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Articles in This Issue

Supplier Index

Trees Won't Save Us from Climate Change

By Mike Howie

Carbon dioxide is the exhaust of human existence. Whether spewed from our cars or our factories, all this gas affects our atmosphere, slowly building up and changing the very nature of our planet.

So how do we fix this? How do we heal the damage we've caused?

Some suggest that we should head for the trees. The Earth's woody pillars absorb carbon dioxide through their leaves and use it in the life-sustaining process of photosynthesis. When fully mature, an average hardwood tree will absorb about 48 pounds of carbon dioxide.

Trees are beautiful works of nature, more complex and vital than they seem, that support the environment and wildlife even while lying dead on the ground. But they can't do it all.

There's simply too much pollution. The U.S. Energy Information Administration estimated that the United States alone emitted more than 5 billion tons of energy-related carbon dioxide in 2017. It would take more than 100 million trees to offset those emissions. Extrapolated to a global scale, there's probably not enough room for all the trees we'd need to offset carbon dioxide emissions from human activity.

There is plenty of treeless ground around the world, but not all of it should be transformed into dense forests. Northern tundra, for example, reflects more solar energy than trees. If we forested those areas, the trees would hold more heat and we'd worsen global warming. And if we transformed grassy lands like those in Yellowstone National Park, we'd deprive threatened animals of the environment they depend on. And we'd hurt ourselves too — humans need grasslands just as much as animals, using them for water sources, hunting lands, and grazing lands for livestock.

To be clear, planting more trees is a good thing. New trees will help offset carbon dioxide emissions, if only a little bit. But we must be smart about where we plant these trees. And we can start by looking for areas to reforest, finding the places that have been devastated and helping them return to former glory.

But trees alone will not solve our climate problems. To truly make a difference, we need to reexamine our own lives to see where we can make a difference. After all, the best solution to an overabundance of greenhouse gasses like carbon dioxide is to stop releasing so much of them.

DISCUSSION QUESTIONS

How many trees would it take to offset the carbon dioxide emissions from your normal activities?

Where in your area could you plant more trees?

VOCABULARY

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Australian Wildfires Put **Hundreds of Species at Risk**

By Moira Bell

Scientists estimate 100 billion animals were lost in these wildfires.

Australia is one of the most biodiverse countries in the world. Its varied ecosystems that range from lush tropical rainforests to sparse deserts are home to 570,000 different species, accounting for more than 5 percent of the world's plants and animals.

Wildfires that blazed through the continent from September 2019 to February 2020 have put the populations of hundreds of these species at risk.

Assessing the Damage

Leveraging previous calculations that were used to determine the loss of animals from land-clearing practices, scientists estimate 100 billion animals were lost in these wildfires. This number, which does not account for bats, frogs, or invertebrates, is likely to be much higher and could be closer to the trillions, according to Mike Lee, biologist at the South Australian Museum in Adelaide.

The glossy black cockatoo, native to Australia's Kangaroo Island, was at one time considered critically endangered with extinction. A recovery program that began in 1995 was responsible for increasing its numbers in the wild from 150 to 400, allowing scientists to change its status to endangered. Now, with most of its habitat destroyed, food sources scarce, and its numbers unknown, a much more hopeless narrative is unfolding, and the glossy black cockatoo is not the only victim.

Among the lost could be the Richmond birdwing butterfly, many species of peacock spiders, and the dunnart, a shrew-sized marsupial. Before the wildfires, there were only 500 known dunnarts in the wild. All 13 sites inhabited by dunnarts were burned by the fires.

It's also estimated that three in every 10 koalas that were living in the eastern state of New South Wales died in the fires. This was the only population that hadn't been affected by a disease spreading through koalas.

Aftereffects

Heavy rains are a welcome relief from the wildfires, but they pose a new set of issues for animals down under. The water will wash soot and ash into rivers, lakes, and oceans, which could harm freshwater and marine species.

The effects of these wildfires are likely to be felt for years to come. Even if animals managed to survive, their habitats and food sources may be gone or, at the very least, scarce. Many endangered species have adapted to a very specific ecosystem to survive, making it improbable that their exact conditions for life on Earth have been preserved.

Although the wildfires have stopped, the devastation to Australia's stunning biodiversity will continue to reveal itself over time.

DISCUSSION QUESTIONS

Find three animals that are unique to Australia. How would the loss of these rare species affect their habitats, prey, food sources, and humans?

Research what can we do as a society to prepare for more frequent and extreme weather conditions such as wildfires and storms.

VOCABULARY

BIODIVERSITY ECOSYSTEMS CONSERVATION HABITAT

Picture This:
Ice Volcanoes on the Shores of Lake Michigan

By Gina Wynn

People who live near the Great Lakes know about the unusual weather effects they are capable of producing like lake-effect snow, cooler springs, and warmer falls. But few were aware of the Great Lakes' power to produce mini icy volcanoes along their shorelines, until the snowy structures made their debut on social media.

Ever since an employee of the National Weather Service, Grand Rapids, Michigan, was able to snap a photo of one of the frosty beach anomalies during a frigid February walk and tweet about it, nature and weather enthusiasts have been captivated by the phenomenon.

What Are Ice Volcanoes?

According to the Live Science online article "Bizarre 'ice volcanoes' erupt on Lake Michigan beach," by Nicoletta Lanese, the cone-shaped formations like the one photographed at Oval Beach on the eastern shore of Lake Michigan are not technically volcanoes.

In a Facebook post, Tom Niziol, winter weather expert for The Weather Channel, explained what the objects actually are and how the elements combine to make it look like a volcanic eruption has occurred.

