Microbes: Friend or Foe?
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Microbes: Friend or Foe?

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Introduction

Achoo! You sneeze and cough all night. You can’t sleep because you’re too hot, but a minute later you’re cold. Your throat is sore, and you don’t feel like eating. These are all symptoms, or signs, of being sick. You have a disease.

A long time ago, people thought that being sick was a punishment or a curse. They thought that witches or bad smells in the air caused disease. Because no one knew what really caused diseases, no one knew how to cure diseases. Now we know that certain microbes, commonly called germs, can cause diseases. But what are microbes? Are they all bad? Can knowing about them help us prevent diseases?

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. They are so small that they can be seen only with a powerful microscope. Microbes live all around us—in the air we breathe, on every surface we touch, on our skin, and inside our bodies. We will never notice most microbes, even though there are more microbes in a handful of dirt than there are people on Earth.

Some microbes can cause disease, but others can help to cure diseases and prevent sickness. Other microbes make some of the food we eat and help us to digest it. There are four major groups of microbes: bacteria, viruses, fungi, and protozoa.

Louis Pasteur

Modern medicine owes a lot to Louis Pasteur (PASS-toor). He proved the Germ Theory of Disease, which states that contact with harmful microbes is what causes 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, it can be heated to 145 degrees Fahrenheit (62.8°C) for 30 minutes; or to 163 degrees Fahrenheit (72.8°C) for 15 seconds. How many seconds quicker is it to pasteurize milk at a higher temperature?
The Immune System

To many microbes, the human body makes a great home. It is warm, moist, and a good source of food. Many microbes naturally live in our bodies and help us in exchange for a place to live. But sometimes these microbes get out of balance, or harmful microbes enter our bodies and multiply. Both types of microbes can cause problems.

The immune system can recognize invading microbes. If the immune system recognizes microbes that have invaded the body in the past, it can defend the body more effectively by using the same defenses it used before. If you have ever had mumps, you will probably not get sick from mumps again.

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.

Fortunately, we have natural defenses to keep microbes out. Our bodies are like fortresses: we have layers of skin to protect our insides, layers of microbe-killing mucus, and white blood cells that travel through our blood vessels like guards on patrol. White blood cells constantly search for and destroy millions of invading microbes every day. Friendly microbes also fight harmful microbes and signal white blood cells for help. These defenses are part of a healthy immune system.

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.

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Sometimes, harmful microbes get past the immune system. Once inside your body, they multiply, making more of themselves. In time, there are more microbes than the body can fight. The harmful microbes steal nutrients and leave your body weakened.
Harmful bacteria cause infections like strep throat and food poisoning. The bacteria that cause strep throat usually live in your body without causing any problems. When they multiply and get out of control, they cause a very painful, swollen throat. Other symptoms that come with strep throat include a headache, stomachache, and swollen glands in the neck beneath the jawline. White spots of pus appear on the back of the throat and on the tonsils.

Some types of bacteria cause food poisoning. These bacteria invade when we eat foods that have not been properly washed, stored, or thoroughly cooked. It is important to cook meat, such as chicken or pork, to the right temperature to kill harmful bacteria. Food poisoning often causes an upset stomach, vomiting, and diarrhea.

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

Viruses (VY-russ-es) are even smaller than bacteria. They are so small that they cannot be seen with a normal microscope. A virus is a tiny bit of living material that lives inside the cells of plants, animals, and bacteria. They cannot live outside another living creature, but once inside a living thing they can spread from cell to cell.

Viruses can make people sick, and some can cause death. A virus can easily mutate, or change, to survive and multiply. This makes viruses difficult for the body to fight. The only way to kill a virus is to destroy the cells that contain it. The flu, chicken pox, and the common cold are diseases caused by viruses. The body can fight these viruses more easily than it can fight less common, but more dangerous viruses such as smallpox, HIV, and West Nile virus.

Scientists are looking at ways to use viruses to help people get healthy, too. Viruses take control of the cells they invade and tell them what to do. If a cell started multiplying out of control, a scientist might be able to use a virus to tell the cell to slow down its growth. This treatment is being studied as a way to fight cancer, a disease in which cells grow out of control.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Common Cold</th>
<th>Flu</th>
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<tbody>
<tr>
<td>Headaches</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Fever</td>
<td>None or Mild</td>
<td>High Fever, 102–104°F for days</td>
</tr>
<tr>
<td>Muscle Aches &amp; Tiredness</td>
<td>Sometimes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sore Throat</td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Runny Nose</td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Sneezing</td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Coughing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chills</td>
<td>No</td>
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</tr>
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Influenza virus at 295,000 magnification
Fungi

In some ways, fungi (FUN-guy) are like plants, but they cannot make their own food. Many types of fungi are parasites, which means that they live by taking the nutrients they need to survive from other living things. There are two types of fungi: many-celled, which include mushrooms and bread mold; and single-celled, which include the yeast that makes bread rise.

Two common fungal infections are ringworm and athlete’s foot. Ringworm causes a worm-like red ring to appear on the skin. Athlete’s foot attacks the bottom of feet and between toes, causing the skin to crack and peel. The fungi that cause athlete’s foot are common in gyms, public showers, and around swimming pools. Both of these fungal infections cause painful itching.

Protozoa

Protozoa (pro-toe-ZO-ah) are single-celled organisms that are larger and more complex than bacteria. Tiny protozoa are the simplest animals in the world. They are food for many larger, more complex organisms, such as some types of whales.

