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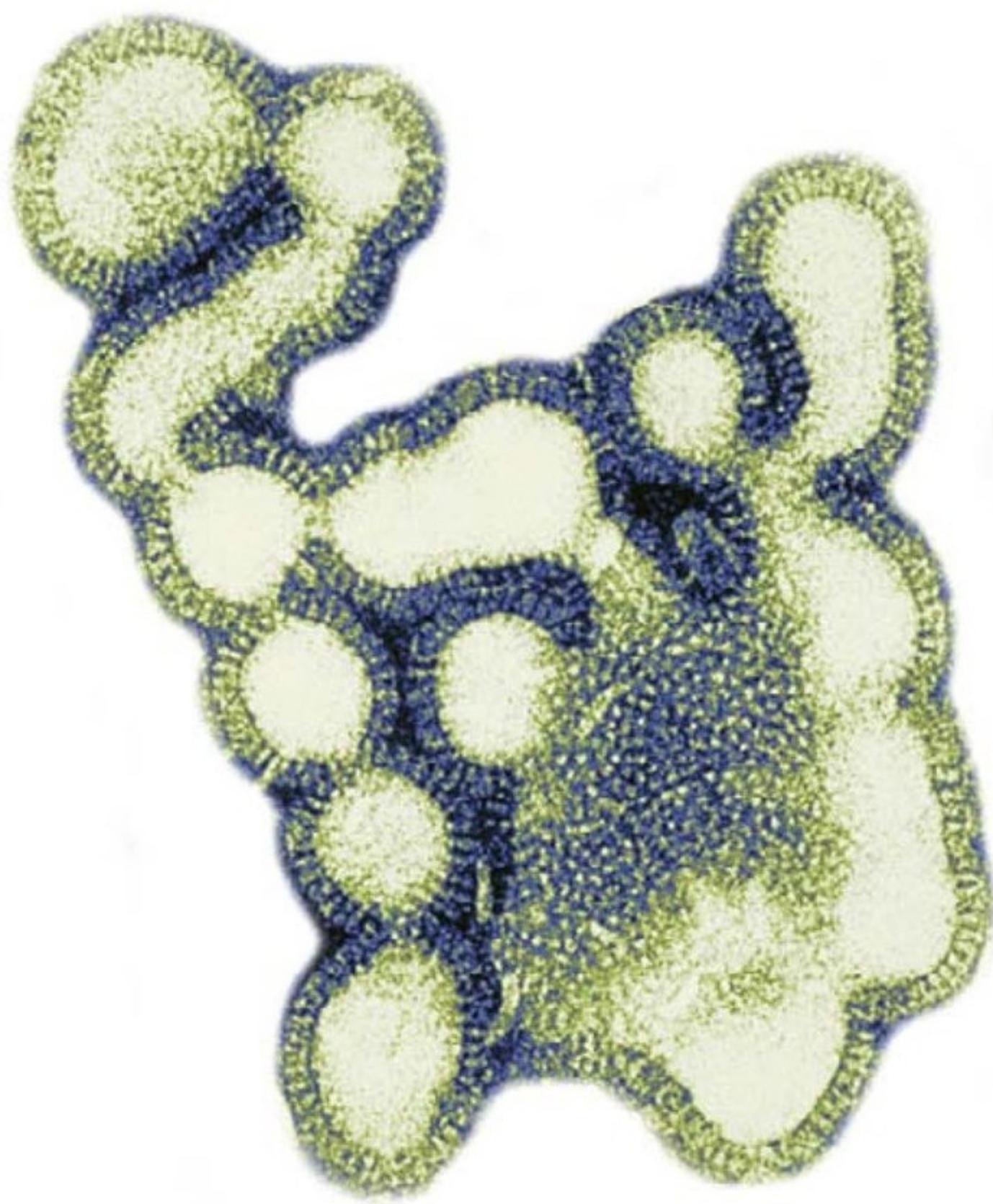
Microbes: Friend or Foe?

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Written by Lisa Ing
Illustrated by Cende Hill

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Air coming out of the mouth from a sneeze may travel as fast as 120 kph (75 mph).

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Introduction

Achoo! You sneeze. You cough. You're tired. Your throat hurts. You know from these **symptoms** that you're getting sick—but why? You might be sick because of a tiny microbe—a *germ*.

Long ago, no one knew what made us sick. No one had studied **disease** and health. Many people imagined they were cursed, or being punished for something. Now, we know that some microbes, or germs, can cause disease. But what are microbes? Where are they? Are all microbes bad? Can learning about microbes help us stay healthy?

Do You Know?

George Washington, first president of the United States, caught a throat infection in 1799. His doctors did a common treatment at the time called bloodletting. They took nine pints of blood from his body in one day. The human body holds only 12 pints of blood. Sadly, Washington died from the treatment, not the disease.



