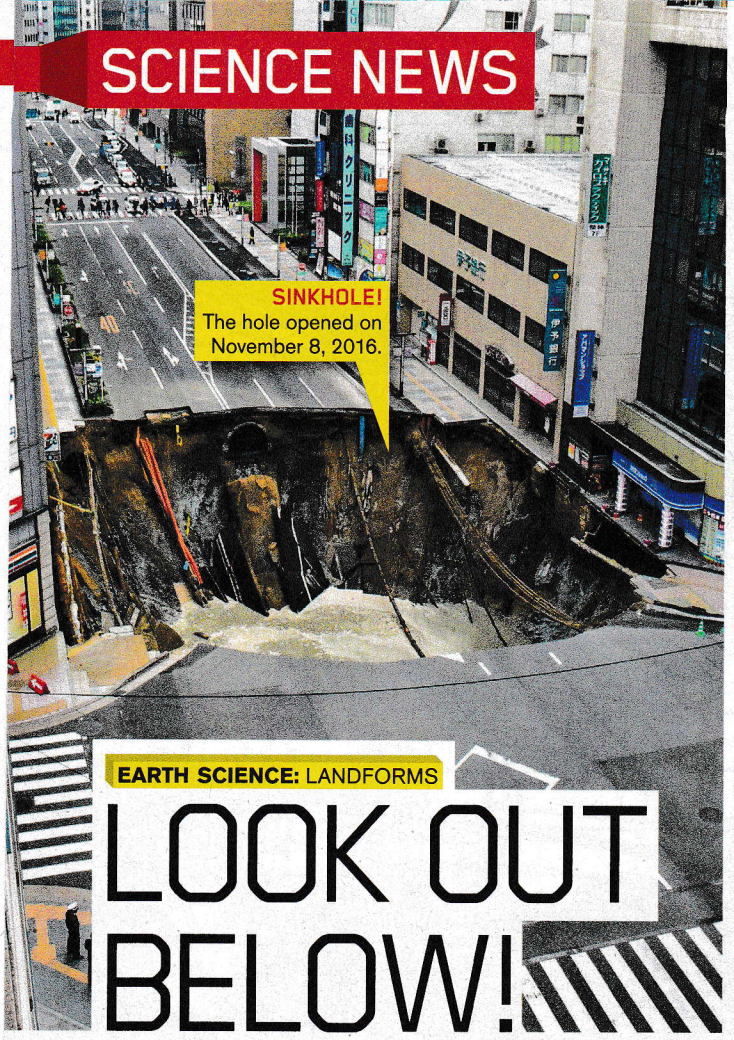
# REVOLUTIONARY ROOF

Minnesota Vikings fans know just how cold Minnesota winters can be. Protection from the elements is a must. The roof of the team's old stadium, made of fiberglass and fabric, blocked sunlight. It collapsed under snow in 2010. This season, the Vikings played in a new stadium with a cutting-edge roof.

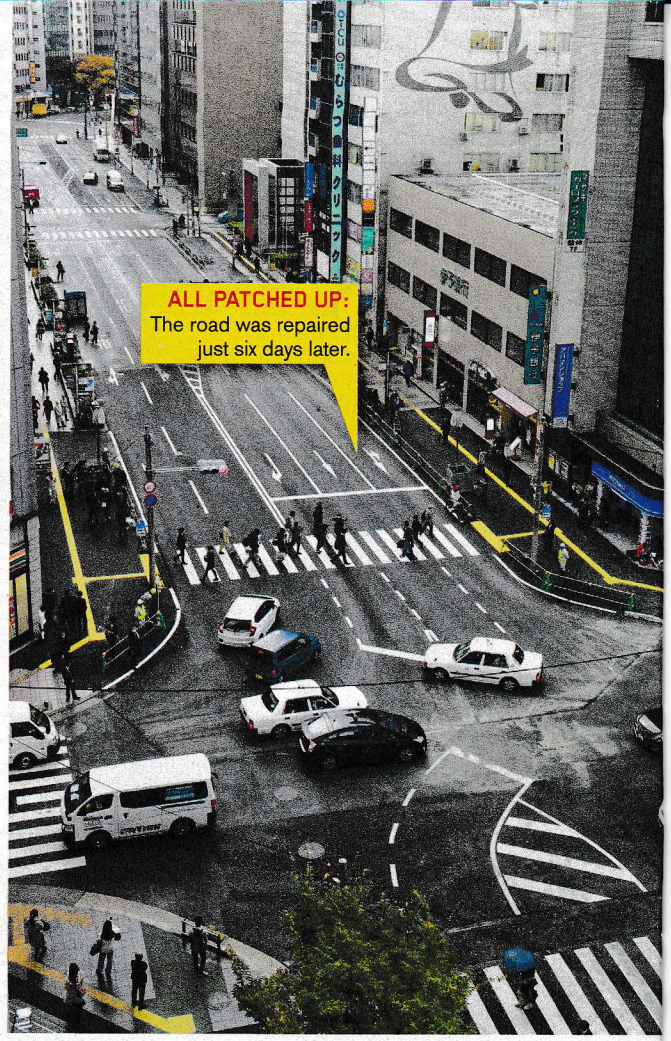
A plastic called *ethylene tetrafluoroethylene* (ETFE) covers the new U.S. Bank Stadium. The translucent material is durable, strong, and lightweight. It provides protection from the elements and lets in plenty of natural light.

ETFE's properties make it a great choice for architects who want to design long-lasting, sustainable buildings, says civil engineer Jianhui Hu.

*—Jeanette Ferrara*



**SINKHOLE!** The hole opened on November 8, 2016.



**ALL PATCHED UP:** The road was repaired just six days later.

**EARTH SCIENCE:** LANDFORMS

# LOOK OUT BELOW!

Last November, the ground beneath a busy city street in Fukuoka, Japan, suddenly collapsed. It left a 30 meter (98 foot)-wide *sinkhole* in the middle of the roadway.

Sinkholes can form naturally through *erosion*. As water wears away underground rocks, empty spaces form. With nothing to support the surface above, it sinks. The collapse of underground structures like sewers can also create sinkholes, says Andrew Farrant, a geologist with the British Geological Survey.

Officials say the sinkhole in Fukuoka may have been caused by nearby tunnel construction. Luckily, no one was injured. Engineers quickly filled in the hole with sand and cement. Certain types of rock are more prone to sinkholes, so investigating local geology before tunneling can help prevent them, says Farrant.

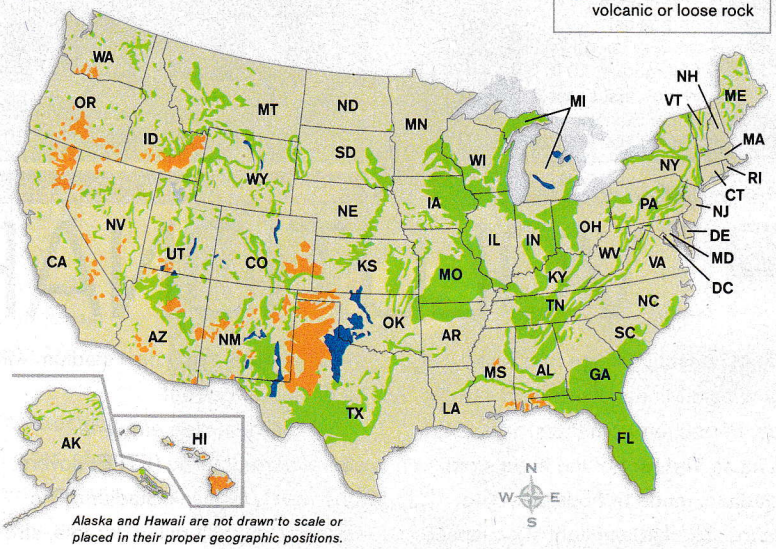
*–Hailee Romain*

## SINKHOLES CLOSER TO HOME

About 20 percent of the U.S. sits on *karst terrain*, where water has carved holes in the bedrock beneath the soil. That makes these areas susceptible to sinkholes. Karst forms in several types of rock. Do you live in a karst region?

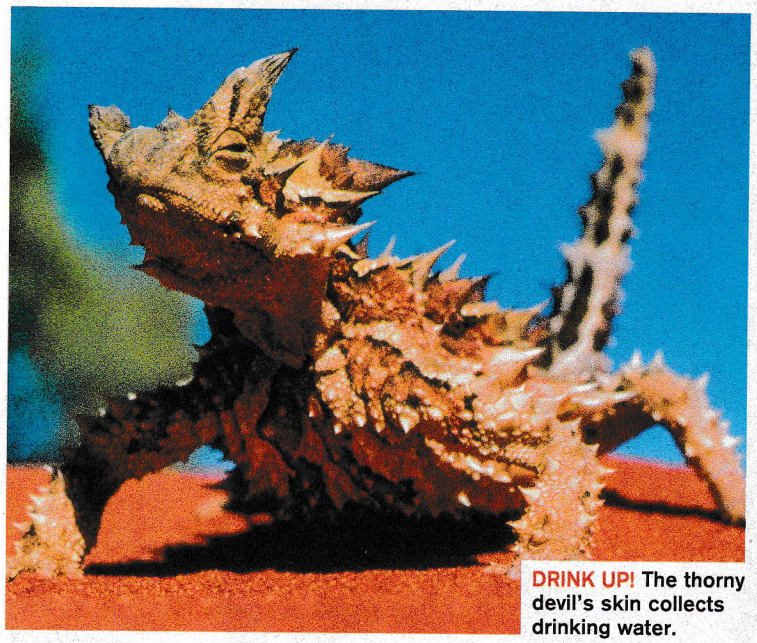
**KARST FORMATIONS**

- **Carbonate rocks:** limestone, dolomite, and marble
- **Evaporite rocks:** gypsum and halite
- **Pseudokarst:** volcanic or loose rock




*Alaska and Hawaii are not drawn to scale or placed in their proper geographic positions.*

SOURCE: AMERICAN GEOLOGICAL INSTITUTE



**DRINK UP!** The thorny devil's skin collects drinking water.

**BIOLOGY:** ADAPTATIONS

# Thirsty Skin

A lizard known as the thorny devil, found in Australia, has an unusual way of staying hydrated in its desert environment: The animal collects morning dew from sand using its skin, a new study shows.