> The conditions were "just right" for the volcanic waterspout.

When thin sheets of ice form at the edges of lakes, the water underneath pushes up into a mound. As the pressure under the ice increases, the water shoots out through holes that form in the ice. If it's very cold, then that spray freezes, settles, and piles up until it eventually builds a cone-shaped structure.

A Novelty on the Great Lakes

Even though these ice cones are relatively rare, Niziol has also seen them along the eastern shores of Lake Erie. Others have observed them on the shores of Lake Ontario in New York and on Lake Michigan near Gary, Indiana.

The beaches of the Great Lakes are popular for such sightings because of the enormous sizes of the bodies of water, according to a news report by Matt Benz, AccuWeather meteorologist. Even though the temperature of the winter air is below freezing for long periods of time, the lakes don't completely freeze.

"While this type of ice could develop on large lakes, most lakes outside of the Great Lakes in the U.S. tend to freeze up before you can accrete enough ice along the beaches," said Benz.

And oceans don't present ideal conditions for ice volcanoes either. The saltwater needs much colder conditions in order to freeze and the harsher wave action prevents ices shelves from forming.

The Perfect Storm

When the photo of the ice volcano at Oval Beach was taken, Benz explained that the conditions were "just right" for the volcanic waterspout.

You need moderate wind and wave action and below-freezing temperatures for the occurrence, said Benz. The wind must be blowing in the right direction so the waves will form at the right angles. Freezing temperatures are necessary so the ice shelves will form. Then when large waves crash against them, the freezing water will build layers onto the structure.

If you plan to venture shoreside to get your own shot of a Great Lakes geyser, watch the weather forecast, bundle up, and hope the wind blows your way.

DISCUSSION QUESTIONS

Have you ever seen a real volcano? What was it like?

Why are the Great Lakes unique? How were they formed?

VOCABULARY

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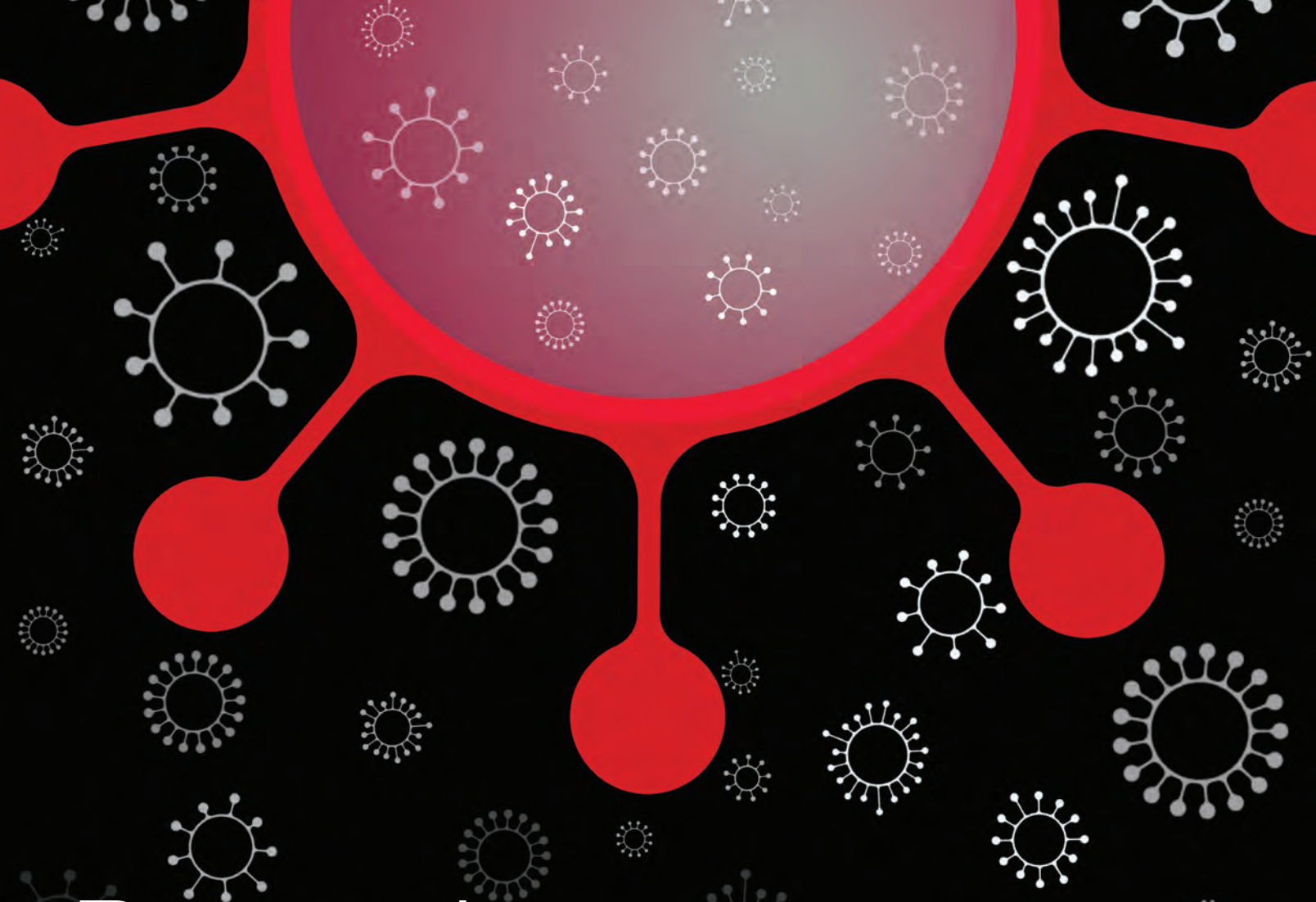

Researchers Progress with **Virus Prevention**

By Kylie Wolfe

The novel coronavirus (SARS-CoV-2) first made headlines in December of 2019. It originated in Wuhan, China, and has spread globally. The World Health Organization (WHO) classified the virus as a global health emergency, launching many people and places into action. Since then, with new knowledge and numbers, the WHO updated its classification of the coronavirus. It is now considered a pandemic.