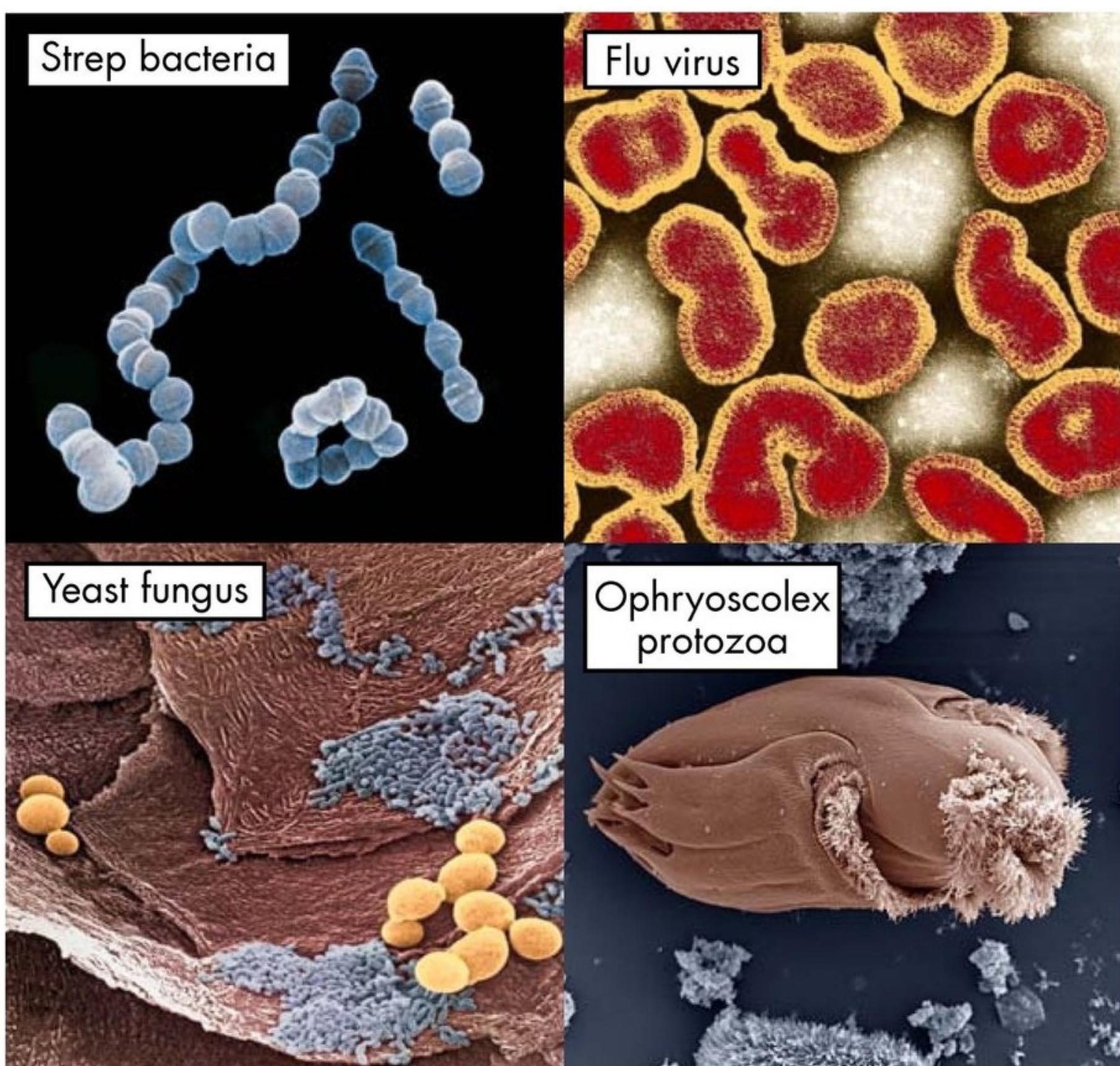
Doctors used leeches in bloodletting.

What Are Microbes?

Microbes are tiny, living **organisms**. We need a strong **microscope** to see them. Microbes live all around us. They are in the air we breathe. They sit on everything we touch. They are on our skin and shoes. Many live inside our body. They are everywhere!

Some microbes are good for us. They help protect us from disease. Other microbes are harmful. Harmful microbes can make us sick.

Different kinds of microbes



Louis Pasteur

Modern medicine owes a lot to Louis Pasteur (pas-TUR). He proved the Germ Theory of Disease, which states that contact with harmful microbes is the cause of disease.

Pasteur's most important discovery was that heating a sealed canister filled with food to a specific temperature for a certain length of time would kill many organisms inside. This heating process is called pasteurization. Today it is used on fresh milk and canned food.



The border of the page features a repeating pattern of mathematical equations in white on a dark background. The equations include:
Top row: $1 = 3 + 5 + 2 = 10 - 4 + 10 \div 2 = 14 \times 2 - 3 = 25 - 5 -$
Bottom row: $1 = 3 + 5 + 2 = 10 - 4 + 10 \div 2 = 14 \times 2 - 3 = 25 - 5 -$
Right side: $5 \times 2 = 17 + 3 \times 2 - 20 \div 2 -$
Left side: $2 = 17 + 3 \times 2 - 20 \div 2 -$

Math Minute

To pasteurize milk, the milk is heated to 145 degrees Fahrenheit (62.8°C) for 30 minutes, or to 163 degrees Fahrenheit (72.8°C) for 15 seconds. How much quicker in seconds is it to pasteurize milk at the higher temperature?