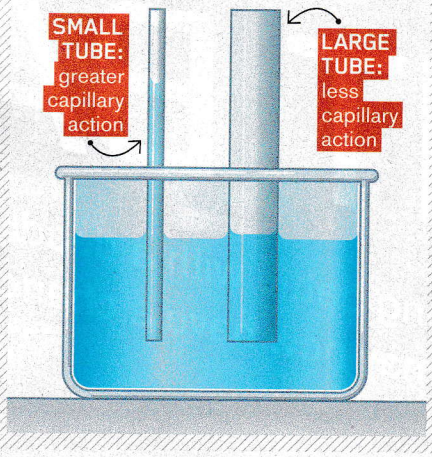
To harvest dew, the thorny devil burrows its body into damp sand, "almost like making a sand angel," says Falk Esser, a biologist at the University of Freiburg in Germany. The lizard's body is covered in spiky scales. Between the scales are tiny grooves. Any moisture that touches the animal's body is collected in these channels. They act like drinking straws to funnel the water toward the lizard's mouth.

The thorny devil's thirst-quenching trick relies on *capillary action*, which causes liquids to move through narrow spaces. This phenomenon occurs when a liquid's molecules interact with one another and surrounding surfaces. This water-collection method "is a huge advantage for the animal" in its hot, dry habitat, says Esser. *–Hailee Romain*

## HOW CAPILLARY ACTION WORKS

A liquid in a narrow tube will naturally rise upward without any external assistance. The narrower the tube, the farther the liquid travels. Two forces play major roles in this process:

- **ADHESION:** This force causes molecules of liquid to stick to the sides of the tube.
- **COHESION:** This force causes molecules of liquid to stick to one another.




# NUMBERS IN THE NEWS

**300 million**
Number of children worldwide currently exposed to toxic levels of air pollution, according to a new report from Unicef.

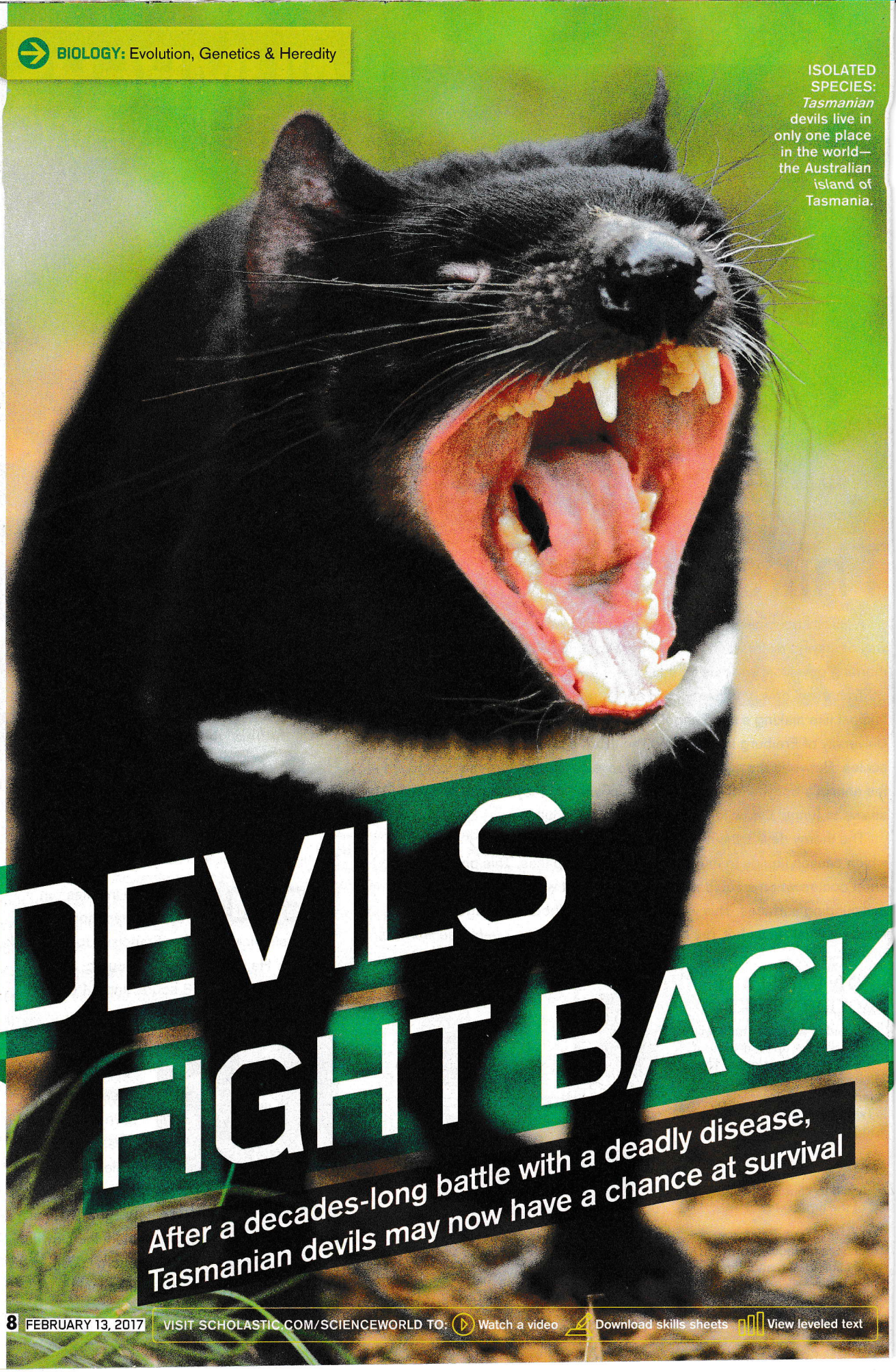
**50,000**
Number of oysters now living on an artificial bed in Jamaica Bay in New York City. The bed was created out of broken porcelain from 5,000 recycled toilets that were being discarded from public schools.

**6,200**
Age in years of the oldest known fabric dyed with indigo—the same bluish-purple coloring used in today's blue jeans.

**3,100**
Distance in miles run by ultramarathoner Pete Kostelnick from San Francisco to New York City. He made the cross-country trek in a record 42 days, 8 hours, and 34 minutes.

**162**
Rate at which three-toed sloths burn energy, measured in kilojoules per day per kilogram of body weight. That makes them the slowest energy users of all mammals.

KYODO NEWS VIA AP PHOTO (SINKHOLE); JIM MCMAHON/MAPMAN® (MAP); MITSUAKI IWAGO/MINDEN PICTURES (THORNY DEVIL); ARVIND YADAV/HINDUSTAN TIMES VIA GETTY IMAGES (AIR POLLUTION); SHUTTERSTOCK (TOILET); SUZI ESZTERHAS/MINDEN PICTURES (SLOTH); FLYING CHILLI LTD (DIAGRAM)



ISOLATED SPECIES: *Tasmanian* devils live in only one place in the world—the Australian island of Tasmania.

# DEVILS FIGHT BACK

**After a decades-long battle with a deadly disease, Tasmanian devils may now have a chance at survival**

**ESSENTIAL QUESTION:** What is cancer, and how does it occur?

Tasmanian devils have been the top predators on the Australian island of Tasmania for more than a century. But for the past 20 years, the furry, cat-size creatures have been the ones under attack. A deadly disease has been threatening the animals' existence. Conservationists have been working hard to save the dying species. Now scientists think the endangered animals may be combatting the disease on their own.

Tasmanian devils suffer from an illness known as *devil facial tumor disease* (DFTD). It causes massive lumps to form on a devil's face and neck. The lumps can prevent the animal from eating and breathing, and the illness is almost always fatal. "The sheer number of animals that don't survive is overwhelming," says David Pemberton. He's the manager of the Save the Tasmanian Devil Program.

DFTD was first discovered in Tasmania in 1996. The disease spread across the island so quickly that scientists predicted the species would be wiped out in a matter of decades (*see Widespread Illness, right*).

Contrary to the predictions, today's devils seem to be fighting back. A new study shows that a small number of the animals carry *genes*—units of hereditary material—that may make them resistant to the disease. As these genes spread through the Tasmanian devil population, its genetic makeup appears to be quickly evolving. These changes could help the animals take a step back from the brink of extinction.

## A DEADLY DISEASE

Devils are found only on Tasmania. They're named for their ferocious-sounding screeches. The animals are the world's largest *carnivorous marsupials*—meat eaters whose babies finish developing in pouches outside their mothers' wombs. Devils are also one of only three types of animals, along with clams and dogs, known to be susceptible to *transmissible cancers*, like DFTD. These cancers can pass between animals of the same species.

Normally, cancer isn't contagious. It occurs when one of the cells that make up an organism develops a *mutation*, or error, in its *DNA*. This molecule carries genetic information that contains the instructions cells need to function. A mutation to a cell's DNA can cause it to divide uncontrollably, forming a tumor.

Usually, if a healthy animal comes into contact with cancer cells from another member of its species, the healthy animal's disease-fighting *immune system* immediately recognizes and destroys the cells. But when devils come into close contact with one another—through biting, for example—a sick animal can transmit DFTD cells to a healthy one. That's because the cells disguise themselves so they aren't detected by a recipient's immune system (*see Contagious Cancer, p. 11*).