Scientists in particular have raced to the front lines, researching the virus and taking steps toward a vaccine or drug treatment. That's how a team at the University of Texas, Austin, made the initial discovery: a coronavirus spike protein map, an essential step in vaccine development.

Experts use various terms to describe the spread of a disease or virus. Understanding these terms and concepts can help you assess the severity of what happens in the world around you.

Outbreak

An unexpected rise in the number of cases in a community or country

- Often limited to a single community
- May spread across countries
- Can last a few days or continue for years

Epidemic

The sudden, rapid spread of an infection to many people within a population, community, or region

- Impacts many people at the same time
- Typically more widespread than an outbreak

Pandemic

The spread of an infection to many people in different countries across continents

- Affects a large portion of the population, possibly worldwide
- Infects more people and causes more deaths than an epidemic

How It Works

New vaccines undergo extensive development processes that include exploratory, pre-clinical, clinical, regulatory review and approval, manufacturing, and quality control stages.

The United States Food and Drug Administration's Center for Biologics Evaluation and Research regulates this process and continues to oversee production after a vaccine's release.

Progress for Prevention

As of February 2020, researchers at the University of Texas, Austin, determined the molecular structure of the aforementioned proteins. Knowing the shape and structure helps scientists better understand how to target the virus during product development stages and ultimately prevent the disease (COVID-19).

The team used the genome of the virus to identify genes that code for a particular protein, injected those genes into cells, and produced spike proteins. Then, using cryogenic electron microscopy, researchers generated a three-dimensional map of the protein's structure.

"The spike is what we want to try and target with vaccines, with antibodies, and with small molecules, so that we can prevent the virus from entering cells," says Jason McLellan, research lead at the University of Texas, Austin.

Understanding Viruses

When viruses attack our bodies, immune cells come to the rescue, producing proteins known as antibodies. These proteins bind to a specific region of the virus known as an antigen. Traditional vaccines introduce virus-related antigens to train the body to produce antibodies that fight the virus.

In the case of the coronavirus, spike proteins bind to receptors on cell surfaces, giving the virus a chance to enter. Preventing the proteins from binding would be the most efficient way to stop the virus.

Though researchers have made progress, it will take months, if not years, to produce a vaccine that's both safe and effective. In the meantime, researchers in Texas are sharing their findings with labs across the globe. They hope that their work will serve as a starting point to help prevent and treat future cases.

Note: The researchers in this article used a Thermo Scientific Krios cryo-TEM for their experiments.

DISCUSSION QUESTIONS

What's the relationship between an antibody and an antigen?

How do vaccines work?

What role do spike proteins play?

Would the coronavirus be considered an outbreak, epidemic, or pandemic? Why?

VOCABULARY

ANTIBODY ANTIGEN

VACCINE VIRUS

Students Want to **Learn More About Climate Change**

By Iva Fedorka

Not long ago, most students at Granada Hills Charter High School didn't use the recycling bins or understand how plastic waste contributes to greenhouse gas emissions. But California's science standards are helping educators incorporate more relevant, hands-on lessons and instruction about the environment and climate change.

Teacher Education

About half of the new math and science teachers in California during the 2016-2017 school year started teaching without full state credentials. To help address this, the University of California (UC) and California State University (CSU) systems launched a "Climate Change Literacy Project." These educational institutions prepare more than half of the state's elementary and high school teachers and have decided to partner with scientists to help future teachers learn more about climate change.

Examples of the New Curriculum

Granada Hills chemistry teacher Jeanette Chipps knows firsthand about fueling inquisitive minds. Students may know about climate change as a broad topic but may not understand its science or history.

> "We want children to learn science concepts through investigating phenomena in the world."

"They hear these things and they want to know why, they want to better understand it and they want to do something about it," Chipps said. "It's just about finding and then giving them the tools to do something about it."

The Rialto Unified School District leaders revamped the whole high school science course pathway and extended the science requirement to three years instead of two, as required for admission to CSU or UC. The new courses include science-related issues and not the traditional focus on biology or chemistry alone. In one class, students learn about water as part of chemistry, biology, or engineering and review the environmental impact report for the creation of a new local flood detention basin.

Program Successes

Research suggests that students learn more when they practice science rather than just reading it from a textbook, said Bill Sandoval, a UCLA education professor who studies how children learn science.

"We want children to learn science concepts through investigating phenomena in the world," Sandoval said.

Students may learn about plastic waste and water in several different classes. They learn about salt and plastic bonds in chemistry, create a website about historic U.S. water use in social studies, and use recycled materials to create artwork for a combined English/science assignment.

More Work Is Needed

Some instructors have resisted the new teaching methods, and the districts have invested heavily in professional development. The use of these new hands-on techniques and climate change lessons is still inconsistent. Teachers struggle with class time, their own reluctance to teach topics in which they lack expertise, and the shift from giving students information to helping them function as scientists.

DISCUSSION QUESTIONS

What are greenhouse gas emissions?

What is a flood detection basin?

What local climate change issues would make good discussion topics?

