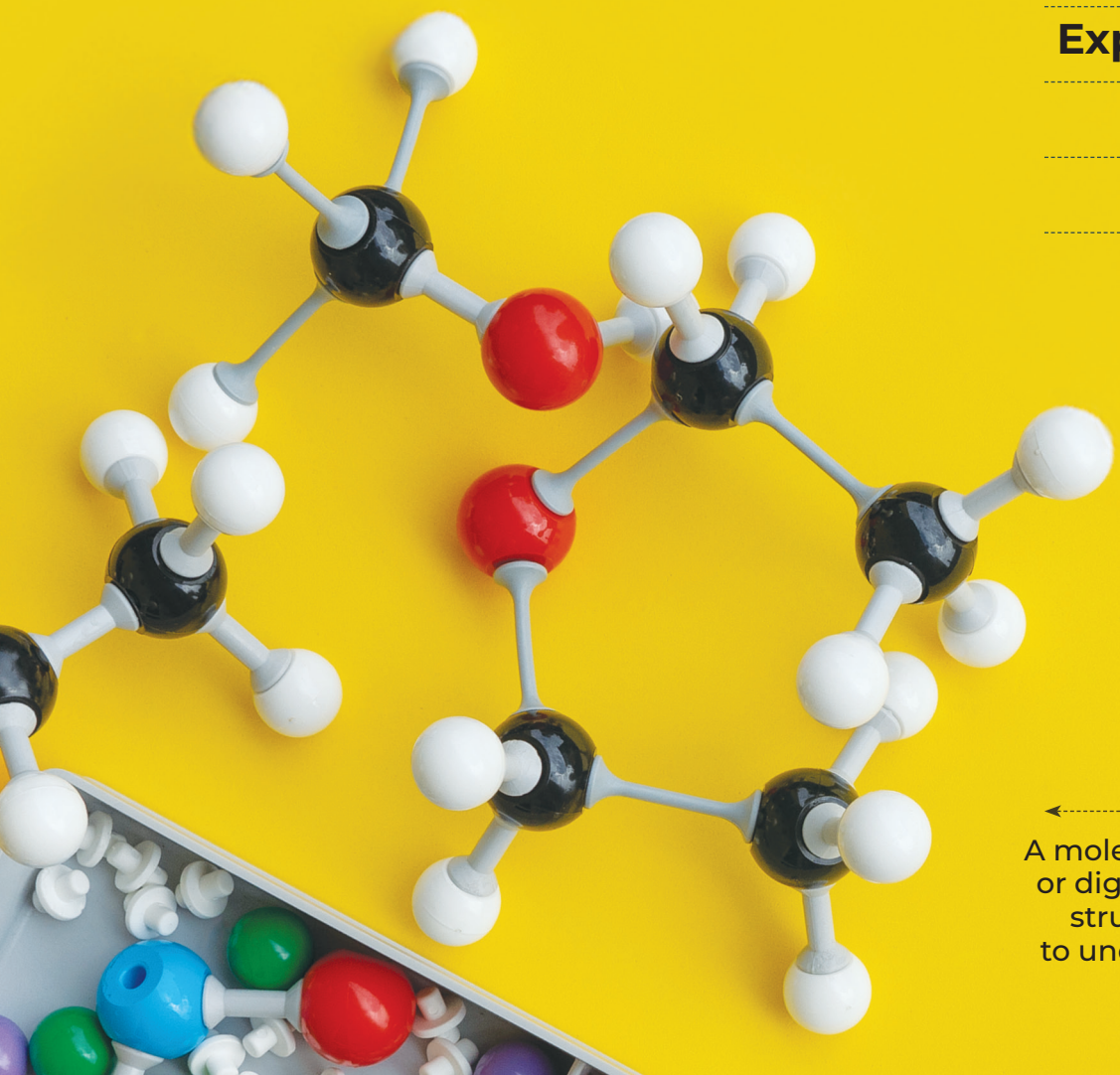
QUARTERLY ISSUE: AUGUST–OCTOBER 2025

SCIENCE SPARK

CULTIVATING CURIOSITY



Molecular Model

A molecular model is a physical or digital representation of the structure of molecules, used to understand their properties and behavior.

SCIENCE SPARK

CULTIVATING CURIOSITY

MACMILLAN

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Browsing of websites suggested in activities and projects in the book is to be done under adult supervision and Macmillan holds no responsibility for the content or the availability of these resources.

Acknowledgement

Science Journal for Kids <www.sciencejournalforkids.org> for the articles [under the Creative Commons Attribution (CC BY)] in *Science Spark*.

From the MD's desk

MACMILLAN 180
ENGAGING CURIOUS MINDS SINCE 1843

180 years of progress and discovery!

Nearly two centuries of progress and advancement in science and education have helped shape the business we are today. Research and learning continues to be the cornerstone of progress, and we continue to open doors to discovery through trusted brands and innovative products and services. Springer Nature was created in May 2015 through the combination of Nature Publishing Group, Macmillan Education and Springer Science+Business Media.

'Macmillan Budding Scientist' was launched in India in 2018 as a Springer Nature initiative. It is run to cultivate curiosity in young learners, channelise their interest in Science, give a structure to their questioning and offer them a platform to showcase, present and learn. We are committed to taking 'Macmillan Budding Scientist' to thousands of schools and giving them the benefit of our partnership with the Indian Institute of Technology for campus tours and residential experiences. In the process, we will be fostering the next generation of scientists and innovators who will solve India's challenges of inequity and inaccessibility to resources.

The Path to Progress is built on Science.

Mr. Rajesh Pasari
Managing Director
Macmillan Education India

From the Marketing desk

In India, most students view Science as a subject to be mastered to get admission into premier institutes. Faculty at these institutes say that students who enter these premier institutes are the ones who have genuine interest in Science – they ask questions all the time and do not accept things at face value! I believe Science is a mindset—rooted in logical thinking, observation, and critical analysis. It is experimenting, learning from failure, and persistently seeking solutions to make life easier and more enjoyable. As a way of learning, enquiry is the best way to explore problems, seek potential solutions, make observations, pose questions, experiment with ideas, and engage in creative and intuitive thinking.

Science Spark is our collaborative effort with Science Journal for Kids to make scientific research accessible to young learners by presenting it in a language they can understand. *Science Spark* is a compilation of scientific articles of interest from all over the world, written to ignite curiosity and trigger deeper reading and action. It also has other snippets like a quiz, curiosity corner and science skill focus. We would like learners to spend time reading and absorbing it – questioning it and writing back to us.

Science Spark provides scaffolding for our Science programme, 'Macmillan Budding Scientist', which aims to fill the gap between focused acquisition of scientific concepts and their application to real-world challenges. 'Macmillan Budding Scientist' is a transformative experience for students. It only accepts original thinking, questions logic and emphasises science communication. If we can achieve this for even a few students every year, we see it as success for us as a learning company.

The world needs more original thinkers, problem-solvers, and innovators. *Science Spark* and 'Macmillan Budding Scientist' aim to identify some of them!

Ms. Vandana R Juneja

Director Marketing
Macmillan Education India

Contents

WHAT DOES HUMMINGBIRD COLORATION TELL US ABOUT COMPETITION?*

Authors: Jay J. Falk, Dustin R. Rubenstein, Alejandro Rico-Guevara, and Michael S. Webster
Associate Editors: Miranda Wilson and Rachel Watson

Abstract

Have you ever wondered why animals of the same species look different from each other? Think of the impressive tail and call of a rooster compared to the duller hens. Well, usually there's a reason those differences have evolved.

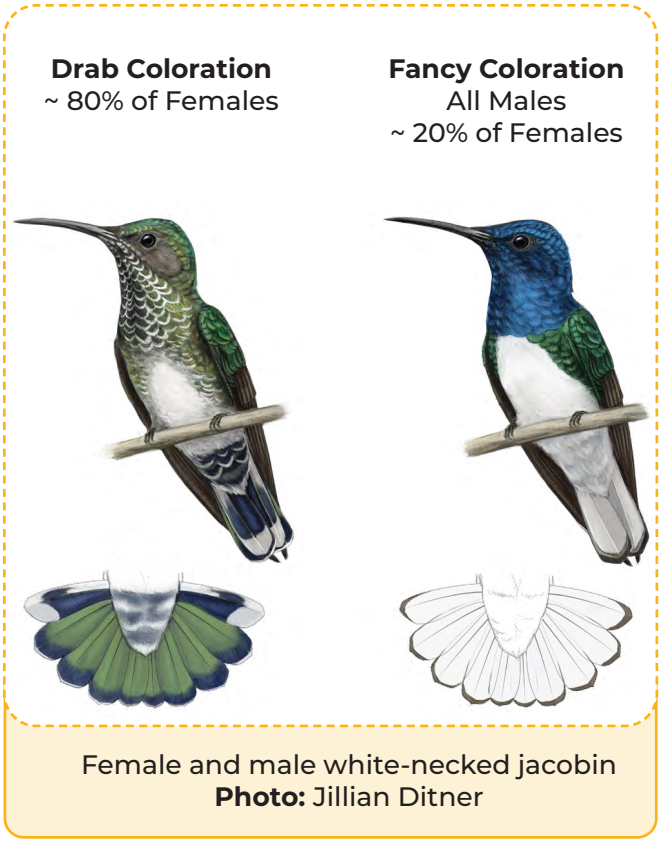
We examined white-necked jacobins to learn more about their coloration. Some of the females of this hummingbird species have a fancy coloration pattern like the males do. The males of this species are aggressive and socially dominant. Other birds think the fancy females are males and leave them alone to feed. We wanted to know if the fancy females just look fancy or if they are actually better competitors.

We found that fancy females are mimicking male coloration patterns. Otherwise they are more like other female jacobins. This is the first time we've seen females mimicking males to get the advantages of a socially dominant form.

*Article Source: https://www.sciencejournalforkids.org/wp-content/uploads/2023/10/hummingbird_article_lower_level.pdf taken from: https://www.sciencejournalforkids.org

Introduction

Animals look different. Their appearance gives them unique characteristics and behaviors. It also allows them to survive in their environment. Often there are two or more different forms within a species. This is called polymorphism and could include different coloration patterns, different shapes, or different behaviors. A familiar example is that males and females of a species often look different (sexual dimorphism). Another example of polymorphism is when only one of the sexes has multiple coloration patterns or morphologies. The other sex only has one form. This is called sex-limited polymorphism.



Female and male white-necked jacobin
Photo: Jillian Ditner

Most research on sex-limited polymorphism focuses on males that have multiple forms. This is commonly a result of sexual selection. Males try to attract females with a variety of bright colors and flashy displays. We know a lot less about sex-limited polymorphism where females have multiple forms.

Interestingly, some hummingbirds show female-limited polymorphism. A few species even have some females that mimic the fancy coloration of males. Mimicry happens when one organism looks or behaves like another. This gives them some kind of advantage. For example, coral snakes are venomous and have a distinctive red, yellow, and black banded coloration pattern. Milk snakes have evolved with a similar coloration pattern, but they are not venomous. Predators avoid the milk snake. They look the same as the coral snake, so predators think they are venomous.

We know that fancy hummingbird females get more access to food because they look like aggressive males. No one wants to pick a fight with a good competitor, so they leave the fancy females alone to eat.

We wanted to know, though. Do the fancy females behave more like males or more like other females? Are they actually better competitors than drab females? Or are they just faking it with their coloration patterns?

Methods

We looked at white-necked jacobin hummingbirds in Panama to answer our questions. Female white-necked jacobins have two coloration patterns: drab and fancy. About 80% are a dull greenish-brown (drab), but 20% have a blue head and white neck and tail (fancy). The fancy females look exactly like the males.

We looked at three different types of information:

1. Morphology – We caught 436 birds and measured traits like mass, wing length, and wing width. We recorded their coloration. We also took blood to determine their sex.
2. Flying ability– We captured 210 birds and measured how much weight they could lift when flying. We also looked at the ratio of their body weight to their wing area. These characteristics both help hummingbirds turn and speed up while they are flying.
3. Feeding strategies – We tagged hummingbirds with radio tags. We recorded how often they visited feeders at our study sites. We used a model to help us figure out if their behavior was territorial or non-territorial.

All three affect a hummingbird's ability to compete with each other while chasing each other in the air. We used statistics to find out if there were any differences between drab and fancy females. We also looked for any differences between males and females.

Results

Other than color, we couldn't tell the difference between the two types of females. They had similar mass, wing length and width. The difference between females based on flying ability was also too small to be important (Figure 1). In contrast, males had

Which hummingbirds were more similar in their lifting ability?

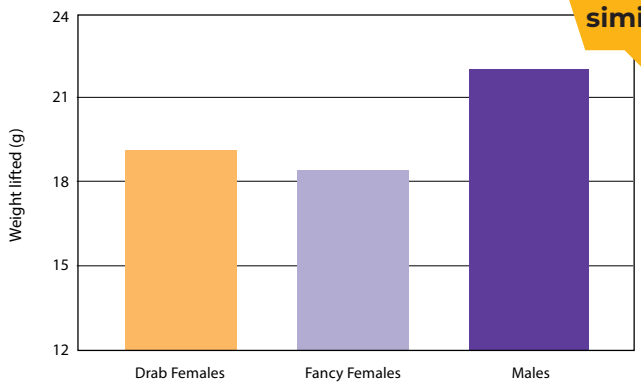


Figure 1:
Weight lifted by whitenecked jacobins with different coloration patterns. The amount of weight a bird can lift shows their potential to be competitive over food.

larger wing lengths and widths than females. Males could also lift more weight and had a greater bodyweight-towing area ratio than females. We saw that both males and females had non-territorial feeding strategies. They visited a large number of feeders. Some males also visited a small number of feeders a lot of times. This is a territorial feeding strategy.

Discussion

Our results show that fancy females are mimicking males. They don't have the same morphology or behaviors. They are more like drab females. Males have qualities that make them more competitive in the air. Our feeding study also shows that some male hummingbirds are territorial. Males compete for food and try to prevent other birds from accessing feeders. Males are more aggressive than females. This makes them socially dominant.

Fancy females are harassed less because they look like aggressive males. This means they get to eat more food instead of being chased away. Hummingbirds have the highest metabolic rate of any animal for its size. Getting enough food is really important. Fancy females don't have to have bigger muscles or greater strength to get more food. They just have to look like males!

This is the first time that we have seen a female-limited polymorphism that mimics the colors of the socially dominant male. In the future we'd like to study the genetic basis of this polymorphism. There may be differences between the different forms that we can't see or measure easily. This could help us understand the evolution of polymorphism and variation in organisms.

Conclusion

Hummingbirds are amazing birds. They can be found as far north as Alaska and as far south as Chile. If you live in the Americas, you can set out your own feeders to watch the hummingbirds in your neighborhood. If not, you can still set out bird feeders and keep track of any behaviors you notice. Do you see different species of bird visiting your feeders?

Do you notice any aggressive behaviors? Are there any birds that seem to be territorial? Also, make sure to have fun and enjoy your bird watching!