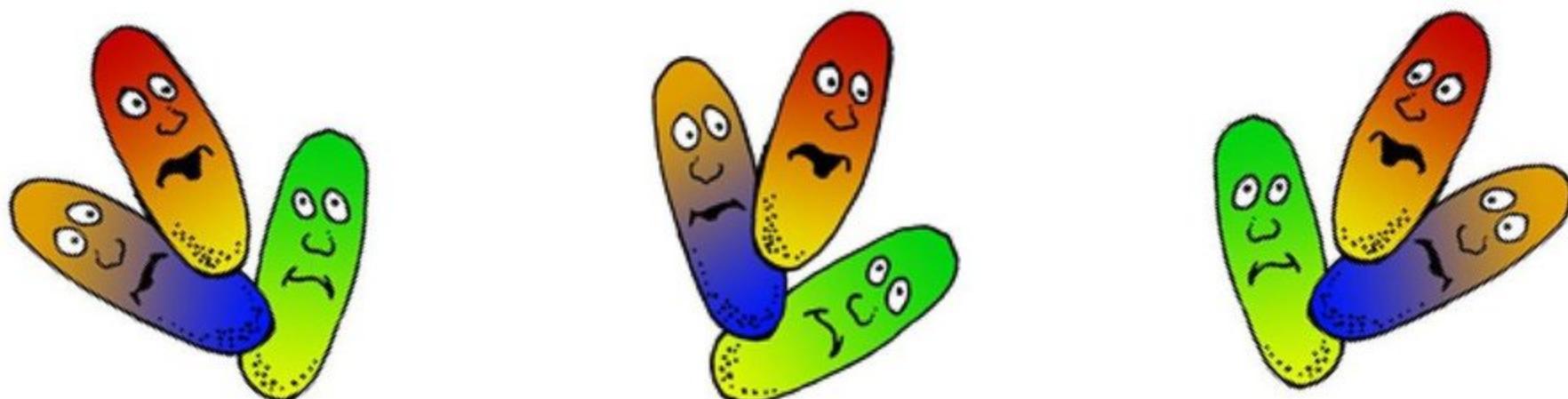
The Immune System

Our **immune system** is like our bodyguard. It protects us. It's made up of our body's important **cells**, tissues, and glands. The parts of the immune system work together as a team. The team's job is to protect us from **infection** and disease.

Math Minute

Some microbes can double their population every 20 minutes. If you start out with 1 microbe, how many microbes will you have after 4 hours?

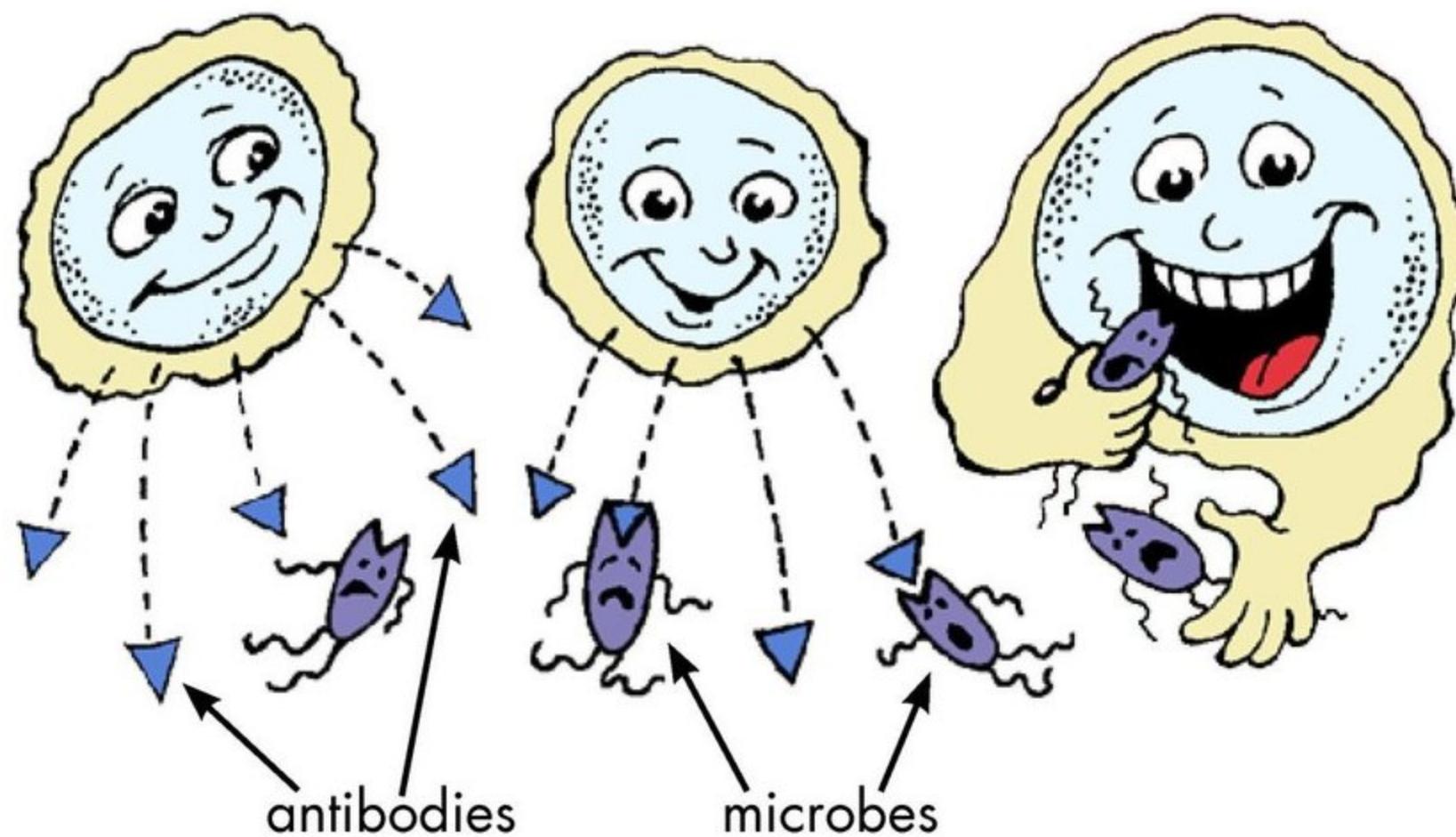
Hint: Start with 1 microbe at 0 minutes.



