# Microbe Mysteries

## A Journey Through a Tiny World

By Keilin Gorman and Lauren Mark

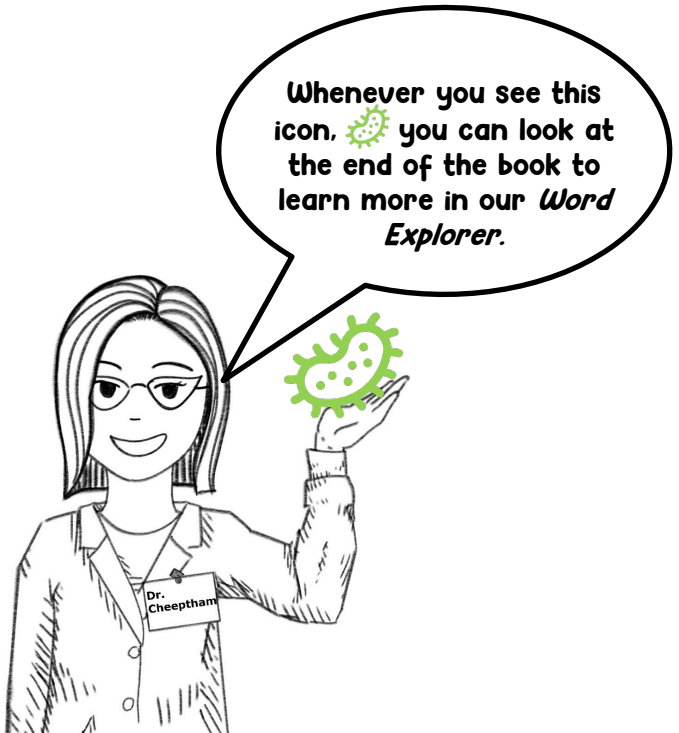
with Dr. Naowarat Cheeptham ( Ann )

# Microbe Mysteries: A Journey Through a Tiny World

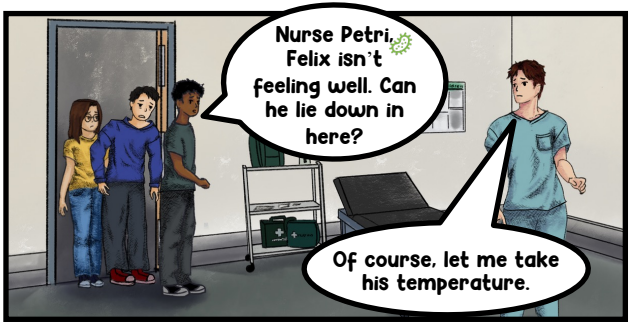
Written by Keilin Gorman
and Lauren Mark

Illustrated by Lauren Mark

In collaboration with Dr. Naowarat Cheeptham (Ann)


Whenever you see this icon, you can look at the end of the book to learn more in our *Word Explorer*.
Dr. Cheeptham

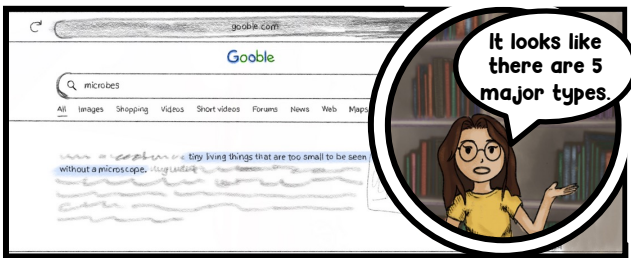
One day, Lily, Max, and Felix were getting ready for a presentation...


His temperature is 39.8°C. He definitely has a fever.
What's wrong with him?
First Aid For Children
I'm not sure, it might be a *bad* microbe... For now, let's let him rest.
Max, are you thinking what I'm thinking?
It's up to us to figure out what's wrong with him, Lily!


Hang in there, Felix! You can count on us!