VOCABULARY

CURRICULUM INQUISITIVE

Earth Day Finds Renewed Purpose at 50

By Christina Phillis

Once upon a time smoke and smog filled the skies, acid and oil clogged rivers and streams, and trash piles formed an ominous backdrop for most major U.S. cities. This was before rigorous water and air pollution regulations, the U.S. Environmental Protection Agency (EPA), and modern recycling. In the 1960s, people were just starting to learn about the grave effects of pollution on their health and the environment. Rachel Carson's *Silent Spring*, which documented the dangerous effects of pesticides, came out in 1962. Years later Cleveland's Cuyahoga River caught on fire due to chemical waste disposal.

The first Earth Day, held on April 22, 1970, is when 20 million Americans took to the streets to say enough is enough. Rallies were held in Philadelphia, Chicago, Los Angeles, New York City, Washington, D.C., and hundreds of other U.S. cities to protest against the destruction of the environment. The day was so influential that it led to the creation of the EPA and the passage of the Clean Air, Clean Water, and Endangered Species Acts.

A New Call to **Action**

2020 marks Earth Day's 50th anniversary and, with it, a greater urgency than ever before to protect our planet. This year's "climate action" theme hearkens back to the day's original grassroots spirit, while focusing on future challenges and opportunities for turning the tide of climate change. With thousands of events planned involving billions of people worldwide, the Earth Day Network is using this semicentennial celebration to usher in a new wave of environmental activism that demands more meaningful and lasting change for the better. Get involved with these events and tools.

The Great Global Cleanup

Earlier this year, Earthday.org President Kathleen Rogers spoke at the Clean World Conference in Estonia to share the details of the Great Global Cleanup and invite cleanup organizations worldwide to engage in solving global waste issues.

The Great Global Cleanup is expected to be the largest environmental volunteer effort in history with a goal of removing billions of pieces of trash from green spaces, urban communities, and waterways. Use the interactive map at earthday.org to find and register for a nearby event or create your own.

EARTHRISE

Hundreds of rallies, meetups, and strikes have already taken place all over the world with the goal of mobilizing change. Earth Day Network and Strike With Us, a campaign of nine youth-led climate organizations and adult allies, coordinated strikes on Wednesday, April 22; community action events on Thursday, April 23; and a push for voter registration and participation in 2020 elections on Friday, April 24. Visit earthday.org to register your EARTHRISE event.

Earth Challenge 2020

Make your own contribution to the amount of open and interoperable citizen science data. The Earth Challenge 2020 mobile app allows you to collect observations on air quality, plastic pollution, and insect populations. The goal is to collect billions of data points that will contribute new insights and help drive policy changes in these areas.

Foodprints for the Future

Food production and consumption account for more than a quarter of all greenhouse gas emissions. Foodprints for the Future hopes to show individuals and institutions how they can decrease their "foodprint" — the impact their food production and consumption has on the environment.

Resources at earthday.org include foodprint calculators to estimate your current impact and tips for consuming less meat and eating more plants. Colleges and universities can take the 20/20 Foodprints for the Future pledge by replacing 20% of animal products with plant-based alternatives and reducing campus food waste by 20%.

Artists for the Earth

Art can reach people on a more personal level to help drive a deeper understanding and emotional connection with what's happening to our planet. Artists for the Earth encourages artists and art organizations all over the world to engage the public in critical environmental issues. Educators are being asked to integrate arts programming about the environment into their curricula.

Global Teach-Ins

Inspired by the original teach-ins from the first Earth Day 50 years ago, the Earth Day Network is providing the resources necessary to organize your own environmental teach-in in your local community. Teach-ins are defined as lectures and discussions on a subject of public interest. A 2020 Teach-In Toolkit on earthday.org outlines the steps you can take to plan your own event.

DISCUSSION QUESTIONS

Brainstorm actions individuals, businesses, and governments can take to combat climate change. How can all of these stakeholders work together to make a difference?

Use the Earth Challenge 2020 mobile app. Collect observations on plastic pollution, air quality, and insect populations. Discuss your findings.

VOCABULARY

GRASSROOTS CLIMATE CHANGE FOODPRINT INTEROPERABLE TEACH IN

Earth Day Every Day

From the wildfires in Australia to the melting ice sheet in Greenland, the effects of climate change are being felt all over the world every day. Scientists warn that we have only a decade to reduce our carbon emissions by half to avoid the worst-possible outcomes. Earth Day is certainly a great opportunity to reinvigorate the cause, but the work is far from over.

The Earth Day Network is encouraging and supporting continued action at every level. Heads of state are being asked to increase their national commitments to the Paris Agreement on climate change. Leaders in the private sector are being called upon to address climate change at every step of the supply chain. Individual citizens are being challenged to use their influence to drive change. As we quickly approach our climate's breaking point, there has never been a better time to stand up, speak up, and show up.

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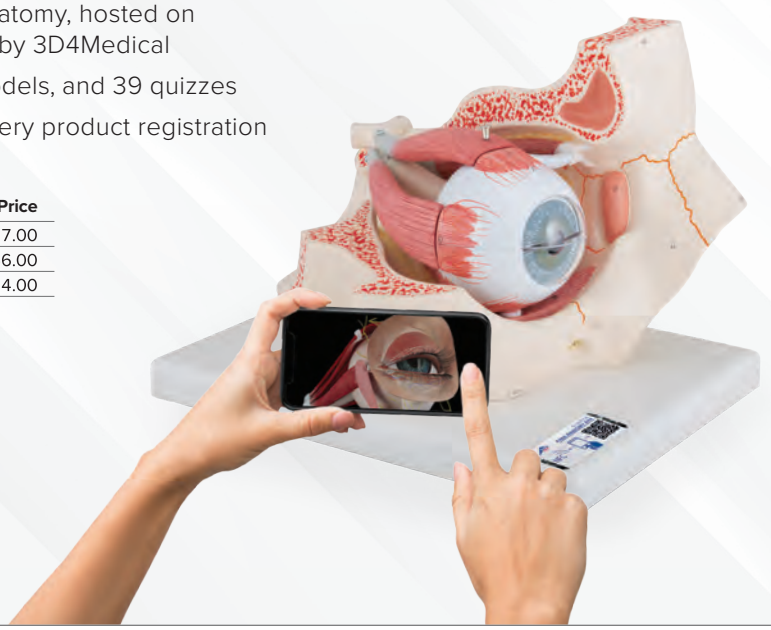