Glossary of Key Terms

- **Coloration** - the arrangement of colors on the outside of an organism.
- **Mimicry** - the evolution of organisms looking like each other. This can occur between two species or within the same species.
- **Morphology** - the form of an organism. This includes the outward appearance of an organism like colors, shapes, and textures. It can also include internal structures like bones and organ systems.
- **Polymorphism** - two or more different forms within a species.
- **Sex-limited polymorphism** - when two or more forms within a species only appear in one of the sexes. The other sex only has one form.
- **Sexual dimorphism** - when the males and females of the same species look different. This could include differences in coloration, size, or ornamentation.
- **Sexual selection** - a mechanism of natural selection where one sex chooses mates of the other sex. This usually relates to competition for access to mates and sex-selected polymorphism.
- **Socially dominant** - describes an individual at the top of a hierarchy within a group. This is based on group interactions. Socially dominant individuals can sometimes exclude others from important resources like food.
- **Territorial** - a group of behaviors that allow an organism to protect a specific area from other individuals. These behaviors include making sounds, displaying aggression, leaving scents or marks, or actually chasing other individuals away.

Acknowledgment: This article's adaptation was supported by the Moderna Charitable Foundation.

Check your understanding

1. What is polymorphism? What are some examples of polymorphism that you can think of?

2. What three broad categories of things did we collect data about? What did we compare using this data?

3. What are the two hypotheses that we tried to test with our data? Which hypothesis was supported? How would our data have looked different if the alternative hypothesis was supported?

4. We found that male hummingbirds exhibited both non-territorial and territorial feeding strategies. What would a non-territorial feeding strategy look like? What about a territorial feeding strategy? Describe these strategies based on the number of feeders that hummingbirds visited and how often they visited those feeders.

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CAN WE USE BACTERIA TO MAKE RENEWABLE ROCKET FUEL?*

Authors: Pablo Cruz-Morales, Kevin Yin, Jay D. Keasling, and others
Associate Editors: Lois Flounders and Rachel Watson

Abstract

NASA's space shuttle has to go really fast to reach outer space. In fact, it has to go about 300 times faster than a car going 60 mph (97 km/h)! Rockets need fuel with lots of energy to go that fast. We call these high-energy fuels. Airplanes and cargo ships use the same type of fuel. Right now, these high-energy fuels are made using fossil fuels. When we burn fossil fuels, it causes climate change. It would be nice if we could make high-energy fuels more sustainable.

Some bacteria make molecules that have lots of energy. We wanted to know if we could use these molecules to make more sustainable high-energy fuels. We looked at DNA from bacteria. We also used some clever chemistry. And we made a new biofuel. It seems to have even more energy than the high-energy fossil fuels we have now!

***Article Source:** https://www.sciencejournalforkids.org/wp-content/uploads/2023/03/pop_fuel_article_lower_level.pdf **taken from:** https://www.sciencejournalforkids.org

Introduction

Do you know what we use fossil fuels for? You probably know we use gas (or petrol) for cars. If you live somewhere cold your family might use fossil fuels to heat your home. We need to use less fossil fuels to slow down climate change (Fig. 1). But they are everywhere! We even use fossil fuels to make things like crayons, toothpaste and plastics!

It might be tough, but we need to break up with fossil fuels. We do have some sustainable fuels already. We call them biofuels. We already use them to power specially adapted cars. But it is very hard to find high-energy fuels that are sustainable. We use these types of fuels to power rockets and airplanes. These fuels are hard to make and they are dangerous. They are also expensive.

When we burn fuels, we make energy. That energy comes from breaking apart the fuel molecules. In high-energy fuels, like jet fuel, many of the molecules look like rings. Rings contain a lot of energy. But molecules that look like triangles have the most energy. Just imagine trying to bend a straw into a triangle shape. You have to put a lot of work into keeping the shape. Otherwise it will spring back to being a straw.

Breaking ring-shaped or triangle-shaped molecules makes them release a lot of energy. But it's hard to make fuel with lots of these molecules in a lab. Luckily, some bacteria make molecules with this triangle shape. Bacteria use them to kill fungus. We call these molecules POP molecules.

We wanted to make high-energy fuels with POP molecules from bacteria. We call them POP biofuels. Can we make them in a safe and easy way? Can we make them quickly and sustainably for the future?

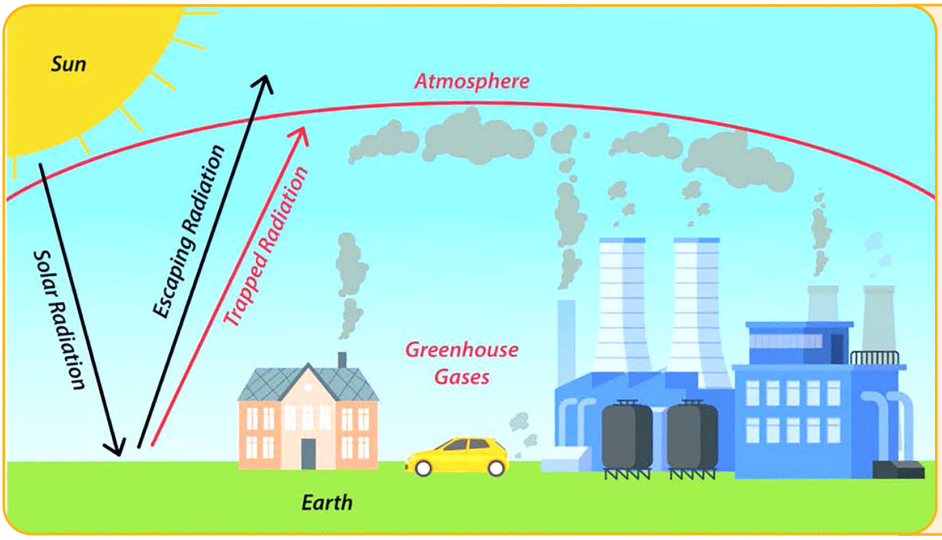

Figure 1:
Burning fossil fuels releases gases that trap heat in the atmosphere. This causes the average global temperature to increase and the climate to change.

Methods

There are a lot of bacteria on our planet - over 30,000 different kinds! But very few of them can make POP molecules.

- First, we had to find bacteria that make POP molecules.
- So, we did some DNA detective work! We looked at the DNA of 7,762 different bacteria.
- We found that some soil bacteria produce POP molecules on their own. But the bacteria were hard to grow in our lab.
- So, we transferred the DNA that made POP molecules from the bacteria. Then we changed the DNA to make POP molecules in a different bacteria that was easier to grow.
- Then we modified these POP molecules to turn them into high-energy POP biofuels.
- Finally, we compared the POP biofuels to other fuels.

Results

- We discovered a new way to make POP biofuels from POP molecules.
- Our new POP biofuels are high energy. They can also be kept at room temperature. This means that they can be used for a lot of things, like fueling ships and airplanes.
- These POP biofuels might even be higher energy than the fuels we have now! (See Figure 2.)
- We found a new, sustainable, and safe way to make high-energy fuel – from bacteria!

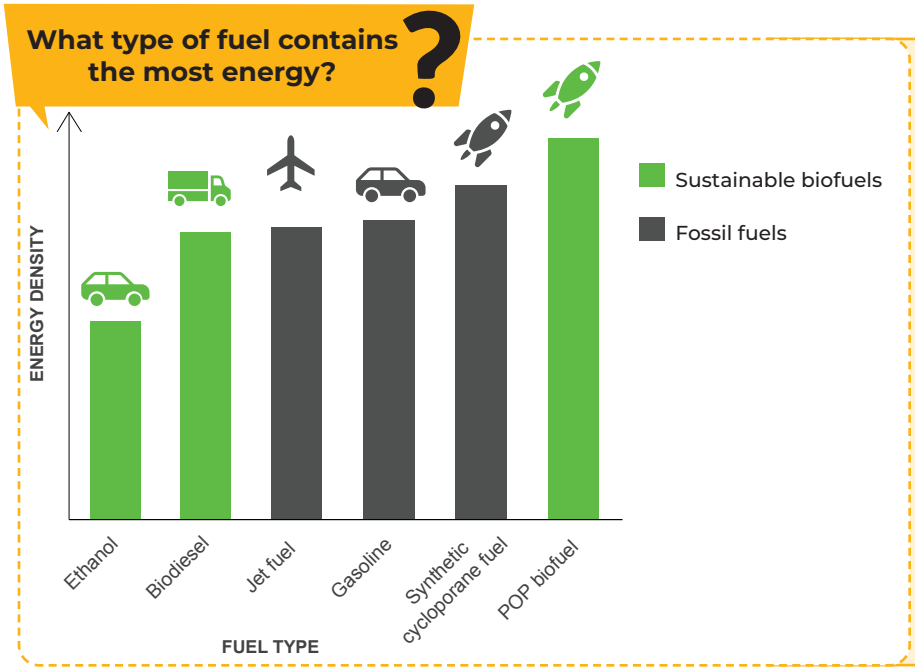

Figure 2:
Different types of fuels and the amount of energy they contain.

Discussion

The climate is changing because of fossil fuels. Scientists think the planet will warm by 2.5°C by 2100. Humans and the environment will both suffer. We need to stop using fossil fuels as fast as possible. We need high-energy fuels to launch rockets and fly airplanes. Current biofuels don't have enough energy to help. Rocket launches today are rare. Going into space might be more common in the future. But flying is quite common now. If we can make high-energy biofuels, we could help slow climate change.

We made high-energy POP biofuels using bacteria! We can replace fossil fuels with more sustainable ones. This can help slow climate change. Next, we need to make more POP biofuels and put them to the test.

Conclusion

We depend on fossil fuels for so many things in our lives. We use them to fuel our cars and make the plastics that we use every day. It's a huge problem. Look around you. Maybe you're sitting on a plastic chair, or using a plastic pen. And what about the clothes you wear? Have a look at the label. Does it say nylon, polyester, or acrylic? These fibers are all forms of plastic, too.

One simple way to reduce fossil fuel use is to shop secondhand for things like clothes and furniture. Or why not organize a clothes swap with your friends? And of course, it always helps to walk, bike, or use public transportation instead of going by car whenever possible.

CURIOSITY CORNER

Do you have a WHY buzzing in your mind? Do you want to ask about black holes, dinosaurs, dreams in colour, telepathy or anything at all? Ask us!

In the Curiosity Corner, our science expert will answer all your questions and tickle your curiosity.

- ***Mail your question to mbs@macmillaneducationcom***
- ***Subject Line: Curiosity Corner – [Your Name]***

We will feature selected questions (and expert answers) in the next issue of Science Spark.

Glossary of Key Terms

- **Bacteria** – a large group of microscopic living organisms. They only have one or a few cells. Some can cause harm to animals and humans. But many help us digest food and break down waste. They can also help fertilize plants and make medicines.
- **Biofuel** – a fuel that is made from something living. This could be a plant or an animal, or even a bacteria. The most common biofuels are wood and corn. We also have biofuels we use to power specially adapted cars (ethanol and biodiesel).
- **Climate change** – change in temperature and weather that happens over a long time period. Humans burn fossil fuels. This is a main contributor to climate change.
- **DNA (Deoxyribonucleic acid)** – molecules inside cells. They carry information about how the cell works. It also has information about everything the cell can make.
- **Fossil fuel** – molecules that contain lots of energy. They are made from plants and animals that decompose and get buried. After millions of years, they form molecules that can be burned for energy. Common fossil fuels are coal, natural gas, and oil.
- **Molecule** – the smallest unit of a chemical compound. It is made of atoms or smaller molecules bonded together.
- **POP biofuel** – fuel made by living things. They have lots of triangle-shaped molecules in them. POP fuels are a new type of high energy fuel made using bacteria instead of fossil fuel!
- **Sustainable** – when people interact with the environment in a responsible way. People avoid harming the environment. And they don't use up resources. For example, they can use renewable energy.

Acknowledgment: This article's adaptation was supported by the GM Foundation.

Check your understanding

1. Why do we need high-energy fuels? Why would it be better if they were made in a sustainable way instead of made using fossil fuels?

2. There are not many bacteria that produce POP molecules. How did we find them? What did we have to do to work with them in our lab?

3. Our POP biofuels might have more energy than other high-energy fossil fuels. Why is this important?

4. Look around the room you are in. List as many objects as you can that are made from fossil fuels. How about things that rely on fossil fuels to work? Or needed fossil fuels to help make them?

5. With a partner or small group, brainstorm ways that your school can reduce its fossil fuel use. Then write a letter to your principal sharing your ideas!

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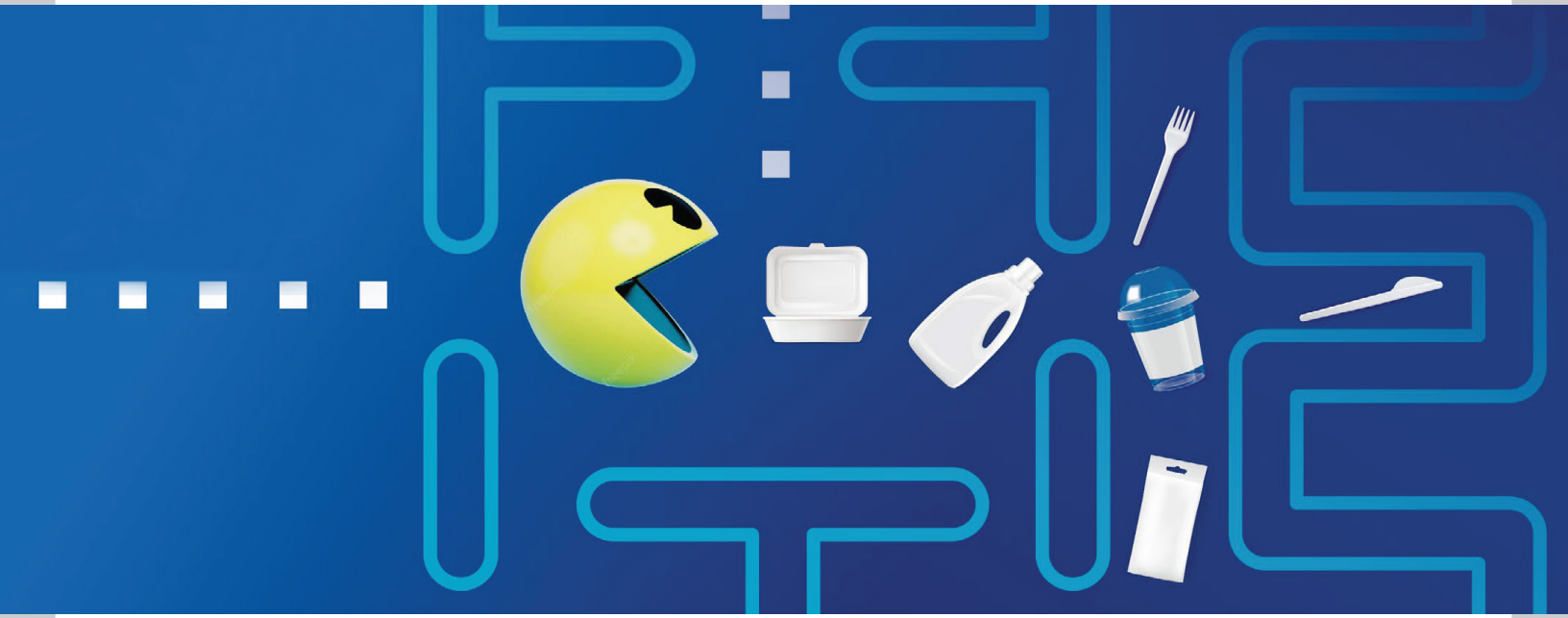
HOW CAN WE RECYCLE PLASTIC MORE SUSTAINABLY?*

Authors: Christian Sonnendecker, Juliane Oeser, Thorsten Oeser, and others
Associate Editors: Jared Smith, Miranda Wilson, and Rachel Watson

Abstract

Plastic is all around us: in our toothbrushes, pens, cars, and even clothing! It is very useful. But plastic trash ends up in the environment and is bad for animals and humans. It can take hundreds of years to break down. Recycling this plastic can take a lot of energy and often still leaves waste. We wanted to find a better way to break plastic down and reuse it to make new plastic. We discovered an enzyme that "digests" plastic in the same way that humans can digest food. Using this enzyme to break down used plastic means we will need much less energy to recycle plastic. Plus, we can even use the products of the process to make plastics that are just as good as new ones!



