

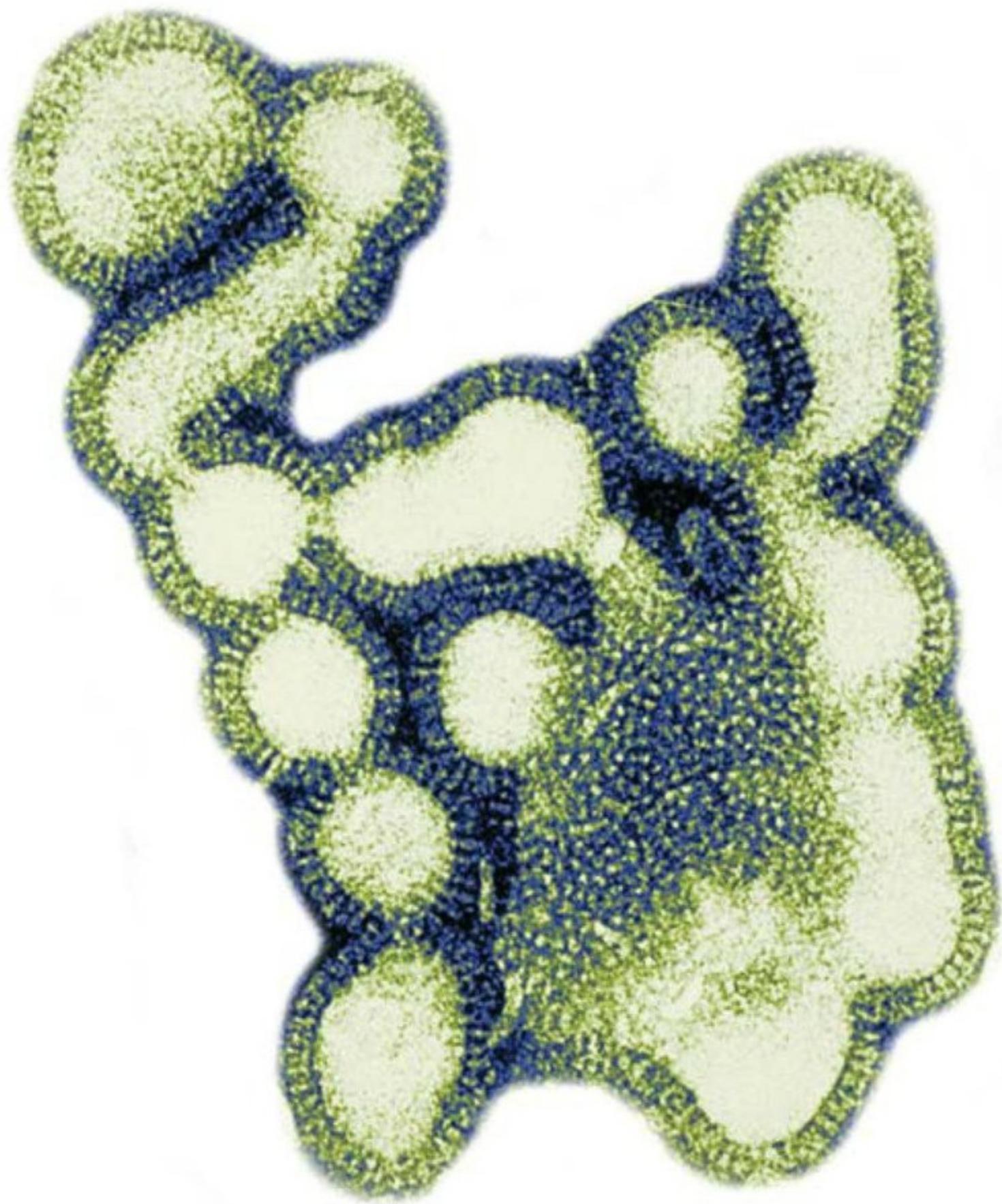
LEVELED READER • W

# Microbes: Friend or Foe?

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U•W•Z

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).