Let's find out everything we can about these "*microbes*".
First, let's look up what a microbe is.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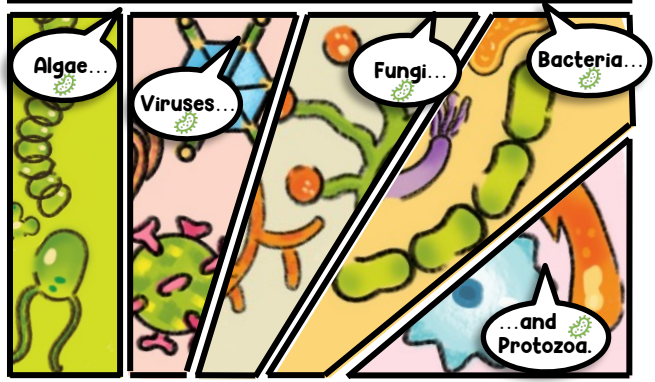
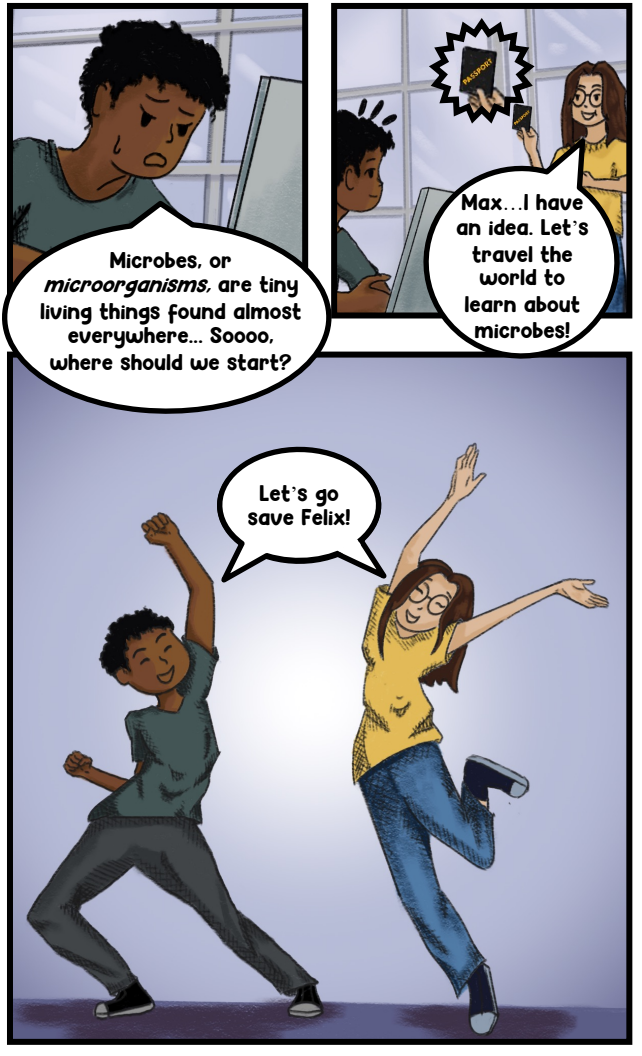
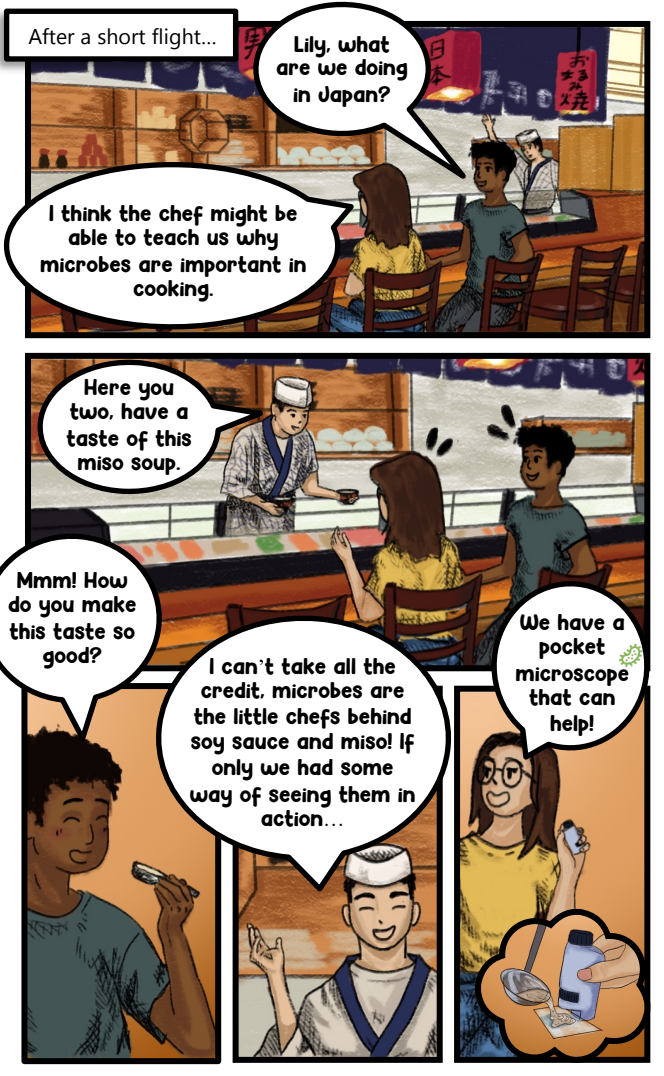
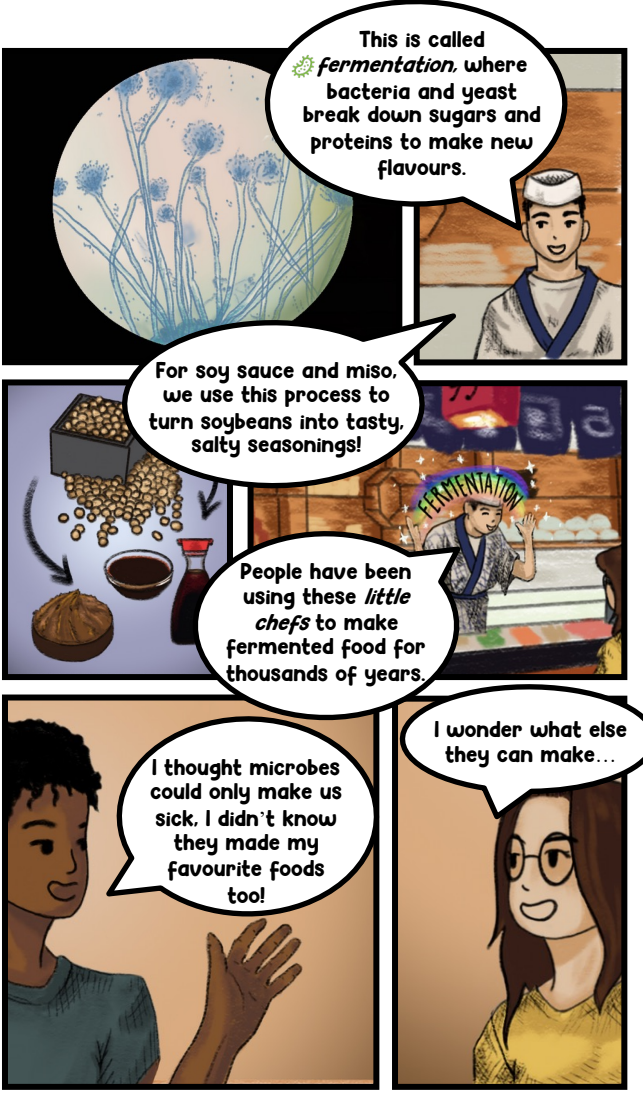
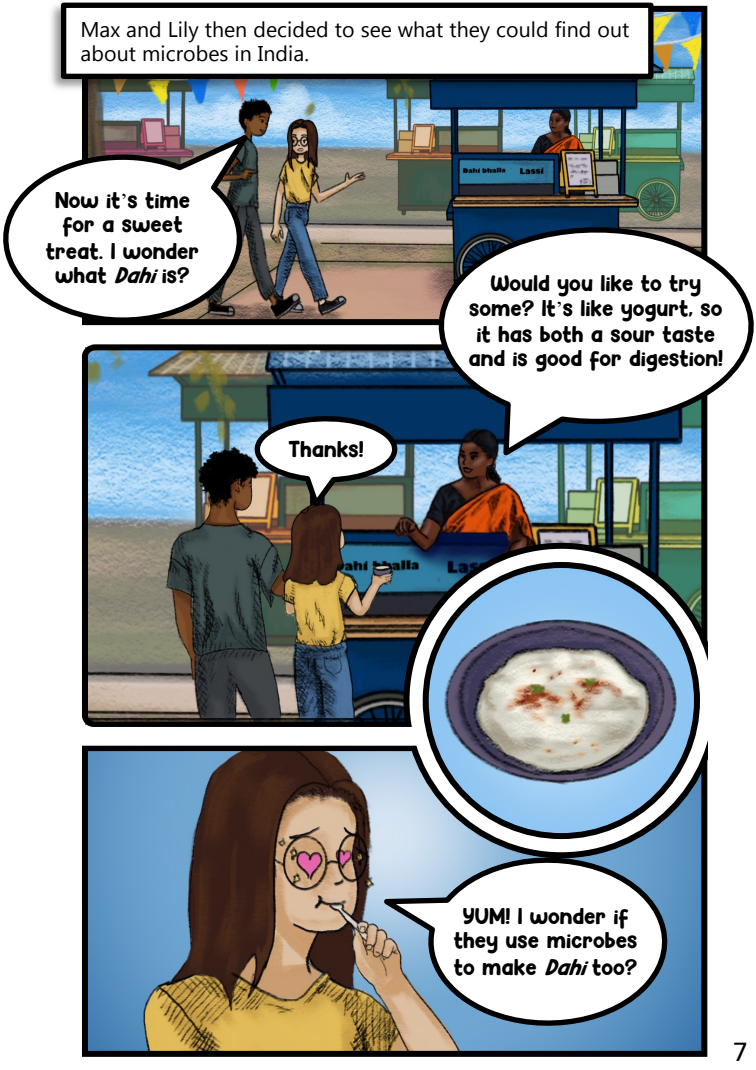
tiny living things that are too small to be seen
without a microscope.
It looks like there are 5 major types.

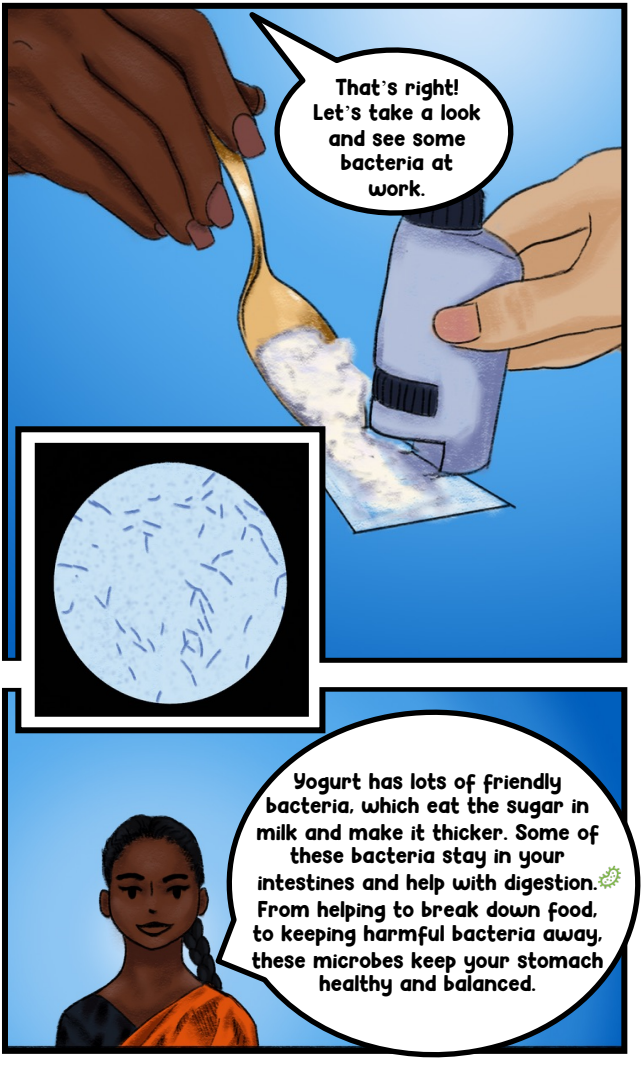

Algae...
Viruses...
Fungi...
Bacteria...
...and Protozoa.