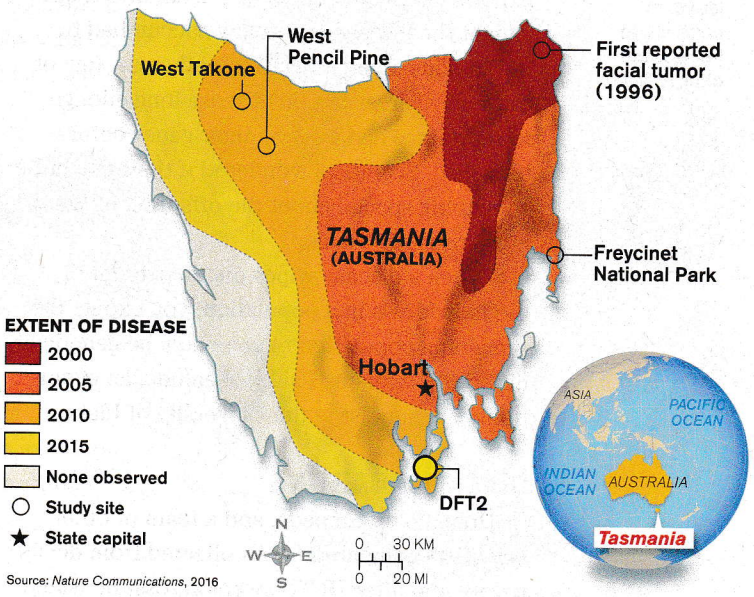
"This is what makes the disease so unique—and deadly," says Rodrigo Hamede, a DFTD

*Continued on the next page* →

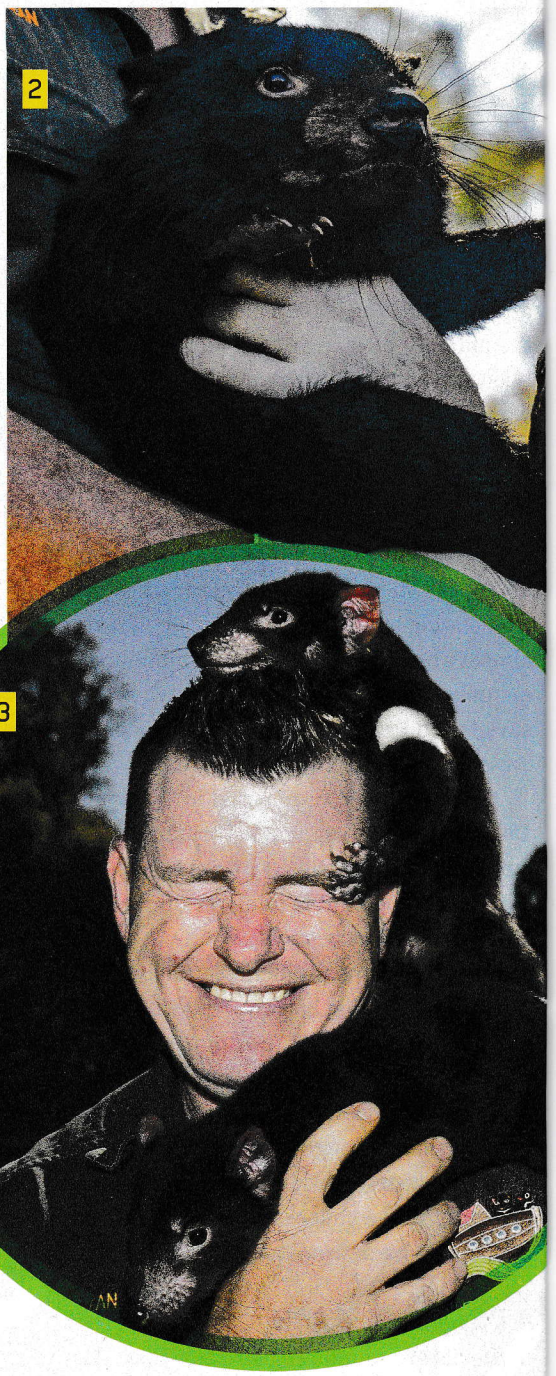
**DISFIGURING DISEASE** A devil with a deadly facial tumor

## WIDESPREAD ILLNESS

**Devil facial tumor disease (DFTD) was first reported in 1996 in northeastern Tasmania. The disease has since swept across the island. In 2016, a new strain of cancer called devil facial tumor 2 (DFT2) was discovered in southeastern Tasmania.**




Source: *Nature Communications*, 2016





**FRIENDS OF THE DEVIL**

1 A devil that took part in a DFTD study is returned to the wild.

2 Workers disinfect a devil before releasing it. It's part of the largest group of genetically diverse devils ever freed in Tasmania.

3 Scientists raise baby devils, called joeys, in captivity to keep them cancer free.

expert at the University of Tasmania. With no immune system response, the cancer cells can multiply unchecked. Once infected, a devil usually dies within 6 to 12 months.

## PUSHED TO THE BRINK

By 2011, DFTD had wiped out more than 80 percent of wild devils. Conservationists were making plans in case the animals became extinct. "At that point, we were prepared to repopulate the wild population using individuals we had bred in captivity, since they were the only animals who hadn't been exposed to the disease," says Pemberton.

By early 2016, it was clear that the devils weren't vanishing as fast as experts had feared. Most of the animals that caught the disease eventually succumbed to it. But some lived longer than others. A few of these devils resisted the disease long enough to reproduce and pass on their genes before they died. Scientists wondered if there might be something special about the offspring of these more-resistant devils.

"When a disease wipes out 80 percent of the individuals in a population, you expect the remaining population to somehow be genetically different," explains Paul Hohenlohe, an evolutionary geneticist at the University of Idaho.

## QUICKLY ADAPTING

Hohenlohe, Hamede, and a team of other scientists compared DNA collected from devils before and after DFTD swept across the island to test their hypothesis. They found that two regions of DNA were different in more recent generations of devils. Scientists think these regions may be related to devils' immune system response and cancer defense.

The genetic changes the scientists observed probably first entered the population long ago as a result of *genetic variation*, or normal mixing of genes, says Hohenlohe. But as DFTD spread across the island, only the devils born with the more disease-resistant DNA lived long enough to reproduce and spread their genes throughout the population.

In the evolutionary process known as *natural selection*, animals that are better adapted to their environment survive to produce more offspring. This process usually takes place very slowly. Devils, though, are changing more rapidly than normal—spreading DFTD-resistant genes through the population in as few as four to six generations.

## A CHANCE FOR SURVIVAL?

Devils' rapid evolution may be the key to their rebound. Last fall, researchers made a remarkable discovery: For the first time, some devils are recovering from the disease. So far, there have been about half a dozen of these cases. "It's only a tiny proportion, but it's a start," says Hamede.

Scientists see these recovering devils as further proof that genetic changes and natural selection are helping wild devils evolve to overcome the disease naturally. One day, breeding programs may be able to encourage disease-resistant traits in Tasmanian devils to help the more resilient animals spread through the wild populations, says Hohenlohe.

Despite the good news, devils aren't out of the woods yet. In 2016, a second strain of transmissible cancer, called devil facial tumor 2 (DFT2), was discovered in devils in southeastern Tasmania. Scientists don't know much about this illness yet, and they're not sure what effects the disease will have. But devils are tough creatures, says Pemberton. Plus, the people of Tasmania won't let their most iconic animal slip away without a fight. "Tasmanians love their devils," he says. ❀ *—Hailee Romain*