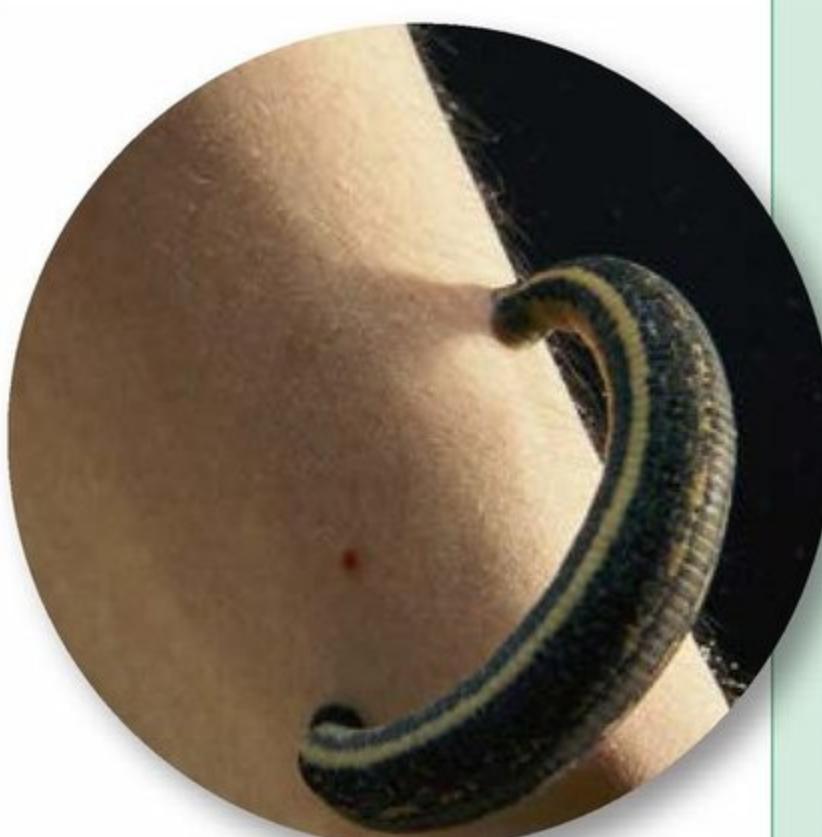
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## Introduction

*Achoo!* You sneeze and cough all night. You're tired but can't sleep. You're too hot—then you're too cold. Your throat is sore. These are all signs, or **symptoms**, of being sick. You have "caught a bug" and developed a **disease**. It was probably caused by an **infection** from a type of tiny microbe—a *germ*.

Long ago, before scientists studied disease and health, people thought that being sick was a punishment. What had they done wrong? Had a bad witch cursed them? No one knew what really caused us to become sick, so no one knew how to prevent or cure any disease. Now we know that certain microbes, or germs, can cause diseases. But what are microbes? Where are they? Are they all bad? Can knowing about them help us prevent diseases?



Doctors used leeches in bloodletting.