*Article Source: https://www.sciencejournalforkids.org/wp-content/uploads/2023/04/closed_loop_article.pdf taken from: https://www.sciencejournalforkids.org

Introduction

Plastic is very important. We use it for food containers, clothing, bags, and much more! Can you count the number of plastic things you use every day?

Unfortunately, most plastic waste ends up in landfills. We only recycle a small amount of plastic because it's hard to do. Plastics are separated, melted down, and then reshaped into new plastics. This process needs high temperatures and takes a lot of energy. It also produces harmful pollution. Plus, recycling decreases the quality of the plastic. This means we can only recycle plastic a few times before throwing it away.

A closed-loop system would be much better for the environment. In closed-loop recycling, plastic would never end up in a landfill. Instead, it would be recycled forever.

To do this, we need to make sure the quality of plastic stays the same during recycling. We think enzymes can help! Enzymes are like little machines working inside your body and in the environment. Enzymes help all kinds of chemical reactions happen, including breaking down molecules into smaller molecules. When you eat, enzymes help break down food into smaller molecules your body can use.

We decided to look for an enzyme that could help break down plastic. Then maybe we could use it to create a closedloop recycling system for plastics (Fig. 1).

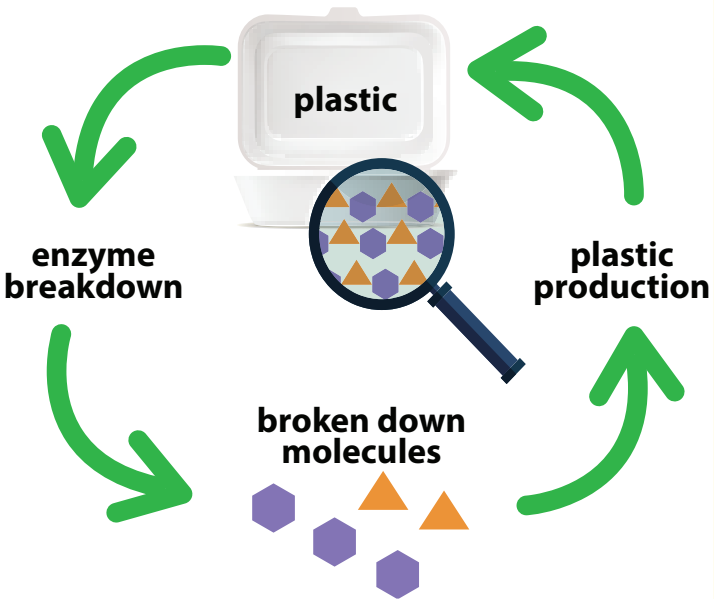


Figure 1:
How a closed-loop recycling system could work. The enzyme breaks down the plastic into molecules that can be reused to make more plastic.

Methods

Plants contain molecules that are similar to the plastic molecules we wanted to break down. In compost piles, microscopic organisms produce enzymes that can break down these plant molecules. So we collected several samples from compost sites in Leipzig, Germany. We looked at the DNA in our samples to find enzymes that might help us break down plastic. We found seven different enzymes! So we did some experiments to see how well they worked.

First, we placed each enzyme in a container with plastic. We let the enzymes break down the plastic molecules for 24 hours. We did this at different temperatures, too. Then we measured how much plastic got broken down. We also compared our enzymes to another enzyme that we already know breaks down plastic. We did more tests using the best enzyme. We tested to see how fast it worked. We looked at its shape and figured out how stable it was as well.

Once we knew enough about the best enzyme, we did one final experiment. We used it to break down a plastic takeout container. Then we used the broken down molecules to make new recycled plastic.

Results

Our experiments led to the following key results:

- The best enzyme was the one we named “Plastic Hydrolase Leipzig 7”, but we’ll call it Enzyme #7 here. After 24 hours Enzyme #7 had digested almost 100% of the plastic! (See Figure 2.)

How many times more effective was Enzyme #7 than the second most effective enzyme?

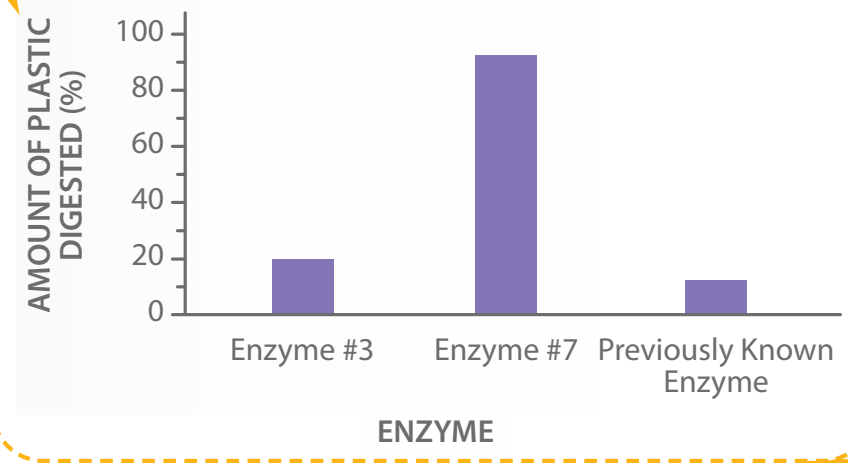


Figure 2:
Percentage of plastic digested in 24 hours at 70°C by Enzyme #7, another enzyme from the landfill in Leipzig, and an enzyme previously known to digest plastic.

- Enzyme #7 works best at 70°C (158°F).
- Enzyme #7 can work really fast! It worked the most quickly between 4 and 8 hours after it started breaking down the plastic.
- Enzyme #7 can break down plastic into very pure molecules. We were then able to create new, high quality plastic from those molecules. This is an example of closedloop recycling.

Discussion

Enzyme #7 is a great enzyme to try using for plastic recycling. Enzyme #7 broke down a lot of plastic compared with the other enzymes. It is also thermostable, meaning that it can work at a variety of temperatures. It worked even at 70°C, about the same temperature as the air inside a hot clothes dryer. This is a lower temperature than we usually use to recycle plastic. Recycling at a lower temperature can save a lot of energy!

Enzyme #7 also breaks down plastics quickly. That means it could also help recycling processes go faster.

Finally, Enzyme #7 breaks down plastic into very pure chemical molecules. We can recycle these to make new high quality plastics. We won't have to use additional materials from the environment. So, Enzyme #7 could help us achieve a closed-loop system of plastic recycling.

Conclusion

It is important to make sure you are recycling any plastics you can. But it can be even more important to reduce how much plastic you use. Here are a few ideas:

- Try to reuse plastic containers. They can be great for drawer organization, gift boxes, or even small planters!
- Bring your own reusable shopping bags to the grocery store.
- Choose to buy items that have no or reduced amounts of plastic packaging.
- Consider joining an environmental group or start one at your school. You can help raise awareness about actions that we can take to reduce the use of plastics!

Glossary of Key Terms

- **Closed-loop system** – a system that circulates resources so nothing is wasted. Everything is used and then remade into a useful product again without needing any new materials.
- **Compost** – decayed organic material (pieces of plants, leftover food, etc.) that is used as fertilizer.
- **DNA (deoxyribose nucleic acid)** – the genetic material found in all of our cells. This information gets passed on from organism to organism.
- **Enzyme** – a structure that speeds up chemical reactions. They exist in every living organism. Enzymes help you digest food and help plants with photosynthesis.
- **Landfill** – a place where large amounts of trash are buried in the ground.
- **Molecule** – the smallest unit of a substance that has all the properties of that substance. A single water molecule, H_2O, has the properties of water.
- **Thermostable** – when a molecule maintains its structure at a wide range of temperatures.

Acknowledgment: This article's adaptation was supported by the Goggio Family Foundation.

Check your understanding

1. What is an enzyme? Why are they important?

2. What are some chemical reactions that happen in your body?

3. Why is it important that Enzyme #7 is thermostable?

4. How could a closed-loop system for plastics help to reduce our impact on the environment?

5. Why is it important to reduce how much plastic we use? Come up with five ideas for using less plastic in your own life.

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CAN A ROBOTIC ARM BE CONTROLLED BY THE BRAIN?*

Authors: Jennifer L. Collinger, Robert A. Gaunt, and others
Associate Editors: Allison Gamzon and Alexandra Appleton

Abstract

Pick up a nearby object. Easy, right? Not for many people with tetraplegia. They have an injury that prevents their brain from communicating with their hands. That means they cannot move or feel objects.

We want to make a robotic arm that people with tetraplegia can control with their brain. In a previous study, we put small implants in a person's brain. They used their sense of sight to guide the arm to an object. Then they picked it up and placed it in a new location. In this study, we added a second set of implants. We placed them in the part of the brain that senses touch from the hand. That meant the person could feel when the arm touched an object.

*Article Source: https://www.sciencejournalforkids.org/wp-content/uploads/2023/02/robotic_arm_article_lower_level.pdf taken from: https://www.sciencejournalforkids.org

We found that this touch information improved a person's ability to complete a set of tasks with the robotic arm. It cut the time it took to complete these tasks in half! This is because the study participant could grasp the object faster using both senses.

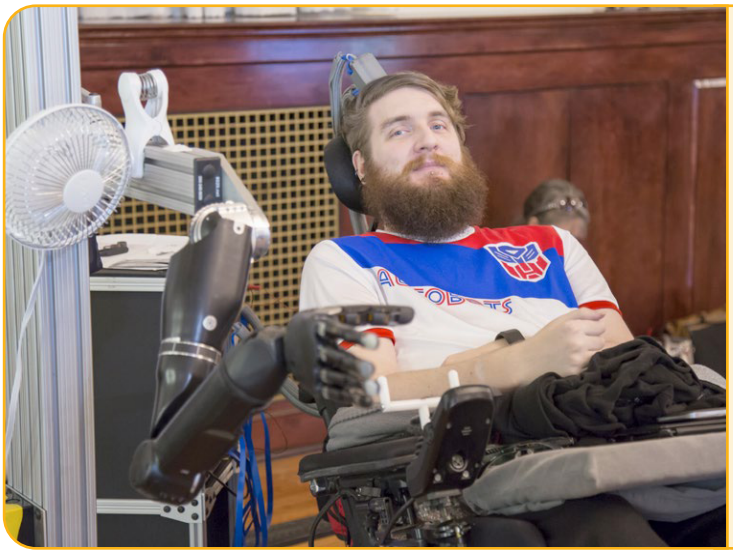
Introduction

Think about how often you use your hands each day. From texting to picking things up, we use our hands all the time. But that's not true for about 170,000 people living in the United States. Because of a spinal cord injury, they have tetraplegia. That means they cannot move or feel parts of their bodies. This often includes their arms and legs.

We wanted to make a robotic arm to help people with tetraplegia pick up and move objects. That's why we developed a brain-computer interface. A braincomputer interface takes brain signals and turns them into instructions. Then a device can follow these directions. For example, a person thinks about picking up an object. The brain-computer interface then tells a robotic arm to pick up the object.

Our first brain-computer interface allowed a person to control a robotic arm. They told it what to do based on what they could see. This brain-computer interface was successful. But it was slow! It also struggled to grasp objects compared to able-bodied hands.

So, we developed a new brain-computer interface. This new interface included touch sensors on the robotic hand. When these sensors made contact with an object, the interface let a person feel a sense of touch. We called this interface a bidirectional brain-computer interface. That's because it brings information to and from the brain. Next we tested it to see if the extra sensors gave more control of the robotic arm.



A study participant testing the bidirectional braincomputer interface.
Photo: UPMC/Pitt Health Sciences

Methods

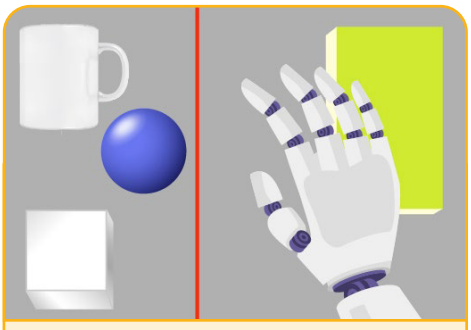


Figure 1:
We wanted to see how quickly the study participant could use the robotic arm to pick up and move individual objects to the platform.

We put four microelectrode arrays into a volunteer's brain. A microelectrode array contains sensors that record and cause neural signals. Neural signals are messages used by the body. They communicate information to and from the brain. We placed two arrays in the part of the brain that controls hand and arm movement. These arrays sent neural signals to control the robotic arm. We placed another two arrays in the area of the brain that receives information from the hand. These sensory arrays made neural signals. They let our volunteer know when the robotic hand was in contact with an object.

We asked our study participant to complete a set of tasks (Fig. 1). They had to use the robotic arm to grasp and pick up an object. Then they placed it on a platform as quickly as possible. They did this for eight different objects. They also had to pick up a cup, pour the contents into another cup, and place the cup back down on the table. We gave each task a score based on how long it took to complete. We calculated a total score for all tasks. The volunteer completed the tasks with and without the touch sensor arrays turned on. They could see the robotic arm, which was not attached to their body.

Results

Touch feedback improved the study participant's ability to grasp and move objects. The highest possible score for each object was a 3 (on a scale from 0-3). Without the touch feedback, the volunteer earned this score only once. With the touch feedback, they earned this score 15 times.

