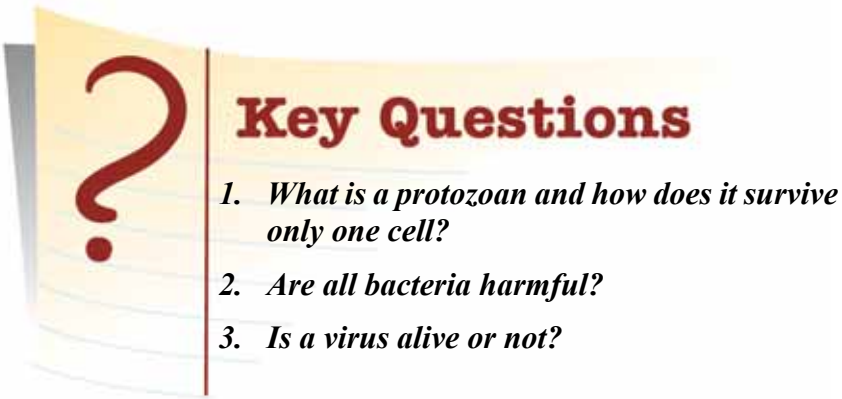
Chapter 7

The Microscopic World

In previous chapters, you learned what cells are like on the inside and how they work. Most living things contain many cells. The human body contains *trillions* of cells. Did you know that some living organisms are made up of only ONE cell? Some of these single-celled creatures have been found living in volcano openings, polar ice, and even inside a human stomach! In this chapter, you will learn how organisms made up of only one cell carry out necessary life functions. You'll also learn about invaders of cells called *viruses.* Viruses aren't considered alive by most scientists. They invade cells and turn them into factories that make more viruses. It's a strange world when you start looking under a microscope!



Key Questions

1. ***What is a protozoan and how does it survive with only one cell?***
2. ***Are all bacteria harmful?***
3. ***Is a virus alive or not?***

7.1 Protozoans

Imagine shrinking down to the size of a cell and going for a swim in a drop of pond water (Figure 7.1). You enter a world filled with strange-looking creatures. One propels itself with a long whip. Another has hairs all over its body and uses them to swim. Watch out! There's a blob coming toward you and he looks hungry! This world might sound strange but it's real. Just look at a drop of water from a pond under a microscope. The creatures described are single-celled organisms known as *protozoans*. In this section, you will learn about their structure and function.

Figure 7.1: *What kind of life would you encounter in a drop of pond water?*

What are protozoans?

Protozoans are single-celled eukaryotes

A **protozoan** (in Greek *protos* = first and *zoon* = animal) is a single-celled *eukaryote* (an organism that has a cell nucleus) that has some animal-like characteristics. Many protozoans move about and feed like animals. Most protozoans exist as a single, eukaryotic cell. Some gather together in groups called *colonies*.

Protozoan habitats

Protozoans need a moist environment to survive. Ponds are ideal habitats for freshwater protozoans. They are also found in the ocean, in moist soil, and in the cells and tissues of plants and animals. In dry conditions, some protozoans can form a thick, protective wall around their cells. In this form, they can be blown about by the wind just like dandelion seeds. When they come in contact with moist conditions, they return to their normal form.

Classification of protozoans

Protozoans are most often placed in the Kingdom Protista. This kingdom also includes the plant-like algae, and strange fungus-like organisms called *slime molds*. Algae live in aquatic environments and make their own food like plants (Figure 7.2). Slime molds grow in damp environments and absorb their food.

VOCABULARY

protozoan - a single-celled eukaryote that has some animal-like characteristics.

Figure 7.2: *Fucus is a type of algae.*

Structure and function of protozoans

Protozoans have specialized organelles

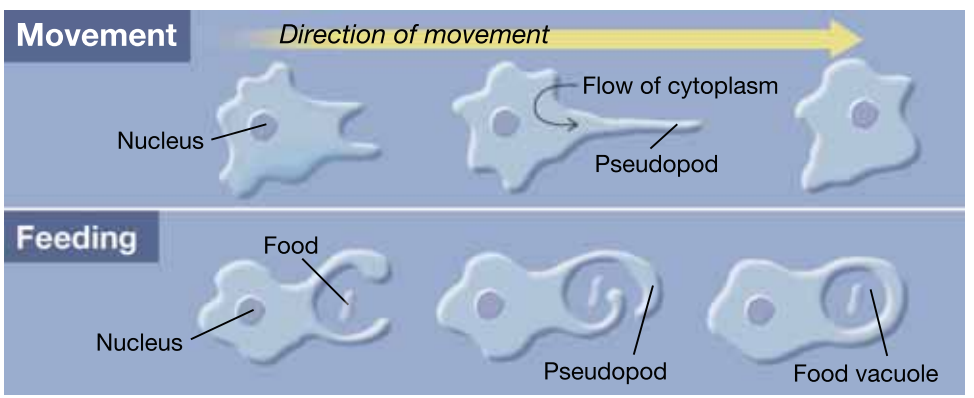
Protozoans come in an amazing variety of forms even though they consist of a single cell. While animals and plants have specialized cells and tissues, protozoans have specialized organelles. These organelles are used for movement, feeding, and other functions.

Ciliates

Ciliates are a group of protozoans that move by waving tiny, hair-like organelles called *cilia* (Figure 7.3). A *paramecium* is an example of a ciliate. It waves its cilia like tiny oars to move through the water. It also uses its cilia to sweep food into an organelle called a *gullet*. The *contractile vacuole* helps control the amount of water inside the paramecium. Since paramecia live in freshwater, there is a tendency for water to move into the cell by osmosis. The contractile vacuole pumps out excess water.

Amoebas

Amoebas are protozoans that move by means of *pseudopods* (in Latin, "false feet.") *Amoeba proteus* is a species found in ponds. An amoeba stretches its cytoplasm in the direction it will move. The stretched part becomes a pseudopod. The rest of the amoeba flows into the pseudopod. Amoebas also use their pseudopods to get food. An amoeba stretches out two pseudopods to surround a piece of food. The food is then taken in to form a *food vacuole*.