Protozoa often live in streams and ponds. These tiny creatures are common in dirty, untreated water. If protozoa get into your body, they can cause stomachaches, nausea, vomiting, and diarrhea.

One dangerous protozoan is spread by mosquito saliva—this protozoan causes a disease called malaria. When a mosquito carrying these protozoa bites a person, the protozoa enter that person’s blood. Malaria’s symptoms include fever, chills, and weakness. Malaria kills a million people around the world every year and is most common in areas around the equator.

Mosquitoes can transfer diseases like malaria and West Nile virus from person to person.
How Do Microbes Spread?

Most diseases are spread through contact with an infected person or contact with things contaminated by an infected person. Many infection-causing microbes live in body fluids such as saliva, blood, and mucus. If a sick person touches a doorknob after she blows her nose, microbes from her runny nose pass from her hand to the doorknob. People who touch the doorknob and then rub their eyes, or eat a sandwich, could catch the first person’s cold. If a sick person sneezes, coughs, or even talks, microbes can fly into the air and infect another person.

Some diseases can spread through the air, water, or other animals. Extremely tiny microbes can float in the air on bits of dust. You can also get sick from eating spoiled food or drinking polluted water. A few diseases can pass from an animal to a human. These diseases include: rabies from mammals, like dogs and skunks; salmonella from birds and reptiles; malaria and West Nile virus from mosquitoes; and Lyme disease from ticks.

Epidemics

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.

Modern travelers move around the world within hours—carrying all their germs with them. Healthy people can travel to another continent and get sick, and then return home carrying the harmful microbes. 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

Our immune system reacts quickly to threats, shutting down infection-causing microbes it recognizes. Around 1800, Dr. Edward Jenner noticed that people who had been sick with cowpox, a mild disease common to farm workers, never got smallpox, one of the deadliest diseases in the world at the time. Jenner realized that cowpox and smallpox were related like cousins. He would give a healthy person cowpox, which made that person slightly sick, but it prevented that person from catching smallpox. Jenner’s treatment dramatically lowered the number of deaths from smallpox wherever it was used.

Jenner’s treatment worked because people’s bodies were given a chance to fight the cowpox virus before the smallpox virus invaded. When the smallpox virus did infect those people, their immune systems already knew how to fight it. Their immune systems could attack right away, and symptoms of smallpox would not develop. However, Jenner’s treatment only weakened one virus and prevented one deadly illness.

In the 1870s and 1880s, Louis Pasteur discovered how to weaken microbes that did not already have a weaker cousin like cowpox. His discovery led to vaccines. Vaccines prevent people from getting sick, but they do nothing to help people who are already ill. Many children get shots of vaccines when they are young to prevent them from ever getting sick with particular diseases. Some vaccines, like flu shots, can be given every year to help people fight infection. However, vaccines do not work against all diseases caused by 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.
Antibiotics: The Magic Bullet

Some microbes fight other types of microbes and kill them, and they can do this without harming healthy cells or unrelated microbes. These killer microbes produce medicines called antibiotics. When scientists discovered antibiotics, they considered these medicines to be “magic bullets,” because they would directly attack the infection.

Unfortunately, antibiotics have become overused or used incorrectly. An antibiotic medicine kills most microbes that cause a disease, but the strongest microbes often survive. If a person takes unnecessary antibiotics or stops before finishing the full dose, the toughest microbes will live and multiply as stronger, deadlier microbes. Many microbes have developed resistances to the most common antibiotics. Scientists keep trying to produce new 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

Children and senior citizens are usually the most vulnerable to disease because their immune systems are weaker than those of healthy adults. When you are sick, it is important to stay home and get rest. This helps your body fight microbes and it also keeps you from infecting other people. Diseases spread most easily when people are in enclosed areas and in contact with many other people.

When you have a cold or a cough, cover your mouth and nose with a tissue. Then throw away the tissue. Do not leave it lying around to infect other people. If you don’t have a tissue, cover your nose and mouth with your cupped hands. Then wash your hands right away. If you are sick, do not share food, utensils, 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—microbes do not obey the “three-second rule.”

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 check-up can prevent problems before they begin. Make sure that 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 many cause diseases. There are many ways to prevent diseases from spreading. Some of these ways are simple, like washing your hands after using the bathroom. Others, such as vaccines and antibiotics, are the result of two hundred years of scientific discovery and modern medicine.

Due to an international effort organized by many countries, organizations, and individual doctors, diseases are being controlled and even eradicated. Yet we will never be able to wipe out all of the world’s harmful microbes.
Glossary

antibiotics medicines made from microbes to fight infections from other microbes (p. 19)

contaminated covered with harmful microbes (p. 15)
disease a condition that changes the way the body normally functions (p. 4)
epidemic the rapid spread of a disease within a community (p. 16)
eradicated completely destroyed (p. 22)
immune system that moves antibodies through your body to fight infection (p. 7)
infections illnesses caused by microbes (p. 10)
lactose sugars found in milk (p. 9)
microscope a device used to view tiny objects (p. 5)
mutate to permanently change (p. 11)
nutrients substances that living things need to live and to be healthy (p. 8)
organisms living things, including people, other animals, plants, and microbes (p. 5)
outbreak the quick spread of a disease (p. 16)
pandemic the rapid, worldwide spread of a disease (p. 16)
parasites living things that take what they need to survive from other living things (p. 13)
resistances the ability to fight against something (p. 19)
symptoms telltale signs of an illness (p. 4)
vaccines a shot containing a weak disease that teaches the body to fight stronger forms of the same disease (p. 18)
vulnerable open to attack (p. 20)

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