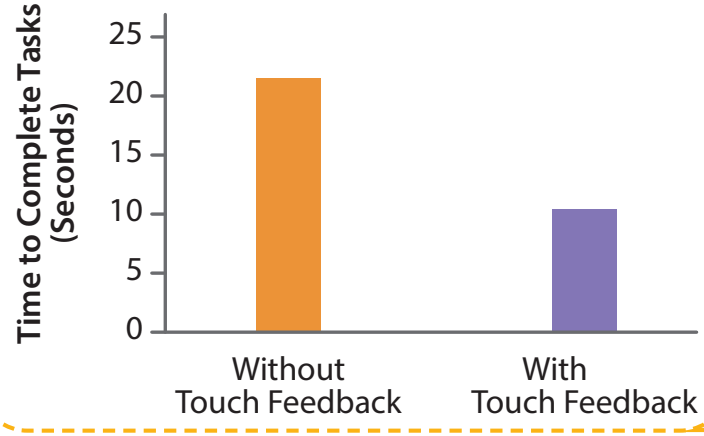


Figure 2:
A comparison of the median time it took to complete the grasp and move tasks with and without the touch feedback.

The highest total score possible for moving the eight objects and pouring the contents was 27. The median score without the touch sensors was 17. With the touch feedback, the median score was 21. The difference in score also matched the time difference. The median time to complete all the tasks without the touch feedback was 20.9 seconds. With the sensors, it went down to 10.2 seconds (Fig. 2).

Discussion

The bidirectional brain-computer interface was successful. It made it easier for our volunteer to pick up and move objects.

We found that the touch information helped the study participant use the hand to grip the object. It also helped them to do it more quickly. Touch information helps because we often use our sense of touch to tell us when we have grasped an object.

We still have more questions to research about the bidirectional brain-computer interface. For example, would a different person also show improved task scores? Also, many objects that we used in the tasks were firm. That made it easier for the participant to hold the object once they picked it up. They could also grasp the object as hard as they needed to. What would happen if the objects were softer or more breakable?

Conclusion

Can you brainstorm a list of activities that need hand movement? Most of them, right?! Unfortunately, some people cannot use their hands because of spinal cord injuries. That's why we need more research. We need new technology and treatments. Then people with spinal cord injuries could do more on their own. But we need more work done in this field. That requires more scientists working on this type of research. Could you be a future neuroscientist who tries to solve these difficult problems?

Glossary of Key Terms

- **Bidirectional brain-computer interface** – a brain-computer interface that brings information in both directions: to and from the brain.
- **Brain-computer interface** – a system that takes brain signals and turns them into instructions that a device follows.
- **Grasp** – hold an object firmly.
- **Median** – the middle number in a set of values when those values are arranged in order from smallest to largest.
- **Microelectrode array** – a device that contains sensors that measure neural signals. They can also cause neural signals.
- **Neural signal** – a message used by the body to communicate information to and from the brain.
- **Spinal cord** – a bundle of nerves shaped like a cylinder that is protected by the spine (backbone). It connects all the parts of the body to the brain and also independently controls some physical behaviors.
- **Tetraplegia** – a condition in which a person is unable to move or feel the upper and lower parts of the body. The areas that cannot be moved typically include the fingers, hands, arms, chest, legs, feet and toes. They may also include the head, neck, and shoulders. It's also known as quadriplegia.

Acknowledgment: This article's adaptation was supported by the GM Foundation and Pitt Health Sciences.

Check your understanding

1. What makes the bidirectional brain-computer interface different from the original brain-computer interface?

2. Humans have touch receptors in their hands. The receptors communicate information to the brain so that they can complete an action. How does the bidirectional brain-computer interface work like the body's touch receptors?

3. Why did the volunteer get better task scores when we added the touch feedback?

4. Touch receptors in our hands are one example of sensory receptors. Our bodies use sensory receptors to gather information about the world. What are other sensory receptors used by the body, and where are they found? (Hint: think about the five senses!)

5. We mentioned that many tasks require hand movement. With a partner or in a small group, brainstorm a list of at least 5 everyday activities that require hand movement. Then, explain which ones you think are the most important for a person to take care of themselves.

6. We noted that more scientists are needed to help people with tetraplegia. Look up what a neuroscientist does. What would someone need to do in order to become a neuroscientist? Do you think you would like to pursue this STEM career?

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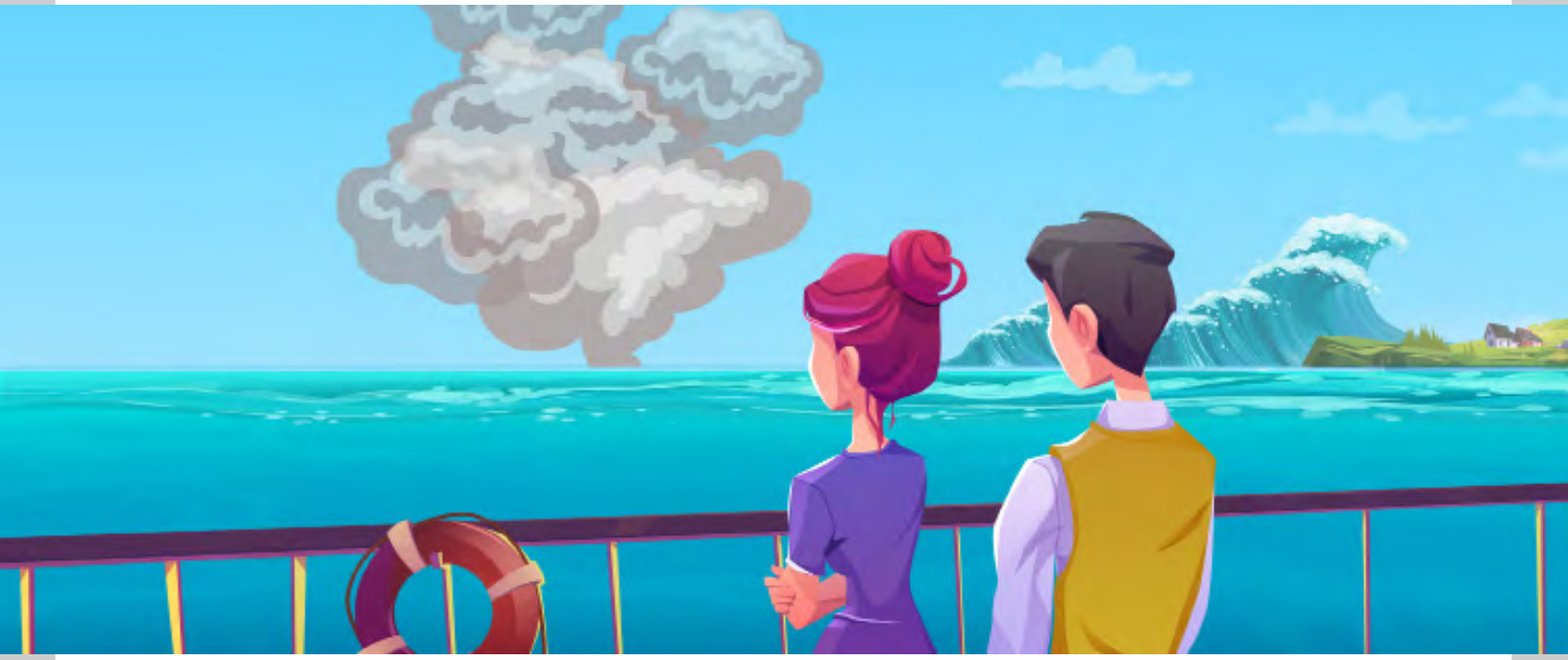
HOW CAN THE ERUPTION OF A VOLCANO AFFECT THE OCEAN EVERYWHERE ON EARTH?*

Authors: María Teresa Ramírez-Herrera, Oswaldo Coca, and Victor Vargas-Espinosa
Associate Editors: Allison Gamzon and Fiona Firth

Abstract

Did you know that a volcanic eruption can affect the entire world? The Hunga Tonga-Hunga Ha'apai volcano did! When it erupted on January 15, 2022, it produced a wave in the atmosphere that affected the ocean. It also caused a tsunami. We analyzed weather station and tidal gauge data from Mexico. We learned that the atmospheric wave moved across the world many times. We also learned that the tsunami reached heights of up to 2 meters (6.5 feet) along the Pacific coast of Mexico. But most people in Mexico were not told to stay away from the ocean! Based on our research, we recommend making changes to tsunami warning systems.



*Article Source: https://www.sciencejournalforkids.org/wp-content/uploads/2023/01/tsunami_mexico_article_lower_level.pdf taken from: https://www.sciencejournalforkids.org

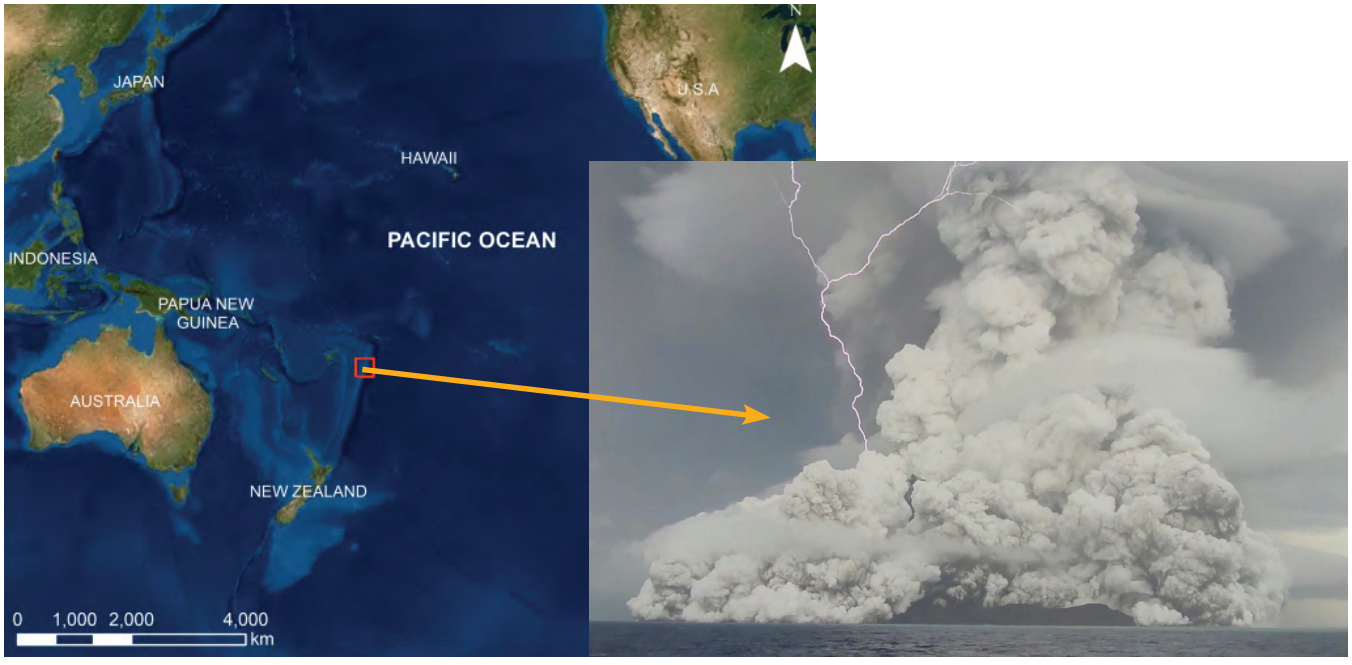
Introduction

On January 15, 2022, the Hunga Tonga-Hunga Ha'apai volcano erupted. It affected countries all over the Pacific Ocean. How? This volcanic eruption was so strong that it created a shock wave and a tsunami.

A shock wave is a type of wave produced by an explosion. Like a regular wave, a shock wave carries energy. When a wave moves through the air, some of the air particles get closer together. When this happens, there is high pressure.

When an eruption creates waves that move very fast, the waves pile up. When waves pile up, the high pressure areas add up to have even higher pressure. People experience these areas of very high pressure as a sonic boom. The sonic boom from the Hunga Tonga-Hunga Ha'apai volcanic eruption was very loud. People heard it in Alaska and Canada!

The Hunga Tonga-Hunga Ha'apai volcano is underwater. That means when it erupted, it caused a lot of ocean water to move. A tsunami is a wave caused by a large movement of ocean water. These waves are different from regular ocean waves. Ocean waves form when the wind moves the ocean's surface. In a tsunami, the wave



The eruption of the Hunga Tonga-Hunga Ha'apai volcano happened in the Pacific Ocean.
Sources: Modified from Ramirez-Herrera et al., 2022/Tonga Geological Services

moves both energy and water. When a tsunami reaches land, it can cause a lot of damage to buildings. It also floods the area with ocean water. The Hunga Tonga-Hunga Ha'apai volcano sent a tsunami in all directions across the Pacific Ocean. We wanted to better understand the impact of this volcanic eruption on Mexico. We also wanted to learn what the tsunami warning system did to try to keep people safe.

Methods

We used three types of data to figure out what happened after the volcanic eruption. They include:

- air pressure data,
- ocean height data, and
- tsunami warnings and information.

The air pressure data came from weather stations. The ocean height data came from tidal gauges. A tidal gauge is a sensor that measures the height of the ocean. Using these data, we tracked the size and timing of the shock wave and the tsunami. What information and warnings did people get? What did they know about how to stay safe during these events? To find out, we looked at news and government websites. We also looked at social media.

Results

Shock wave:

The weather stations recorded the shock wave. They measured it on the Pacific Coast, in the Gulf of Mexico and in the Caribbean Sea. The shock wave reached Mexico about 7.5 hours after the volcano erupted. The stations recorded about eight peaks of high pressure.

Tsunami:

Many places on the Pacific coast of Mexico experienced a tsunami. Tidal gauges measured larger water heights 8.2 hours after the volcanic eruption (see Figure 1). Eight tidal gauges measured tsunami heights greater than 1 meter (3 feet). The largest height was more than 2 meters (6 feet). That means it was taller than the average person.

Circle the two locations that experienced the largest tsunami maximum height. On which ocean coast are these locations?