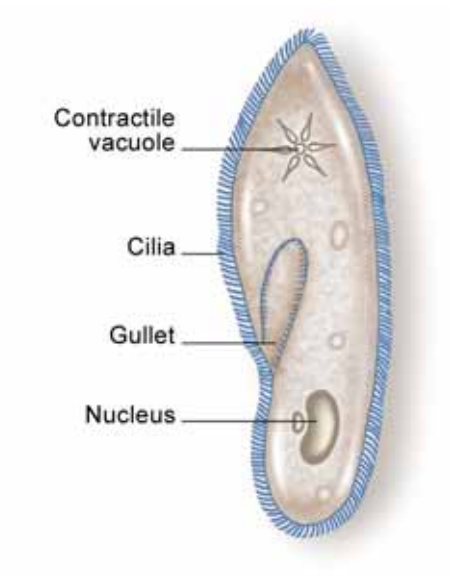


Figure 7.3: *A diagram of a paramecium.*

VOCABULARY

ciliates - a group of protozoans that move by waving tiny, hair-like organelles called cilia.

amoebas - a group of protozoans that move by means of pseudopods.

Flagellates

Flagellates are a group of protozoans that move using a whip-like organelle called a *flagella*. Many flagellates are a combination of plant and animal. They contain chlorophyll and can make their own food, like a plant. But they also eat other things, like an animal.

The euglena is a common flagellate

A *euglena* is a flagellate commonly found in pond water (Figure 7.4). It has a flagella located at one end of its body. Its mouth is located at the base of the flagella and leads to a gullet. At the same end, the euglena has a light-sensitive eyespot. This eyespot helps the euglena swim towards light so it can make its own food. If the euglena is kept from sunlight for long periods of time, its chlorophyll disappears and it loses the ability to make its own food. Then, it survives on food that it takes from its habitat.

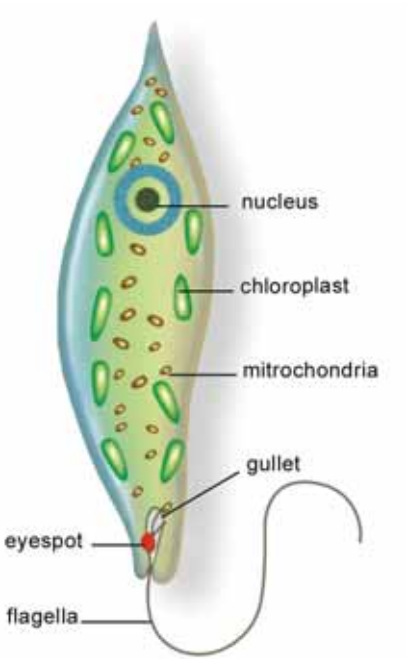
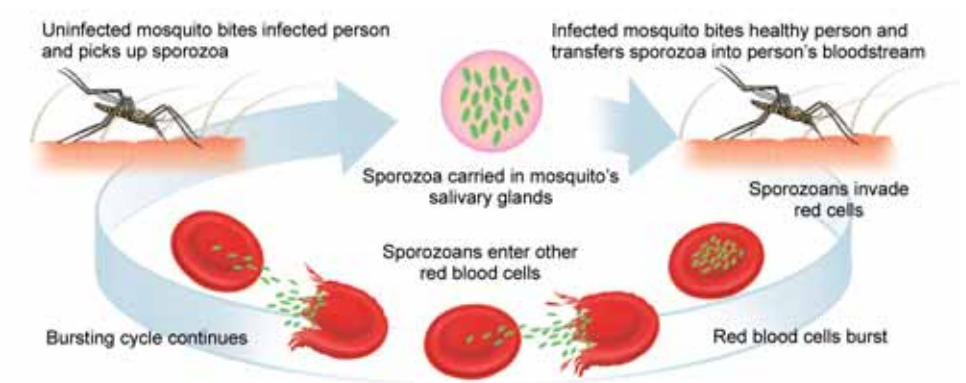


Figure 7.4: *A diagram of a euglena.*

Sporozoans

Sporozoans are a group of protozoans that do not have organelles for movement. All members of this group are parasites and live in the bodies of animals. A **parasite** is an organism that lives in or on another organism called a *host*. Parasites cause harm to their hosts. Malaria is caused by a sporozoan called *plasmodium*. Malaria is transmitted by mosquitoes. When the mosquito bites, plasmodium gets into the blood and infects red blood cells. Infected blood cells eventually burst causing sickness and death.



VOCABULARY

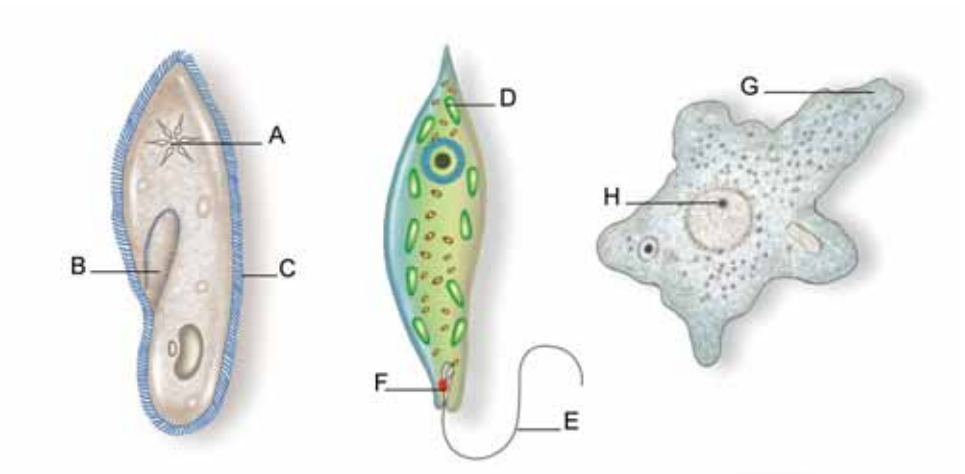
flagellates - a group of protozoans that move using a whip-like organelle called a flagella.

sporozoans - a group of protozoans that do not have organelles for movement and are parasites.

parasite - an organism that lives in or on a host organism and causes it harm.

7.1 Section Review

1. To which kingdom do protozoans belong? What other organisms are in that kingdom?
2. What are some animal-like characteristics of protozoans? Which characteristic of protozoans is not animal-like?
3. What type of environment do protozoans need to survive?
4. Label the parts of the organisms below:



5. Complete the table below:

Protozoan group	Type of movement	Other characteristics	Example
Ciliates			paramecium
Amoebas		use pseudopods to get food	
Flagellates	flagella		
Sporozoans		many species are parasites	

CHALLENGE

Each group of protozoans (ciliates, amoebas, flagellates, and sporozoans) has parasitic species. Use the Internet and books to find at least one disease that affects humans and is caused by a member of each group.

Next, pick one of the diseases and make an informational brochure about it. Include the following information in your brochure.