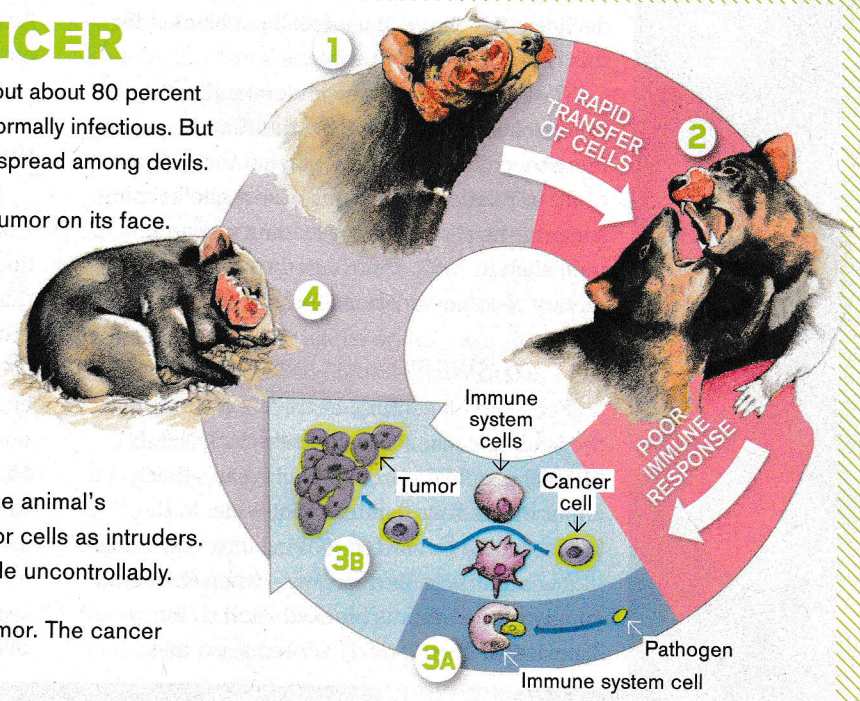
**CORE QUESTION**

**Explain in your own words what Tasmanian devils' changing DNA could mean for the survival of the species.**

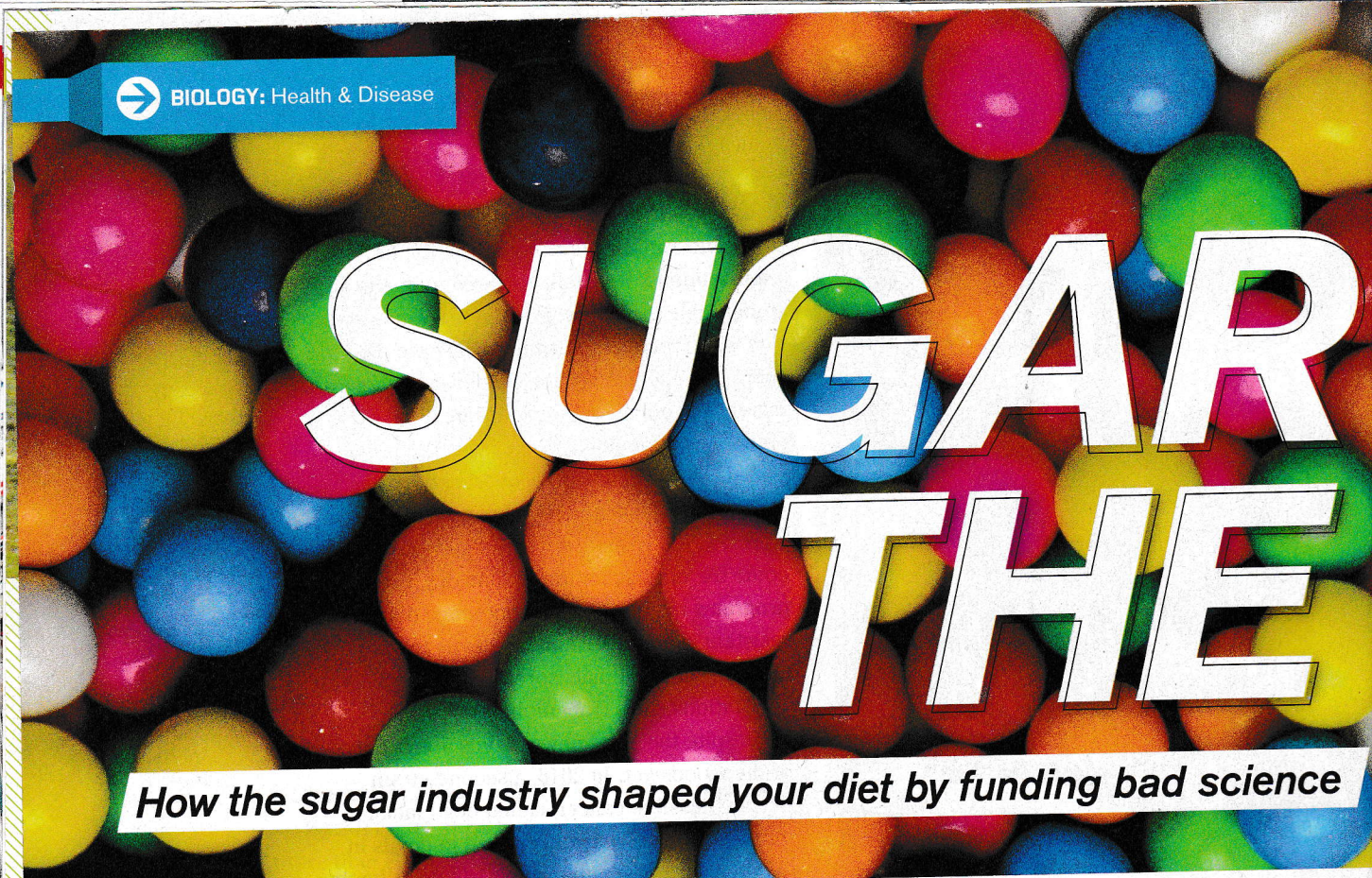
# CONTAGIOUS CANCER

Devil facial tumor disease (DFTD) has wiped out about 80 percent of the Tasmanian devil population. Cancer isn't normally infectious. But DFTD is an unusual form of the disease that can spread among devils.

1. A Tasmanian devil has DFTD, a cancerous tumor on its face.
2. While fighting or mating, a healthy devil bites one sickened with DFTD. Cancer cells enter the healthy devil's body.
3A. Immune system cells usually launch an assault against disease-causing *pathogens*.
3B. But because devils are genetically similar, the animal's immune system does not recognize the tumor cells as intruders. It does nothing to attack them, and they divide uncontrollably.
4. Unstopped, the cancer cells form a facial tumor. The cancer is ready to spread to the next unlucky devil.




DAVE WATTS/ALAMY STOCK PHOTO (RELEASE); JASON REED/REUTERS (DISINFECTING); JASON REED/REUTERS (SCIENTIST)



# SUGAR THE

## How the sugar industry shaped your diet by funding bad science

**ESSENTIAL QUESTION:** How can scientific studies influence people's attitudes and behaviors?

Most people are quick to blame Americans' expanding waistlines on sugar. After all, soda, candy, and other sugary foods are high in calories yet low in nutrients. But until recently, most people didn't realize that consuming sugary foods and drinks may also increase your risk for heart disease. For decades, fat—not sugar—has been blamed for this particular health problem.

The reason for this misunderstanding? Researchers recently uncovered that the sugar industry paid scientists to play up the dangers of fat in relation to heart disease while keeping sugar in the clear. The misleading research, published in 1967, contributed to shaping dietary recommendations for years to come.

### NOT SO SWEET

For nearly a century, heart disease has been the leading cause of death in the U.S. Nearly 610,000 people die from it each year—that's about one in four deaths nationwide. In the 1950s, scientists started looking into why things like heart attacks and *strokes*—when the blood supply to the brain is blocked—kill so many Americans. They quickly zeroed in on diet. Eventually, the science started to implicate both fat and sugar consumption as leading causes of heart disease.

If word got out that sugar was part of the problem, the sugar industry had a lot to lose. Americans might ditch sweets, costing many companies a lot of business. But if scientists could point the finger away from sugar, Americans would focus on fat instead and continue to eat sweets. That's what happened, and sugar consumption has since skyrocketed.

### HIDING THE EVIDENCE

Last year, a team of scientists from the University of California, San Francisco (UCSF), uncovered hundreds of documents indicating that the Sugar Research Foundation, a trade group now known as the Sugar Association, tried to influence what scientists said about sugar. Decades ago, the foundation paid three nutrition researchers from Harvard University $6,500 total—about $50,000 in today's dollars—to publish a *review*. This type of scientific article analyzes past research papers to develop a main conclusion on a topic. Their review concluded that fat alone was linked to heart disease. It dismissed research that also found

# COATING TRUTH

sugar to be a culprit, arguing that those studies were poorly done or that the laboratory findings didn't apply in the real world. "In the review, the evidence blaming fat was [deemed] strong no matter how weak it was," says Stanton Glantz, a professor of medicine at UCSF. "It was the opposite for sugar."

## CHANGING STANDARDS

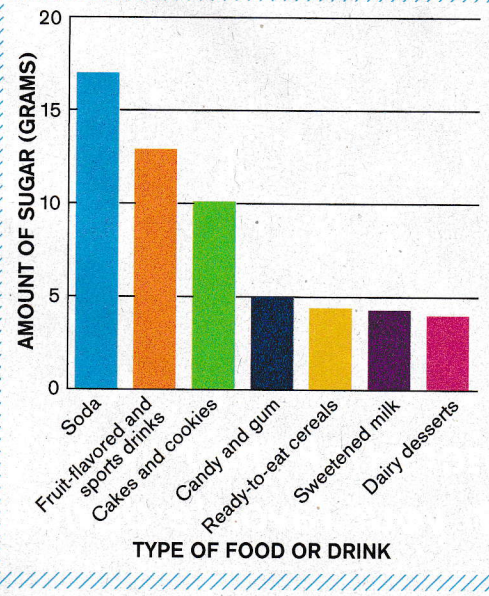
The Sugar Association responded in a statement on the report last September by pointing out that researchers in the 1960s weren't typically required to disclose who funded their studies. But it added that the Sugar Research Foundation "should have exercised greater transparency in all of its research activities."

Scientists now know that high sugar intake causes high blood pressure, abnormal cholesterol levels, heart disease, and obesity. The American Heart Association suggests children ages 2 to 18 not eat more than 25 grams (0.9 ounces) of added sugar a day. "That's less than [what's in] a can of regular soda," says Kimi McAdam, a registered dietitian in Anaheim, California (*see Sugar Rush, left*).

The battle over sugar guidelines continues. In December, a new review argued that warnings to reduce sugar consumption were based on low-quality evidence. The International Life Sciences Institute, a group backed by some of the world's biggest food and drink companies, funded the report. —*Christen Brownlee*

### SUGAR RUSH

This graph shows the biggest sources of daily added sugar in diets of children and teens ages 2-19 in the U.S.



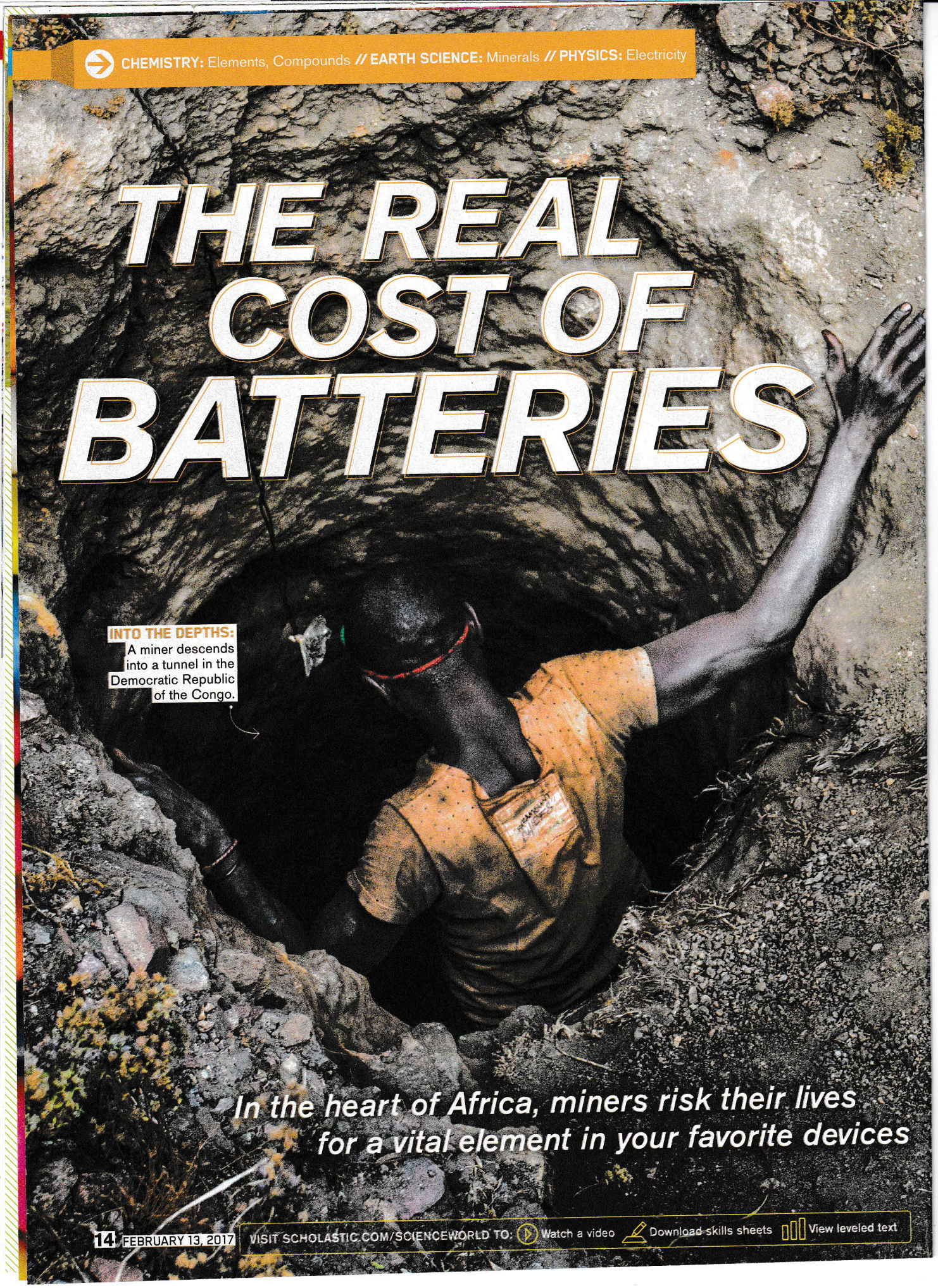

SOURCE: AHA SCIENTIFIC STATEMENT: ADDED SUGARS AND CARDIOVASCULAR DISEASE RISK IN CHILDREN, *CIRCULATION* 2016

SHUTTERSTOCK

**CORE QUESTION**

Now that you know the link between sugar and heart disease, will you change your diet? Use the text to support your reasoning.