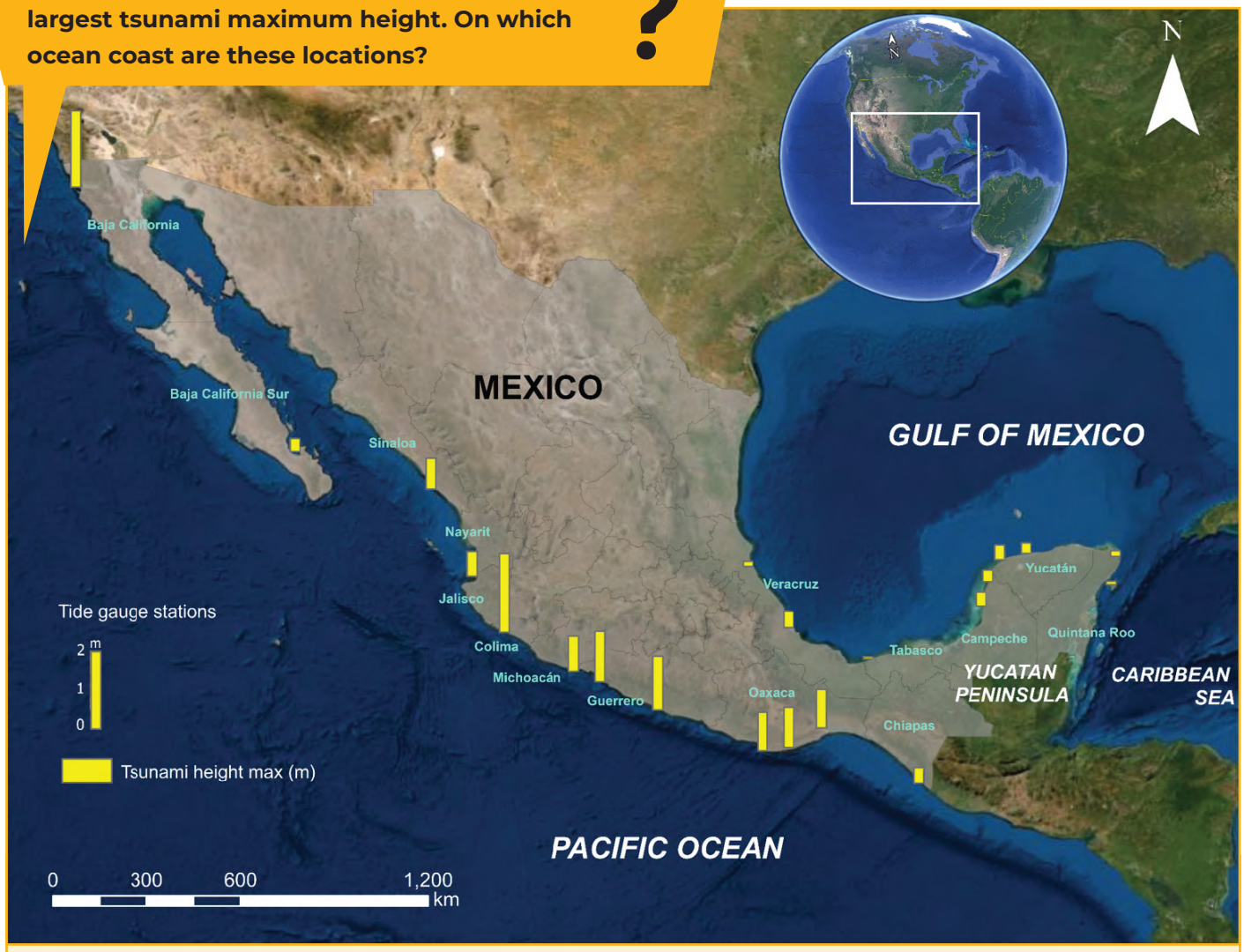


Figure 1:
Mexican tsunami heights for stations on the Pacific coast, Gulf of Mexico, and Caribbean Sea.
Source: Modified from Ramirez-Herrera et al., 2022

The tidal gauges also recorded ocean height changes in the Gulf of Mexico and the Caribbean Sea. The largest height change was less than 0.40 meters (about 16 inches). The changes in the ocean lasted for five days.

Warnings and information:

The Center for Tsunami Warning sent a message to people about a day and a half after the volcano erupted. The warning told people about the volcano. It also said that they didn't expect it to affect ocean height much. People received this information from social media and news websites.

In Mexico, the Civil Protection offices are in charge of public safety. Two offices told people to stay away from the ocean until they received another message that it was safe. Most offices told people to be careful. They said there might be higher water levels and stronger currents.

Discussion

When the Hunga Tonga-Hunga Ha'apai volcano erupted, it produced a shock wave. This wave moved across the Earth many times. As it moved, it affected the ocean. The shock wave caused the height of the ocean to increase in the Gulf of Mexico and in the Caribbean Sea. In the Pacific Ocean, water levels changed because of both the shock wave and the tsunami. This created greater water heights.

Tidal gauge data showed that the height of the tsunami was not the same everywhere. That's because the shape of the land is different. When a tsunami reaches land, the ocean floor causes it to slow down. This makes the wave grow taller. It is not common for a volcano to cause a tsunami. Most warning systems only tell people about tsunamis caused by underwater earthquakes. That's because earthquakes are the main cause of tsunamis. Hunga Tonga-Hunga Ha'apai reminds us that volcanoes do cause tsunamis. That means they should also be part of the warning systems! And when these systems send a message, they need to tell people to stay away from the ocean. We also think that scientists should watch underwater volcanoes.

Conclusion

Being by the ocean comes with some possible dangers. If you live on the coast, check with your local government to find out about tsunami risks. Make sure that you have access to your local tsunami warning system. Also make sure you have a plan on how to stay safe if a tsunami comes. And whenever you are by the ocean, make sure you follow all swimming and safety rules. Staying safe will make your time in the ocean more enjoyable!

Glossary of Key Terms

- **Peak** - the highest point, for example of a wave or a mountain.
- **Shock wave** - a high pressure wave created when a disturbance moves so fast through a medium that the waves pile up.
- **Sonic boom** - a loud explosive noise caused by the shock wave. Aircraft create a sonic boom when they travel faster than the speed of sound.
- **Tidal gauge** - a sensor that records the height of the ocean surface.
- **Tsunami** - a giant wave caused by the displacement of water. They are typically caused by earthquakes and underwater volcanic eruptions.

Acknowledgment: This article's adaptation was supported by the GM Foundation.

Check your understanding

1. Not all volcanic eruptions cause a tsunami. Why did the Hunga Tonga-Hunga Ha'pai volcano cause one?

2. Why did the ocean levels change in the Gulf of Mexico and the Caribbean Sea?

3. Why don't most warning systems include volcanic eruptions?

4. How do we think tsunami warnings should be improved?

5. The Hunga Tonga-Hunga Ha'pai volcanic eruption is an example of a natural hazard. With a partner, identify a type of natural hazard that is common where you live. Then brainstorm ways that people can be prepared when this natural hazard occurs.

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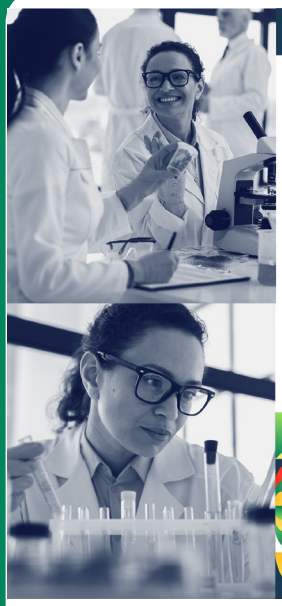

HOW CAN GRATITUDE HELP HEALTHCARE WORKERS?*

Authors: Kathryn Adair, Larissa Rodriguez-Homs and Bryan Sexton
Associate Editors: Elitsa Panayotova and Fiona Firth

Abstract

Have you ever felt stressed? It's not very pleasant. Most healthcare workers feel stress every day. Often that prolonged stress leads to emotional exhaustion. There are different ways to deal with this, but they can take too long or are expensive. What if there was a simpler way to reduce emotional exhaustion? Many studies show that gratitude can increase happiness. We asked healthcare workers to write a letter of gratitude. We assessed their levels of emotional exhaustion before and after this assignment. After using our method, healthcare workers had lower levels of emotional exhaustion. They also said they were happier.

*Article Source: https://caws.dukehealth.org/files/2021/10/gratitude_article.pdf taken from: https://www.sciencejournalforkids.org

Introduction

Working in healthcare can be very rewarding, but emotional exhaustion is common.

Have you ever had too much homework? Or have you been very worried during a test? If you have, you've probably felt stress. Those worries can make your body feel bad, too. The good thing is that stress usually goes away. Having fun, doing exercises, and getting more sleep are good ways to make stress disappear. What if you are worrying every day, though?

Imagine you are a doctor or a nurse. You have to take care of other people. Every day your decisions have consequences on your patients' health and lives. You probably work long and unpredictable hours. You have to talk to worried patients' families. Pretty stressful, right?

This long-term stress can have negative consequences. It can lead to emotional exhaustion, which doesn't go away that easily. And it is pretty common among healthcare workers. So how can they cope? Most existing treatment for emotional exhaustion can take a long time or a lot of effort. For example, meditation helps but takes more time than healthcare workers usually have. What if there is a simpler tool to reduce emotional exhaustion? Gratitude is a very powerful emotion. It improves our mental health and increases happiness. It helps us to sleep better, too. Some studies show that gratitude is better at doing this than hope or compassion. We wanted to use the power of gratitude to help healthcare workers. But would it reduce emotional exhaustion? This is what we wanted to find out.

Methods

We created an online survey where we asked healthcare workers several questions to assess their level of emotional exhaustion. We then showed the participants their score and asked their opinion on it.

Afterward, we asked the participants to write a letter of gratitude (Fig. 1). Half of the participants had to focus the letter on themselves; that is, how the recipient's help

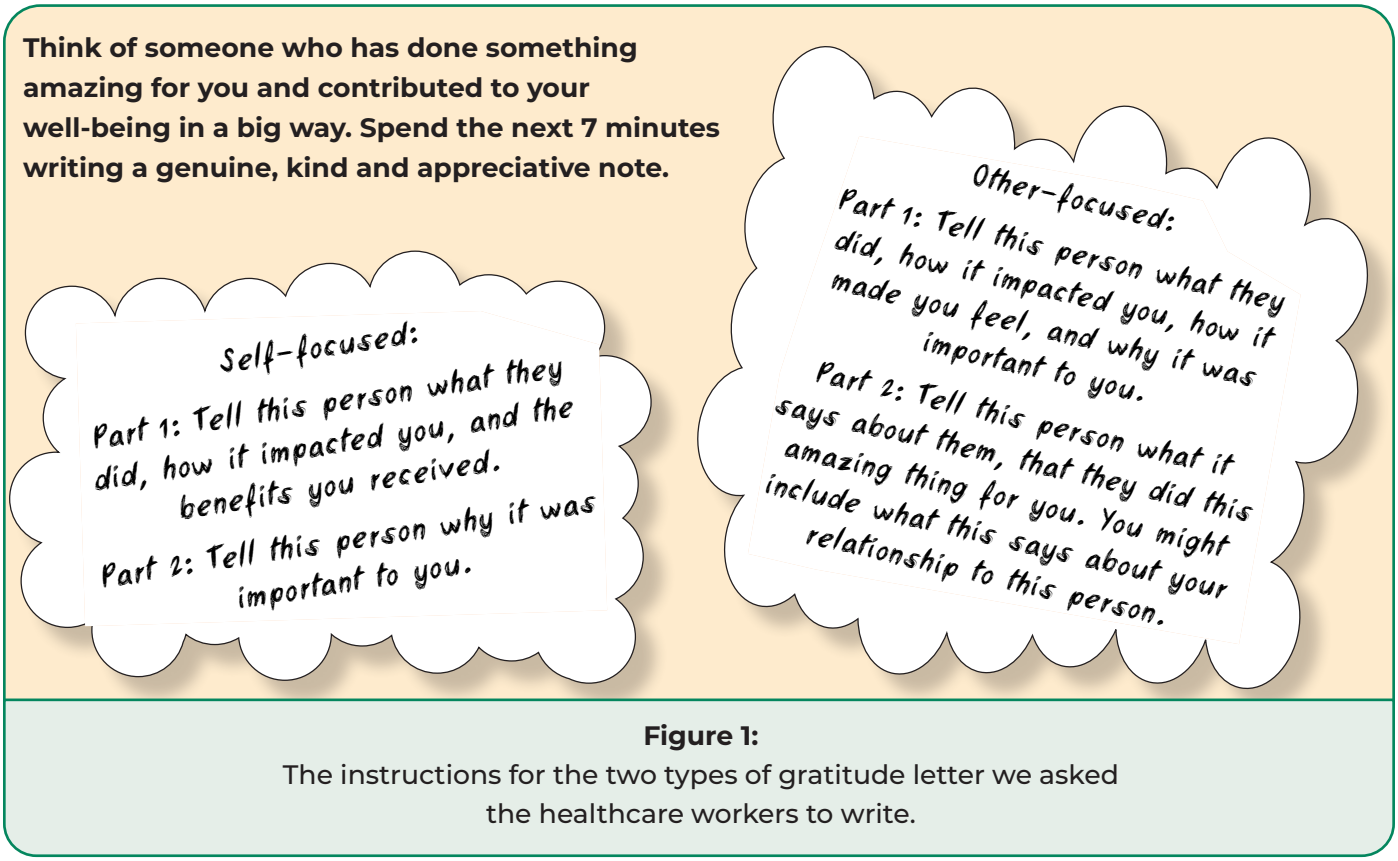

Figure 1:
The instructions for the two types of gratitude letter we asked the healthcare workers to write.

was important to them (self-focused). The other half had to focus on the recipient's qualities (other-focused). We analyzed the words the participants used. We wanted to see if there were more positive or more negative words.

A week later we asked for a follow-up. We wanted to see if the emotional exhaustion levels had changed. This would suggest our method was working.

Results

A total of 1575 healthcare workers completed the first part of the study. They answered all our questions and wrote a gratitude letter. After a week 277 participants returned for the follow-up. We found out that:

- Emotional exhaustion levels were high at first.
- The high scores surprised most of the participants. Most of them wanted to do something about it.

How did the gratitude letter affect healthcare workers' happiness and emotional exhaustion?

Figure 2:
Emotional exhaustion and happiness scores before and after the gratitude letter.

- The higher these levels, the more negative words we found in the letters.
- At the follow-up, we realized our method seemed to help the participants (Fig. 2). It helped reduce their emotional exhaustion and improve happiness. Many said it was easier to think of things to be grateful for.
- The letter helped both groups – self-focused and other focused.

Discussion

Our gratitude letter method shows promising results. It's simple, cheap and takes very little time. Few participants returned for the follow-up. Yet the majority of them said they felt a lot better. Their emotional exhaustion levels were lower and they reported feeling happier. Receiving their emotional exhaustion score probably helped with that as well. It made them want to change and feel better.

Gratitude seems to shift the focus from bad to good things. Participants may have taken some of the best things in their lives for granted. After writing a gratitude letter, they said it was easier to think of things to be grateful for.

Conclusion

We all feel stressed sometimes. It doesn't always mean there is something wrong. But if you feel worried and tired often, maybe it's time to change something. If you have too many after-school activities, you could consider dropping one. Make sure you eat healthy food. Try to get enough sleep and do something fun with friends or family. You could try some relaxation exercises like breathing slowly. You could even write a letter of gratitude, like in our study, or keep a journal.

Glossary of Key Terms

- **Emotional exhaustion** – Too much stress has piled up from work or personal life, making people feel drained, overwhelmed and tired.
- **Follow-up** – After the first survey, researchers collect information after some time (in our case a week) to see if there is any difference.
- **Other-focused letter of gratitude** – The focus is on the person who is receiving the letter. It describes what the recipient has done for the person who is writing the letter. It talks about the recipient's qualities.
- **Self-focused letter of gratitude** – The focus is on the person who is writing the letter. It describes why they are grateful and what they are feeling.
- **Stress** – Our body's response to pressure and worries. Sometimes we have headaches, we start sweating, become irritated, can't sleep, etc. Different things can cause stress, usually something that we think we can't cope with.

Acknowledgment: This article's adaptation was supported by the GM Foundation.

Check your understanding

1. We mentioned some of the stressful things about being a healthcare worker. Can you think of any other negative aspects? How about the positive aspects?