### Do You Know?

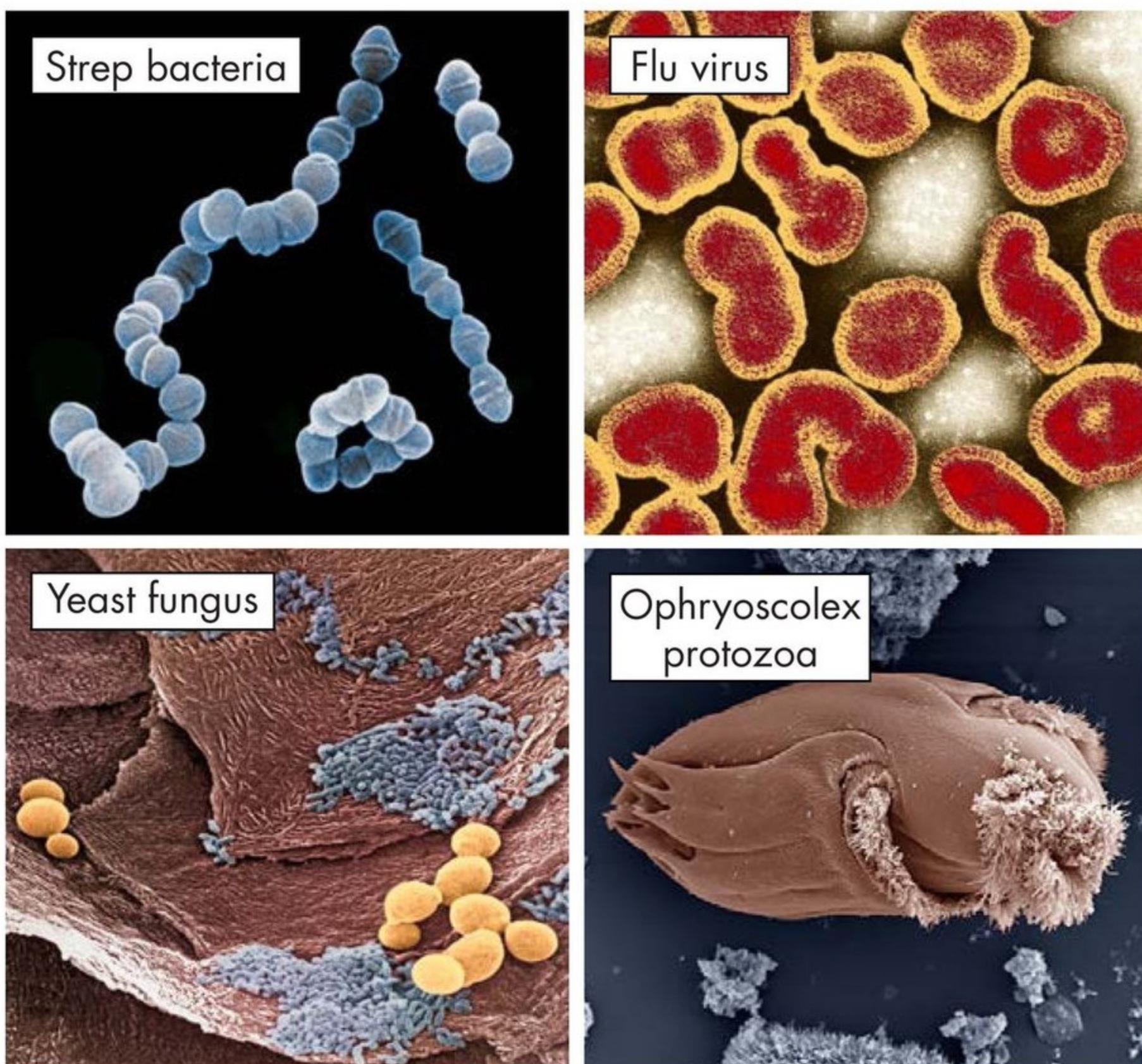
George Washington, first president of the United States, caught a throat infection in 1799. His doctors did a common treatment at the time called bloodletting. They took nine pints of blood from his body in one day. The human body holds only 12 pints of blood. Sadly, Washington died from the treatment,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

# What Are Microbes?

Microbes are tiny organisms, or living creatures, that are almost invisible. They can be seen only with a powerful **microscope**. These tiny **organisms** exist all around us. They are in the air we breathe, on every surface we touch, on our skin and clothes, and inside our bodies. They are everywhere!

There are many types of microbes, both good and bad. Some microbes cause disease, but others can help to prevent or cure illnesses.

## 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.



## Math Minute

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

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# The Immune System

The human body makes a great home for microbes. It is warm, moist, and a good source of food. Many friendly microbes live in our bodies and help us—in exchange for a nice place to live. But sometimes there are just too many of them. Or, harmful microbes enter our bodies and then multiply. Too many of either type of microbe can cause problems for our health.

## Math Minute

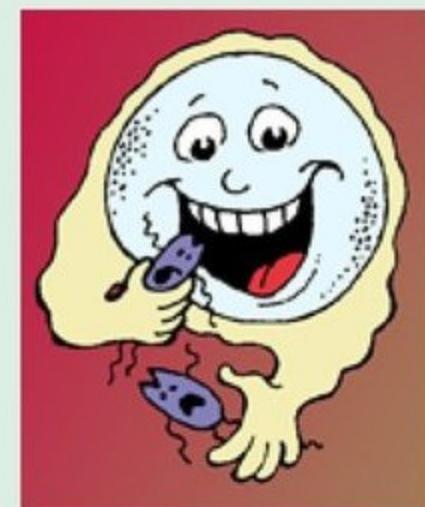
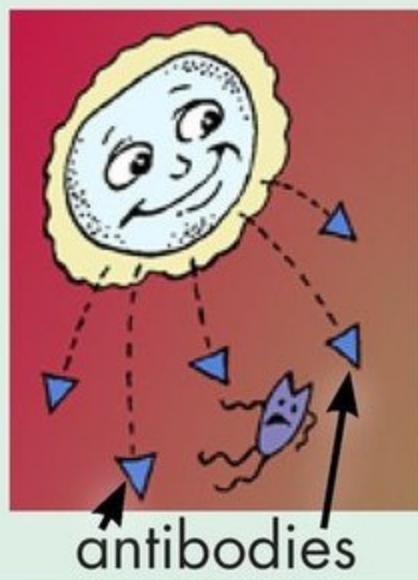
Some microbes can double their population every 20 minutes. If you start out with 1 microbe, how many microbes will you have after 4 hours?