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Reducing Plastic Laboratory Waste

By Mari Yurichko

Single-use plastics, considered a "more convenient and cost-effective" option, have replaced many reusable glass pipettes and culture dishes in today's laboratories.

But stories about plastic bottles found on beaches and microplastics in our food have started to turn public opinion against plastics. Once believed to be a cheap, light, and clean "wonder" material, plastic waste is now considered a serious environmental problem.

The Size of the Problem

In 2015, scientists from the Exeter University bioscience department estimated that they generated as much as 280 tons of plastic waste per year. Extrapolating their data, the world's biomedical and agricultural labs could be producing more than five million tons of plastic waste annually.

> "I was definitely shocked by how much [plastic] I used."

Reduce, Rethink, Replace, Reuse, and Recycle

Let the five Rs guide your efforts to reduce plastic waste.

Reduce — Buy smarter and use less. Review your lab supplies and what you buy. A color-coded spreadsheet may help you identify the different plastics you use and possible alternatives.

Rethink — Assess your use patterns. Consider how many disposables you use to make your experiments easier to conduct. For example, buy smaller multi-well plates when each student must have his own.

Replace — Switch to reusable glass microplates, test tubes, or pipets when decontamination, cleaning, and re-use is a viable option. Reusable racks can replace pre-racked centrifuge tubes, smaller flasks or tubes use less material, bulk pipette tips can refill your tip boxes, and reusable glass products can be substituted whenever possible.

Reuse — Weigh boats can be used multiple times for measuring the same chemical. Reuse offers environmental benefits and may also help a limited budget.

Recycle — The most common recyclable plastics include:

- Polystyrene (PS): cultureware
- Polypropylene (PP): centrifuge tubes
- Polyethylene (high- and low-density, HDPE and LDPE): bottles, wash bottles, closures

Get Your Students Involved

In September 2019, PhD student Samantha Seah collected all the plastic and nitrile waste she used in one day as part of a social media campaign with eLife Sciences Publications. The campaign's goal was to show how much single-use plastic scientists were using across the world. With the hashtag #LabWasteDay, the group posted pictures of their plastic waste and estimated how much they'd generate in a year.

"I was definitely shocked by how much [plastic] I used, and I think many people were, too," Seah said.

Start Now

The environmental impact of laboratory plastic waste cannot be denied or excused. Make changes and educate others about the environmental benefits and cost-effectiveness of reduced plastic waste.

We have a duty as citizens and scientists to educate and conduct ourselves responsibly. By eliminating even some landfill waste, we can make an important contribution.

DISCUSSION QUESTIONS

Is plastic more or less expensive than glass to produce and recycle?

What changes will you make to reduce plastic waste in your lab or classroom?

VOCABULARY

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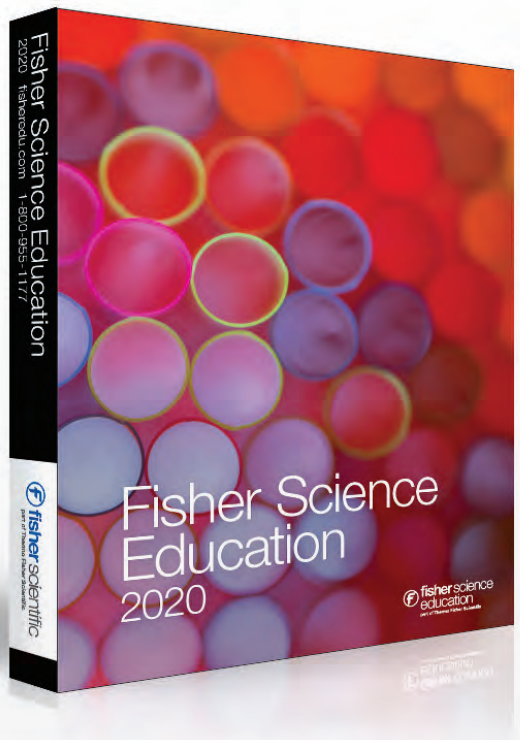

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Whales Migrate to Shed the Skin They're In

By Ralph Birch

Without access to the latest human moisturizers and rejuvenation regimens, whales are resorting to relocation as a means for maintaining healthy skin.

Scientists have discovered that certain whale species are migrating to warmer waters to rid themselves of their bacteria-laden outer layers.

Robert Pitman, a marine ecologist at Oregon State University's Marine Mammals Institute, attached satellite tags to four different species of whales that inhabit Antarctic waters.

Pitman tracked the whales over eight southern summers and found that both baleen and toothed whales traveled as many as 9,400 kilometers to the western part of the South Atlantic Ocean. But they don't make the trip to give birth in warmer waters or escape their typical predators.

> "The cost of being eaten is much higher than the cost of molting in cooler waters."

Researchers are aware that whales, like humans, shed skin cells continuously. But whales are unable to molt in the cold waters of the Antarctic. Instead, they build up a thick, yellow film of microscopic diatoms on their skin.