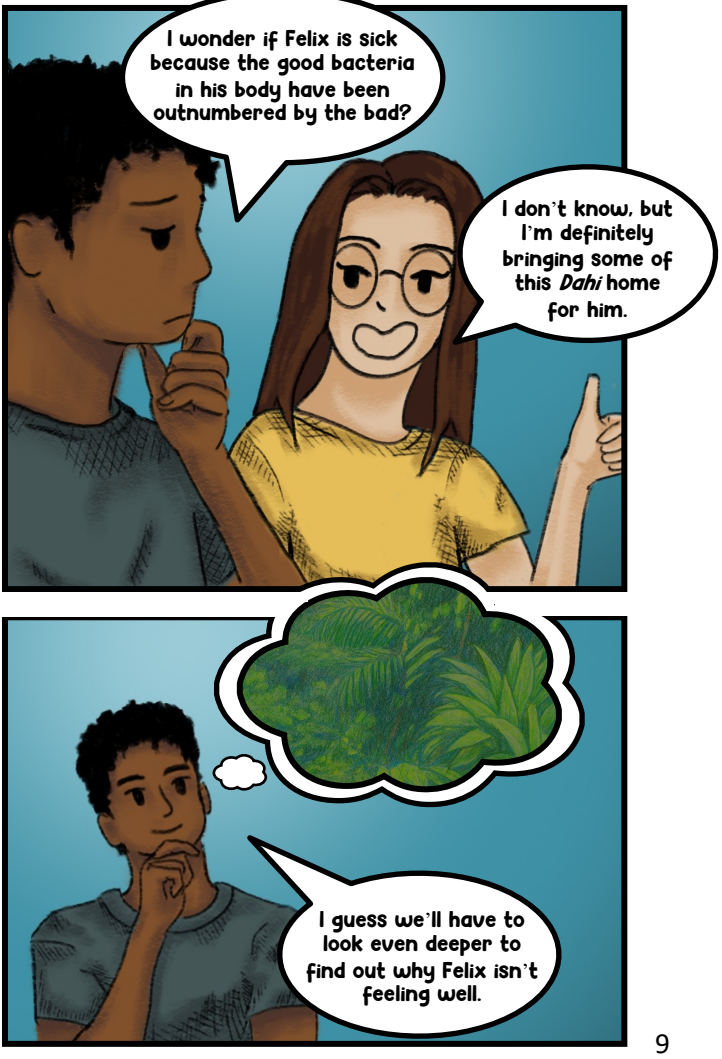

Microbes, or *microorganisms,* are tiny living things found almost everywhere... Soooo, where should we start?
PASSPORT
Max...I have an idea. Let's travel the world to learn about microbes!
Let's go save Felix!

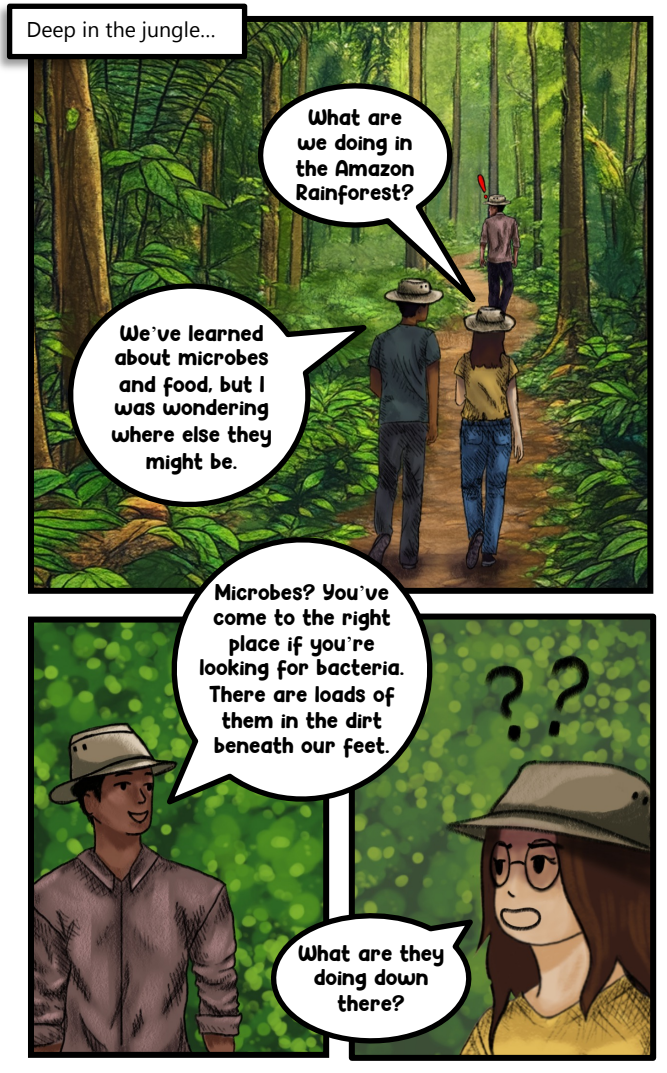

After a short flight...
Lily, what are we doing in Japan?
I think the chef might be able to teach us why microbes are important in cooking.
Here you two, have a taste of this miso soup.
Mmm! How do you make this taste so good?
I can't take all the credit, microbes are the little chefs behind soy sauce and miso! If only we had some way of seeing them in action...
We have a pocket microscope that can help!

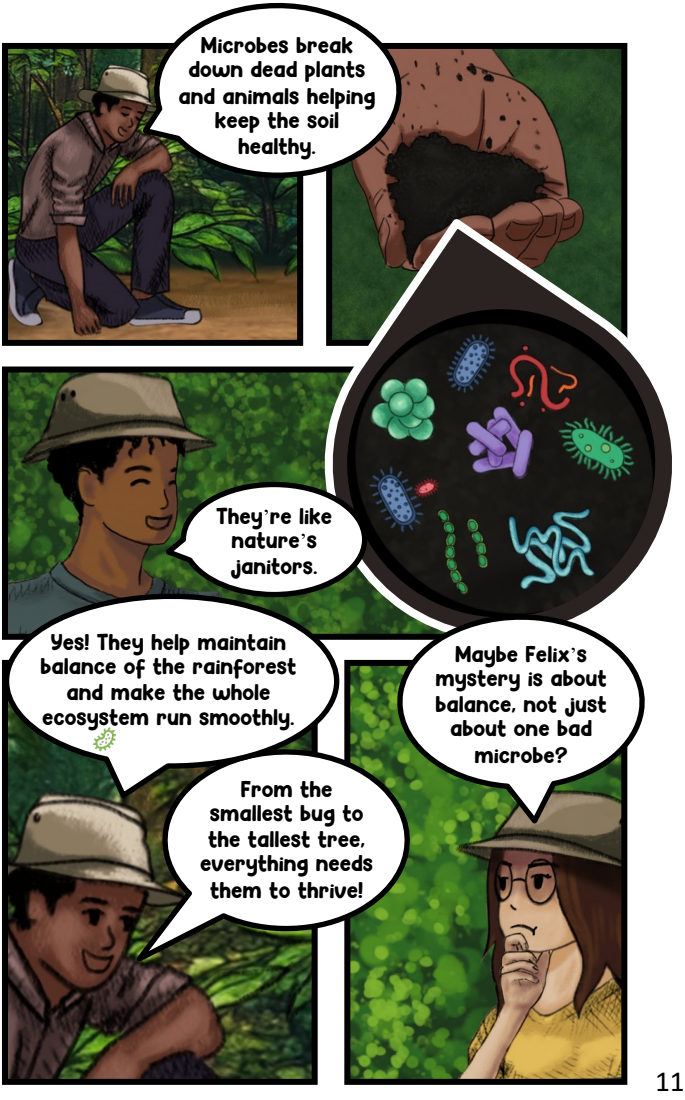

This is called *fermentation*, where bacteria and yeast break down sugars and proteins to make new flavours.
For soy sauce and miso, we use this process to turn soybeans into tasty, salty seasonings!
FERMENTATION
People have been using these *little chefs* to make fermented food for thousands of years.
I thought microbes could only make us sick. I didn't know they made my favourite foods too!
I wonder what else they can make...