*Hint: Start with 1 microbe at 0 minutes.*

Harmful microbes can attack and damage our body's **cells**. Cells make up the parts of our body and form the immune system that protects our health. We have blood cells and bone cells, stomach cells, skin cells, and muscle cells, as well as other kinds of cells. There are trillions of cells inside of us, all working together. Cells all have important body-building and health-protecting jobs to do.

## 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.



To help, we have natural defenses to keep out the troublemaking microbes. Our bodies have layers of skin that cover us completely. Microbe-hunting white blood cells travel through our blood vessels—like security guards. They destroy millions of invading microbes every day. Friendly microbes join in to help them. These strong defenses are all part of a healthy **immune system**.

The immune system knows the difference between good and bad microbes. It recognizes the ones that cause problems and remembers what defenses worked against them in the past. It fights them off if they try to come back. If you have ever had mumps, your immune system remembers—and you will probably not get sick from mumps again.

## Four Groups of Microbes

### *Bacteria*

Bacteria (back-TEER-ee-uh) are simple, single-celled organisms. Like all microbes, they are too small to be seen without a powerful microscope. There are both good and bad bacteria. There are more types of bacteria than there are types of any other organisms on Earth.

One type of good bacteria lives in our intestines. It helps us to break down and digest the food we eat. Some good bacteria also help our white blood cells kill bad bacteria.

### 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.



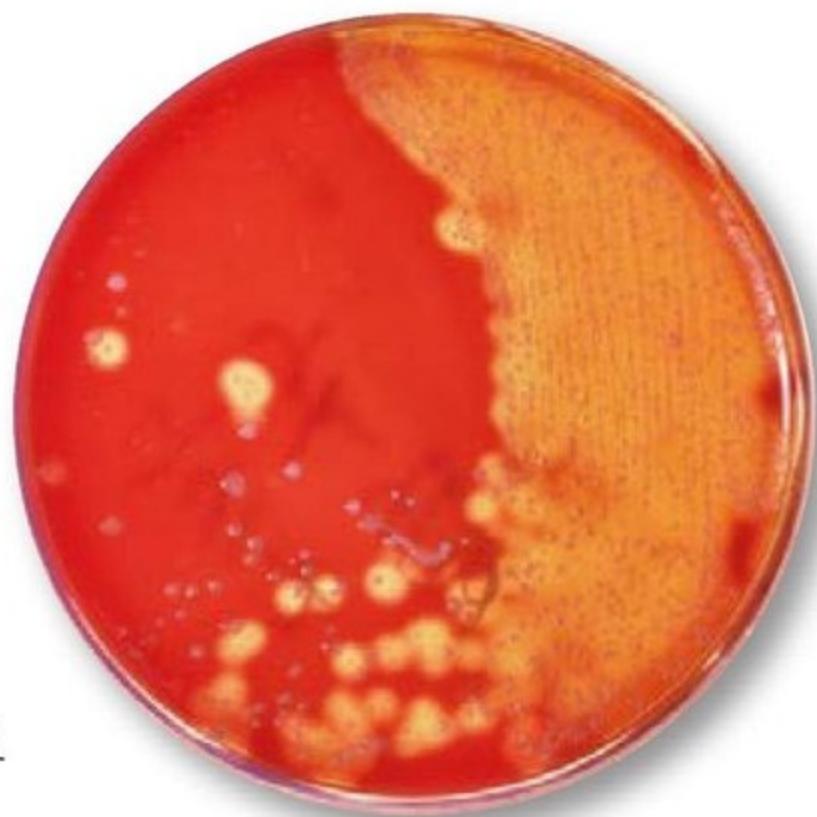
Some bacteria cause food poisoning.