On the outside, our skin is a shield for our whole body. Inside, our strong, white blood cells travel in our blood, looking for harmful microbes. They kill millions of harmful microbes every day. Harmful microbes can damage our body's important cells. They spread an infection from cell to cell, making us sick.

Do You Know?

One drop of blood contains between 7,000 and 25,000 white blood cells. These cells attack invading microbes in different ways. Some white blood cells produce antibodies that cancel out the microbe's chemicals, while others surround the microbe and destroy it.



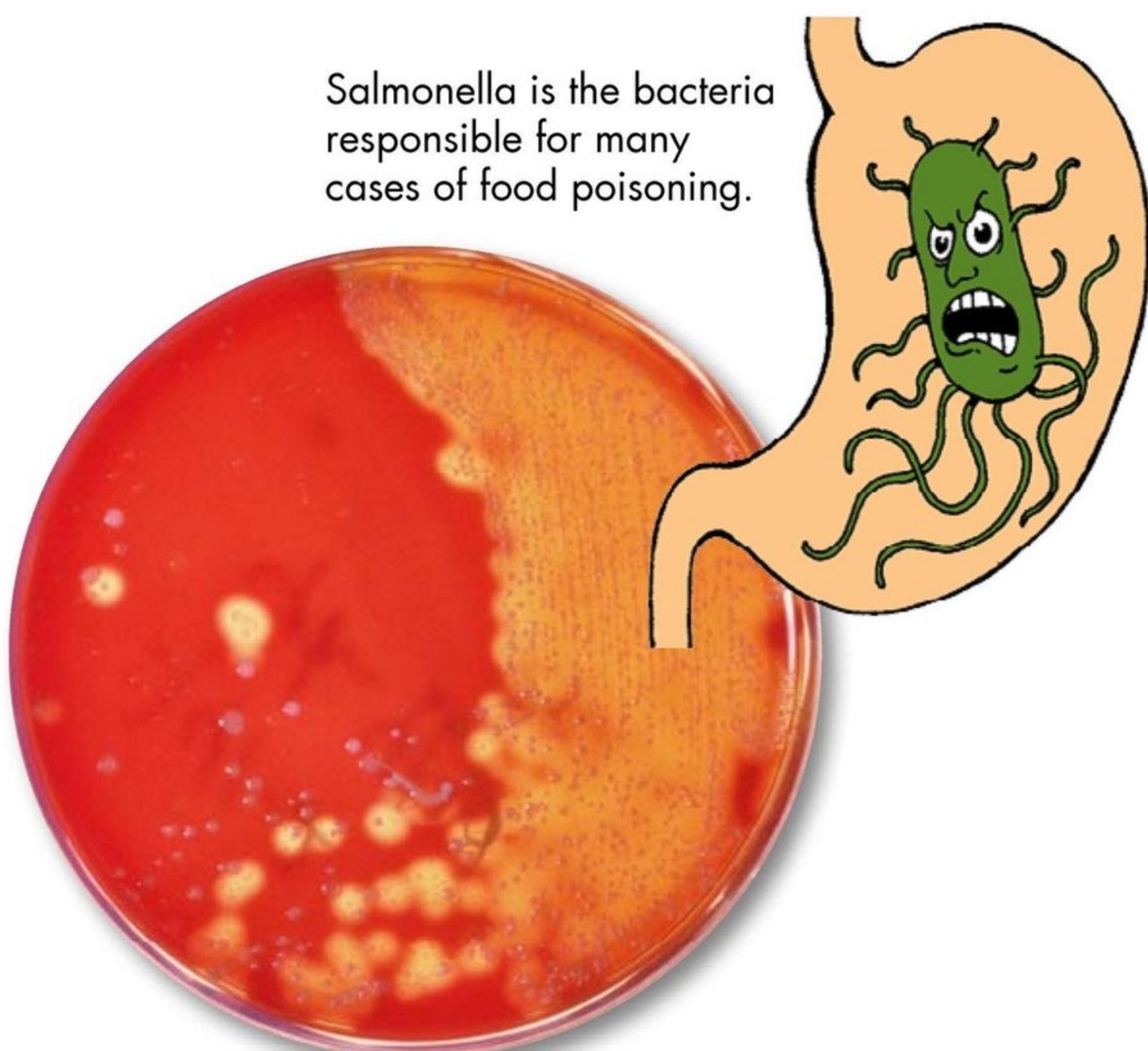
Our body's cells join together like building blocks to help us grow. We have blood cells, bone cells, stomach cells, skin cells, and muscle cells. To protect these cells, the immune system tries to keep out the troublemaking microbes.