2. What is the difference between stress and emotional exhaustion?

3. Why do you think gratitude has such power over our emotions?

4. Think of someone who has done something amazing for YOU. Write them a short letter of gratitude. If you want, you can send or show it to them, or read it to them (in person or over the phone).

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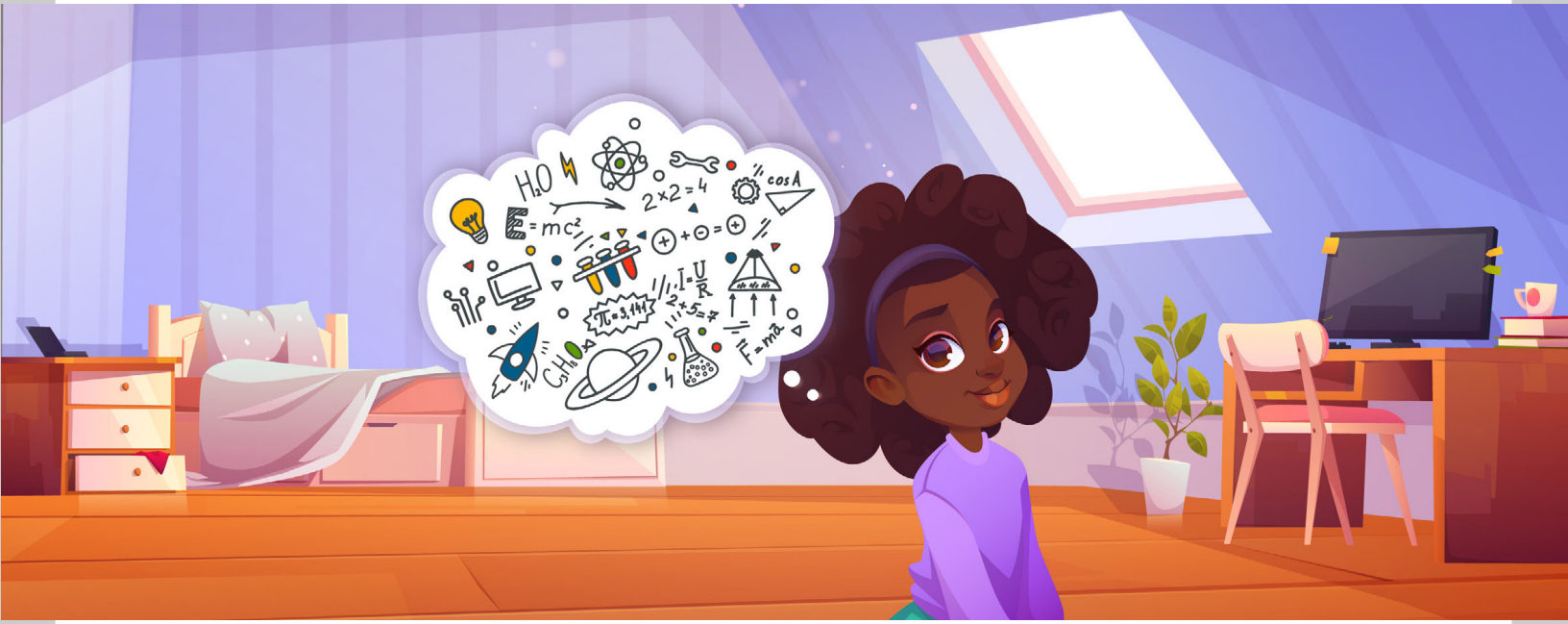
HOW DO GENDER STEREOTYPES IMPACT GIRLS' INTEREST IN SCIENCE?*

Authors: Allison Master, Andrew N. Meltzoff, and Sapna Cheryan
Associate Editors: Miranda Wilson and Rachel Watson

Abstract

Has anyone ever said that you couldn't or shouldn't do something because of one of your traits? If so, you've probably been the victim of a stereotype. A stereotype is a set of shared beliefs based on a trait or the identity of a group. A common stereotype is that women are not as good at or interested in science as men. This can result in fewer women participating in the sciences.

We wanted to know if and when these gender stereotypes about science affect children and adolescents. We also wanted to know if stereotypes cause girls to be less



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interested in and take part less in these fields. To find out, we conducted surveys and laboratory experiments. We found that very young students believed these gender stereotypes. Girls were less interested in participating in computer science and engineering if they believed the stereotypes. So, teachers and schools should try to generate interest in these fields at an early age.

Introduction

Stereotypes are prevalent in society. They can cause a lot of damage to individuals and groups of people. A common kind of stereotype is the belief that one group is better at a task or a subject than another. This is called an ability stereotype. Another kind of stereotype is an interest stereotype. This is the belief that one social group is more interested in a topic than another group. Interest stereotypes can change the way people see themselves. They can also influence a person's motivations and their sense of belonging.

A woman at the Women's March on Washington, 2017.
Photo Credit: Dina Fine Maron

In the United States, the number of women in science, technology, engineering, and math (STEM) varies. Even when women take part in these fields, gender stereotypes are common. An example is the idea that men are more able or interested in STEM compared to women. This is a gender stereotype favoring men. Computer science and engineering have the largest gender disparities. This means that women are less likely to have these jobs. This can lead to discriminatory practices like paying women less than men. And that could increase the wage gap.

We were curious about STEM gender stereotypes in children and adolescents. At what age do they show up? Do genderability or gender-interest stereotypes have a bigger impact on girls? Do these stereotypes actually cause girls to be less interested in these fields? Do they change girls' desire to take part? We decided to find out!

Methods

We designed a survey about gender-interest stereotypes favoring boys in computer science. We asked students in grades 3-7 if:

- they believed boys were more interested in computer science than girls.
- they thought boys were better at computer science than girls.
- they felt like they belonged in the field.
- they were actually personally interested in computer science.

Then we gave a similar survey to a more diverse set of students (grades 1-12, various races/ethnicities). This survey included questions about engineering, too!

We also ran an experiment where we gave students (8-9 yrs old) two activities in the laboratory. One activity stated that "girls are much less interested in this activity than boys". This made a link between the activity and the stereotype. The other stated that "girls and boys are equally interested in this activity". So, that activity didn't have a link to the stereotype. We presented the activities in a random order for each student. We then asked students if they were interested in the activities and which activity they would choose to take home.

Results

We found that a diverse set of students believed gender interest stereotypes favoring boys in computer science and engineering. Students developed these stereotypes at a very young age (Fig. 1).

Which type of stereotype was strongest?

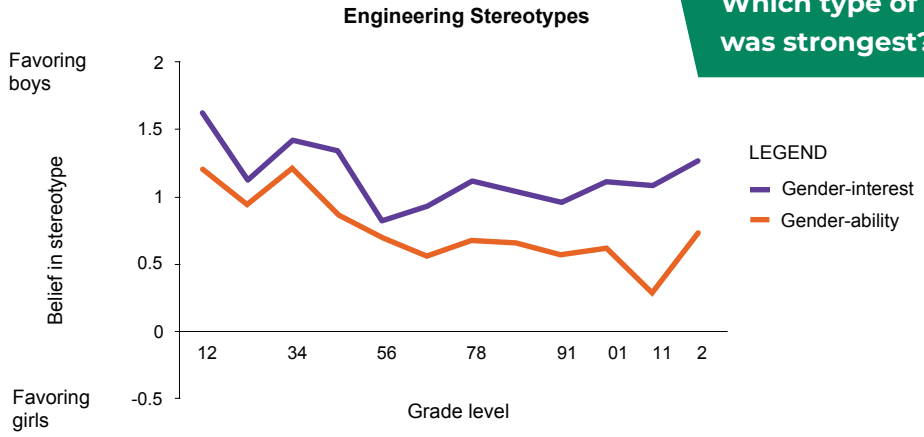


Figure 1:
Gender-interest and gender-ability stereotypes about engineering by grade. Positive values indicate students believed that boys were more interested or more able than girls. Any stereotype favoring girls would show below the 0 line.

Which of the two time periods are most similar? What does this tell you?

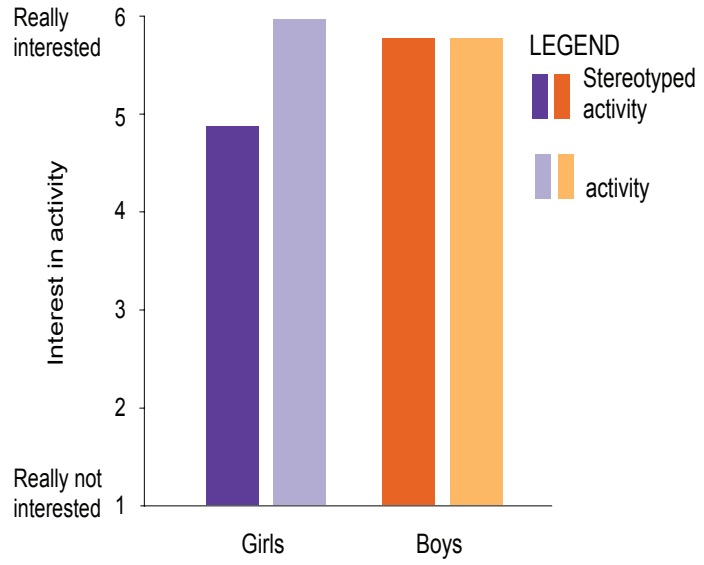


Figure 2:
Student interest in activities with and without genderinterest stereotyped descriptions.

We also found that:

- Gender-interest stereotypes were stronger than genderability stereotypes.
- Girls who believed the stereotypes were actually less interested in participating in computer science and engineering.
- Girls who felt they did not belong in these STEM fields were less interested as well.

In our laboratory experiment, we found that girls were less interested than boys in the activity described by the genderinterest stereotype favoring boys (Figure 2). Girls chose to take those activities home less than activities with the gender equal description.

Discussion

Gender-interest stereotypes can cause changes in girls' interest in STEM. Girls are less likely to take part in STEM activities if they feel like they don't belong. Beliefs in these gender stereotypes at a young age could widen gender disparities in STEM in the future. Our research suggests that:

1. Girls should start to take part in computer science activities in early elementary school. This is before gender-interest stereotypes about computer science become common.
2. Teachers should find and use language that can increase girls' interest in STEM classes and activities.
3. The design of STEM programs and activities should actively fight gender-interest stereotypes.

We still have many questions to address in the future. How long do these gender stereotypes last? What impact will they have on the future careers of students? Does experience in STEM change students' belief in gender stereotypes? If we can understand and address these gender stereotypes, we can improve gender disparities in STEM.

Conclusion

The sciences are for everyone. Give computer science and engineering a try! Ask your parents and teachers for help finding classes and activities. You never know what you might like.

Tell your teachers you want to learn about successful women in STEM like NASA scientist Katherine Johnson, Internet pioneer Radia Pearlman, or computer scientist Grace Hopper. You can also learn more online – why not check out a project like Girls Who Code?

And if you feel comfortable, speak up when you hear others using gender stereotypes. The more you correct others now, the less they will use gender stereotypes in the future.

MY EUREKA **Moment!**

Have you ever had a moment when everything just clicked? Maybe you finally understood a tricky science concept, solved a tough math problem, or discovered something new during an experiment. That's your Eureka Moment — a flash of insight when you feel like an inventor!

- ***We want to hear your story!***
  Write about your Eureka Moment:
  - *What were you trying to figure out or learn?*
  - *How did you feel when you finally understood or discovered something?*
- ***Share Your Eureka Moment:*** *Email at mbs@macmillaneducation.com*
- ***Subject Line:*** *My Eureka Moment – [Your Name]*

We will feature some inspiring moments in the next issue of Science Spark.

Glossary of Key Terms

- **Ability stereotype** - The belief that one group is better at a task or in a field than another. This could be based on intelligence or based on skills. An example of a gender-ability stereotype is that boys are better at computer science.
- **Gender disparity** - The difference in access to resources, status, and well-being between boys and girls or men and women. Some examples of things that cause gender disparities are unequal access to: education, jobs, medical care, legal protections, and social and political representation.
- **Interest stereotype** - The belief that one social group likes, enjoys or wants to participate in a topic more than another group. An example of a gender-interest stereotype is that girls are less interested in engineering.
- **Sense of belonging** - Feeling like you fit in and are similar to other people.
- **Stereotype** - A widely held belief about a particular trait or group of people.
- **Wage gap** - The difference between monetary compensation for women and men who are working.

Acknowledgement: This article's adaptation was supported by the Goggio Family Foundation.

Goggio Family Foundation

Check your understanding

1. What is the difference between ability and interest stereotypes?

2. What negative consequences could there be in believing gender stereotypes in STEM fields?

3. The researchers used both surveys and laboratory experiments. What different information did they get from each type of research process? Why do you think they did both?

4. What are three ways you can think of to help get rid of gender-interest stereotypes related to STEM fields in your school?

References

Allison Master, Andrew N. Meltzoff, and Sapna Cheryan (2021) Gender stereotypes about interests start early and cause gender disparities in computer science and engineering. Proceedings of the National Academy of Sciences of the United States of America.

https://www.pnas.org/doi/full/10.1073/pnas.2100030118

Live Science: What is STEM education?

https://www.livescience.com/43296-what-is-stem-education.html

AAUW: The STEM gap – women and girls in science, technology, engineering and mathematics

https://www.aauw.org/resources/research/the-stem-gap/

HOW CAN GRATITUDE HELP EMOTIONAL WELLBEING?*

Lesson

Introduction

Sometimes we feel overwhelmed and stressed. This lesson plan will introduce students to the concept of emotional exhaustion. It will also show them a simple tool to assess it. Along with the reading activity, the lesson will provide a good way to overcome emotional exhaustion.

Learning Objectives

After the lesson, the students should be able to:

- Define emotional exhaustion and differentiate it from stress.
- Use scale-based questionnaires.
- Explain how gratitude can lower emotional exhaustion.
- Assess gratitude's effectiveness.

Key Terms

- emotional
- exhaustion
- happiness
- stress
- gratitude

Time Requirement

2-3 class periods (with at least one in a different week).

Grade Level

Grades 5-9

Teaching Standards

Aligns with several states' SEL (social-emotional learning) goals.

Materials

- Printed copies of Handout 1: “Emotional Wellbeing Questionnaire”.
- Printed copies of Handout 2: “Emotional Wellbeing Scoring”.
- Printed article and question handout How can gratitude help healthcare workers? from Science *Journal for Kids* (if reading in class).
- A container (such as a box or a hat).
  Whiteboard (optional).

Lesson Plan

1. GETTING STARTED

- **What is emotional exhaustion? (~6 min)**
  Show the students a video that introduces emotional exhaustion – what it is, what its signs are, and what some of the causes are. One example is 6 Signs You Are Emotionally and Mentally Exhausted by Psych2go.
- **Assessment discussion (~5 min)**
  Are the students exhausted? Ask the students how they can assess happiness and emotional exhaustion. Explain that questionnaires are a very simple but effective tool. They help people gather information about themselves and/or others.