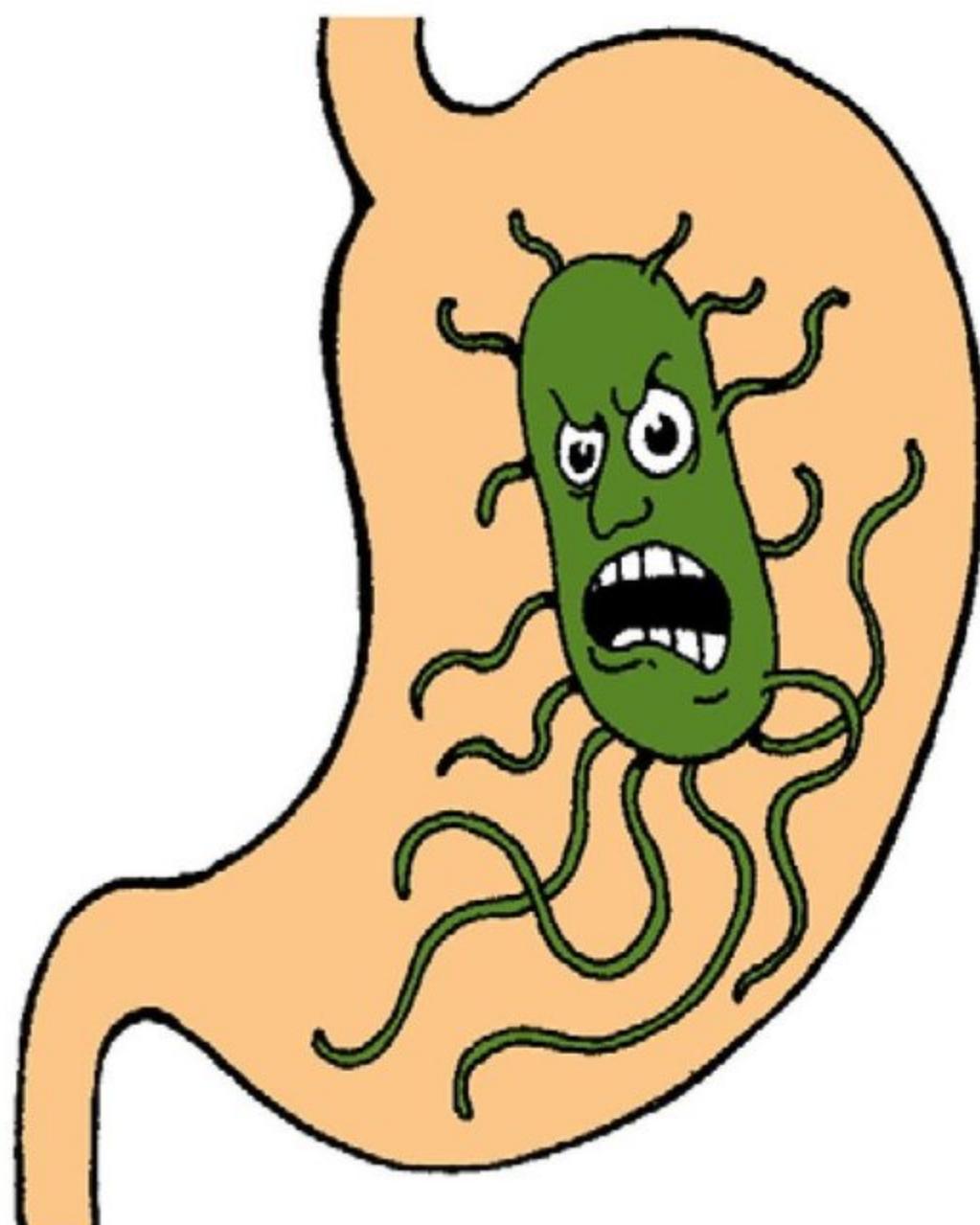
Some good bacteria help create dairy products.

Harmful bacteria cause infections like strep throat and food poisoning. Nasty strep throat bacteria can cause a painful, swollen throat, a fever, a headache, a stomachache, and swollen glands in the neck. White spots of pus appear on the back of the throat.

Some types of harmful bacteria live on, or in, many uncooked foods. They can cause food poisoning. These bacteria **invade** when we aren't careful about how we handle or cook food. Remember to wash your hands before preparing food. Foods need to be cooked to the correct temperature to kill bacteria. Food poisoning often causes an upset stomach, vomiting, and diarrhea.



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.



Salmonella is the bacteria responsible for many cases of food poisoning.

## **Viruses**

Viruses (VY-russ-es) are even smaller than bacteria. Viruses live inside the cells of people and other animals. Viruses cannot live on their own outside another living creature. Once inside, they can multiply. They can spread from cell to cell, causing an infection.

### **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

Viruses can make people sick. Some viruses can cause death. And a virus doesn't always play fair. A virus can easily **mutate**, or change its identity, to avoid being noticed. This ability to change makes it more difficult to find. To kill a virus, the body must destroy the cell, or cells, in which the virus is living. The flu, chicken pox, and the common cold are each caused by a virus.