1. What is the name and group of the organism that causes the disease?
2. How is the disease transmitted?
3. What are the symptoms of the disease?
4. What parts of the world does the disease affect?
5. What are the treatments for the disease?
6. How can the disease be prevented?

7.2 Bacteria

"Wash your hands—you don't want to get sick from bacteria!" How many times have you heard a command like that? Bacteria are everywhere and some can make you sick. But did you know that many types of bacteria are helpful? In fact, life on Earth depends on them. Bacteria take elements like carbon and nitrogen out of the air and turn them into compounds living things can use. They recycle nutrients from dead plants and animals so they can be reused. There are even bacteria in your digestive system (Figure 7.5)! In this section, you'll learn about the structure and function of bacterial cells.

Figure 7.5: *Bacteria in your digestive tract help you digest food.*

What are bacteria?

Bacteria are the only prokaryotes

Bacteria are organisms that consist of a single, prokaryotic cell. Bacteria are the only *prokaryotes* (cells with no nuclei). All other life forms on Earth are eukaryotes. Bacterial cells have a cell membrane that is surrounded by a tough cell wall (Figure 7.6).

Where do bacteria live?

Bacteria live on or in just about every material and environment on Earth. They live in soil, water, and air. They are found in the coldest regions of the Arctic and even in boiling waters near undersea volcanoes. There are many bacteria in each environment. A square centimeter of your skin has thousands of bacteria. A teaspoon of soil contains more than a billion bacteria.

1 or 2 kingdoms of bacteria?

Some scientists group all bacteria into the Kingdom Monera. Others divide bacteria into two kingdoms, Archaebacteria and Eubacteria. Archaebacteria are found in extreme environments like volcanic vents in the ocean. They are thought to be the first organisms on Earth. Eubacteria are found almost everywhere else and have a different chemical makeup than archaebacteria. Both types of bacteria are prokaryotic, single-celled organisms. As future discoveries are made, these groups may change.

VOCABULARY

bacteria - organisms that consist of a single, prokaryotic cell.

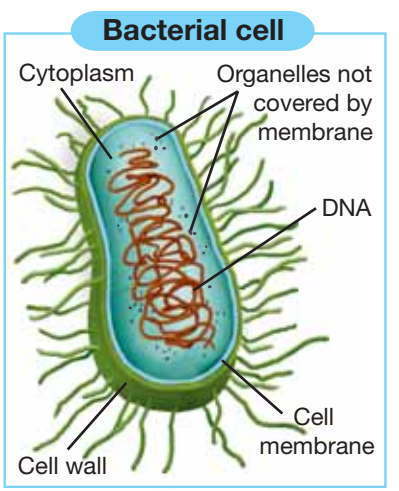


Figure 7.6: *A bacterium is a prokaryotic cell.*

Size and shape of bacteria

How big are bacteria?

The average bacterial cell is about 1.5 million times smaller than the average person. Bacteria are not easy to measure using meters, centimeters, or even millimeters. *Micrometers* (µm) are used to measure them. One micrometer is equal to one-millionth of a meter. The size of bacteria range from 1µm to 5µm. Eukaryotic cells tend to be about ten times larger than bacterial cells (Figure 7.7).

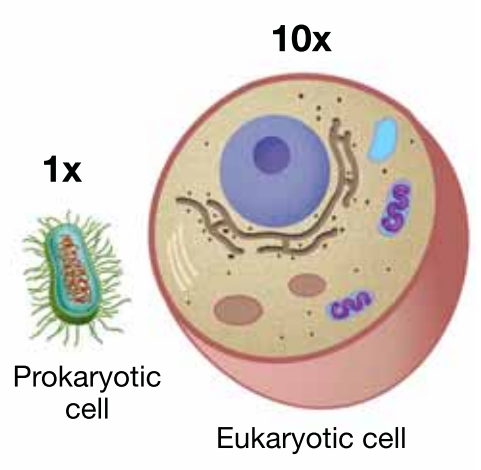
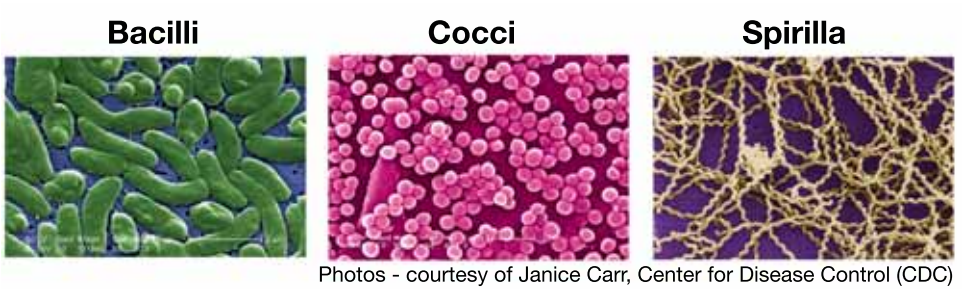


Figure 7.7: *Comparing the size of a typical bacteria to a typical eukaryotic cell.*

Shapes of bacterial cells

Bacteria are often described according to the shape of their cells. Rod-shaped bacteria are called *bacilli*. Ball-shaped bacteria are called *cocci*. Spiral-shaped bacteria are called *spirilla*. Some bacterial cells exist as individuals while others exist in pairs, chains, or clusters. The graphic below shows the shapes of bacteria.



Photos - courtesy of Janice Carr, Center for Disease Control (CDC)

Rod-shaped bacteria are called bacilli. Ball-shaped bacteria are called cocci. Spiral-shaped bacteria are called spirilla.

Make a set of study flash cards to help you remember the terms you learn in this chapter. Place the term on one side of the card and its definition on the other. Draw pictures along with the definition where appropriate.

Movement and feeding

How bacteria move

Bacteria move around in many ways. Some bacteria move using flagella. They rotate their flagella to propel themselves through liquid environments (Figure 7.8). Other bacteria have a slimy layer on the outside. They use it to slide over surfaces. Many types of bacteria do not have their own means of movement. Bacteria are simply carried by the movement of air or liquid. They can also be transferred from surface to surface. For example, when you touch a surface, bacteria are transferred from that surface to your skin.