Our immune system's best weapon is its great memory. It remembers which microbes are good and which are bad. It recognizes and remembers harmful microbes it has seen before. It remembers how to fight them off if they ever come back.

Four Groups of Microbes

Bacteria

Bacteria (back-TEER-ee-uh) are tiny, simple organisms. Bacteria are everywhere. One good type of bacteria lives in our intestines. It helps us digest the food we eat. Other, harmful, bacteria cause infections. Strep throat and food poisoning are infections caused by harmful bacteria. Strep throat bacteria can cause a very painful, swollen throat and a fever.



Scientists sometimes grow bacteria on purpose so that they can study them. Here, strep throat bacteria grow in a dish filled with a liquid that provides food and a safe environment.

The bacteria that cause food poisoning live on many uncooked foods. Cooking foods to the right temperature kills bacteria. But disease-causing bacteria also live on kitchen countertops and on our hands. We should wash our hands with soap before we touch food. Food poisoning can cause an upset stomach, vomiting, and diarrhea.



Fun Food Fact

Several types of bacteria help change milk into yogurt and sour cream. These bacteria eat **lactose**, or milk sugars, and release lactic acid, which curdles the milk and makes it more solid. The lactic acid gives yogurt and sour cream a tangy, sour flavor.

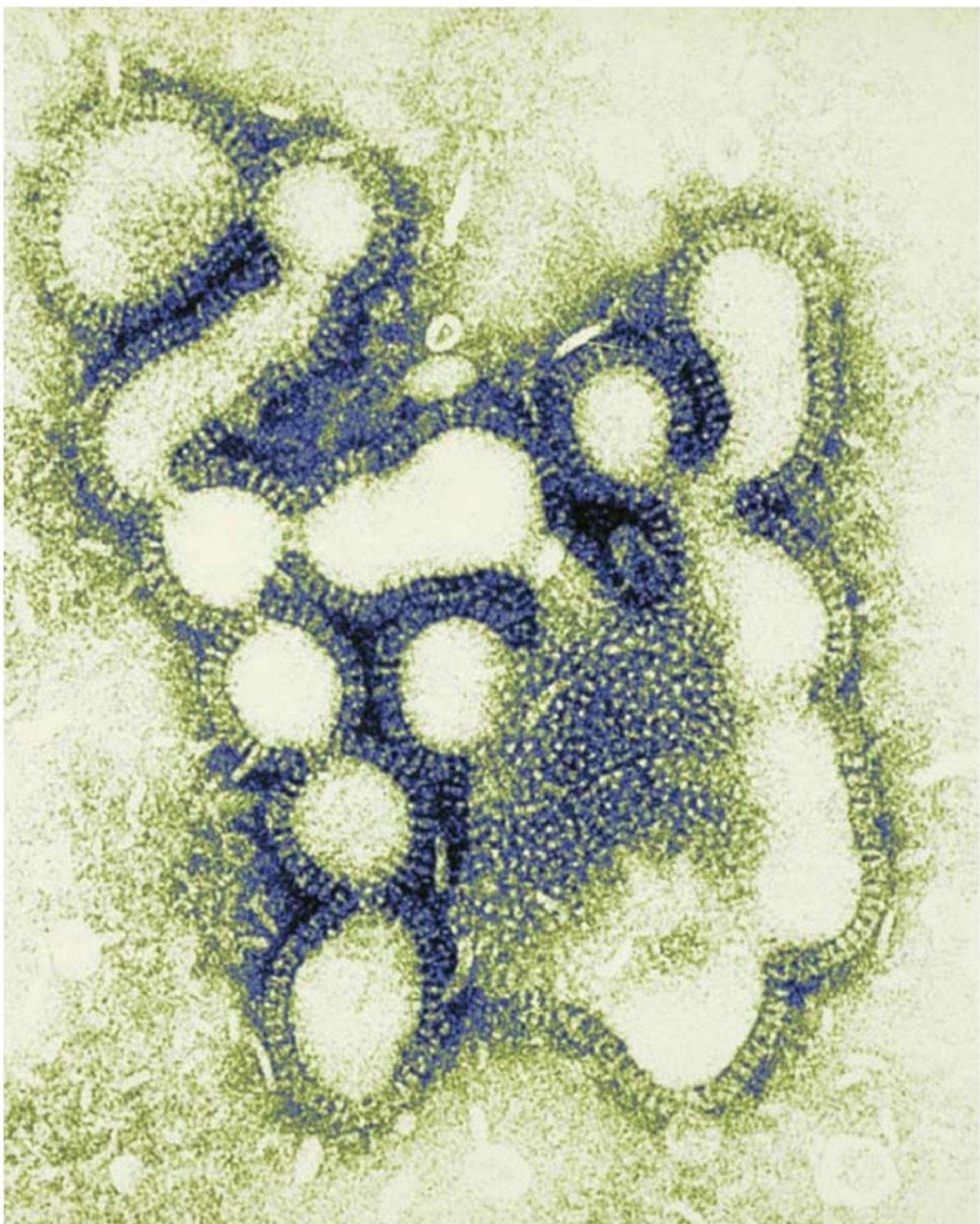
Viruses

Viruses (VY-russ-es) are even smaller than bacteria. A virus gets inside the cells of people or other animals. Then, it spreads an infection from cell to cell.

Do You Have a Common Cold or the Flu?

Symptoms	Common Cold	Flu
Headaches	No	Yes
Fever	None or Mild	High Fever, 102–104°F for days
Muscle Aches & Tiredness	Sometimes	Yes
Sore Throat	Yes	Sometimes
Runny Nose	Yes	Sometimes
Sneezing	Yes	Sometimes
Coughing	Yes	Yes
Chills	No	Yes