# THE REAL COST OF BATTERIES



**INTO THE DEPTHS:** A miner descends into a tunnel in the Democratic Republic of the Congo.

*In the heart of Africa, miners risk their lives for a vital element in your favorite devices*

**KEY INGREDIENT:** Cobalt nuggets (*left*) and refined metal (*right*)

MICHAEL ROBINSON CHAVEZ/THE WASHINGTON POST (MINER); WALDO SWIEGERS/BLOOMBERG VIA GETTY IMAGES (COBALT NUGGETS); RUSS LAPPA/SCIENCE SOURCE (COBALT)

**ESSENTIAL QUESTION:** Where do the materials used to make electronic devices come from?

Every day, millions of people casually turn on a smartphone or laptop. The screens light up almost instantly, allowing people to study, work, or connect with friends anywhere at any time. But many people don't realize that this familiar act is made possible thanks to miners in the Democratic Republic of the Congo. The DRC, as it is also called, is a country in Central Africa (*see map, p. 17*). The miners work in dangerous conditions to collect *cobalt* (Co), an essential ingredient in the rechargeable batteries that power electronic devices.

Cobalt is a toxic material that can cause serious health problems. Miners—some as young as 7—gather it wearing no protective gear. The work is also problematic for people living near mining operations. Pollution from cobalt production contaminates residents' homes and food supplies. And experts say that the problems surrounding cobalt mining may worsen as consumer demand for electronics continues to grow.

## POWERHOUSE ELEMENT

Cobalt is a silvery-gray metal. Pure cobalt isn't found in nature because it reacts easily with other elements to form *compounds*. A compound is made of two or more chemically combined elements. Compounds containing cobalt are found in rocks and minerals. Workers mine and extract cobalt from these sources.

Cobalt is used in many products, including jet engines, paint, and magnets. But its fastest-growing application is *lithium-ion batteries*. These rechargeable batteries power cell phones, laptops, and even electric vehicles.

Inside a lithium-ion battery are compounds containing lithium and cobalt, such as lithium cobalt oxide ($LiCoO_2$). They are the source of lithium *ions*. These positively-charged atoms move through a salt solution, producing the electrical current that powers devices (*see How a Lithium-Ion Battery Works, p. 16*). Batteries made with lithium-cobalt compounds are relatively lightweight but still powerful. That's why they're so popular in mobile devices and electric vehicles.

Today about 110,000 tons of cobalt are mined every year. Roughly half of that goes to batteries. Demand for the metal is expected to increase dramatically, says analyst Caspar Rawles, who studies the global cobalt trade. He predicts that the amount of cobalt needed for battery manufacturing will likely double by 2025 (*see Booming Cobalt Demand, p. 17*).

## GOING TO THE SOURCE

The DRC produces 60 percent of the world's cobalt. The mining process is hazardous, and sometimes deadly. Many mines have been dug by hand using shovels, hammers, and chisels. Without proper supports, these mines are at risk of collapsing. Miners descend hundreds of feet without safety equipment such as helmets,

*Continued on the next page* →

### HOW MUCH COBALT?

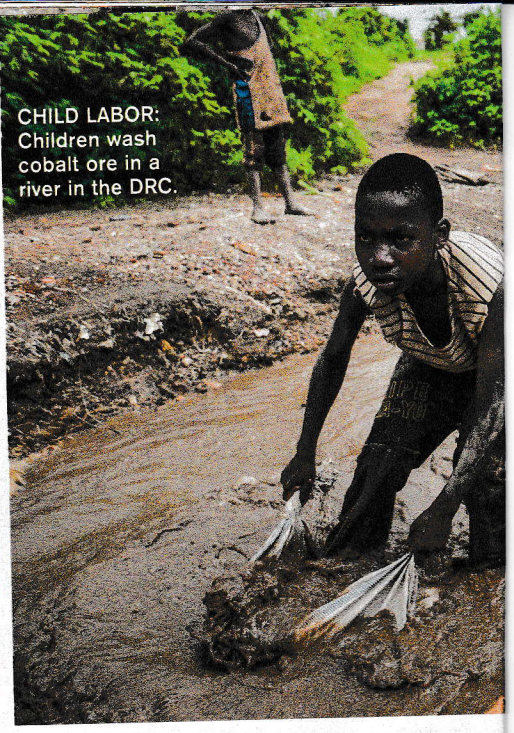
**SMARTPHONE**
0.3 ounces (the weight of 3 pennies)

**LAPTOP**
1 oz (the weight of a slice of bread)

**ELECTRIC CAR**
15 pounds (the weight of about 2 gallons of milk)

SOURCE: THE WASHINGTON POST

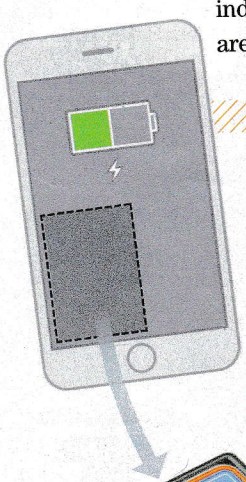
AT HOME IN THE DRC: Cobalt dust that gets into local homes poses a health risk, especially for children.



CHILD LABOR: Children wash cobalt ore in a river in the DRC.

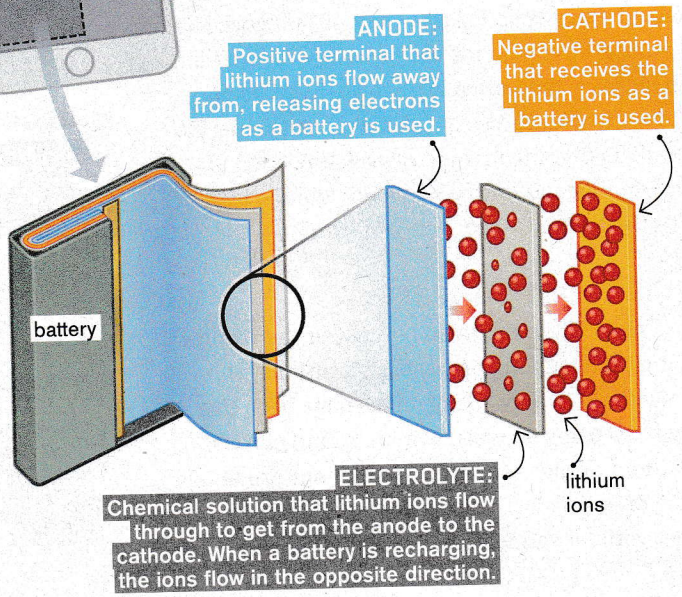
gloves, or face masks. An estimated 100,000 people mine cobalt this way in the country.

"These miners go down with only rudimentary tools," says Benoit Nemery, a public health researcher at the University of Leuven in Belgium who has studied the environmental and human consequences of the DRC's mining industry. "The work is very dangerous. Accidents are common."



## HOW A LITHIUM-ION BATTERY WORKS

Batteries convert chemical energy into electrical energy to power devices such as smartphones.



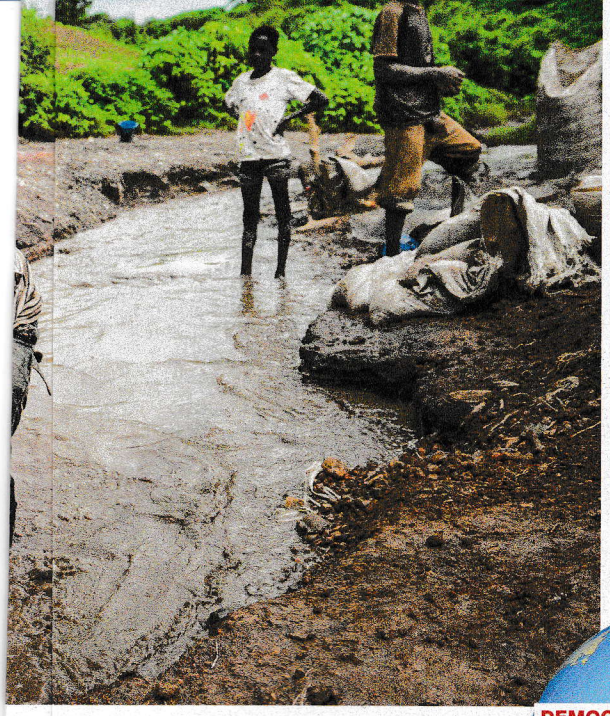

There is little safety supervision for the miners. Thirteen people died in a mine collapse in 2015. The year before, 16 miners died in a landslide, and a fire killed another 15. In addition to accidents and injuries, the work carries long-term health risks. Cobalt dust, for example, can eventually cause lung disease.

Child labor is also common. The United Nations Children's Fund (Unicef) estimated in 2012 that about 40,000 children work in the mining industry in the southern DRC, mainly in cobalt and copper mines. In 2015, researchers from two human rights organizations visited five cobalt mines and interviewed 90 workers, including 17 children. A 14-year-old described working underground at age 12, sometimes for 24-hour shifts. "I arrived in the morning and would leave the following morning," he said. Many children work at the surface, sorting through and washing *ore* brought up from the mines. Ore is the raw material containing valuable minerals, in this case cobalt.

Miners collect as much cobalt ore as they can. They transport it by bicycle or bus to nearby shops. On a good day, they may make $2 or $3 for their haul.

## DANGEROUS DUST

Miners aren't the only ones who face health consequences as a result of cobalt extraction. Nemery and his colleagues tested the urine of people who live near mines. "We found that they have very high levels of cobalt and other



GETTING TO MARKET: Miners transport sacks of cobalt ore by bicycle.


metals—even if they don't work in the mines," says Nemery. Not only is cobalt toxic at high levels, but to make matters worse, it's almost always found with uranium (U) and often with arsenic (As). "So these communities are being exposed to a whole cocktail of toxic metals," says Nemery.

People who live near mines or ore-processing areas are exposed to these elements through foods they eat, like fruits and vegetables. These crops take up pollutants when dust from the mines or from trucks transporting ore settles on the soil. Dust also makes its way into yards and homes, and children who play there get it in their mouths.

Cobalt can cause problems affecting the heart, blood, and *thyroid gland*, which helps regulate growth and development. Uranium can damage the kidneys, and arsenic can cause cancer.