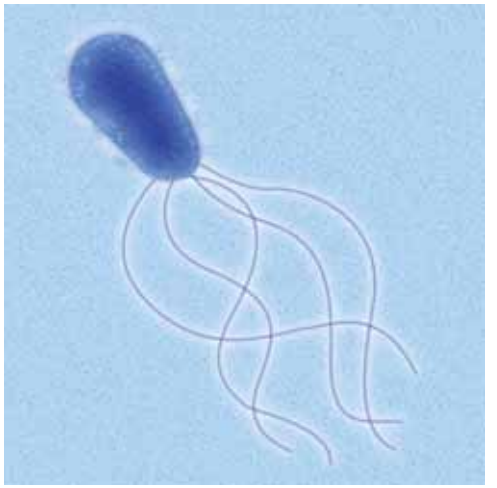
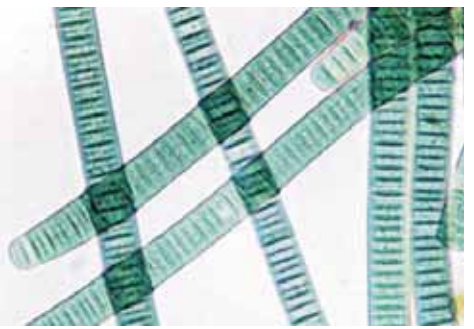


Figure 7.8: *Some bacteria move using flagella.*

Some bacteria make their own food

Bacteria get their food in many ways. **Photosynthetic bacteria** make their own food from sunlight and carbon dioxide, just like plants. Also like plants, they produce oxygen. *Cyanobacteria* are examples of photosynthetic bacteria (right). Bacteria that live around volcanic vents or other harsh environments can make their own food without sunlight. They use chemicals to produce their food instead of energy from the sun. This process is called *chemosynthesis*.



VOCABULARY

photosynthetic bacteria - bacteria that produce their own food through photosynthesis.

Some bacteria get their food from outside

Many types of bacteria absorb food from the material they live on or in. Bacteria that break down dead organisms get their food in this way. You have bacteria in your digestive system that absorb nutrients from the food you eat. Termites have bacteria in their stomach that absorb and break down cellulose. Cellulose is the compound that makes up wood, a termite's favorite food. The bacteria help the termite get energy and nutrients from wood.

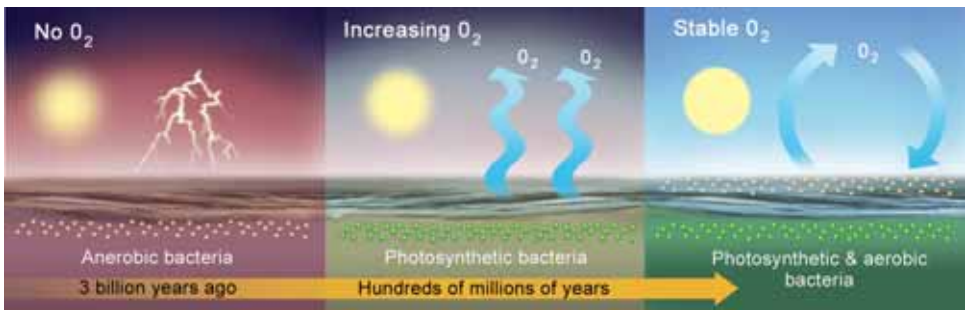
Bacteria and the beginning of life on Earth

Bacteria were the first organisms

Scientists believe that bacteria were the first organisms on Earth. Evidence comes from fossils of single-celled prokaryotes found in rocks that are more than 3 billion years old. At that time, there was little oxygen in the atmosphere. The earliest life was therefore *anaerobic* (Latin for "without oxygen"). **Anaerobic bacteria** do not require oxygen for cellular respiration. Today, anaerobic bacteria thrive in places that have little or no oxygen, like swamps.

Bacteria increased oxygen in Earth's atmosphere

Over time, some bacteria developed the ability to use photosynthesis. Cyanobacteria, still in existence today, were one of the first photosynthetic bacteria. One of the products of photosynthesis is oxygen. Over hundreds of millions of years, the amount of oxygen in Earth's atmosphere increased. This allowed *aerobic* bacteria to develop. **Aerobic bacteria** use oxygen for cellular respiration. There are many different species of aerobic bacteria living today.



Eukaryotic cells developed from prokaryotic cells

Eventually, eukaryotic cells developed from bacteria. A scientific theory states that long ago, smaller prokaryotic cells were engulfed by larger prokaryotic cells. The smaller cells began to survive by living inside of the larger cells. Over time they took on specific functions inside the larger cells like producing energy. Eventually, the smaller cells became the organelles (like mitochondria) inside of eukaryotic cells (Figure 7.9).

VOCABULARY

anaerobic bacteria - bacteria that do not require oxygen to survive.

aerobic bacteria - bacteria that use oxygen for cellular respiration.

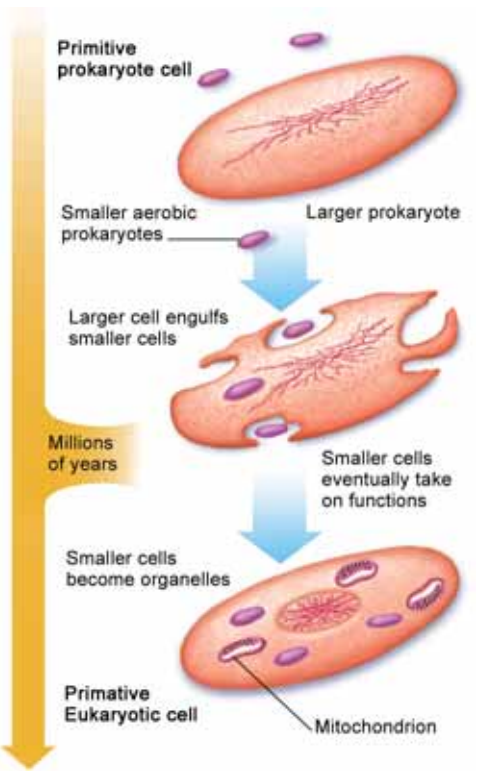


Figure 7.9: *How eukaryotic cells developed from prokaryotic cells.*

The importance of bacteria

Bacteria and industry Bacteria are used in many areas of industry. Yogurt and cheese are made with certain types of bacteria. Some important drugs like insulin are made with the help of bacteria. Sewage treatment plants use bacteria to break down waste products. Other bacteria are used in mining and to clean up oil spills. There is a good chance that you've benefitted from bacteria today!

Symbiosis Many kinds of bacteria have developed close relationships with other organisms. In many relationships the bacteria and the organism it lives with benefit. We learned in Chapter 3 that this type of symbiosis is called *mutualism*. One species of bacteria lives in your intestines. You provide the bacteria with a warm, safe place to live. In return, the bacteria help you break down and absorb certain compounds in foods. Bacteria even make some vitamins that your cells cannot make on their own.