High concentrations of diatoms can result in the accumulation of harmful bacteria on the skin, which can have an adverse effect on the health of both killer and baleen whales.

The observation of the yellow buildup on the skin of killer whales led researchers to take a closer look. To help them conserve heat in colder waters, researchers hypothesized that killer whales divert blood flow away from their skin.

This causes skin cell regeneration to slow down and drives the whales to seek out warmer waters where their metabolism — and presumably their ability to molt — increases. A recent report published in Marine Mammal Science supports Pitman's assertions, concluding that all whales, not just certain species, migrate for the purpose of molting.

Scientists consider this explanation to be plausible for killer whales, but they're doubtful this pattern of behavior can be applied to all whale species. Richard Connor, a cetacean biologist at the University of Massachusetts-Dartmouth, points out that newborn baleen calves are incredibly vulnerable to predatory killer whales.

"The cost of being eaten is much higher than the cost of molting in cooler waters," Connor said.

Pitman stands by his findings, pointing out that the effects of whale molting on ocean ecosystems is deserving of further study.

"Most people don't consider skin molt important to whales," Pitman said. "But it's an important physiological need. Shedding their skin is a first-line defense against disease and bacteria."

DISCUSSION QUESTIONS

Can you think of any other reasons why whales migrate?

What effects do you think whales' molted skin cells have on other marine life?

VOCABULARY

BALEEN MOLT

DIATOM CETACEAN

Safe Chemical **Waste Disposal**

By Dora Fatula

What's the safest way to dispose of unused chemicals? It depends. Your school or district should have a Chemical Hygiene Plan (CHP) that outlines disposal procedures. If no CHP exists, work with administration and local fire, safety, waste, and water authorities to create one.

Chemicals to Discard

Discard any chemicals that are:

- Expired – Expiration date has passed
- Old – No expiration date, but it has been on the shelf for more than five years
- Degraded – Was not properly closed, has absorbed water, or is otherwise compromised
- Superfluous – Not needed or being used
- Hazardous – Explosive, toxic, irritant, carcinogen, corrosive, oxidizer, poison, allergen, flammable, or violently reactive
- Prohibited – Refer to the ACS Restricted-Use Chemicals list*

*General guidelines developed by the Committee on Chemical Safety; includes an extensive but not all-inclusive list of chemicals that are inappropriate for high school labs.

Disposing of Chemicals in the Trash

Refer to a chemical's Safety Data Sheet (SDS) to determine if it can be discarded in the trash or dumpster. If an SDS is not immediately available, contact the product or chemical manufacturer or search their websites. Also, check with local regulations before disposal.

Chemicals placed in the trash may not be:

- Radioactive
- Biologically hazardous or carcinogenic
- Flammable, reactive, or corrosive
- Hazardous (per the U.S. Environmental Protection Agency)

Alert your maintenance staff when placing chemicals in the trash to help avoid accidents.

Put the chemical in tightly sealed containers and discard only small amounts (no more than five to ten pounds) at a time.

Disposing of Chemicals in Water

Some chemicals may be diluted with water and flushed down the drain:

- Chemicals that meet the criteria for trash disposal
- Acids or bases with a pH between 5.5 and 10.5

Never flush halogenated hydrocarbons, nitro compounds, mercaptans, water-immiscible flammables, explosives, water-soluble polymers, water-reactive materials, foul-smelling chemicals, toxins or carcinogens, insoluble solids (hair, ash, sand, metal, or glass), oil, or grease.

Flush a single chemical at a time and follow each one with copious amounts of water.

Dispose of only a few hundred grams or milliliters in a single day; check with maintenance staff before flushing larger amounts. Flush into the laboratory sink only and never into storm drains, which go directly to the water source without treatment.

Disposing of Hazardous Chemicals

Label, store, and dispose of hazardous chemicals carefully and maintain a log of what you are discarding. Hazardous materials may be collected only periodically, so proper storage until pick-up is critical. It may also be possible to drop off hazardous chemicals at remote collection locations, another school, or other facilities that have regular pick-ups.

Sequester chemicals that cannot be safely stored together, and make sure to place them in dedicated cabinets for flammables and corrosives. Some common school lab hazardous wastes include:

- Heavy metal solutions (including chromium, copper, and lead)
- Organic solvents (like hexane, benzene, and toluene)
- Corrosive liquids (strong acids or bases)

DISCUSSION QUESTIONS

What is a chemical hygiene plan and why is it important?

What are the key sections of a safety data sheet (SDS)?

What resources are available to help you safety dispose of chemicals?

VOCABULARY

SAFETY DATA SHEET CARCINOGEN COPIOUS

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A New Way to **Synthesize Diamonds**

By Mae Pyer

Diamonds are more than an icon of the jewelry industry. They're used in medicine, quantum computing, biological sensing, and other industries. Their extreme hardness, optical transparency, and chemical stability are properties that make them highly sought after.

Using a substance found in fossil fuels, a new study at Stanford University's School of Earth, Energy, and Environmental Sciences found that the right combination of pressure and heat can create pure diamond. Their work was published in *Science Advances*.

Understanding What's Underground

Diamonds are made of carbon that's crystallized hundreds of miles underground and exposed to thousands of degrees of heat (in Fahrenheit). Many of the diamonds we see today are a result of volcanic eruptions that brought them closer to the surface and made them easier to collect.

> Under these conditions, the transformation happened in a fraction of a second.

Through a microscope, diamonds have a unique crystal structure that contributes to their symmetry, as well as other desired properties. Their atoms are tightly bonded and arranged in patterns.