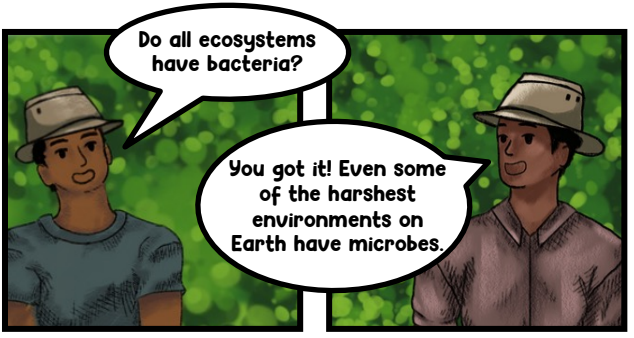

Max and Lily then decided to see what they could find out about microbes in India.
Now it's time for a sweet treat. I wonder what *Dahi* is?
Dahi bhalla
Lassi
Would you like to try some? It's like yogurt, so it has both a sour taste and is good for digestion!
Thanks!
YUM! I wonder if they use microbes to make *Dahi* too?


That's right! Let's take a look and see some bacteria at work.
Yogurt has lots of friendly bacteria, which eat the sugar in milk and make it thicker. Some of these bacteria stay in your intestines and help with digestion. From helping to break down food, to keeping harmful bacteria away, these microbes keep your stomach healthy and balanced.


I wonder if Felix is sick because the good bacteria in his body have been outnumbered by the bad?
I don't know, but I'm definitely bringing some of this *Dahi* home for him.
I guess we'll have to look even deeper to find out why Felix isn't feeling well.

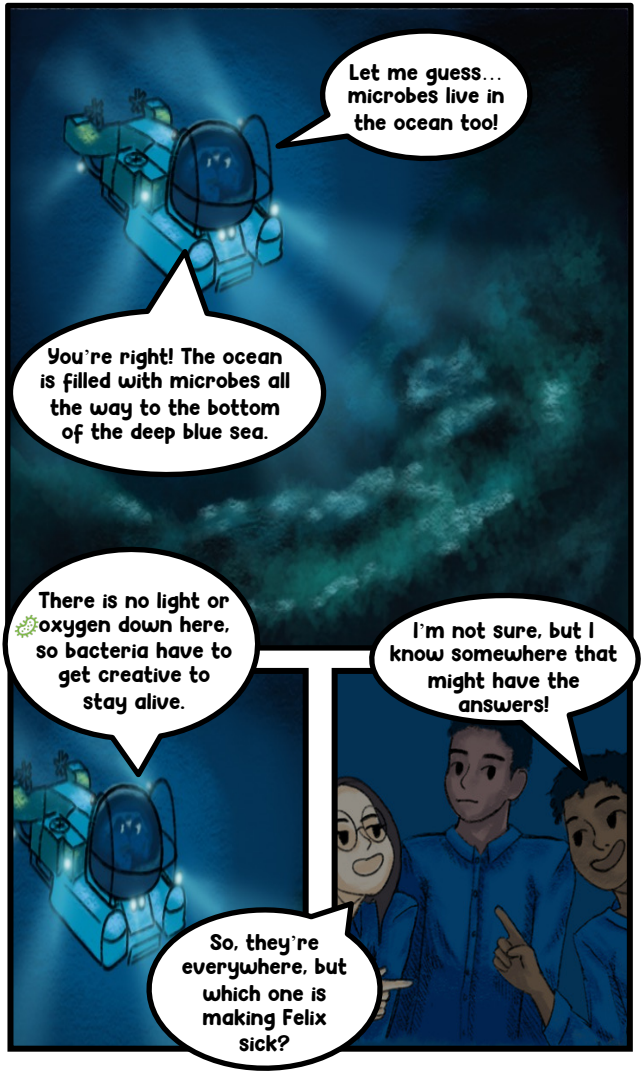

Deep in the jungle...
What are we doing in the Amazon Rainforest?
We've learned about microbes and food, but I was wondering where else they might be.
Microbes? You've come to the right place if you're looking for bacteria. There are loads of them in the dirt beneath our feet.
What are they doing down there?


Microbes break down dead plants and animals helping keep the soil healthy.
They're like nature's janitors.
Yes! They help maintain balance of the rainforest and make the whole ecosystem run smoothly.
From the smallest bug to the tallest tree, everything needs them to thrive!
Maybe Felix's mystery is about balance, not just about one bad microbe?

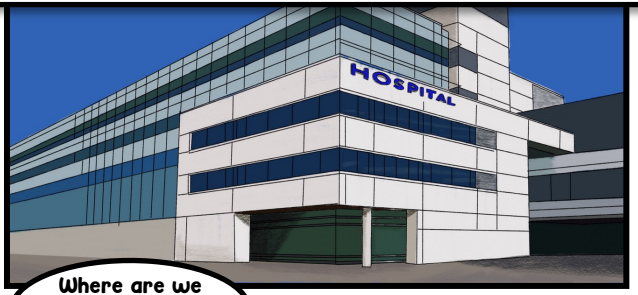

Do all ecosystems have bacteria?
You got it! Even some of the harshest environments on Earth have microbes.


No way! Can you show us?
I thought you'd never ask! You two better prepare for some extreme places...

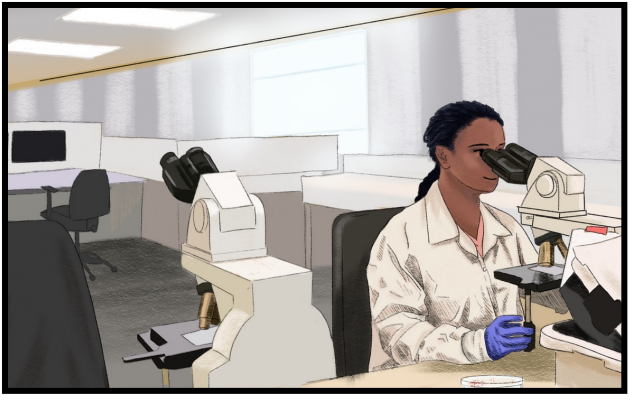

They visited some *very* extreme environments.
I can't believe bacteria can live in lava!
They can survive temperatures above 100°C, which is hotter than boiling water!
Well, bacteria actually live in the steam vents around volcanoes.
Brr, I liked it better at the volcano.
I guess even microbes like hanging out in hot tubs.
Some microbes can live in the ice of glaciers.
You might like the warm, but some bacteria love the cold too!

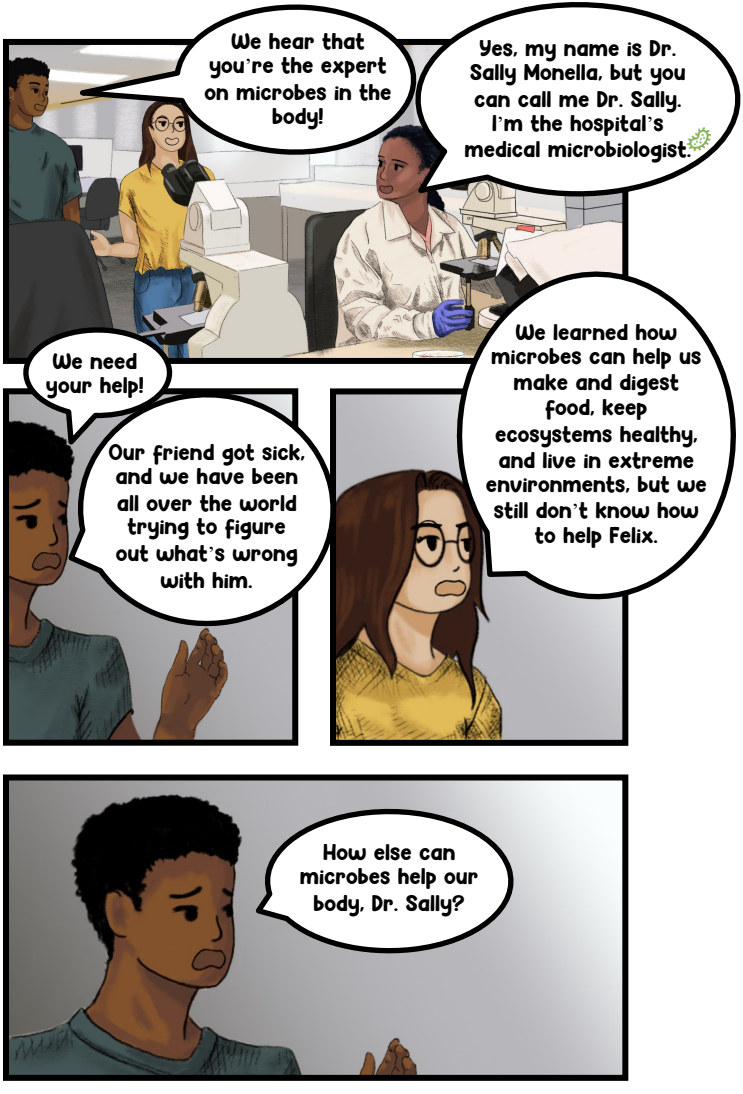

Let me guess... microbes live in the ocean too!
You're right! The ocean is filled with microbes all the way to the bottom of the deep blue sea.
There is no light or oxygen down here, so bacteria have to get creative to stay alive.
I'm not sure, but I know somewhere that might have the answers!
So, they're everywhere, but which one is making Felix sick?