Duration: 10-15 min, depending on grade level

2. HANDS-ON ACTIVITY

- **Fill out the questionnaire (~10-15 min)**
  Give each of the students a copy of Handout 1: “Emotional Wellbeing Questionnaire.” Let them fill out the emotional exhaustion, personal achievements, and happiness scales.
- **Scoring activity (~5-10 min)**
  Now give each student a copy of Handout 2: “Emotional Wellbeing Scoring.” Explain that the scores aren’t like for their math tests; instead, these give a relative idea (i.e. not a diagnosis) of emotional exhaustion, sense of personal achievement, and happiness. Ask them to also answer the questions at the bottom of Handout 2, regarding their reactions to the scores. Make it clear that the students should keep Handout 1 for themselves, but fill out Handout 2 anonymously and then put them into the container provided (for example, a box or hat).

- **Scores discussion (15-20 min)**
  You or a group of students should divide the "Emotional Wellbeing Scoring" handouts into three piles according to the emotional exhaustion scores: (1) low degree; (2) moderate degree; (3) high degree. Discuss which pile is the largest. Why do they think that is? Take a closer look at the "high degree" pile and address some questions. Were the students surprised by their answers? Do they want to change something about it? Are happiness levels low there? Take a closer look at the "low degree" pile – are happiness levels higher there?
- **Brainstorming (5-10 min)**
  Ask students to come up with some ideas (and consider making note of them on a whiteboard). What do they think might be able to help someone become less emotionally exhausted? What could help someone become generally happier, not just in the moment? (Note: this could be done as a warm-up prior to the reading assignment if done in a second class period.)

Duration 35-55 min

3. READING ASSIGNMENT

- Individually or in groups, have the students read the article 'How can gratitude help healthcare workers'? published in *Science Journal for Kids*.
- Answer the assessment questions at the end of the article, including the last one – writing a gratitude letter.
- Discuss as a class: why is gratitude so powerful? Have any of them ever kept a gratitude journal? Do students think reflecting on what they're grateful for could help them feel better in the future?

Duration 30-45 min, depending on reading level

4. FOLLOW-UP HANDS-ON ACTIVITY (A WEEK LATER)

- **Follow-up questionnaire and scoring (10-15 min)**
  Again give each of the students a copy of Handout 1 and Handout 2. Let them fill out the questionnaire again and ask them to write down their scores. (Consider asking the students to bring their original copies of Handout 1 back to class so they can see how their own scores changed over time.)

- **Second score discussion (20-25 min)**
  Divide the answers from Handout 2 into three piles according to the emotional exhaustion scores. Are there any differences from the week before? Which is the largest pile? Are happiness levels higher? Did gratitude have any impact?

5. EXTENSION ACTIVITIES

- **Gratitude journals**
  Ask students to write three things they are grateful for 3-4 times a week for one month. No repetitions! Encourage them to write at least one thing that was particular to the day each day.

- **School gratitude mail**
  Guide students in designing a school-wide gratitude mail campaign. They can make "Gratitude Mailboxes" for their teachers and other staff members using empty tissue or shoeboxes. They can make posters to advertise the campaign around the school or write a skit to perform on the morning announcements. They could encourage students to write letters to teachers or staff members, or teachers could serve as "mail deliverers" so students could write letters to other students as well.

Duration 30-45 min

Online Learning

TeensHealth: Gratitude – a Worksheet
https://kidshealth.org/en/teens/gratitude-worksheet.html

Additional Resource

The "Look for the Good" project offers resources like gratitude journals and starter kits for appreciation campaigns at a price, but sponsorships are available for schools without sufficient funds.
https://www.lookforthegoodproject.org/schools

NAME: ..... DATE: .....

EMOTIONAL WELLBEING QUESTIONNAIRE

Are you exhausted? Do you feel fulfilled and happy? Please answer the questions below by circling a number. How frequently do the following statements apply to you?

0 = never

1 = at least a few times a year

2 = at least once a month

3 = several times a month

4 = once a week

5 = several times a week

6 = every day

	Statement	Frequency						
1	I think I study too much.	0	1	2	3	4	5	6
2	I feel tired when I come home from school.	0	1	2	3	4	5	6
3	I feel tired when I get up in the morning and have to face another day at school.	0	1	2	3	4	5	6
4	Studying or attending class is stressful.	0	1	2	3	4	5	6
5	I feel burned out from my studies.	0	1	2	3	4	5	6
6	My schoolwork annoys/frustrates me.	0	1	2	3	4	5	6
7	It's stressful to study with my classmates.	0	1	2	3	4	5	6
8	I feel exhausted because of activities outside of school.	0	1	2	3	4	5	6
9	I feel stuck/lost/at my wit's end	0	1	2	3	4	5	6
10	I can easily understand the actions of my classmates and teachers.	0	1	2	3	4	5	6

	Statement	Frequency						
11	I think I'm good at solving problems in my studies.	0	1	2	3	4	5	6
12	I feel I make contributions in my classes.	0	1	2	3	4	5	6
13	I think I am a good student.	0	1	2	3	4	5	6
14	I am learning many interesting things.	0	1	2	3	4	5	6
15	I feel interested when I study with my classmates.	0	1	2	3	4	5	6
16	I feel relaxed at school.	0	1	2	3	4	5	6
17	I make good use of my time outside of school.	0	1	2	3	4	5	6
18	In general, I consider myself:							
	1. Not a very happy person	2.	3.	4.	5.	6.	7. A very happy person	
19	Compared to most of my classmates, I consider myself:							
	1. Much less happy	2.	3.	4.	5.	6.	7. Much happier	
20	Some people are generally very happy. They enjoy life regardless of what is going on, getting the most out of everything. To what extent does this characterization describe you?							
	1. Not at all	2.	3.	4.	5.	6.	7. A great deal	
21	Some people are generally not very happy. Although they may not be depressed, they never seem as happy as they might be. To what extent does this characterization describe you?							
	7. Not at all	6.	5.	4.	3.	2.	1. A great deal	

Fill out your scores after you calculate your results using the Scoring handout.

Scale	Score	Interpretation
Emotional exhaustion		
Personal achievements		
Happiness		

EMOTIONAL WELLBEING SCORING

This handout is anonymous, so please do not write your name on it. Refer back to the handout from last class, the Emotional Wellbeing Questionnaire. Circle the number that you arrive at for each part of the survey. Then copy them onto the bottom of the handout from last class so that you have your own scores. When you have finished, please put this handout wherever your teacher is collecting them.

1. Score for emotional exhaustion: add together the answers to questions 1 to 9.

0	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16	17	18	19	20
	21	22	23	24	25	26	27	28	29	30
	31	32	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48	49	50
	51	52	53	54						

Emotional exhaustion	Score < 17	Score 18-29	Score > 30
	Low	Moderate	High

2. Score for personal achievements: add together the answers to questions 10 to 17.

0	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16	17	18	19	20
	21	22	23	24	25	26	27	28	29	30
	31	32	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48	49	50
	51	52	53	54						

Personal achievements	Score > 40	Score 34-39	Score < 33
	High	Moderate	Low

3. Happiness score: add together the answers to questions 18-21.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28		

Then divide by 4 (sum/4).

Personal achievements	Score > 5	Score 4-5	Score < 4
	Generally happy	Moderately happy	Not very happy

4. How much did your scores surprise you?

1. Not at all	2.	3.	4.	5.	6.	7. A great deal

5. Based on your scores, how interested are you in making some changes?

7. Not at all	6.	5.	4.	3.	2.	1. A great deal

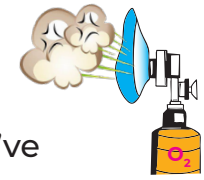
3. SCIENCE Facts

Cutting-Edge Science with a Twist of Fun!

Poke-Free Protection: 3D-Printed Vaccine Patches

Say goodbye to scary needles! Scientists are cooking up 3D-printed skin patches that deliver COVID-19 vaccines with zero pain. Just slap it on like a sticker, and your immune system gets a boost without the pain.

Vaccines with a Puff: Air-Powered Delivery!



Who needs needles when you've got air? Researchers are working on a small device that uses a gentle puff of air to send vaccines under your skin. It's quick, painless, and perfect for remote areas.

Eavesdropping Like a Spider: The Silk Mic Mic

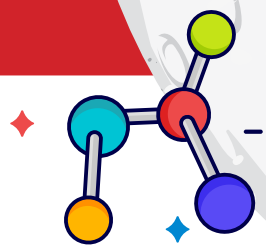
Inspired by the way spider silk dances with the breeze, scientists have spun up a super-sensitive microphone. It's tiny, powerful, and could one day help us detect earthquakes—or maybe even hear you whispering mischief.

Crime Scene Glow-Up: Jellyfish-Inspired Fingerprint Spray

A fluorescent spray, totally safe and non-toxic, makes fingerprints light up under a blacklight. It's like a disco party for detectives!

Fungi-tastic Construction: Building with Living Mushrooms

Fungi are moving from forests to construction sites! Scientists have brewed up a building material made from fungal mycelium and bacteria. It's sustainable, strong, and might even heal itself if it gets damaged. Move over, bricks—nature's taking the lead!



4. SCIENCE Quiz

Multiple Choice (Choose the correct answer)!

1. **What is DNA Often Called?**

   a) The Life Ladder

   b) The Brain Code

   c) The Blueprint of Life

   d) The Colour Chart

2. **What is the Shape of a DNA Molecule?**

   a) Spiral stairs

   b) Double helix

   c) Zig-zag line

   d) Twisty ladder

3. **Which of These Pairs are Alleles?**

   a) Eye and ear

   b) Tall and short height genes

   c) DNA and RNA

   d) Protein and enzyme

4. **Who is known as the “Father of Genetics”?**

   a) Albert Einstein

   b) Charles Darwin

   c) Gregor Mendel

   d) Isaac Newton

5. What are Chromosomes Made Of?

a) Bones and tissue

b) RNA and sugar

c) DNA and protein

d) Water and fat

6. True or False

a) You get all your genes from your mother.

b) Identical twins have exactly the same DNA.

c) Your genes can be found in bananas.

d) All living things have DNA.

e) A giraffe can pass its long neck to its baby through genes.

Just for Fun

If you could design your own gene, what cool trait would you give yourself?

(e.g., glitter hair, super bouncy feet, rainbow eyes? Let your imagination go wild!)

Macmillan Budding Scientist

Powered By SPRINGER NATURE

in association with Indian Institute(s) of Technology

WHAT IS IT?

Macmillan Budding Scientist (MBS) is a unique science programme designed for school students by Macmillan Education India (powered by Springer Nature). The programme encourages young learners in middle years, to address real-life challenges through project based learning. Participation in MBS fosters curiosity, original thinking and problem-solving skills in students. It inspires them to embark on a journey of discovery.

Running for six years, MBS is organized in association with the prestigious Indian Institute(s) of Technology (IIT Delhi, IIT Madras, IIT Bombay and IIT Guwahati), it is a platform for young learners to showcase their talent, interact with the science fraternity and develop confidence, research skills and a sense of enquiry.

The Macmillan team shares a candid moment with the team from Navrachana Higher Secondary School, Vadodara. The Macmillan Budding Scientist programme ignites curiosity and empowers students to explore, experiment, and excel — providing a platform to showcase innovative ideas with the support of dedicated mentors.

Scan Me

WHO CAN PARTICIPATE? ALL ENQUIRERS!

MBS is open to all learners in grades 6 to 8 in schools across India and in the Middle East. Each school can nominate up to three teams, with each team consisting of three students (from classes 6-8) and one mentor teacher.

Explore the IIT campuses and attend curated lab tours.

Present to academia and industry experts; get questioned by the best minds in STEM.

An immersive and rewarding experience.

Macmillan Budding Scientist

Powered By SPRINGER NATURE

in association with Indian Institutes of Technology

SPEAKS

PROF. SHILPI SHARMA

Associate Dean, Academics (Outreach & New Initiatives), and Professor, Department of Biochemical Engineering and Biotechnology, IIT Delhi

The word "Science" refers to the state of knowing through questioning, answering, and solving problems. It starts off with basic questions like Why is it happening? Is it possible to modify it? The Macmillan Budding Scientist (MBS) program aims to cultivate these urges in learners, guiding them to seek beyond their books and think about how science relates to the real world. By fostering curiosity and critical thinking, MBS empowers young students to engage with scientific concepts in a meaningful way.

IIT Delhi's Academic Outreach & New Initiatives office has been supporting MBS for the past two years now, and we are proud as it complements our goal of bringing science to more schools and inspiring students to develop a scientific temperament. Science, in our opinion, is for everyone, especially for students who want to address real-life problems, pose thought-provoking queries, and come up with creative answers. This active and practical style of learning is what scientific research is based on.

A crucial aspect of this collaboration is the involvement of IIT Delhi's research scholars, who not only contribute to MBS by evaluating the entries but also gain valuable insights from their experiences. Interacting with young curious students helps our scholars to experience science in a new light - one that is unfiltered by conventional academic boundaries. This interaction feeds their own inquisitiveness, which strengthens the essence of scientific curiosity. While interacting with the bright young minds, our researchers are refreshed on the principles of inquiry-based learning that helps formulate their own investigations.

I take great pride in the association with the Macmillan Budding Scientist Programme and hope to sustain this partnership. By joining hands, we can create a world where every child is able to reason, investigate, and create, like a real scientist.

At IIT Delhi, we remain dedicated to helping young learners while also inducing a spirit of scientific inquiry. We salute Macmillan Budding Scientist for nurturing the coming generation of problem-solver, researchers and innovators. Over the years, the programme has grown in scale and stature and now receives participation from over 1200 schools spread across India and the Middle East. Let us make deeper attempts to motivate, educate and research because the future of science starts here!

SPEAKS

PROF. SUBODH SHARMA

Associate Professor and Pankaj Gupta Chair Professor in Privacy and Decentralisation, Department of Computer Science and Engineering, IIT Delhi

It has been my privilege to be associated with an initiative like Macmillan Budding Scientist (MBS). Since its inception in 2019, the MBS initiative has completed six successful iterations and grown significantly, with many prestigious IITs joining hands to support this noble endeavor over the years.

Fostering a scientific temper among students and democratizing science to make it more accessible are two objectives that are extremely close to my heart. MBS provides a unique platform for students, encouraging them to view science as an application-driven discipline while nurturing their boundless creativity. Through MBS, students not only apply their scientific knowledge to address real-world challenges—problems they encounter in their daily lives—but also gain the invaluable experience of life at an IIT. IIT Delhi, in particular, has been a beacon of inspiration, championing the cause of pursuing science and fueling curiosity.

The contributions of mentor teachers deserve special recognition. These dedicated educators invest themselves wholeheartedly to ensure their students excel, shaping young, inquisitive minds and inspiring them to explore science beyond the confines of textbooks.

Equally commendable are the principals and school leaders of the participating institutions. Creating an environment that encourages students to ask questions and think critically is no small feat. Their leadership fosters a culture of inquiry that is vital for nurturing the innovators of tomorrow.