New Processes and Possibilities

Scientists have been making diamonds in labs for over 60 years. The process usually requires time, energy, and a catalyst, a factor that contributes to decreased quality. But researchers at Stanford, in collaboration with the SLAC National Accelerator Laboratory, have found a cleaner process.

"What's exciting about this paper is it shows a way of cheating the thermodynamics of what's typically required for diamond formation," said Rodney Ewing, Stanford geologist.

Their starting material, an odorless powder resembling rock salt, consisted of atoms arranged like those in a diamond crystal. Instead of pure carbon, these molecules are made of hydrogen and carbon, and are therefore considered diamondoids.

Researchers placed samples of the powder into a diamond anvil cell, a small pressure chamber that sandwiches samples between two polished diamonds. This amounted to 20 gigapascals of pressure. They also heated the samples with a laser to 1160 degrees Fahrenheit.

Under these conditions, the transformation happened in a fraction of a second. The carbon atoms immediately aligned, skipping other forms like graphite. The result? A diamond.

A Diamond a Dozen

The Stanford team's method generates low quantities, but it helps them learn more about diamond formation and the conditions beneath the Earth's surface. This process is more energetically efficient and doesn't require a catalyst, potentially increasing the quality of the diamonds produced in this way.

"Starting with these building blocks you can make diamond more quickly and easily," said Wendy Mao, Stanford mineral physicist, "and you can also learn about the process in a more complete, thoughtful way than if you just mimic the high pressure and high temperature found in the part of the Earth where diamond forms naturally."

DISCUSSION QUESTIONS

What materials and conditions are needed to form a natural or man-made diamond?

What's the difference between a diamond and diamondoid?

What makes a diamond unique? And what about its carbon structure makes it so strong?

VOCABULARY

CARBON DIAMOND

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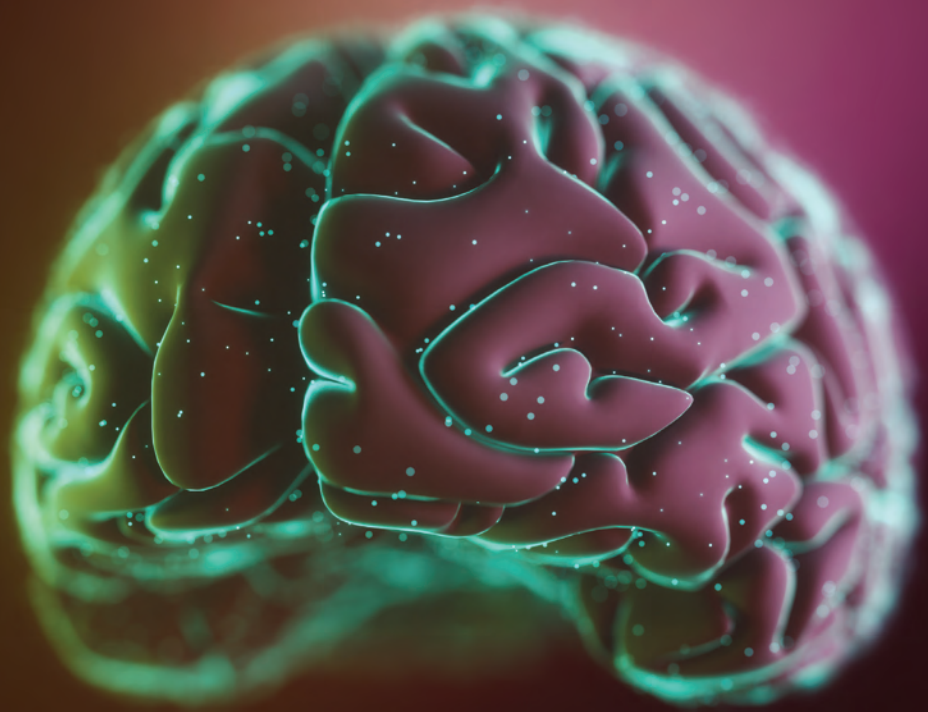
Forget the Strain, **Train Your Brain**

By Kevin Ritchart



If you find that you're often easily distracted, it might have little to do with external stimuli like crowds, ambient noise, or the temperature of the room where you're sitting. The answer to being more attentive could very well lie between your ears.

A new study, published earlier this year in *Neuron*, suggests that brain waves tell us a lot about how the brain focuses attention.

Yasaman Bagherzadeh, a neuroscientist, from the Massachusetts Institute of Technology (MIT), helped lead the study. Her team monitored the brain activity in 20 adults with the goal of finding out how brain waves might affect attention.

The MIT team employed a device that identifies and records the magnetic fields associated with brain waves. One variety of brain waves, known as alpha waves, pulse at a rate of approximately 10 times per second. Alpha waves play a part in the brain filtering out distractions, according to Bagherzadeh.

> As alpha waves strengthen, people are less likely to pay attention.

During the study, participants sat beneath a brain wave monitoring device and looked at a computer screen. Each person was shown a pattern of lines in the middle of the screen. At first, these lines looked somewhat blurry.

The participants were instructed to look at the lines and try to make them less blurry, but they weren't told how to accomplish this. They were essentially playing a game without being told the rules.

Researchers used the lines on the screen to give each participant feedback about their alpha waves in real time. The pattern of lines got clearer when participants changed their brain waves based on the instructions they received from researchers.

Without realizing it, participants changed their alpha waves. Researchers found that strengthening alpha waves on one side of the brain changed the way participants focused their attention in later tasks.