## NO EASY FIX

The DRC is one of the poorest countries in the world, so the problems of its mining industry aren't easy to address. The country already has some environmental regulations and laws protecting children, for example, but they often aren't enforced, says Nemery.

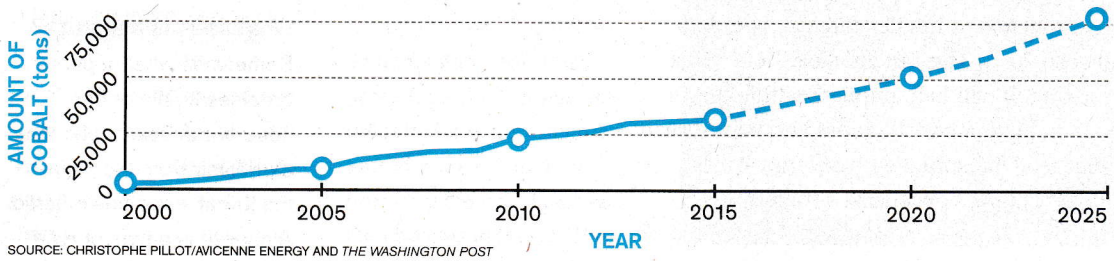
Following an investigative report by *The Washington Post* in September, some companies that produce or use lithium-ion batteries promised to do a better job of making sure their cobalt is mined safely. In the meantime, says Nemery, it's important to understand that "our smartphones and computers, and many other products we use every day, come at a very high human cost." —*Jennifer Barone*

### CORE QUESTION

Imagine you are explaining the human toll of making rechargeable batteries to your friends. What would you tell them?

## BOOMING COBALT DEMAND

As electronic devices continue to grow in popularity, more cobalt is needed to make the batteries that power them. This graph shows the amount of cobalt used for batteries since 2000 (with future projections through 2025).




SOURCE: CHRISTOPHE PILLOT/AVICENNE ENERGY AND *THE WASHINGTON POST*

MICHAEL ROBINSON CHAVEZ/THE WASHINGTON POST VIA GETTY IMAGES (FAMILY); EYEWASH (DIAGRAM)

MEINRAD SCHADE/LAIF/REDUX (BOY); MEINRAD SCHADE/LAIF/REDUX (TRANSPORTING); JIM MCMAHON MAPMAN® (MAP)

# SNEEZE SCIENTIST

## Lydia Bourouiba examines how snot droplets in sneezes help spread disease

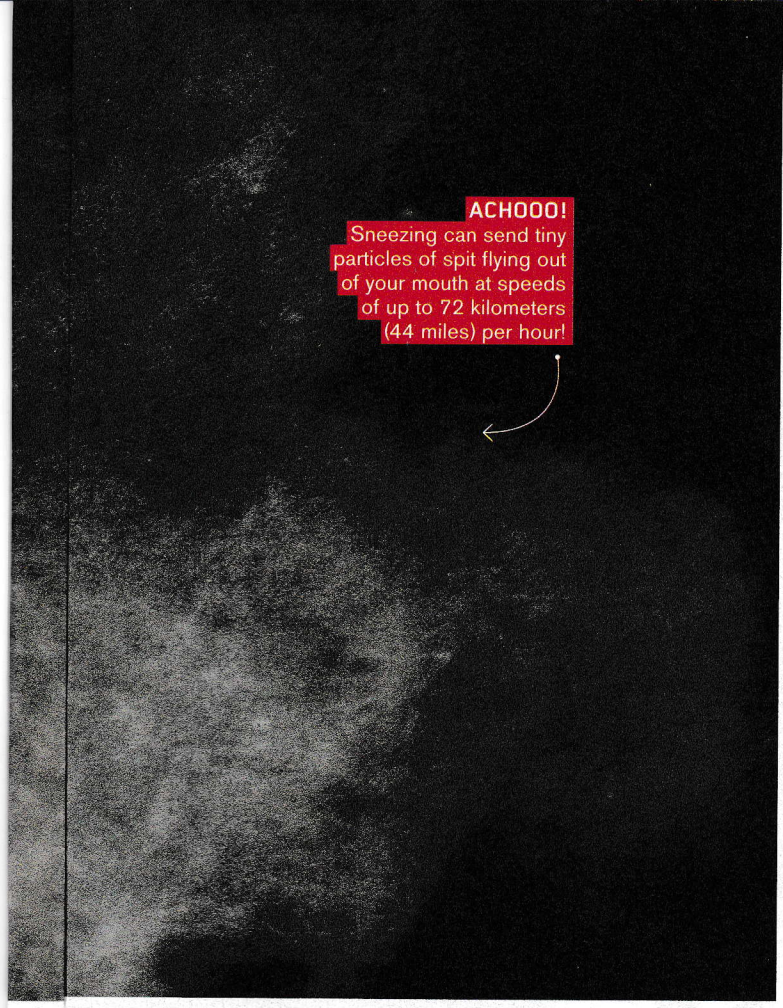
CAUGHT ON CAMERA: Bourouiba uses slow-motion video to study sneezes.

Lydia Bourouiba has recorded more than 100 sneezes and coughs. She watches the videos in slow motion to learn how these actions produce droplets of mucus that can fly through the air. Bourouiba is a mathematical physicist at the Massachusetts Institute of Technology who studies how fluids move. She's also one of the world's leading sneeze and cough experts.

Sneezing is the body's way of expelling unwanted particles, like dust or germs. It can also spread disease. If another person touches or inhales infected droplets sprayed by a sneeze, he or she can get sick. Bourouiba hopes that her research will help public-health experts stop *epidemics*. An epidemic is the rapid and widespread outbreak of a disease. She spoke with *Science World* about her job investigating how sneezes travel.

### What causes a sneeze?

Sometimes when a person breathes in, his or her nose or *trachea*, a tube that carries air from the lungs to the throat, becomes irritated. A sneeze is a type of *reflex*,



**ACHOOO!** Sneezing can send tiny particles of spit flying out of your mouth at speeds of up to 72 kilometers (44 miles) per hour!

or automatic response, to that irritation. It occurs when a person quickly inhales to fill his or her lungs. Then a fast-moving, turbulent cloud of hot, moist air is expelled from the mouth. The cloud is full of droplets that can carry germs.

### How and why do you record people sneezing?

To trigger a sneeze, we use a special device to tickle the inside of a volunteer's nostrils. Suddenly—ACHOOO! The person sneezes, sending a spray of snot through the air. A lot of these droplets are so small, and travel so fast, that you can't see them with the naked eye. By capturing them on video, we can slow down the process and zoom in on the details. We use different types of lighting when recording so we can see the larger droplets as well as the cloud of tinier particles that make up a sneeze. Some types of lighting can make the particles look white, so we can view how this cloud moves.

### How does this help you study diseases?

We track the sneeze cloud and its *trajectory*, or path through the air. This helps us understand how germs spread. We look at how the droplets form, how quickly and where they settle, or how long the cloud carries the particles in the air. The more elastic mucus is, the longer it can stretch before breaking into droplets. We use mathematics and physics to create equations based on data collected from our videos. These equations predict what happens to a sneeze or a cough cloud. They also factor in how conditions like temperature and moisture can influence how a sneeze contaminates a room or even a whole building.

### What prompted you to start studying sneezes?

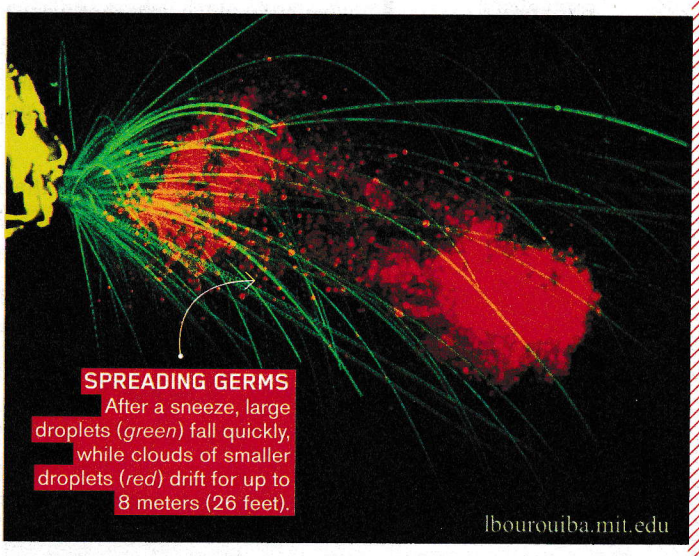
I was trained in mathematics and physics but was also interested in health. We still have a lot to learn about how illnesses spread from one person to another. Do they spread differently depending on the type of room we are in? Does people's distance from an infected person affect whether they also get sick? We simply do not know. I started trying to find some answers to these questions. If we can stop the spread of disease from one person to another, we could potentially stop an epidemic.

### What are you working on right now?

So far, my team and I have focused on healthy patients. We are about to start recording individuals with cold and flu symptoms. We will examine how their exhaled particle clouds might differ from those of healthy people.