Life on Earth depends on bacteria Bacteria are an important part of the nutrient cycles that all life depends upon. For example, plants need nitrogen to make amino acids, the building blocks of protein. Bacteria in the soil take nitrogen out of the air and turn it into a form plants can use. When animals eat plants, they rearrange the amino acids into other proteins. When an organism dies, bacteria break down the dead material and turn it back into compounds that living things can use again (Figure 7.10). Bacteria are "nature's recyclers."

Bacteria and antibiotics Have you ever had a bacterial infection? If so, you've experienced one of the harmful effects of bacteria. Bacteria cause diseases like strep throat, respiratory infections, and infected wounds. Bacterial diseases are treated with drugs called *antibiotics*. Antibiotics kill bacteria without harming your own cells. Different antibiotics are used for fighting different types of bacteria.

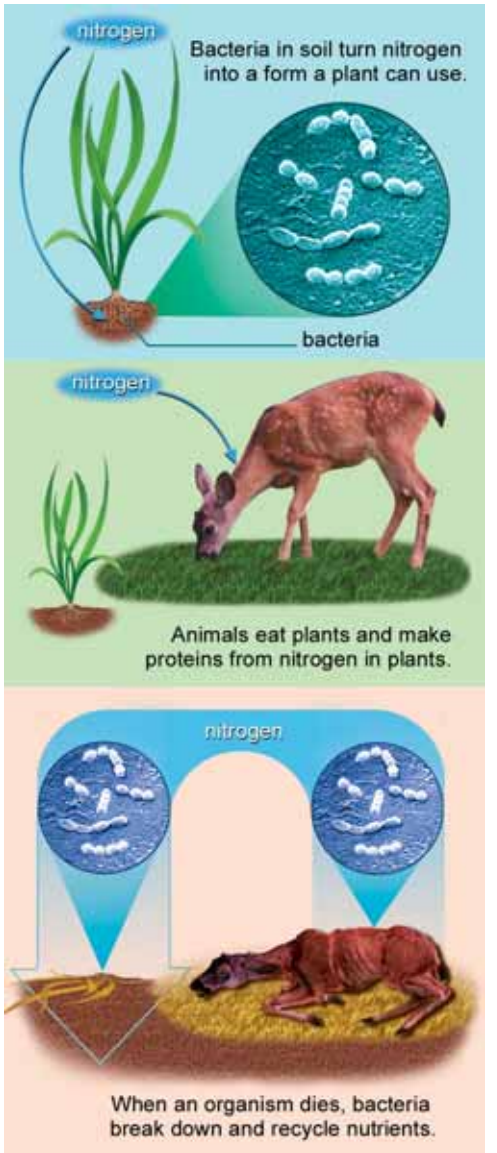
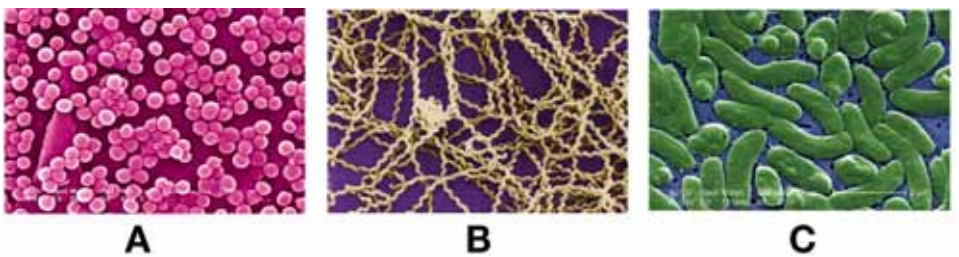


Figure 7.10: *Bacteria are an important part of nutrient cycles.*

7.2 Section Review

1. How are bacteria similar to and different from protozoans?
2. Name the two major groups of bacteria.
3. Which units are used to measure bacteria?
4. Name each type of bacteria in the picture below.



5. What is the difference between aerobic and anaerobic bacteria?
6. Explain how bacteria changed Earth's atmosphere.
7. What is mutualism? Give one example of mutualism that involves bacteria.
8. List four important things about bacteria.
9. How do plants depend on bacteria?
10. Why are bacteria sometimes referred to as "nature's recyclers?"
11. What are antibiotics and how are they used?
12. Beginning with ancient anaerobic bacteria, list the sequence of steps leading to the first eukaryotic cells.

CHALLENGE

Scientists believe that cyanobacteria were the first photosynthetic organisms. Explain how this may have helped more oxygen-breathing organisms to develop.

SOLVE IT!

Bacteria reproduce rapidly. Suppose a population of bacteria doubled every 24 hours. You start out with only 2 bacteria. Make a population vs. time graph. Use days as your units of time and graph the population from 0 to 14 days.

7.3 Viruses

Have you ever had the flu? Your muscles ache and your throat is sore. You also get a fever and an upset stomach. The flu is a disease caused by a *virus*. Viruses infect cells and cause many diseases, including smallpox, flu, AIDS, and the common cold. To *infect* means to invade and produce an infection. Viruses infect virtually all types of cells: bacterium, protozoan, fungus, plant, animal, and human. In this section you will learn about viruses and how they infect cells.

VOCABULARY

virus - a tiny, nonliving particle made up of genetic material and protein.

host cell - a cell that is, or becomes, infected with a virus.

The structure of viruses

What is a virus?

A **virus** is a tiny, nonliving particle made up of genetic material and protein. Viruses are not cells and are not made of cells. By itself, a virus can do nothing. It does not eat, produce its own food, or reproduce. All a virus can do is wait for a *host cell* to infect. A **host cell** is a cell that is, or becomes, infected with a virus. Both prokaryotic and eukaryotic cells can be hosts to viruses. Flu viruses may infect cells of your respiratory tract (Figure 7.11). When the virus spreads to many of your cells, you get sick.