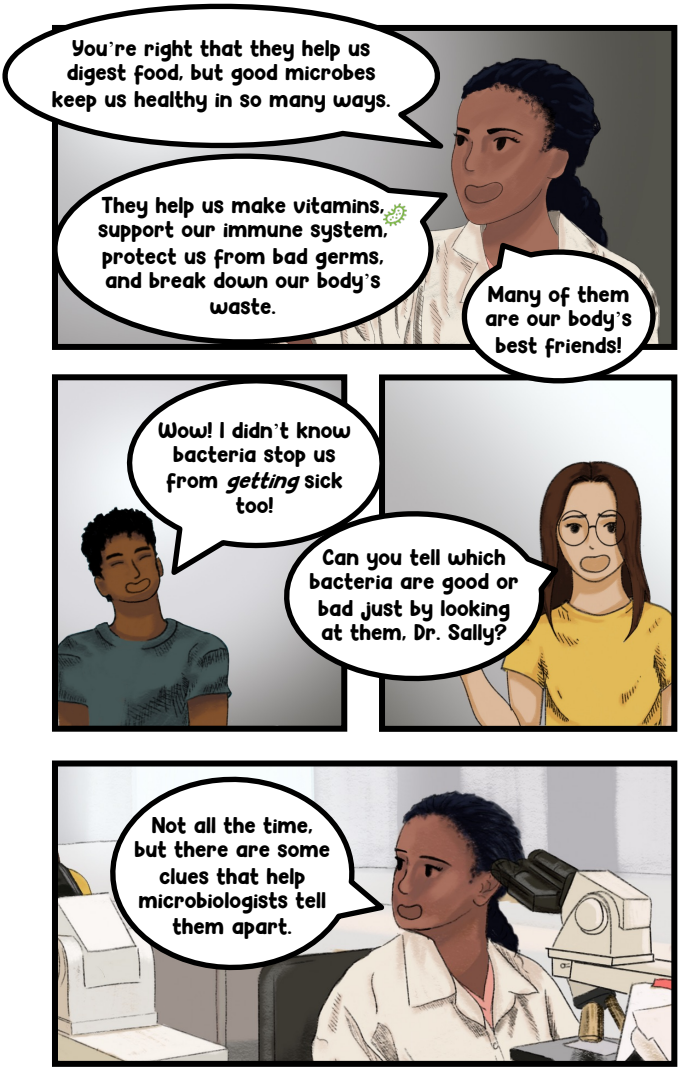
Back in Canada, Max and Lily made their way to their local hospital.

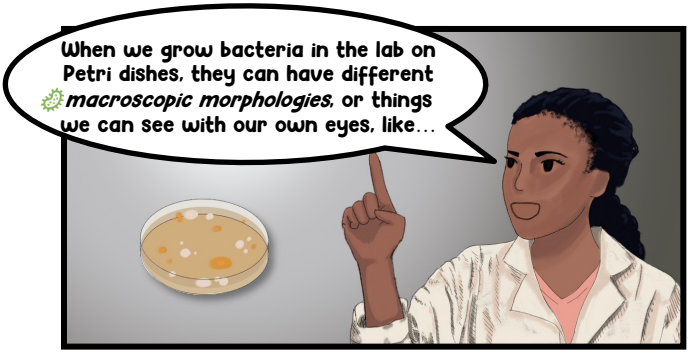


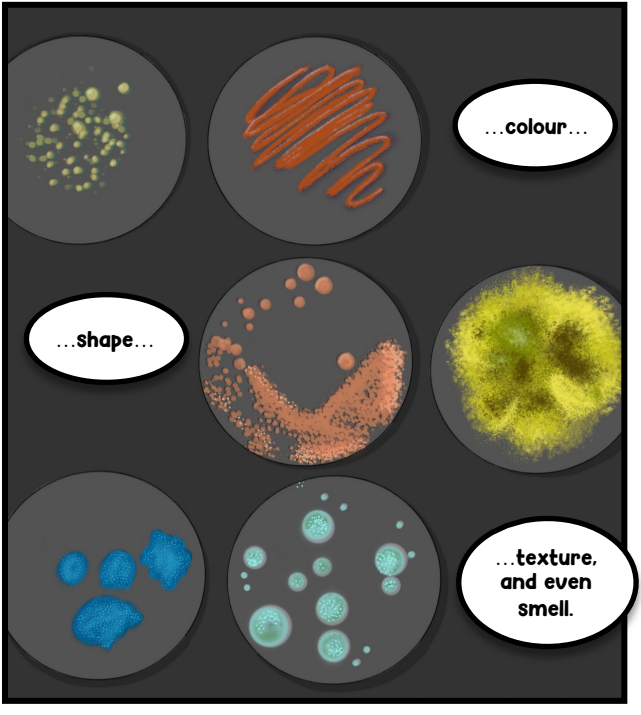


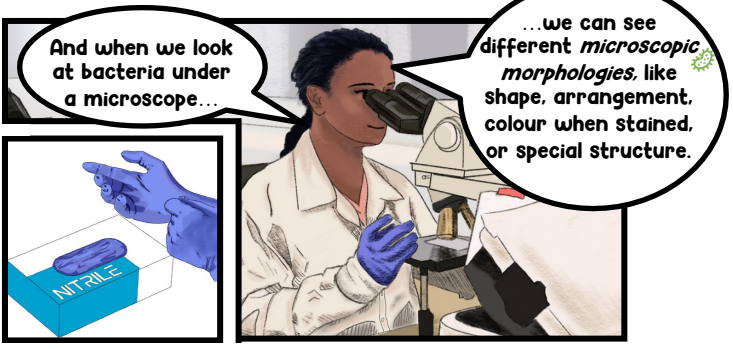


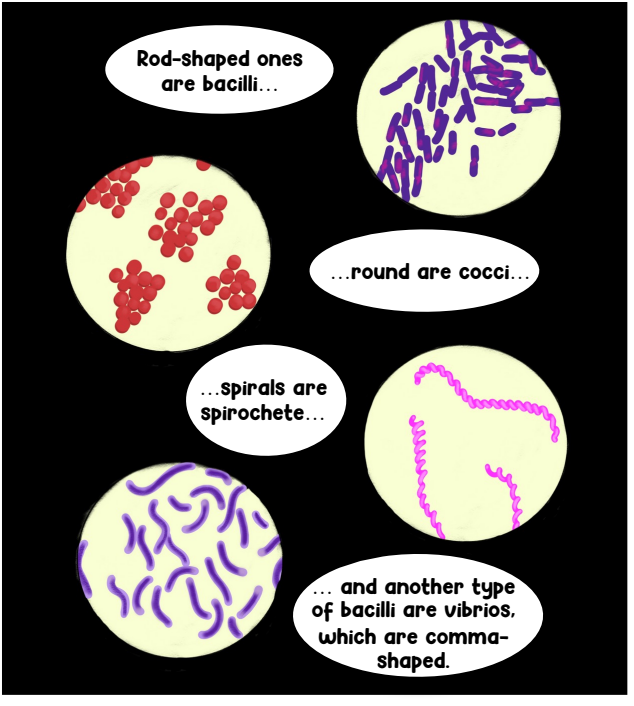

We hear that you're the expert on microbes in the body!
Yes, my name is Dr. Sally Monella, but you can call me Dr. Sally. I'm the hospital's medical microbiologist.
We need your help!
Our friend got sick, and we have been all over the world trying to figure out what's wrong with him.
We learned how microbes can help us make and digest food, keep ecosystems healthy, and live in extreme environments, but we still don't know how to help Felix.
How else can microbes help our body, Dr. Sally?