### What can be done to stop epidemics?

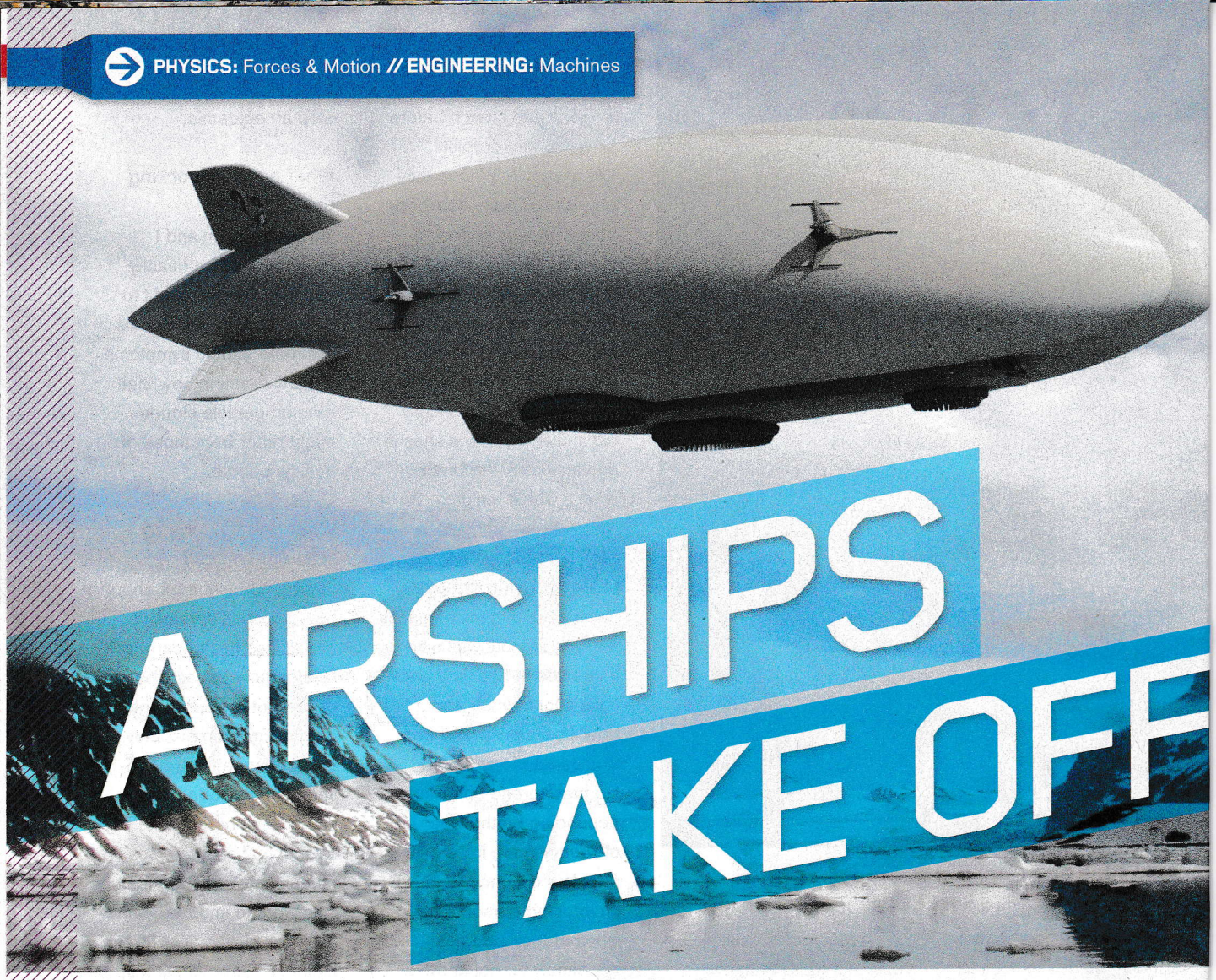
Once we know more about how illnesses spread, we can advise health-care facilities on how to best contain or prevent the spread of germs. For example, they might change their guidelines on how long people should wait before entering a room that an infectious person was in. They might also work to improve *ventilation*—the movement of fresh air into a room. Airplanes, schools, and other crowded or confined locations might also benefit from these changes. —*Amy Barth*



**SPREADING GERMS** After a sneeze, large droplets (*green*) fall quickly, while clouds of smaller droplets (*red*) drift for up to 8 meters (26 feet).

lbourouiba.mit.edu

LILLIE PAQUETTE/MIT MASSACHUSETTS INSTITUTE OF TECHNOLOGY (BOUROUIBA); WILLIAM RADCLIFFE/SCIENCE FACTION/GETTY IMAGES (TOP); MIT MASSACHUSETTS INSTITUTE OF TECHNOLOGY RIGHT)



# AIRSHIPS TAKE OFF

## People once thought floating aircraft would be the future of flight. Could that still be true?

**ESSENTIAL QUESTION:** How is an aircraft's design related to its purpose?

Today, airplanes and helicopters rule the skies. But that wasn't always the case. In the early 20th century, people thought floating, gas-filled *airships* would be the flying machines of the future.

Henri Giffard of France invented the airship in 1852—more than 50 years before the Wright brothers built and flew the first airplane in Kitty Hawk, North Carolina. But when airplanes began taking off, airships quickly fell out of favor.

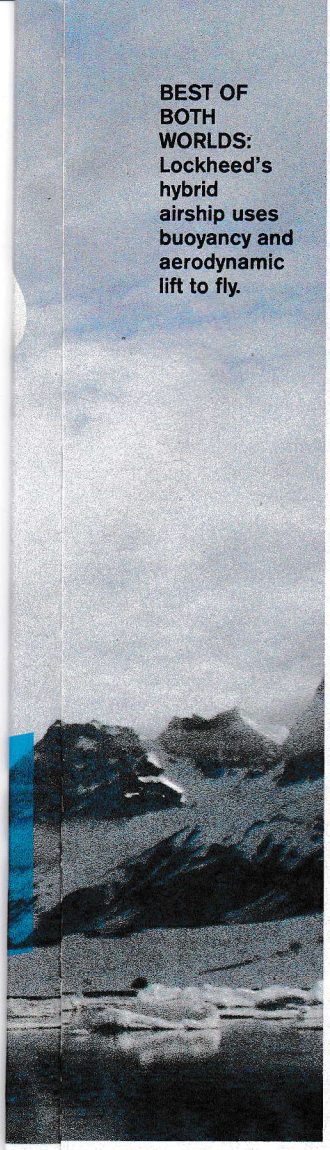
Not everyone thinks the floating vehicles are just a side-note in aviation history. In fact, leading engineers say fleets of airships could take to the skies once again. They believe the cleaner, cheaper aircraft could revolutionize how cargo is shipped around the world.

### LIGHTER THAN AIR

Airships operate on one basic principle—*buoyancy*. Buoyancy is the tendency of an object to float in a *fluid* (a liquid or a gas). The upward force of buoyancy is equal to the weight of the fluid *displaced*, or moved aside, by an object. In order to float, an object must weigh less than the liquid or gas it pushes aside. For airships, that means being lighter than air.

Airships are filled with lighter-than-air gases such as helium (He) and hydrogen (H). These gases are less dense than the nitrogen (N), oxygen (O), and other gases that make up Earth's atmosphere. With enough helium or hydrogen, you can make almost anything fly.

In the early 20th century, airships were used for exploration, transportation, and even

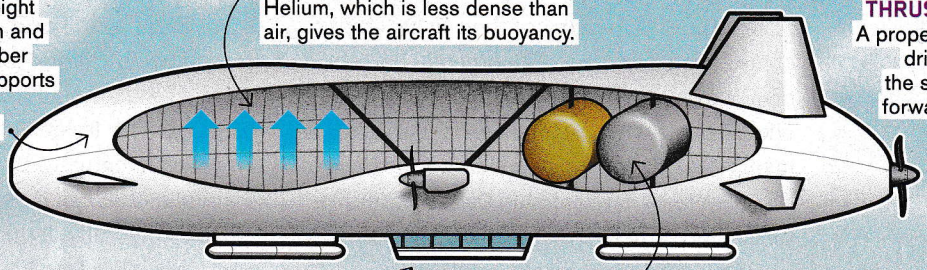


**BEST OF BOTH WORLDS:** Lockheed's hybrid airship uses buoyancy and aerodynamic lift to fly.

**DRAGON BONES:** Workers in California assemble the aluminum and carbon fiber frame of the prototype airship *Dragon Dream*.

## FUTURE FLYER

The *Dragon Dream* is a prototype airship built by the California-based Worldwide Aeros. It uses a special system that changes the amount of helium in the hull to control the ship's buoyancy.



**RIGID HULL:** A lightweight aluminum and carbon fiber frame supports a fabric covering.

**GAS-FILLED:** Helium, which is less dense than air, gives the aircraft its buoyancy.

**FORWARD THRUST:** A propeller drives the ship forward.

**STORAGE COMPARTMENT:** The ship's cockpit and cargo are located in a section called the gondola, found under the body of the ship.

**BALANCING ACT:** Ballast tanks store compressed helium and air. The tanks release helium into the ship to make it rise. To make the ship descend, air is released from the tanks.

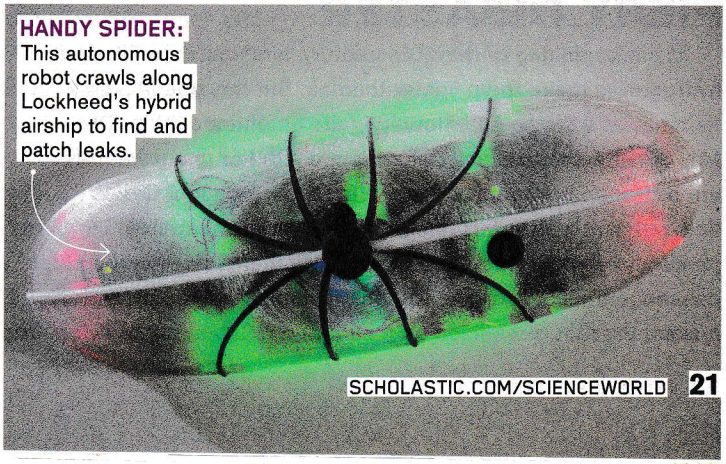
warfare. Quiet as a cloud, they could spy on enemies and drop bombs from afar. Then in 1937, a hydrogen-filled airship named the *Hindenburg* exploded over Lakehurst, New Jersey (*see Fiery Disaster, p. 22*). The tragedy helped end the age of airships. It would be decades before a new generation of inventors once more dreamed of floating in the sky.

### CARGO CARRIERS

If fleets of airships someday sail through the clouds, it's most likely that they will be carrying cargo—not people. But that's not because airships are dangerous. Today's airships use helium, which, unlike hydrogen, isn't flammable. So there's little risk of another *Hindenburg* disaster happening again. It's the design of airships that makes them uniquely suited for carrying large amounts of cargo. They can deliver to hard-to-reach places by taking off and landing almost anywhere—no runway required.

Airships also have a high *lift-to-drag ratio*. This ratio is an aircraft's *lift* (the upward force caused by air flowing around an object), divided by its *drag* (the slowing force of air pushing against the aircraft as it moves). The higher an aircraft's lift-to-drag ratio, the more easily it can get off the ground and the less fuel it uses.