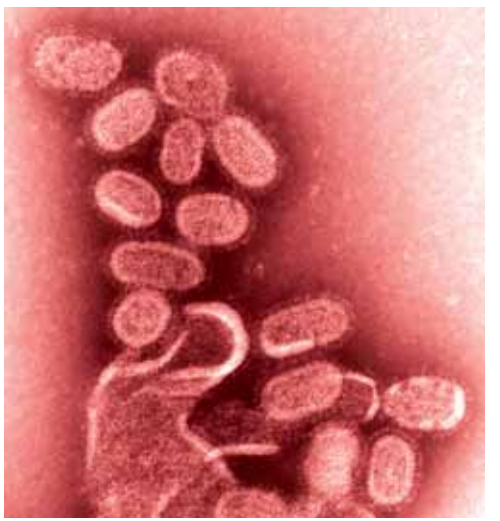
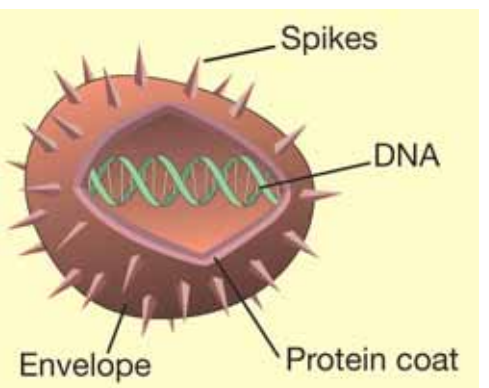


Figure 7.11: *An image of flu viruses bursting out of a cell. The image was captured using an electron microscope. Photo courtesy CDC Public Health Image Library.*

The structure of viruses

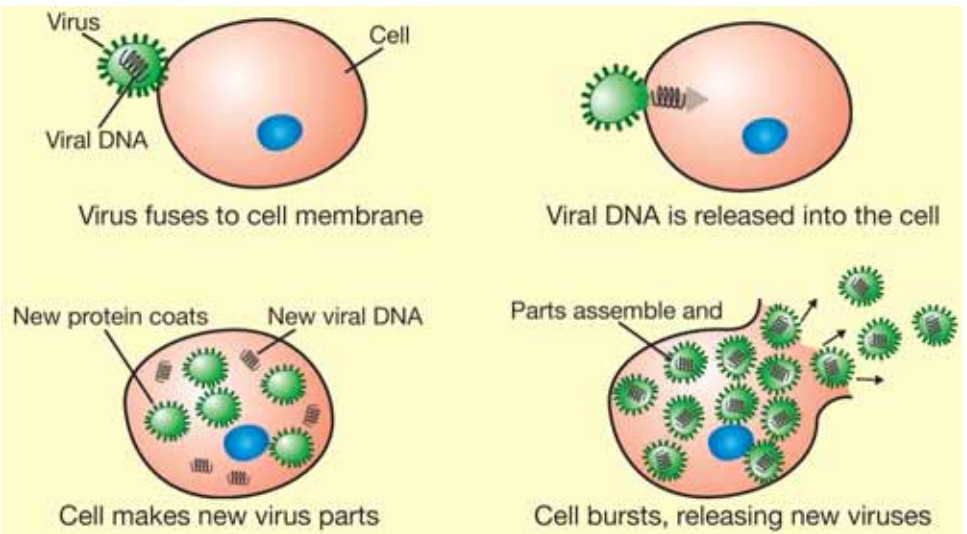
Viruses can be as much as 10,000 times smaller than bacteria. A virus contains a core DNA. Surrounding that core is a *protein coat*. In some viruses, the protein coat is covered by an envelope made of proteins, lipids, and carbohydrates. That envelope may have spikes made of carbohydrates and proteins that help the virus particles attach to host cells.



How viruses infect cells

Host cells become factories for the virus

When some viruses come into contact with host cells, they trigger the cells to engulf them. Other viruses fuse themselves to the cell membrane and release their DNA into the cell. Once inside, the viral DNA changes the function of the cell. The cell now becomes a factory that produces new viruses. Eventually the infected cell dies and bursts, freeing the new viruses. In some cases, new viruses just pinch off so the cell remains alive.



Viruses and host cells

A virus must be able to get its DNA inside of a cell before it can multiply. The cell membrane controls what enters the cell. How does a virus trick a cell into letting it enter? The "lock and key" mechanism is the most common explanation. Certain proteins on the virus' protein coat must fit certain receptor sites on the host's cell membrane (Figure 7.12). If the proteins fit, the virus can enter and infect the cell. If the proteins do not fit, the virus cannot enter the cell or fuse with its cell membrane. Thus the viral DNA cannot enter the cell and cause an infection.

STUDY SKILLS

A tank crashes through the walls of a car factory. People in the tank get out and turn the car factory into a tank factory. An *analogy* is a way to find similarities between things that are different. How does this analogy explain how a virus reproduces? Try and think of another analogy for how a virus reproduces.

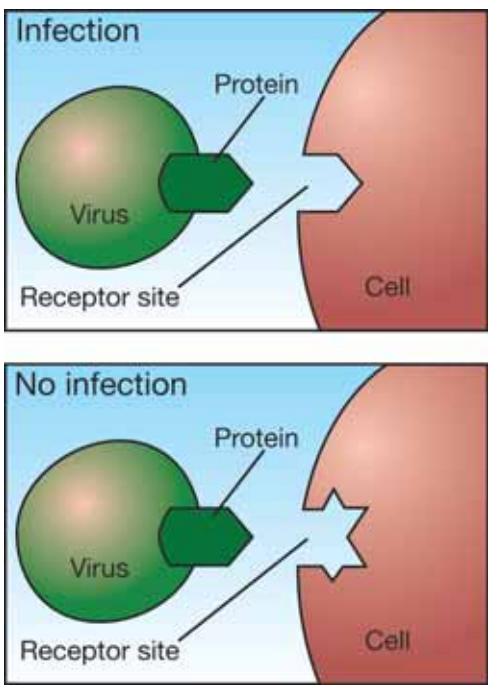


Figure 7.12: *If the proteins fit, the virus can infect the cell.*

The spread of viruses and immunity

The spread of a viral infection

Once free from the host cell, new viruses infect other cells. Because one virus causes a cell to produce thousands of new viruses, viral infections spread quickly throughout the body. Catching the flu is a good example of how this process works.

1. An infected person sneezes near you.
2. You inhale a virus, and it attaches to cells lining the inside of your nose.
3. The virus attacks those cells and causes them to make new viruses.
4. The host cells break and new viruses spread into your bloodstream and also into your lungs. Infected tissues cause different symptoms like muscle aches and sore throat.

The immune system

Your **immune system** protects your cells from unfamiliar objects like viruses and bacteria (Figure). With the flu virus, your immune system produces chemicals that cause your body temperature to increase. You get a fever. That fever slows down the production of new viruses. This is because most of your body's chemical reactions work best at a temperature of 98.6 °F (37 °C). If your temperature rises, the reactions slow down.