You're right that they help us digest food, but good microbes keep us healthy in so many ways.
They help us make vitamins, support our immune system, protect us from bad germs, and break down our body's waste.
Many of them are our body's best friends!
Wow! I didn't know bacteria stop us from *getting* sick too!
Can you tell which bacteria are good or bad just by looking at them, Dr. Sally?
Not all the time, but there are some clues that help microbiologists tell them apart.

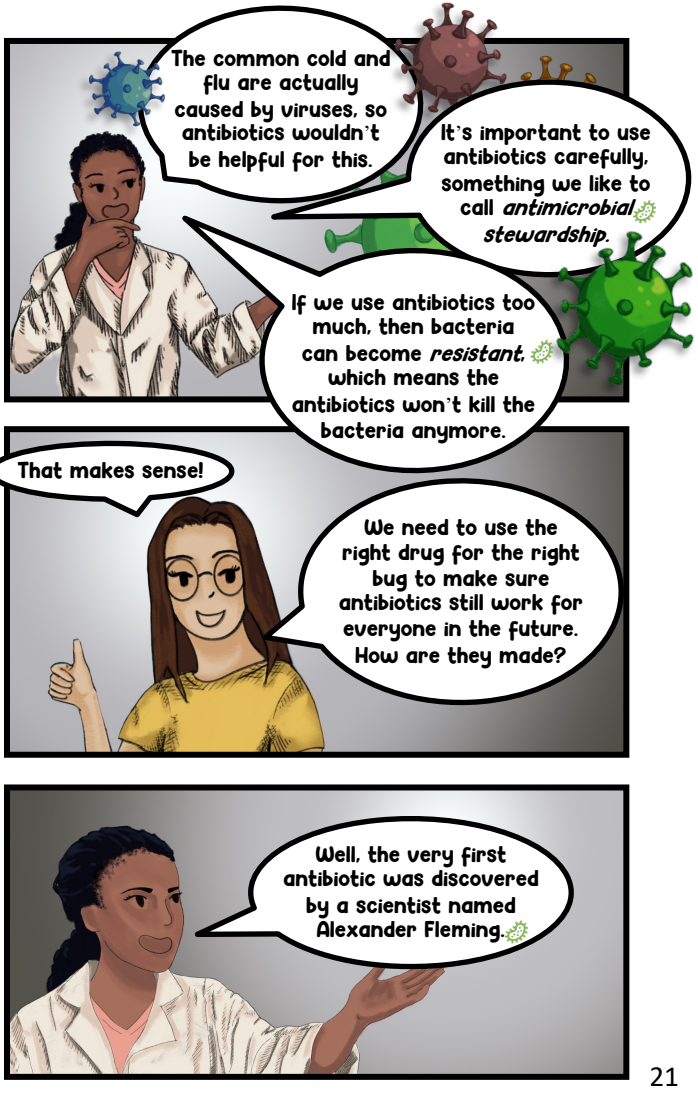

When we grow bacteria in the lab on Petri dishes, they can have different *macroscopic morphologies*, or things we can see with our own eyes, like...

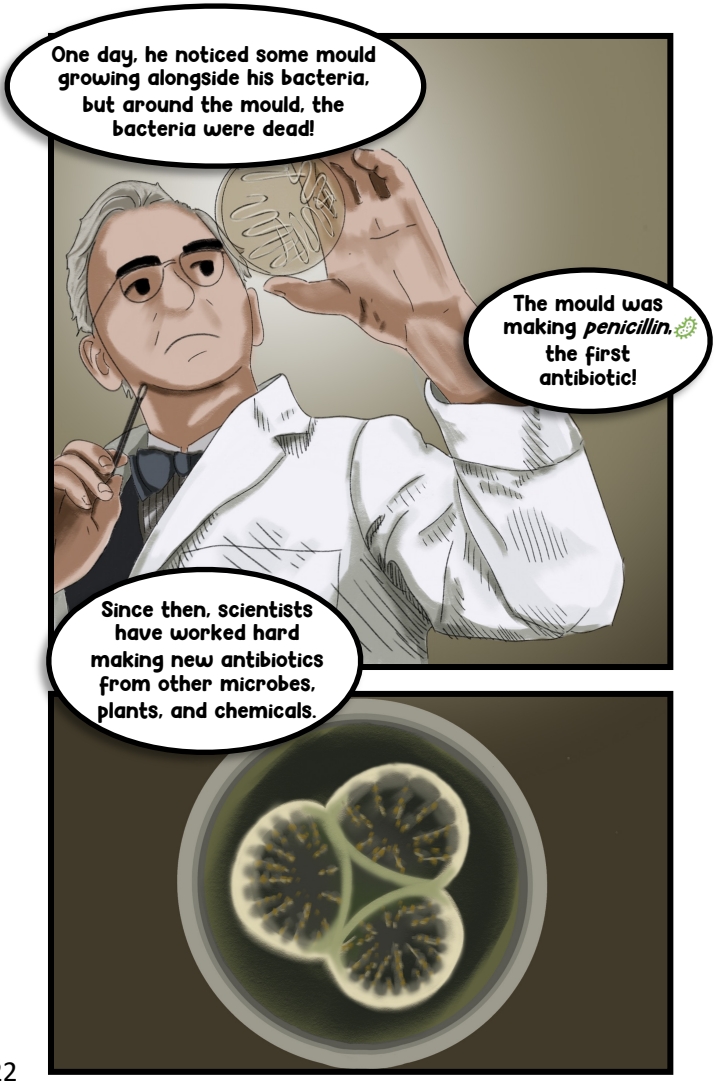

...colour...
...shape...
...texture, and even smell.

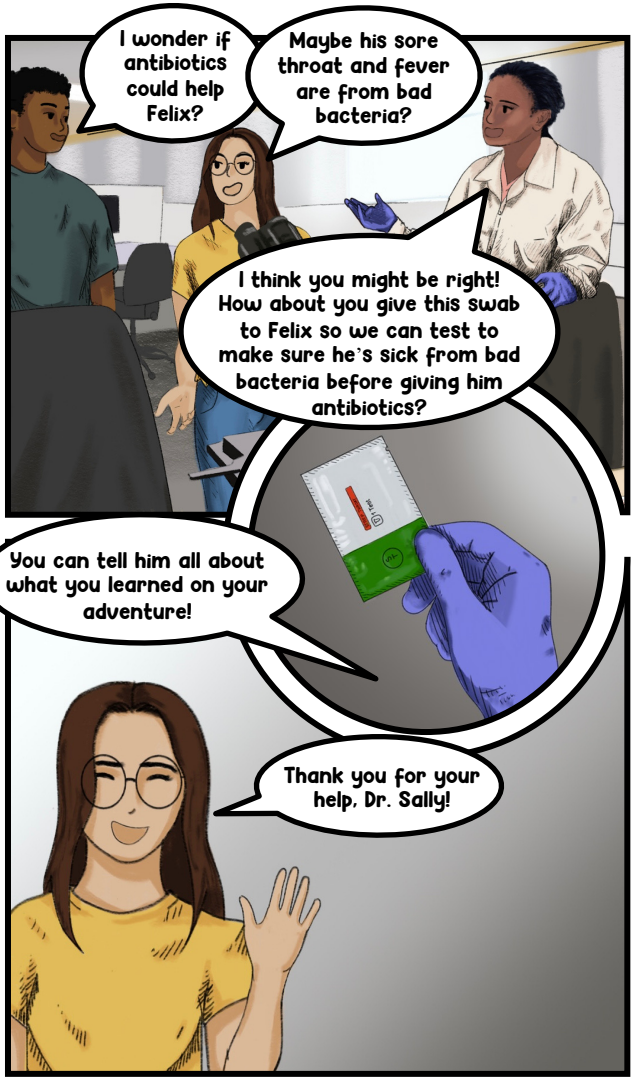

And when we look at bacteria under a microscope...
...we can see different *microscopic morphologies,* like shape, arrangement, colour when stained, or special structure.
NITRILE