Influenza virus at  
295,000x magnification



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

## Fungi

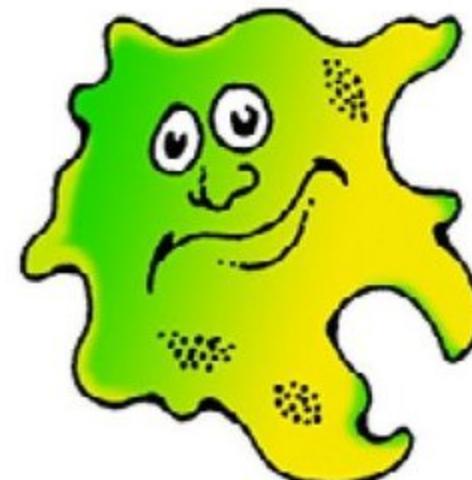
In some ways, fungi (FUN-guy) are like plants, but they cannot make their own food. There are two types of fungi: many-celled, which include both edible and poisonous mushrooms; and simple, single-celled fungi, which include the yeast that makes bread rise. Many types of fungi are **parasites**. A parasite lives by absorbing the energy it needs from other living things.

Two common infections caused by harmful fungi are ringworm and athlete's foot. Ringworm causes a wormlike, red ring to appear on the skin. Athlete's foot attacks the bottom of the feet and area between the toes, causing the skin to itch, crack, and peel.

## *Protozoa*

Protozoa (pro-toe-ZOE-uh) are tiny, single-celled organisms that often live in streams and ponds. They are food for some birds and fish. Protozoa are often found in dirty, untreated water. If protozoa get into your body, they can cause stomachaches, nausea, vomiting, and diarrhea.

One dangerous protozoa is spread by saliva from an infected mosquito. It causes a disease called malaria. When an infected mosquito bites a person, the protozoa enter the person's blood through the bite. Malaria is a serious illness that causes a high fever, delirium, and weakness. It occurs most often in hot, tropical areas. Malaria kills a million people around the world every year.



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

## How Do Microbes Spread Infection?

Germs spread easily. Many infection-causing microbes live in our body fluids. They hide in saliva, blood, and nasal mucus. These fluids transfer germs easily. If a person sneezes or coughs on us, we can pick up germs. You can also pick up germs if you handle something that has been touched and **contaminated** by an infected person.

Doorknobs are touched by dozens of people every day. If a sick person touches a doorknob after he or she blows his or her nose, microbes stay behind. The microbes travel from the runny nose, to the hand, to the doorknob. People who then touch the doorknob can pick up the germs. If they then rub their eyes, or pick up and eat a sandwich, the germs can enter their body. If a sick person sneezes, coughs, or even talks, microbes can fly into the air and infect another person.

There are many ways to get sick. Some diseases can be spread through the air. We can catch germs from an unclean surface. We can eat spoiled food or drink polluted water. A few diseases can pass from an infected insect or other animal to a human. We can get rabies from infected mammals like dogs, raccoons, and

skunks. Salmonella may be on chickens, birds, fish, and reptiles. We can contract malaria and West Nile virus from infected mosquitoes, avian flu from sick birds, and Lyme disease from tick bites.

## Outbreaks and Epidemics

Diseases can spread quickly. When a small group of people in the same place gets the same disease, it is called an **outbreak**. When an outbreak of disease rapidly spreads to a large number of people, it's called an **epidemic**. When an epidemic quickly spreads to infect groups of people worldwide, it is called a **pandemic**.

An outbreak of a disease is no longer expected to stay in one place. Modern transportation carries both people and their germs quickly. Airplane passengers move around the world within hours. A sick traveler can infect any person he or she encounters



during a trip. The new, infected person can start another outbreak in another place. In the United States, the Centers for Disease Control and Prevention (CDC) monitor infections around the globe because a dangerous disease in one region can threaten people worldwide.