A viral infection can make you very sick. Some viruses can cause death. A virus is able to **mutate**. It can change its identity—like putting on a mask. That can make it harder for the body to recognize the virus and fight it off. Viruses cause diseases like the flu, chicken pox, and the common cold.



Influenza virus at 295,000x magnification



Mosquitoes can transfer diseases like malaria and West Nile virus from person to person.



Athlete's foot is caused by a fungal infection of the skin.

Fungi

Like other types of microbes, most types of harmful fungi are almost invisible. Two infections caused by harmful fungi microbes are ringworm and athlete's foot. Ringworm causes a raised, itchy, red ring to appear on the skin. Athlete's foot attacks the bottom of feet and the skin between the toes. It makes the skin itch, crack, and peel.

Protozoa

Protozoa (pro-toe-ZOE-uh) are also tiny, simple organisms. They often live in streams, ponds, and dirty water. Be careful about the water you drink. If protozoa get into your body, they can cause vomiting, diarrhea, and mouth infections.

One dangerous protozoa is spread by the bite of an infected mosquito. It causes a serious disease called malaria. Malaria kills a million people every year.

How Do Microbes Spread Infection?

Infections can spread easily. Many microbes that cause infections live in body fluids. These fluids include saliva, blood, and nasal mucus. Microbes in body fluids can be spread when a person blows his or her nose or coughs. The microbes are now on the person's hands. If we touch the person's hand, we pick up the germs. Coughing also puts germs into the air. We can breathe in those germs. Sometimes we touch something that the sick person has already touched. What he or she touched is **contaminated** with the germs on his or her hands.

There are also a few diseases that can pass from an infected insect or other animal to a person. Some come from infected dogs, raccoons, and skunks. Bacteria can be on chickens, birds, fish, and reptiles. A type of flu virus comes from sick birds and another infection from tick bites.



Tissues help keep germs from spreading.