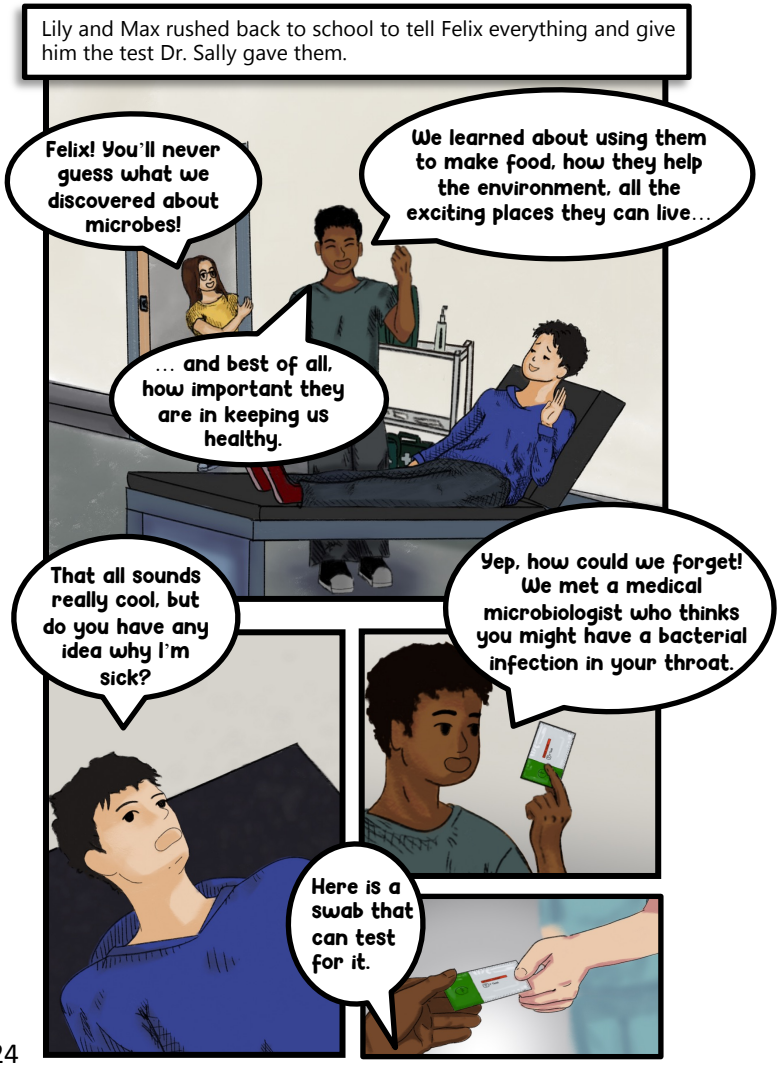

Rod-shaped ones are bacilli...
...round are cocci...
...spirals are spirochete...
... and another type of bacilli are vibrios, which are comma-shaped.

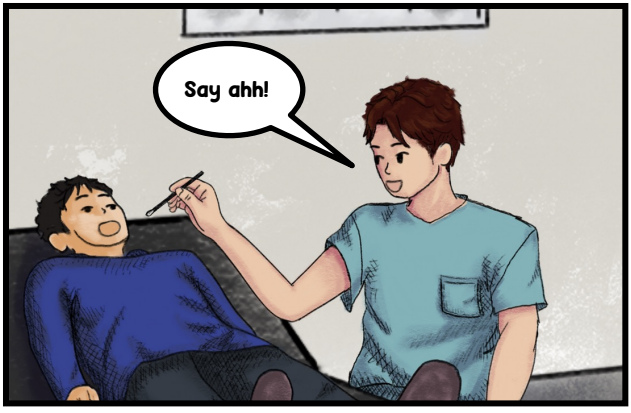

Does that mean we know all about bacteria?
Actually, no!
We think we've only discovered less than 5% of bacteria on Earth. Microbiology is still full of mysteries!
What can we use to help someone when they get sick from a microbe?
Well, not all infections need medicine, and sometimes all you need is a healthy immune system to fight off bad microbes!
But when someone is really sick from a bacterial infection, we can use antibiotics to fight them.
So, do we need antibiotics for a cold or the flu?

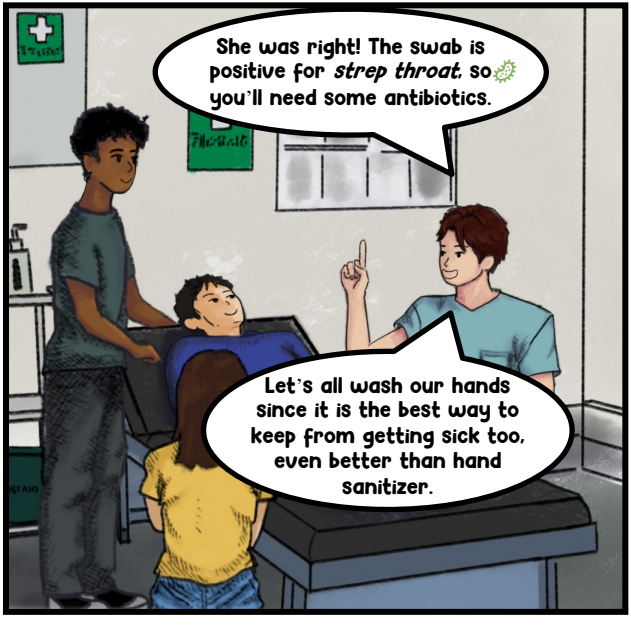

The common cold and flu are actually caused by viruses, so antibiotics wouldn't be helpful for this.
It's important to use antibiotics carefully, something we like to call *antimicrobial stewardship*.
If we use antibiotics too much, then bacteria can become *resistant*, which means the antibiotics won't kill the bacteria anymore.
That makes sense!
We need to use the right drug for the right bug to make sure antibiotics still work for everyone in the future. How are they made?
Well, the very first antibiotic was discovered by a scientist named Alexander Fleming.

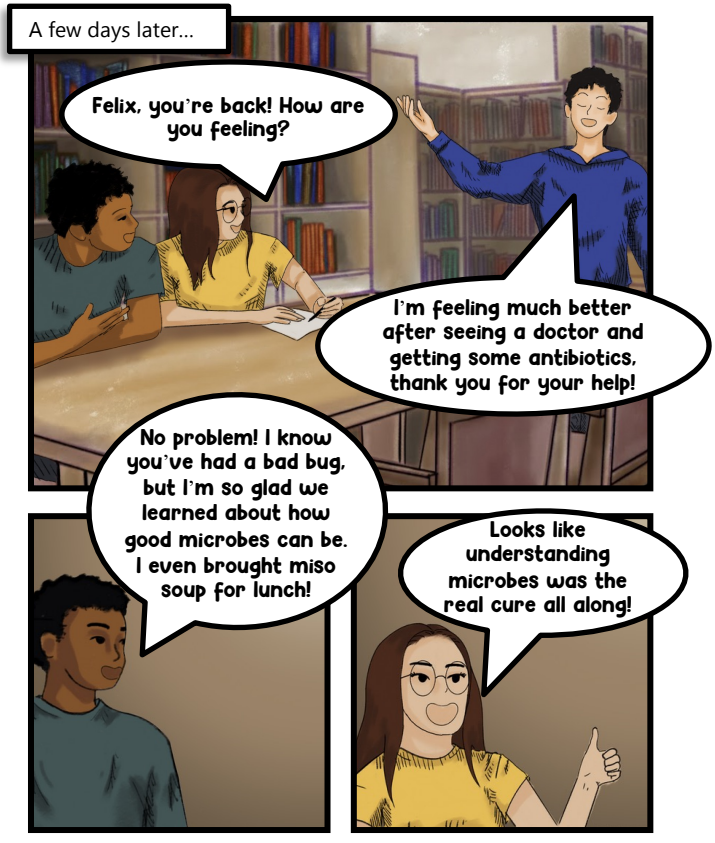

One day, he noticed some mould growing alongside his bacteria, but around the mould, the bacteria were dead!
The mould was making *penicillin*, the first antibiotic!
Since then, scientists have worked hard making new antibiotics from other microbes, plants, and chemicals.