## Fighting Microbes with Vaccines

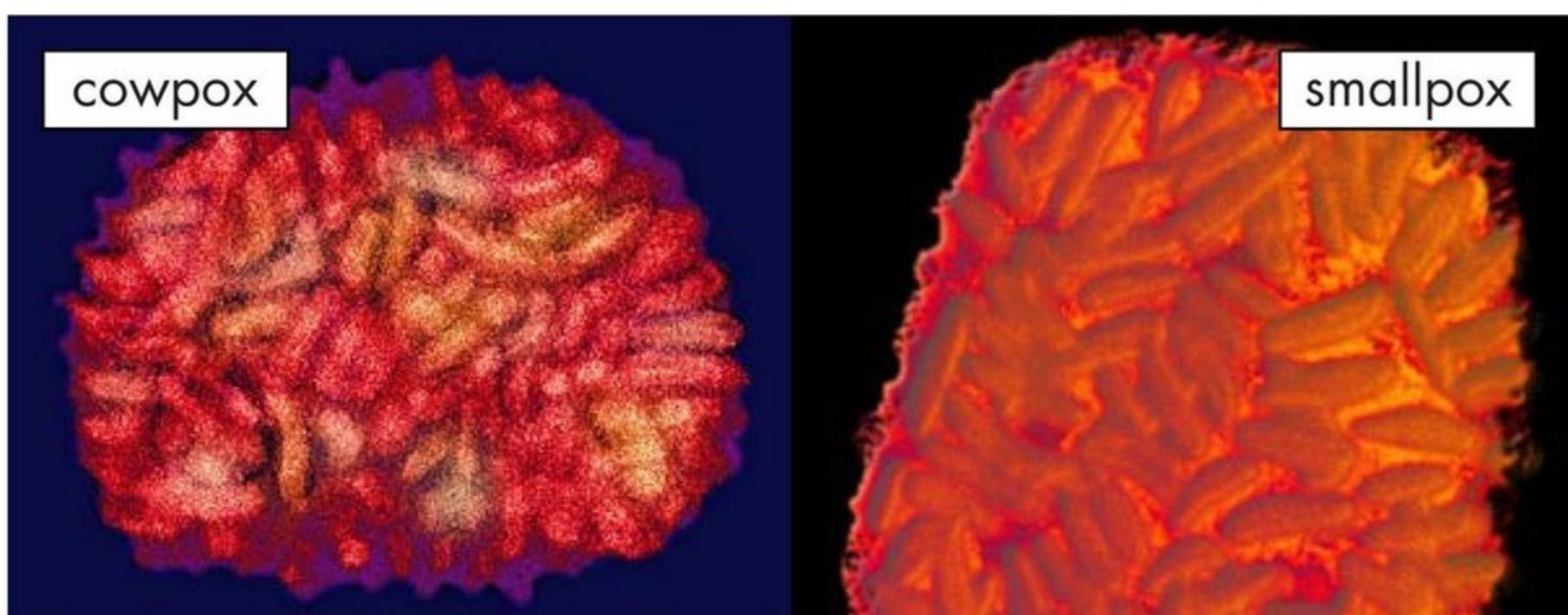
**Vaccines** are a way to plan ahead to prevent disease. Vaccines are strong treatments that build up our immune system's ability to recognize and fight off a disease-causing microbe. Some vaccines are chemicals that are designed to help people who have an already weakened immune system. Other vaccines are made from tiny bits of the virus or bacteria itself.

The idea of using one virus to attack another virus in order to prevent a worse disease, was first thought of about two hundred years ago in England. Dr. Edward Jenner noticed that people who had been sick with cowpox, a mild disease caught by farm workers, never got smallpox. Smallpox was one of the deadliest diseases

Vaccines can be given as shots or taken by mouth.



in the world—it killed thousands of people. Dr. Jenner realized that cowpox and smallpox must be related—like cousins from the same family. He was sure he could use the milder disease to prevent another, worse, disease. In his test, he decided to give healthy people a mild case of cowpox. Their immune systems could easily fight off the mild cowpox and learn about that type of virus. Later, if smallpox tried to invade their bodies, their immune systems would recognize the pox virus and remember how to defeat it. His idea was correct. These people did not get the deadly smallpox virus. His idea saved many thousands of lives.