Outbreaks and Epidemics

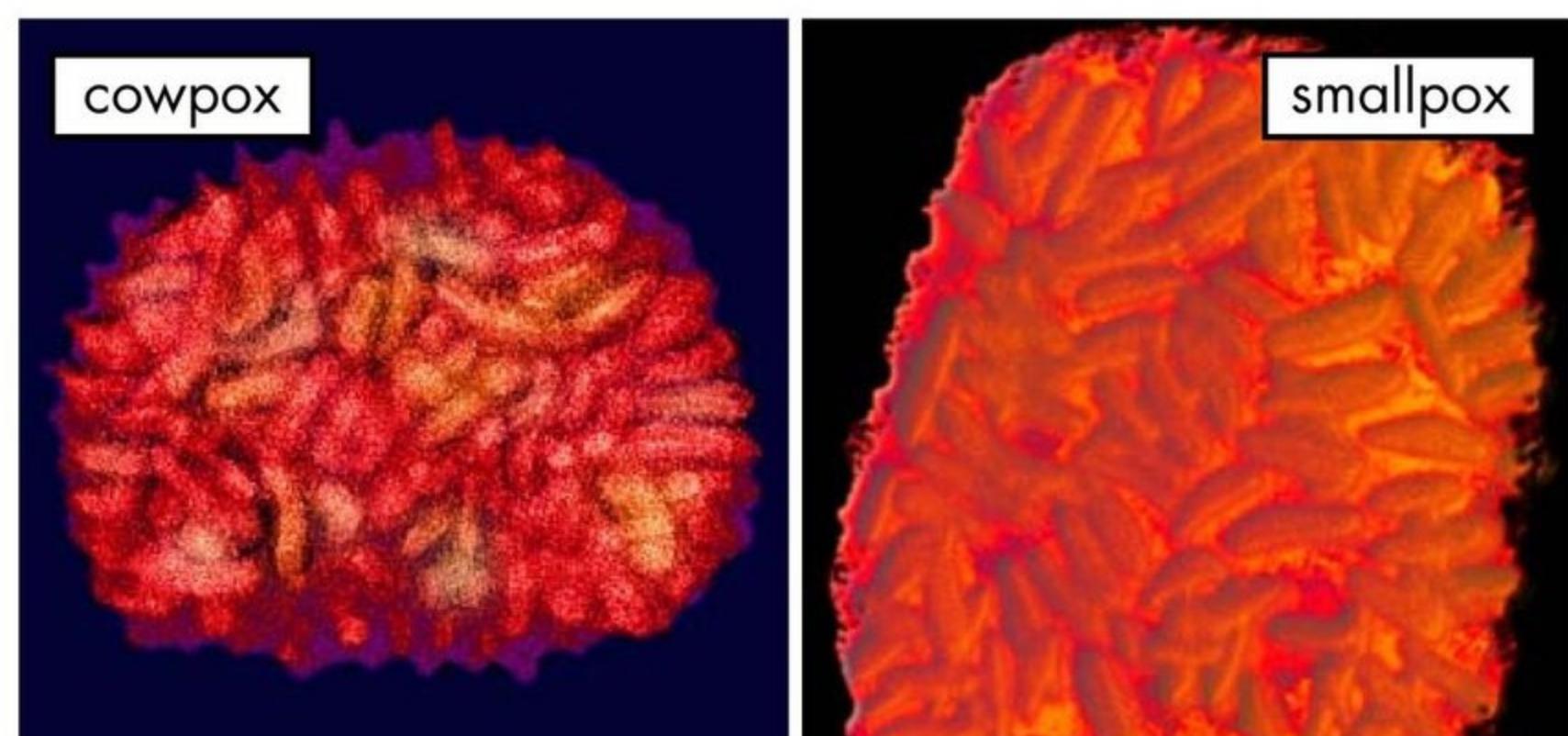
A disease can spread from a few infected people in one place to thousands of people around the world. When a small group of people gets the same disease, it's called an **outbreak**. When an outbreak of a disease spreads to a large number of people, it's called an **epidemic**. When an epidemic spreads to people all around the world, it's called a **pandemic**.

An outbreak of a disease can spread within days. Airplanes, trains, and buses carry both people and their germs quickly. A sick passenger can infect anyone he or she passes during the trip. When another person gets infected, he or she can carry the germs to another place and infect people there. In the United States, there is a disease-watching group called the Centers for Disease Control and Prevention (CDC). The CDC tracks infections around the world.



Fighting Microbes with Vaccines

No one likes to get shots, but they're important. Shots of **vaccines** are given before you get sick. They prevent a disease from starting. The job of a vaccine is to help our immune system learn to fight off a harmful microbe. Most vaccines are made from weak bits of a virus or bacteria. The immune system learns about that virus microbe from the small amount in the vaccine. It learns how to fight off the real virus. Remember that the immune system has a great memory for microbes.



Do You Know?

When Europeans and Africans carried *smallpox* microbes to the Americas, none of the Native Americans had ever been exposed to the disease. They had no immunity to it. As a result, smallpox killed millions. In South and Central America, nine out of ten people in the largest native cities died from smallpox.



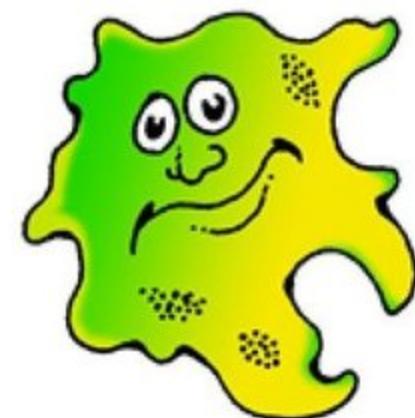
Vaccines can be given as shots or taken by mouth.

The idea of using a virus to fight itself, or for one disease to fight another disease, isn't new. It was first thought of about 200 years ago, in England. Dr. Edward Jenner treated many cases of cowpox, a mild pox disease often caught by farm workers. He also treated many cases of deadly smallpox. Epidemics of smallpox killed thousands of people each year. There wasn't a cure for it. Over time, he noticed that anyone who had first caught cowpox never got the deadly smallpox virus later. But why?

He realized that the two pox diseases must be related to each other. Maybe they were like cousins in a family. But how could he test his idea that one virus could be used to stop another virus?

Dr. Jenner wanted to find out why, or how, this happened. In his test, he gave a group of healthy people a mild case of cowpox. The cowpox made them feel slightly ill for a while. But while they were sick, their immune system was learning about that pox virus. It built up a defense against the pox microbe. It remembered how to fight off that microbe. His idea worked. He used one mild disease to fight off a similar, more dangerous, disease. The people in the cowpox test never caught a deadly smallpox infection. People could be protected. Smallpox was destroyed.

Dr. Jenner's idea of trying to prevent the spread of a disease saved thousands of lives around the world.



About seventy-five years later, Louis Pasteur discovered how to weaken microbes. Like Dr. Jenner's use of cowpox, his discovery led to the use of weakened microbes to make several types of vaccines. These vaccines could fight specific diseases. They could be made in large quantities, so many people could be vaccinated against a disease at one time.