I hope these projects inspire students to push the boundaries of their educational experiences, exploring learning opportunities that extend beyond the classroom while remaining rooted within their school systems. More importantly, I envision this booklet as a pioneering effort to honor the often-unsung champions of our society—school teachers—who consistently go above and beyond to empower every student entrusted to their care.

HOW DOES IT WORK? VERY SIMPLY!

01

Registering for the programme

The mentor teacher registers the team through an online form.
A mentor teacher can register only 1 team.

02

Identifying and analysing a problem

Teams identify a real-world problem they wish to work upon and carry out research, apply scientific principles and consider possible solutions.

03

Creating a prototype

Team develops a working prototype using empirical data.

04

Submitting a video

For the preliminary round they present their project in a 3-minute video.

05

Screening for the preliminary round

Evaluators from various IIT(s) assess submissions to shortlist the top teams from each zone

06

Zonal rounds

Shortlisted teams compete in zonal finals at respective IIT campuses, for the Grand Finale.

07

Grand finale

The top 10 teams compete in the final round, enjoying an immersive experience at the IIT(s).

WHERE DOES IT HAPPEN?

The zonal rounds take place on the IIT campuses in different regions, offering students:

- A first-hand experience of IIT life
- Engaging lab tours to see Science in practice
- A glimpse into hostel life
- Interactions with IIT students and faculty.

The Grand Finale marks the culmination of this six-month journey, where the top 10 teams compete for the ultimate recognition.

WHY PARTICIPATE?

This Programme is more than just a competition—it's a transformational experience for young scientists!

- Develop essential 21st-century skills – collaboration, communication, critical thinking
- Showcase innovative ideas at a premier IIT campus
- Experience life at an IIT – including lab tours and student interactions
- Ignite curiosity and build a scientific temperament.

Macmillan Budding Scientist is not just about winning—it's about learning, exploring, and Igniting Curiosity!

MS. SUDHA NADDI

TGT, Science, Navrachana Higher Secondary School, Sama, Vadodara

I am incredibly grateful to MacMillan Budding Scientist for providing a platform to present our scientific idea. The experience was inspiring, fostering innovation and collaboration. Your unwavering support and encouragement helped us showcase our research with confidence. Thank you for empowering young minds and promoting scientific curiosity.

AANSHI SHETH

Student, Class 8, Navrachana Higher Secondary School, Sama, Vadodara

The chance to visit IIT Delhi was a once-in-a-lifetime opportunity. Maybe it was the thrill of the competition, but the opportunity to interact with IIT professors and students of all over the nation was an amazing ride. I am truly grateful to Macmillan for organizing this wonderful event and even our school for giving us a chance to present our idea in front of respected dignitaries.

MS. POONAM ANAND

TGT, Science, Summer Fields School, Gurugram

As a science teacher, I always strive to ignite a passion for discovery in my students. But this year, I had the incredible opportunity to experience that thrill of discovery firsthand, as a participant in the Macmillan Budding Scientist Programme.

Winning the second position in the Grand Finale was truly an honor. But more than the recognition, the experience was invaluable. Thank you Macmillan for providing us a platform to enhance and explore our talent

Winning accolades at the Macmillan Budding Scientist Programme is a well-deserved recognition of our student's hard work, talent, and potential. This achievement not only brings honor to our school but also serves as an inspiration to other students to pursue their interests in STEM fields.

YUVRAJ SHARMA

Student, Class 8, Summer Fields School, Gurugram

The program brought together aspiring scientists from diverse backgrounds, all eager to share their research and ideas. The atmosphere was electric, with a palpable sense of curiosity and collaboration.

One of the highlights for me was the opportunity to present my own project alongside other talented individuals. The constructive feedback and encouragement from both peers and mentors were invaluable. It was a privilege to be part of a community that fosters creativity and innovation.

Thank you, Macmillan, for creating such an enriching platform for young scientists. I am excited to see how this initiative continues to inspire future generations!

MS. NEVALEAN LANGSTIEH

Science teacher, Carmel School Sadew, Shillong

My sincere appreciation and gratitude to the Macmillan Team for providing a platform to enhance our knowledge and opportunity to showcase it. I've had a brilliant experience and it was a great exposure for my students by participating in this competition. I believe that such competitions will help and inspire us to carry out our activities in the field of education and science with high responsibility and dedication.

EIWANDAKA B. LYNSER

Student, Class 8, Carmel School Sadew, Shillong

Participating in the Macmillan Budding Scientist programme was an incredible experience! It ignited my passion for Science, enhanced my research skills. I gained valuable feedback from the experts, developed confidence and memorable friendships. Thank you Macmillan, for fostering innovation and nurturing young minds.

MS. MAHIMA KHARE

Gitanjali Devshala, Hyderabad

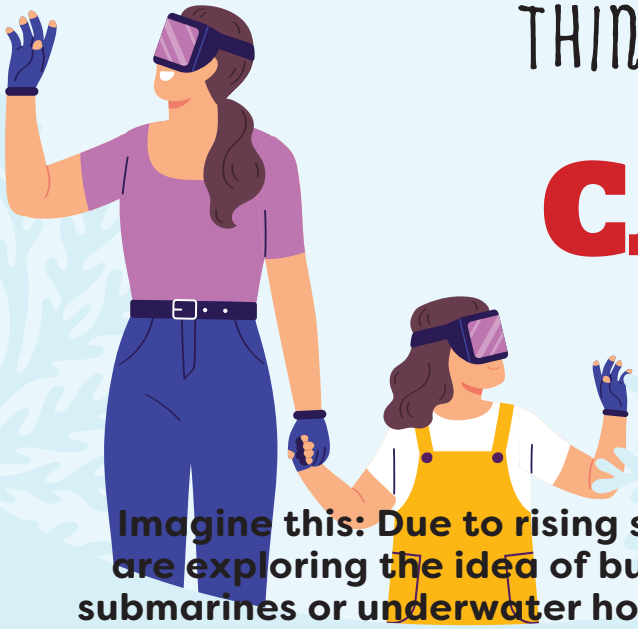
The Macmillan Budding Scientists was not just about projects; it was about fostering critical thinking, teamwork, and resilience. Seeing students grow in confidence as they presented their ideas and engaged with experts was a proud moment for me as an educator. I am grateful for the opportunity to mentor these future scientists and innovators, and I look forward to continuing to nurture a love for science in my students.

ISHAN MANDALA

Student, Class 8, Gitanjali Devshala, Hyderabad

The Macmillan Budding Scientist Programme gave us that invaluable space where our ideas were not just heard, but challenged, refined and strengthened, shaping our perspective for the better, anchoring the foundation of our ambition, helping us learn, grow and realize the true potential of our vision.

THINK LIKE A **SCIENTIST:**



CAN WE LIVE Underwater?

Imagine this: Due to rising sea levels and crowded cities, scientists are exploring the idea of building homes under the ocean! Just like submarines or underwater hotels, future colonies might be built on the seafloor. You're leading the design team for Earth's first underwater village.

HERE ARE THE DEEP-SEA CHALLENGES TO SOLVE:

WATER PRESSURE

Deep underwater, the pressure is so strong it could crush normal buildings. How can we build strong but livable homes?

BREATHING AIR

There's no air under the ocean. How will people breathe safely?

FOOD AND FRESH WATER

How can we grow food or get drinking water in the ocean?

SUNLIGHT AND POWER

It's dark underwater. What kind of lights or energy systems could work?

COMMUNICATION

Wi-Fi and mobile signals don't work well underwater. How will people stay connected?

Your Mission: Design an underwater home, school, or city! Think about shape, material, energy, and how people will live happily and safely.

Draw it, describe it, or create a mini-story. Dive deep into your imagination—science is your oxygen tank!

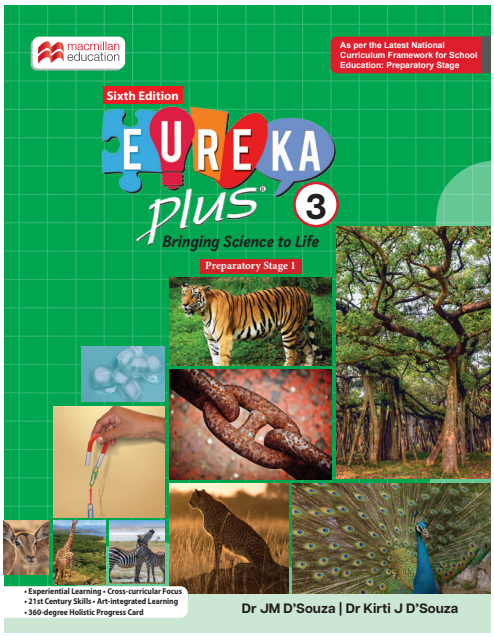
Submit Your Solution: Send your ideas, drawings, or explanations to **mbs@macmillaneducation.com**

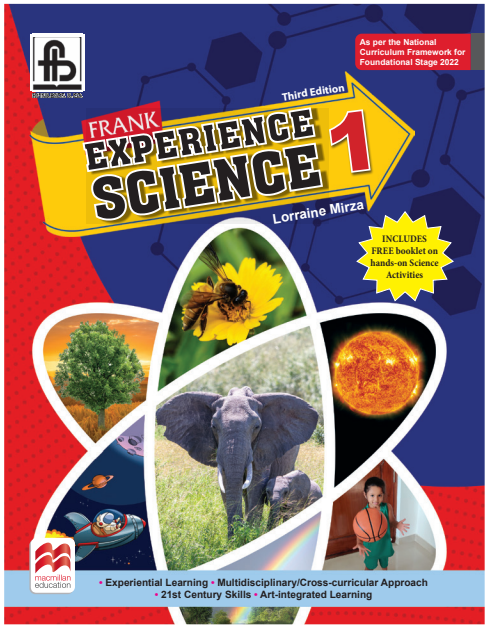
Subject Line: "Think like a scientist – [Your Name]" (Replace [Your Name] with your own name)

Let's explore the final frontier on Earth—the ocean depths!

We'll feature some of the best ideas in the next issue of Science Spark

MACMILLAN'S
SCIENCE BESTSELLERS





Eureka Plus and Experience Science for classes 1 to 8, are both aligned to NCF for School Education 2023 and aim to develop scientific temper amongst learners.

1. Learning Outcomes based on Bloom's Taxonomy
2. Art-integrated Activities: To promote creativity
3. Cross-curricular Projects
4. 360 degree Holistic Progress Card
5. Focus on Sustainable Development Goals

DIGITAL LEARNING RESOURCES

This book is accompanied with a ready-to-use smart suite of digital learning resources, closely linked to the curriculum and aligned with the coursebook. Click on the URL to register and access the digital learning resources.

https://www.macmillaneducationeverywhere.com/

✓✓ Animations	✓✓ Picture Study	✓✓ Interactive Activities and Games	✓✓ Scientists
✓ Learn More	✓ Lesson Plans	✓ Worksheets	✓ Test Generator

✓✓ For both Teacher and Students ✓ Only for Teachers

ANSWERS KEY

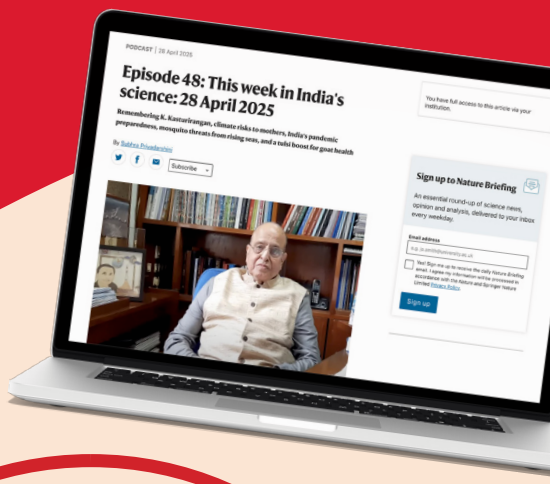
SCIENCE Quiz

1. c) The Blueprint of Life
2. a) Double helix
3. b) Tall and short height genes
4. c) Gregor Mendel
5. c) DNA and protein
5. c) DNA and protein
6. a) False (You get genes from both parents!)
   b) True
   c) True (Bananas have DNA too!)
   d) True
   e) True

Science PODCAST Series

Let Curiosity Speak!

nature india



SCIENCE COMES ALIVE WHEN YOU HEAR IT FROM THE EXPERTS.

- Bite-sized episodes for young listeners
- Hosted by engaging storytellers and science experts
- Covers cool topics like space, climate, tech, biology, and more!
- Perfect for classroom listening or family drives
- Tune in, learn something amazing, and discover the scientist in you

SCIENCE NEWSLETTER FOR MIDDLE SCHOOLERS — RESEARCH MEETS WONDER

Our Science Newsletter, curated specially for middle schoolers, features:

- Amazing discoveries explained in simple language
- Stories from real scientists and researchers
- DIY experiments and classroom activities
- Brain-teasers, trivia, and spotlight sections on student innovators
- 2 exciting issues every month — delivered right to your inbox or classroom!

SCAN ME

*Crafted in partnership with **Nature India**, this newsletter and podcast connects young minds to what's happening right now in the world of science — and shows how they can be a part of it.*

Macmillan Budding Scientist

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Since 1892, Macmillan Education India has been pioneering quality publishing for teachers and institutions. The passion to transform lives is at the centre of our ideology. Macmillan textbooks, developed by leading academicians and practicing teachers are research-based, learner-centric and are the first choice of over 15,000 institutes pan India. Our resources lead the teaching-learning through new methodologies, and sound teaching practices that inspire learners to achieve more through engaging digital and print content.

Macmillan Education India (MEI) has an unrivaled reputation in the school market. MEI produces curriculum resources in both print and digital form, offers assessments, and provides teacher training. With over 130 years in the education sector, MEI partners with 15,000+ schools and reaches 10 million learners across India.

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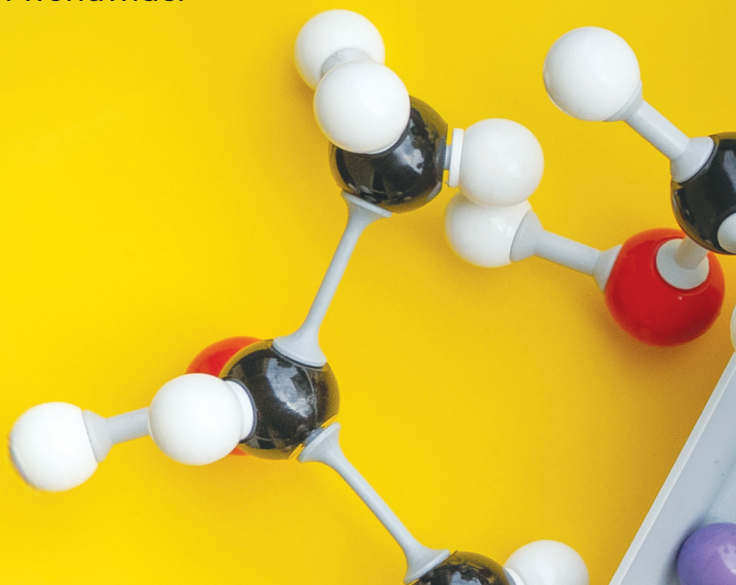

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