I wonder if antibiotics could help Felix?
Maybe his sore throat and fever are from bad bacteria?
I think you might be right! How about you give this swab to Felix so we can test to make sure he's sick from bad bacteria before giving him antibiotics?
You can tell him all about what you learned on your adventure!
Thank you for your help, Dr. Sally!


Lily and Max rushed back to school to tell Felix everything and give him the test Dr. Sally gave them.
Felix! You'll never guess what we discovered about microbes!
We learned about using them to make food, how they help the environment, all the exciting places they can live...
... and best of all, how important they are in keeping us healthy.
That all sounds really cool, but do you have any idea why I'm sick?
Yep, how could we forget! We met a medical microbiologist who thinks you might have a bacterial infection in your throat.
Here is a swab that can test for it.


Say ahh!


She was right! The swab is positive for *strep throat*, so you'll need some antibiotics.
Let's all wash our hands since it is the best way to keep from getting sick too, even better than hand sanitizer.


A few days later...
Felix, you're back! How are you feeling?
I'm feeling much better after seeing a doctor and getting some antibiotics, thank you for your help!
No problem! I know you've had a bad bug, but I'm so glad we learned about how good microbes can be. I even brought miso soup for lunch!
Looks like understanding microbes was the real cure all along!

THE END

# Word Explorer

| | |
|---|---|
| Alexander Fleming | Alexander Fleming was a scientist who discovered penicillin in 1928 by accident after noticing that mould killed bacteria on a Petri dish. His discovery has saved millions of lives. |
| Algae | Algae are plant-like microbes that usually live in water. They make oxygen and are an important food source for many animals. *Fun fact: Much of the oxygen we breathe comes from algae in the ocean.* |
| Antibiotics | Antibiotics are medicine that helps kill bacteria or stop them from growing when they make you sick. Antibiotics do NOT work on viruses. |
| Antibiotic resistance | Antibiotic resistance happens when bacteria change and stop responding to antibiotics. This makes infections harder to treat and is a growing problem around the world. |
| Antimicrobial stewardship | Antimicrobial stewardship means using medicines like antibiotics carefully, so they keep working in the future. It helps prevent antibiotic resistance. |
| Bacteria | Bacteria are tiny, single-celled living things found almost everywhere like in soil, water, food, and inside your body. Some bacteria are helpful, and some can cause sickness. |
| Ecosystem | An ecosystem is a community of living things and their environment working together. Microbes are essential to all ecosystems. *Fun fact: A forest, a pond, and even your skin are ecosystems.* |

| | |
|---|---|
| Fermentation | Fermentation is a process where microbes change sugar into other substances like gas, acid, or alcohol. It is used to make foods like yogurt, bread, cheese, and kombucha. |
| Fever | A fever is when your body temperature rises above normal because your immune system is fighting an infection. |
| Fungi | Fungi are living things that include moulds, yeasts, and mushrooms. Some break down dead material in ecosystems, some help us make food, and some cause sickness. |
| Human digestion | Human digestion is how your body breaks down food so it can absorb nutrients. This happens in your stomach and intestines. ***Fun fact: your small intestine is about 6 meters long when stretched out.*** |
| Human immune system | The human immune system is your body's defence system. It is made up of special parts of your body that help us from getting sick. Everybody's immune system responds to bacteria differently because our bodies are different. |
| Infection | An infection happens when a bad microbe grows and multiplies in your body, sometimes causing you to get sick. |
| Macroscopic morphologies | Macroscopic morphologies are the appearance of bacterial colonies that you can see on a Petri dish. Each colony or spot is made up of millions of bacteria that all come from one original bacterial cell. |
| Medical microbiologist | A medical microbiologist is a doctor who studies microbes that cause disease and helps diagnose infections and choose treatments. |

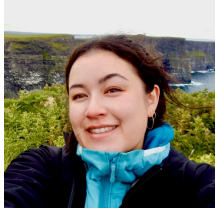
| | |
|---|---|
| Microbiology | Microbiology is the study of tiny living things (microbes) and how they affect our world. |
| Microscope | A microscope is a tool that magnifies tiny objects so we can see things like microbes. |
| Microscopic morphologies | Microscopic morphologies are the appearance of individual bacteria that you can see under a microscope after staining. |
| Oxygen | Oxygen is a gas that some living things need to breathe and survive. |
| Penicillin | Penicillin is the first antibiotic ever discovered. It comes from a mould and is still used to treat many bacterial infections today. |
| Petri dish | A Petri dish is a small, round dish used by scientists to grow microbes like bacteria or fungi in a lab. It contains *media*, which has nutrients to feed the microbes, and *agar*, a jelly-like substance made from seaweed that gives them a surface to grow on. *Fun fact: It was invented in the late 1800's by a German scientist named Julius Richard Petri.* |
| Protozoa | Protozoa are single-celled microbes that often live in water or soil. Some protozoa are harmless, while others can cause sickness in humans and animals. |
| *Salmonella* | *Salmonella* is a type of bacteria that can cause food poisoning. It is often linked to raw or undercooked eggs, chicken, or contaminated food. |

| | |
|---|---|
| Strep throat | Strep throat is an infection caused by *Streptococcus* bacteria. It causes a sore throat, fever, and swollen glands and is treated with antibiotics. |
| The 5 types of microbes | The 5 types of microbes are bacteria, viruses, algae, fungi, and protozoa. |
| Virus | A virus is a very small microbe that needs a living cell to survive and multiply. Unlike bacteria, viruses are not alive on their own. Examples include the flu and COVID-19. |
| Vitamins | Vitamins are nutrients your body needs to grow, stay healthy, and fight illness. We can get vitamins from food, sunlight, and microbes. |

# Our Team

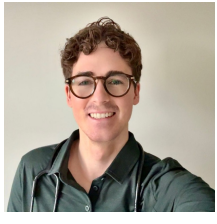
**Naowarat Cheeptham ( Ann)**
Professor (Cave Microbiology, Thompson Rivers University, Kamloops, BC, Canada) and 3M National Teaching Fellow (2022)
*Project Mastermind*

As an Earthling, a mom, and a microbiologist/educator, one of Ann's life missions is to debunk the bad press microorganisms unfairly and undeservingly get. To do so, she continues to volunteer to visit local schools near and far to make sure kids know how fun science (microbiology) can be. She spearheads this graphic novel project to reach a wider and younger audience and bring awareness to a broader audience. Ann can be reached at ncheeptham@tru.ca



**Lauren Mark**
Teacher
B.Ed., Thompson Rivers University
*Author and Illustrator*

Lauren is a high school science educator with a background in biomedical engineering who brings curiosity, creativity, and enthusiasm into the classroom. By blending scientific inquiry with artistic expression, Lauren strives to make science approachable, engaging, and meaningful by encouraging students to ask questions, think critically, and develop a lifelong love of learning.



**Keilin Gorman**
Pediatrics Resident
M.D., University of British Columbia
*Author*

Keilin is a graduate from UBC medical school and is completing his residency in pediatrics. He is passionate about humanizing medical and science education by grounding research and clinical knowledge in human connection. He strives to create meaningful relationships with the children and families he works with through collaboration, curiosity, and compassion.

Thank you for reading our book. We hope it helped clear up common misconceptions about microbiology and encouraged you to think more critically about the microscopic world that influences our everyday lives. Microorganisms are not just causes of disease. They are part of complex systems that connect human health, animal health, and the environment.

To continue learning, we encourage you to explore the World Health Organization's *One Health* approach. One Health is a global framework that recognizes that the health of people, animals, plants, and the environment are closely linked. Many major health challenges, such as infectious diseases, antibiotic resistance, and food and water safety, cannot be fully understood or solved by looking at human health alone. Instead, scientists, health professionals, and communities work together across disciplines to prevent problems before they start and to create healthier systems for everyone.

You can learn more about this interconnected view of health by visiting the World Health Organization's One Health page:

https://www.who.int/health-topics/one-health

We hope this resource helps you see how microbiology fits into the bigger picture, and why understanding these connections matters for our future.

Stay curious,

Keilin, Lauren, and Dr. Cheeptham