*Continued on the next page* →



**HANDY SPIDER:** This autonomous robot crawls along Lockheed's hybrid airship to find and patch leaks.

LOCKHEED MARTIN (AIRSHIP); AEROSCRAFT (AIRSHIP FRAME); PETER SUCHESKI (DIAGRAM); LOCKHEED MARTIN (SPIDER ROBOT)

**CORE QUESTION**

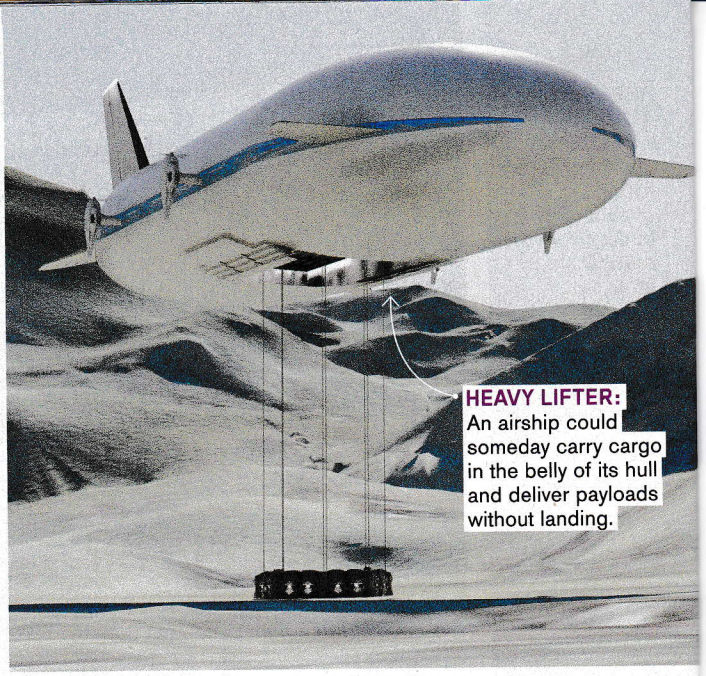
Why do some people think airships would be better than airplanes for carrying cargo? Cite evidence from the text.

This means airships can be cheaper to fly and create less pollution than traditional aircraft.

"In our modern world, we've moved toward greener and more efficient technology, and this technology fits that perfectly," says Bob Boyd, who works in the aerospace industry. "It's a more efficient way to fly."

## THE FUTURE OF FLIGHT?

Boyd works at Lockheed Martin's Skunk Works facility in Palmdale, California, where many advanced aircraft designs are developed. He and his team are building a fleet of *hybrid airships*. These airships are a cross between a blimp and a plane. About 80 percent of their flying ability comes from buoyancy. The other 20 percent comes from the ships' *aerodynamic* shape. Like airplanes, hybrid airships have wings that manipulate airflow to create an upward force. The result is a cargo airship that is about five times more efficient than a plane, says Boyd.



**HEAVY LIFTER:** An airship could someday carry cargo in the belly of its hull and deliver payloads without landing.

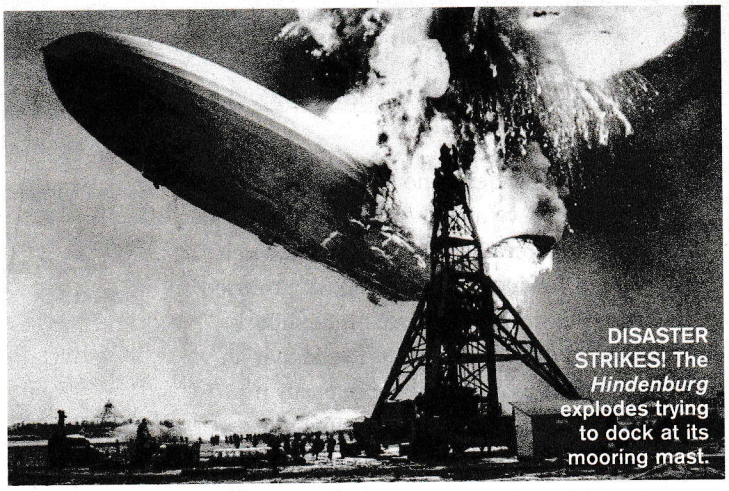
Right now, Lockheed is designing, building, and testing hybrid airships that are the size of a football field and can carry 22 tons of cargo—far less than what many planes can carry. Eventually, the company wants to build an airship that can carry 500 tons. An airship of that size could fill a large sports stadium.

Engineer Igor Pasternak also dreams of a future filled with airships. Pasternak immigrated to the U.S. from Ukraine at the age of 29. Soon after, he founded a company called Worldwide Aeros based in Montebello, California, and began making blimps. While his first models were used mainly for advertising and surveillance, he's now focused on building cargo-carrying airships.

In 2013, Pasternak built and successfully flew the largest airship made in the U.S. since the *Hindenburg* disaster. The prototype was called the *Dragon Dream*, and it could someday carry 66 tons of cargo (*see Future Flyer, p. 21*). Since then, he has continued to pursue a world in which airships—not planes—rule the skies. Pasternak believes that within 5 to 10 years, airships will deliver huge amounts of cargo around the globe—even to the most remote places on the planet.

Pasternak first fell in love with airships more than 40 years ago, when he was just 12 years old. "I read an article in a kids' magazine about airships that could move vast amounts of cargo anywhere you like," he says. "I knew these airships could change the world. Everything started from a simple wish—to build something and fly."

*—Jacob Batchelor*



**DISASTER STRIKES!** The *Hindenburg* explodes trying to dock at its mooring mast.

## FIERY DISASTER

**At the beginning of the 20th century, airships were filled with hydrogen to make them lighter than air. But this gas is highly flammable. A single spark could ignite an entire airship. On May 6, 1937, that's exactly what happened. For unknown reasons, the hydrogen inside the *LZ 129 Hindenburg* caught fire as it hovered over a New Jersey airfield. The airship, carrying 97 people, went down in a fiery blaze. More than a third of the ship's passengers died. After the tragedy, it would be decades before anyone thought of airships as a safe and reliable way to fly again.**

# POOP... OR PREY?

This moth caterpillar might have one of the best disguises in nature. It looks like a pile of bird poop! While resting on branches or leaves, the caterpillars curl up to resemble bird droppings. They use the trick to hide from predators like birds.

Many animals use *camouflage* to blend in with their surroundings. Coloring and body shape can all be part of the trickery. The moth caterpillars' disgusting disguise is a type of camouflage called *masquerade*. "Masquerade is a defense that makes prey resemble inedible objects such as bird poo, stones, or twigs," says Toshitaka Suzuki, a biologist at the Graduate University for Advanced Studies in Japan.

Suzuki found that the caterpillars' curled pose was the key to fooling hungry birds. He and his research partner made more than 400 fake caterpillars out of pastry dough and placed them in cherry trees. Their fake caterpillars were either green or poop-colored, and their "bodies" were either curled or straight.

In real life, poop-colored caterpillars curl at rest, but those with other coloration are typically straight when resting. For the green caterpillar replicas in Suzuki's study, posture didn't affect the number of attacks by birds. However, straight poop-colored replicas were three times as likely to be attacked by birds as those that were curled up. Without the poop-like pose, the fake caterpillars' cover was blown.

In nature, caterpillars masquerading as bird poo can't rest all the time, though. They need to straighten their bodies to eat, says Suzuki. "Some caterpillars with bird-dropping coloration keep a resting posture during daytime, when predators are active, and then eat leaves at night."

*—Hanneke Weitering*

# SUGAR SHOWDOWN

**In "Sugarcoating the Truth" (p. 12), you read about the health risks of consuming too much sugar. Can you match the following foods with the amount of sugar they contain? See answers below.**

**1**

**Strawberry Fruit-at-the-Bottom Yogurt** (170-gram single-serving cup)

vs.

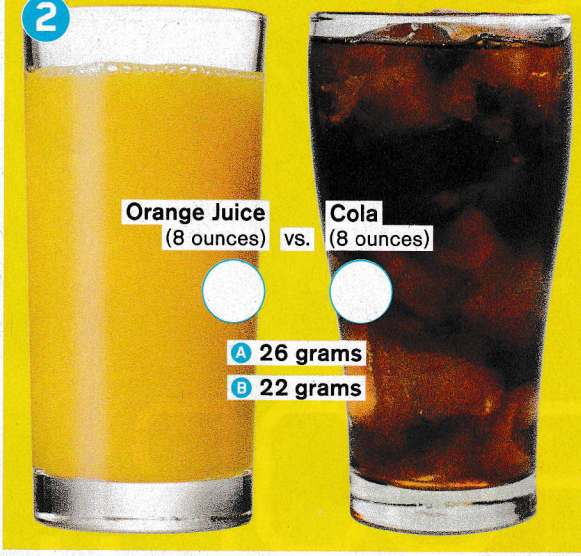
**Strawberry Ice Cream** (85-gram serving)

Ⓐ 24 grams
Ⓑ 17 grams

**2**

**Orange Juice** (8 ounces) vs. **Cola** (8 ounces)

Ⓐ 26 grams
Ⓑ 22 grams



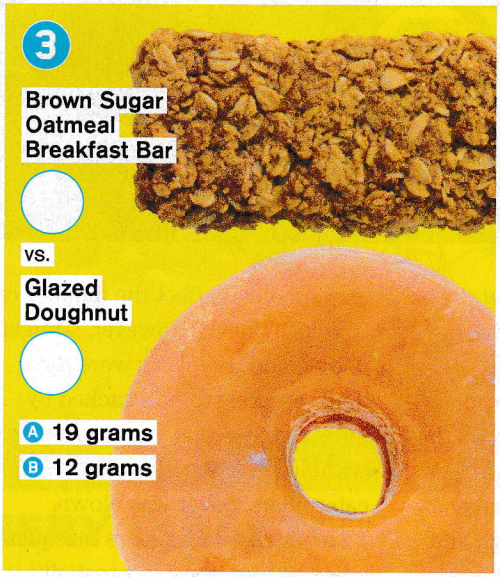
**3**

**Brown Sugar Oatmeal Breakfast Bar**

vs.

**Glazed Doughnut**

Ⓐ 19 grams
Ⓑ 12 grams



**4**

**Fast-Food Cheeseburger** vs. **Turkey Sandwich With Cheese**

Ⓐ 10 grams Ⓑ 8 grams

SOURCE: USDA FOOD COMPOSITION DATABASE

## ANALYZE IT

What are some healthier, low-sugar alternatives to the foods and drinks listed on this page? Research to find out how much sugar these alternatives contain.


## TEST YOUR SCIENCE SMARTS

Play our science trivia game online! Just click this button in the digital edition and select whether you'd like questions from this issue only or from our archive.

Visit scholastic.com/scienceworld to play Sci-Triv.

## CHECK US OUT ONLINE

ScholasticTeachers
@ScholasticTeach
ScienceWorld@scholastic.com

ANSWERS: 1. A, B; 2. B, A; 3. A, B; 4. A, B.