Antibodies

Once the cells of your immune system recognizes a virus, they make antibodies to stop further infections. **Antibodies** are proteins that bind to viruses and prevent them from infecting cells (Figure 7.13). If you come in contact with the same virus again, the cells of your immune system recognize it and immediately start producing antibodies to stop the virus's spread. The cells of your immune system produce different antibodies for different viruses.

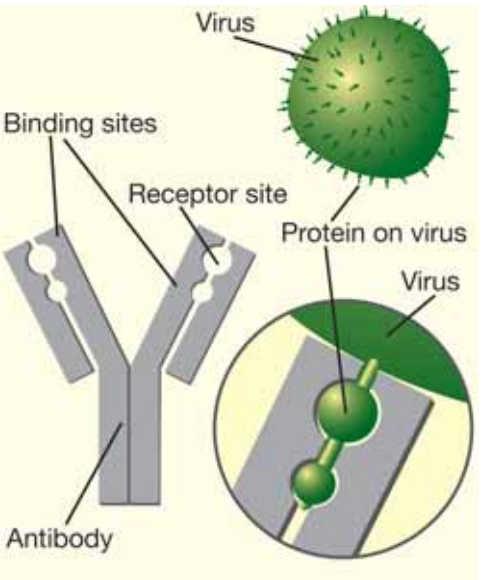


Figure 7.13: *Antibodies prevent viruses from entering cells.*

VOCABULARY

immune system - a system that protects an organism from unfamiliar objects like viruses.

antibodies - proteins that bind to viruses and prevent them from infecting cells.

Vaccines

A vaccine causes your immune system to produce antibodies to a particular virus. A **vaccine** is a preparation made from weakened virus particles or their empty protein coats. That is why vaccines do not make you sick. Your immune system mounts a response against the particles and makes antibodies. When you come in contact with the real virus, your immune system acts quickly to prevent illness (Figure 7.14).

Changes in the protein coat

New vaccines must be made each year to prevent some viral infections. The flu is a good example. After multiplying many times, flu viruses end up with mistakes in their genetic instructions. These mistakes may alter the protein coat slightly. With a different protein coat, the immune system may not recognize the virus. This means that one year's batch of flu vaccines might not be as effective against the flu virus the next year.

7.3 Section Review

1. Why is a virus not considered a living thing?
2. Explain using steps, how a virus multiplies.
3. Name three diseases caused by a virus.
4. Explain how a virus tricks a cell so it can enter it through the cell membrane.
5. Describe, using several steps, how a virus infects cells and spreads throughout an organism.
6. How does the immune system try to fight off a virus?
7. What is a vaccine? Why do you think a vaccine is sometimes referred to as "artificial immunity?"
8. Explain why a new flu vaccine has to be produced each year.

VOCABULARY

vaccine - a preparation of virus particles that, when injected into the body, causes the immune system to produce antibodies.

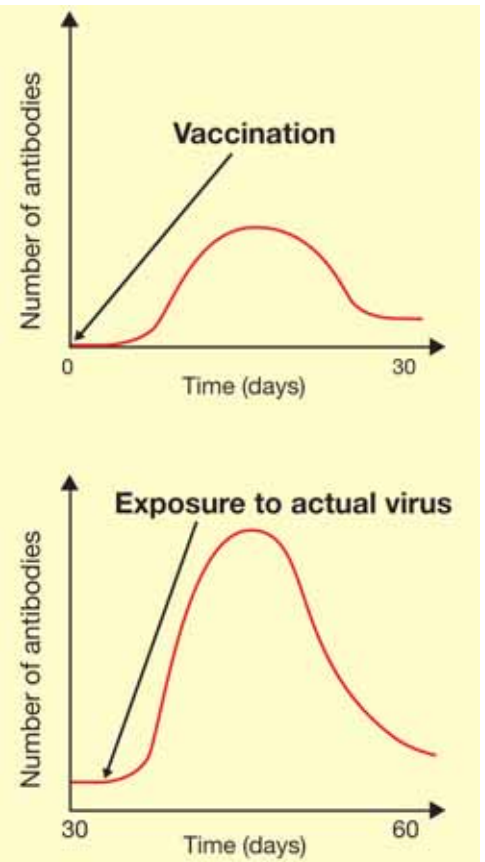


Figure 7.14: *A vaccination helps your immune system produce antibodies quickly when exposed to a virus.*

ECOLOGY CONNECTION

The Good, The Bad, The Microbe

What are our bodies made of? Water, oxygen, tissue, yes - but you might be surprised to learn that living creatures also make up much of the human body. They are called microbes and billions of them are swirling inside you and on your skin right now. We cannot see or feel them, but microbes are all over us. And we can't live without them.

What is a microbe?

Microbes are single-celled organisms too small to see with the human eye. Scientists use microscopes to study them and understand how they work. There are four major types of microbes: bacteria, viruses, fungi, and protozoa.

Microbes live all around us, in air and soil, in rocks and water. They also live in plants, animals, and in our bodies. Microbes are the oldest life form on Earth. Scientists estimate that these creatures date more than 3.5 billion years.

Microbiologists are scientists who study microbes. They work in a variety of settings: helping to keep our food and water from contamination, working in hospitals to determine what germs make us sick, or trying to solve environmental problems.

A friend and an enemy

Microbes are often called by the nickname "bugs." Some microbes can cause sicknesses like the common cold, strep throat, and chicken pox. However, more than 95 percent of microbes are harmless, despite their bad reputation. For example, *Escherichia coli* (*E. coli*) lives safely in our intestines. *E. coli* produces vitamins K and B-complex, two essential nutrients we cannot make otherwise. We also have many other useful bacteria living in our intestines that prevent dangerous bacteria from infecting our bodies.

Although most *E. coli* is helpful to our bodies, a rare strain causes severe food poisoning. It has a slightly different genetic makeup than the *E. coli* in our intestines. That other strain of *E. coli* is usually spread through contaminated animal meat, but can be killed easily by heat. All the more reason why the meat we eat be cooked to an internal temperature of 160° Fahrenheit.

Bacteria play an important role in producing food and medicine. For example, yogurt, sauerkraut, and cheese are all made with bacteria. Streptomyces, a bacteria found in soil, is used to make the antibiotic streptomycin.