### 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.

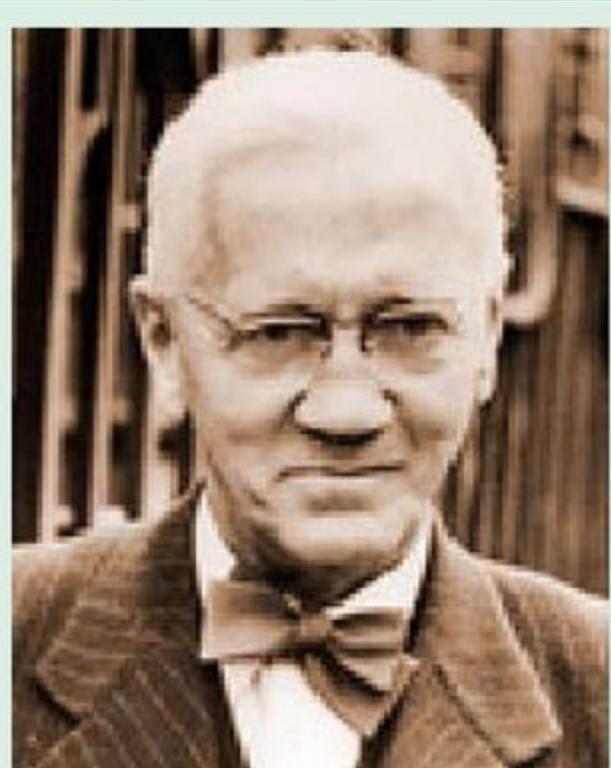
## Antibiotics: The Magic Bullet

Scientists discovered that some microbes naturally fight other types of microbes and kill them. They can do this without harming healthy cells or helpful microbes. These killer microbes produce medicines called **antibiotics**. When scientists first discovered antibiotics, they considered these medicines to be “magic bullets” because they would directly attack the targeted infection and leave nearby healthy cells alone.

An antibiotic medicine kills most microbes that cause a disease. But the strongest microbes sometimes survive. Often, these hard-to-kill microbes change themselves just enough to hide from the antibiotic. Other antibiotics have become overused, or misused, so microbes have developed a **resistance** to them. Scientists keep trying to produce new antibiotics to fight stronger, deadlier 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

You can help to reduce the chance of a harmful microbe getting into your body and making you sick. Remember that when you are sick, it is important to stay home. Stay away from other people and rest. This helps your body fight microbes, and it also keeps you from infecting other people.

When you have a cold or a cough, always cover your mouth and nose with a tissue. Then throw away the tissue in a trash can. Don't leave the used tissue lying around to pass those germs on to other people. If you don't have a tissue, cover your nose and mouth with your cupped hands and then wash your hands right away. If you are sick, do not share food, cups, or plates with other people.



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 of them are harmless, but some microbes cause disease. There are many ways to prevent diseases from spreading. Some are simple things, such as washing your hands before eating or handling food and after using the bathroom. Other efforts, such as treatments of vaccines and antibiotics, are the result of two hundred years of scientific discovery, research, and modern medicine.

Many countries, organizations, and individual doctors are coordinating their efforts to control and even **eradicate** many diseases. Even with all of this effort, we will never be able to wipe out all of the world's harmful microbes—but we can learn how to fight them and to be healthier.

## Glossary

<b>antibiotics</b> ( <i>n.</i> )	medicines made from microbes to fight infections from other microbes (p. 19)
<b>cells</b> ( <i>n.</i> )	the smallest independently functioning units in organisms (p. 7)
<b>contaminated</b> ( <i>v.</i> )	covered with harmful microbes (p. 15)
<b>disease</b> ( <i>n.</i> )	a condition that changes the way the body normally functions (p. 4)
<b>epidemic</b> ( <i>n.</i> )	the rapid spread of a disease within a community (p. 16)
<b>eradicate</b> ( <i>v.</i> )	completely destroy (p. 22)
<b>immune system</b> ( <i>n.</i> )	system that moves antibodies through your body to fight infection (p. 8)
<b>infection</b> ( <i>n.</i> )	illness caused by microbes (p. 4)
<b>invade</b> ( <i>v.</i> )	to enter aggressively to conquer, weaken, or injure (p. 10)
<b>microscope</b> ( <i>n.</i> )	a device used to view tiny objects (p. 5)
<b>mutate</b> ( <i>v.</i> )	to permanently change (p. 12)
<b>organisms</b> ( <i>n.</i> )	living things, including people, other animals, plants, and microbes (p. 5)
<b>outbreak</b> ( <i>n.</i> )	the quick spread of a disease (p. 16)
<b>pandemic</b> ( <i>n.</i> )	the rapid, worldwide spread of a disease (p. 16)
<b>parasites</b> ( <i>n.</i> )	living things that take what they need to survive from other living things (p. 13)

<b>resistance</b> ( <i>n.</i> )	the ability to fight against something (p. 19)
<b>symptoms</b> ( <i>n.</i> )	telltale signs of an illness (p. 4)
<b>vaccines</b> ( <i>n.</i> )	preparations containing a weak disease that teach the body to fight stronger forms of the same disease (p. 17)



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