Because of how the brain is wired, when you look to the right, the left side of the brain responds. As alpha waves strengthen, people are less likely to pay attention. By reducing alpha waves in the left side of the brain, it's easier for people to focus on something that's happening on their right.

With that in mind, researchers had participants attempt to make alpha waves stronger on one side of their brains and weaker on the other. Half were asked to make the alpha waves stronger on the right, and the other half were asked to make them stronger on the left. If participants shifted the strength of their brain waves as instructed, the fuzzy lines on the computer screen became clearer.

The goal of the study was never to train one side of the brain to concentrate better than the other. Researchers want to learn how to change brain waves to boost attention, how long the attention boost lasts after training, and whether other types of brain waves play a role.

DISCUSSION QUESTIONS

What are some examples of times when you find it difficult to pay attention?

What kinds of things can you do to help improve your focus?

VOCABULARY

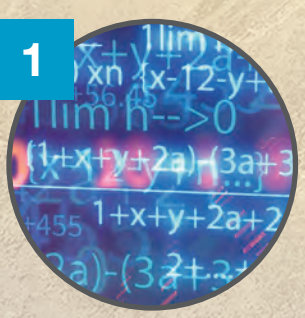
NEUROSCIENTIST BRAIN WAVE

10 Noteworthy **Science Anniversaries** in 2020

By Sadie Laurie

It's another big year for science anniversaries according to *Science News* Contributing Correspondent Tom Siegfried. In his online article, "Top 10 science anniversaries in 2020," he recognizes people and discoveries that, "left the world a different place than it had been before."

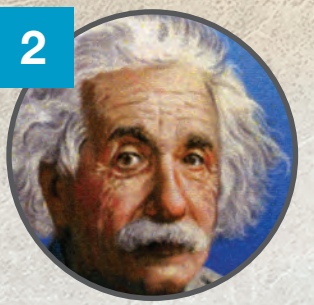
1



Roger Bacon, 800th Birthday

A leading natural philosopher of his time, born around 1220, Bacon was among the first to believe in the necessity of using experiments to investigate nature. He advocated for the use of optics as a fundamental science and understood the importance of applying math to his research.

2



Bose-Einstein Condensate, 25th Anniversary

Albert Einstein made many discoveries in his lifetime and his ideas have continued to inspire scientific revelations long after his death. For seven decades, physicists had been trying to produce the specific conditions required to create a Bose-Einstein condensate cloud of unified matter. Finally, in 1995, physicists were able to bring Einstein's idea to life.

3

The Great Debate, Centennial

On April 26, 1920, astronomers Harlow Shapley and Heber Curtis met to debate about the makeup of the universe. Shapley argued that the Milky Way galaxy comprised the entire universe, while Curtis countered that other distant universes existed, but were being misclassified as spiral nebulae. Astronomer Edwin Hubble settled the debate in 1924 when he published findings that proved Curtis to be correct.

4

Discovery of Electromagnetism, Bicentennial

In 1820, Hans Christian Oersted, a chemist-physicist at the University of Copenhagen, made a discovery that changed the course of civilization. He found that wires carrying an electric current generated magnetism outside of the wire. The knowledge of this electromagnetic force helped establish the principle of large-scale power generation that is so vital to our lives today.

5

Discovery of X-Rays, 125th Anniversary

Wilhelm Röntgen was the German mechanical engineer and physicist who discovered X-rays in 1895. This discovery helped strengthen the realization that electromagnetic radiation existed in several forms in addition to light. X-rays went on to transform the fields of medicine, astronomy, and biology.

6

Rosalind Franklin, 100th Birthday

Born in London July 25, 1920, Rosalind Franklin was a chemist at King's College London where she worked with Maurice Wilkins studying the molecular structure of DNA. She was particularly skilled at producing X-ray images of DNA and came close to identifying DNA's double-helix structure. A follower of her work, James Watson, used one of Franklin's images to determine the correct DNA architecture in 1953, along with Francis Crick.

7

John Graunt, 400th Birthday

John Graunt, born April 24, 1620, was a pioneer in drawing scientific conclusions from analysis of statistical information. An owner of a London drapery business, he became interested in creating tables to track records of people's births, deaths, and diseases. When he began to notice trends and patterns in the data, he decided to analyze it mathematically, gaining insights into male/female and urban/rural life expectancy.

8

Florence Nightingale, 200th Birthday

The most famous nurse of the 19th century, Florence Nightingale was born May 12, 1820. In 1854, during the Crimean War, she instituted a cleanliness policy that reduced the death rate among hospitalized British soldiers. Nightingale was also a groundbreaking practitioner of applied statistics. She presented much of her statistical evidence for the benefits of proper health standards in graphical form, which earned her a reputation as an innovator of data visualization.

9

Prediction of the Neutron, Centennial

In a lecture delivered June 3, 1920, Ernest Rutherford, physicist at the University of Cambridge, introduced a new kind of atom with zero electric charge that we now call a neutron. In the speech, he made an important prediction that his colleagues took to heart, "In consequence it should be able to move freely through matter." Decades later, physicists realized that this unique capability enabled neutrons to initiate nuclear fission chain reactions.

10

Atomic Bomb, 75th Anniversary

The American-led team of scientists working on the Manhattan Project detonated the first atomic bomb in Alamogordo, New Mexico, in 1945. By harnessing the power of the innards of atoms, the team created a weapon capable of destruction on a scale previously unthinkable. It has changed the way war is waged, influencing society solely by its existence and demonstrating the seemingly limitless potential of science.

DISCUSSION QUESTIONS

Which anniversary do you think has had the most impact on our lives? Why?

Are there any scientists in the list who you haven't heard of? What did you learn about them?

VOCABULARY

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