Almost all children are given shots of vaccines before they start school. A flu shot is a vaccine. Many people get a flu shot every year to prevent a flu infection.

Antibiotics: The Magic Bullet

Scientists discovered that some helpful microbes are natural fighters. These special microbes naturally produce strong medicines called **antibiotics**. *Anti* means “against.” These helpful microbes fight certain harmful microbes and kill them. Antibiotics are very particular and attack only the cells infected by harmful microbes. They don’t harm healthy cells or destroy other, helpful, microbes. Your doctor might prescribe an antibiotic to stop an infection.

Antibiotics work well. But sometimes, a strong microbe fights back. An antibiotic may not stop an infection for several reasons. A microbe might change itself just enough so that the antibiotic doesn’t recognize it. Also, an antibiotic might fail because that type has been used too often. Microbes may have learned about it already—and how to **resist** it. And some antibiotics have been used in the wrong way. Scientists keep trying to produce new, better antibiotics to fight stronger microbes.

Do You Know?

In 1928, Dr. Alexander Fleming discovered that a common bread mold would kill bacteria. This discovery led to the world’s first antibiotic, penicillin, which is still the world’s most widely used antibiotic.

Don't Spread Disease

When you're sick, it's important to stay home and rest. This helps your body fight an infection. Staying home also keeps you from infecting other people.

Remember that there are simple things we can do to stop germs from spreading. If you're sick, don't share food, cups, or plates with other people. If you have a cold, carry tissues. When you blow your nose, cover it. When you cough, cover your mouth. Use a tissue, then throw away the tissue in a trash can. Used tissues can infect other people. Remember to cover it and toss it! And remember to wash your hands.



Germs, or harmful microbes, spread easily in crowded places.

Staying Healthy

Keep your immune system healthy

- In order to stay healthy, you must keep your immune system strong. Eat a balanced diet of nutritious foods, including fruits and vegetables, and drink lots of water. Get fresh air, exercise, and enough sleep each night.

Preparing food

- Wash knives and cutting boards with water and soap after cutting raw meat, and never let raw meat touch cooked foods.
- Do not eat food from dented or swollen cans.
- Do not eat food that has fallen onto the floor.

Keeping clean

- The most important microbe-fighting action is staying clean with soap and water. Eighty percent of diseases are transmitted through touch because many people do not wash their hands. If everyone washed his or her hands, we could cut down the spread of disease.
- Wash your hands after you go to the bathroom, after touching animals, and before and after you make and eat food. Wash with soap for at least fifteen seconds, or as long as it takes to hum the song "Happy Birthday" twice. Rub soap lather all over your hands, even under your fingernails. Then rinse your hands and dry them on a clean towel.

Take care of your teeth

- Brush and floss your teeth to remove bits of food. Mouth bacteria cause cavities and feed on rotting food. Infections can easily get into your bloodstream through your mouth.

See a doctor regularly

- A healthy person should see a doctor once a year. Getting a regular checkup can prevent problems before they begin. Make sure you get all of your shots.

Outdoor safety

- When you go outside, do not touch wild animals. They may bite or scratch, or they may have disease-carrying bugs on them. Wear insect repellent to keep mosquitoes and ticks away when camping or hiking.
- Don't drink water that has not been purified and chlorinated.



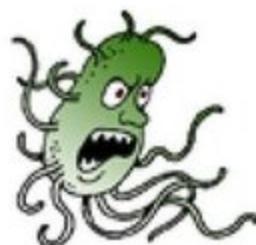
Conclusion

Microbes live in, on, and around almost everything. Most microbes are harmless. But harmful ones cause disease. Scientists and doctors around the world are trying to control or eliminate diseases. We know that we can never wipe out all of the world's harmful microbes. But we can learn how to help control them and how to be healthier.

Glossary

antibiotics (<i>n.</i>)	medicines made from microbes to fight infections from other microbes (p. 19)
cells (<i>n.</i>)	the smallest independently functioning units in organisms (p. 7)
contaminated (<i>adj.</i>)	covered with harmful microbes (p. 14)
disease (<i>n.</i>)	a condition that changes the way the body normally functions (p. 4)
epidemic (<i>n.</i>)	the rapid spread of a disease within a community (p. 15)
immune system (<i>n.</i>)	system that moves antibodies through your body to fight infection (p. 7)
infection (<i>n.</i>)	illness caused by microbes (p. 7)
lactose (<i>n.</i>)	sugars found in milk (p. 10)
microscope (<i>n.</i>)	a device used to view tiny objects (p. 5)
mutate (<i>v.</i>)	to permanently change (p. 12)
organisms (<i>n.</i>)	living things, including people, other animals, plants, and microbes (p. 5)
outbreak (<i>n.</i>)	the quick spread of a disease (p. 15)

pandemic (<i>n.</i>)	the rapid, worldwide spread of a disease (p. 15)
resist (<i>v.</i>)	to fight against something (p. 19)
symptoms (<i>n.</i>)	telltale signs of an illness (p. 4)
vaccines (<i>n.</i>)	preparations containing a weak disease that teach the body to fight stronger forms of the same disease (p. 16)



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