Photo - courtesy of USGS

Microbes can live in all kinds of environments. Some require oxygen, others thrive without it. Also, microbes can survive along a huge spectrum of temperatures. Psychrophiles are cold-loving bacteria that live in the Arctic and Antarctic at subfreezing temperatures. In great contrast, thermophiles are heat-loving bacteria that exist at extremely high temperatures. Thermophiles are found in the hot springs of Yellowstone National Park, where temperatures are about 160°F. Extreme thermophiles, or hyperthermophiles, live near volcanic vents on the ocean floor, where temperatures reach as high as 235°F.

Bacteria of Searles Lake

Searles Lake, located in the Mohave Desert of southeastern California, is also home to bacteria living in extreme conditions. In the summer, temperatures in this area reach 100°F. The lake is about 10 times saltier and 70 times more alkaline than seawater. To make matters worse for living creatures, it has high concentrations of toxic elements like arsenic and boron. The arsenic levels are 29,000 times higher than that allowed in drinking water. Not surprisingly, given such a harsh environment, very few organisms live in Searles Lake. But scientists have discovered bacteria that are able to survive. In fact, these microbes use the dissolved arsenic as a source of energy. By learning more about them, scientists hope to find ways to clean drinking water that has been polluted by arsenic. They also believe such knowledge may aid in their search for life on other planets.


Photos - courtesy of USGS

Questions:

1. What are the four major types of microbes?
2. What are the good and bad features associated with bacteria?
3. What are some of the extreme environments in which microbes can live?
4. How do scientists hope to use what they learn from studying the bacteria of Searles Lake?

CHAPTER ACTIVITY Outbreak! Patient Zero

An *epidemic* spreads rapidly by infection and affects many individuals in a population at the same time. Examples of epidemics could be the flu, measles, and strep throat. *Patient zero* is the first patient in a population to become infected.

Imagine that there is an outbreak of a bacterial infection at your school. You know that the infection spreads through physical contact. Patient zero could have caught the bacteria by touching an object that was infected. This person then spread the bacteria by touching other items and individuals. In fact, you could be patient zero and don't even know it! In order to contain the infection, you need to isolate its source. See if you can figure out the source of the infection in the following simulation.

For the activity, you will need a deck of cards.

What you will do

1. Shake hands with 3 different classmates hands and record the names of the students.
2. Your teacher will randomly choose one card from the deck and NOT disclose its identity to the class. The card will then be reinserted back into the deck.
3. Each student will then select one card from the deck.
4. The teacher will ask for all students who have the same card number or face card to stand up. For example, all students holding the number 8 card. There can be up to 4 students with the number 8 card. Or, all students with a King. Again, there can be up to 4 students with a King.
5. The students standing are the infected students. List the name or names on the board.
6. Record the name of the student whom you suspect is patient zero. Use evidence to support your hypothesis.
7. Take a class poll to see who is the number one suspect.
8. After you identify the student that is believe to be patient zero, make a flow chart as a class to see if your hypothesis is correct. Use the information from the hand-shaking activity. If the flow chart does not work out, repeat the process until you are satisfied with the answer.

Applying your knowledge

a. Identify at least 2 ways that the outbreak activity is realistic.
b. You often come in contact with sick students but don't become ill. What defenses does the human body have to fight off an infection?
c. Are there any extra precautions that you and your classmates could have taken to reduce the spread of the disease?
d. Not all diseases are spread by physical contact. How else might diseases spread? List at least 2 other forms of spreading a disease.

Chapter 7 Assessment

Vocabulary

Select the correct term to complete the sentences.

amoebas	aerobic bacteria	anaerobic bacteria
antibodies	bacteria	ciliates
flagellates	host cell	immune system
parasite	photosynthetic bacteria	protozoan
sporozoans	vaccination	virus

Section 7.1

1. ____ move using tiny hair-like organelles.
2. Ciliates, flagellates, amoebas, and sporozoans are the major groups of ____s.
3. A ____ lives in or on a host organism and causes it harm.
4. ____ include the Euglena, which is a common pond organism that has characteristics of both plants and animals.
5. The group of protozoans that have no organelles for movement are ____.
6. ____ use their pseudopods for movement and feeding.

Section 7.2

7. Just like plants, ____ make their own food from sunlight and carbon dioxide.
8. Bacteria that use oxygen for cellular respiration are called ____.
9. Scientists believe that the first life on earth were ____ because there was little oxygen in the atmosphere more than 3 billion years ago.
10. ____ are prokaryotes.

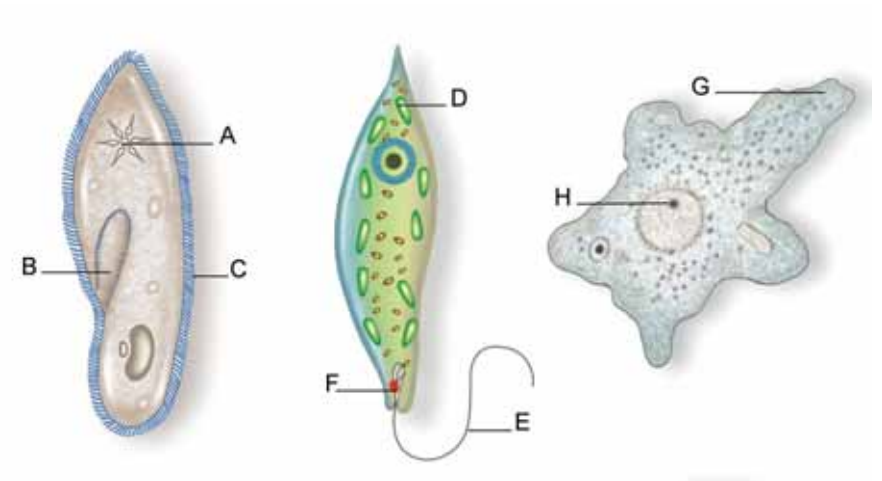
Section 7.3

11. A ____ of an organism becomes infected with a virus.
12. Your _____ protects you from unfamiliar objects like bacteria and viruses.
13. A _____ is not considered a living thing because it is not a cell and cannot eat, move, or reproduce without a host.
14. You get a ____ to teach your immune system to produce the antibodies to fight off viruses.
15. Once your immune system recognizes a virus, it produces ____ to stop further infections.

Concepts

Section 7.1

1. What does the word "protozoan" mean?
2. Name each labeled structure and explain its function.



3. What can some Protozoans do to survive through dry conditions?
4. How are protozoans divided into major groups?
5. Classify these Protozoan characteristics into the correct subgroup:
   a. pseudopods
   b. tiny oar-like hairs
   c. no special structure for movement
   d. whip-like tail

Section 7.2

6. Compare and contrast prokaryotic and eukaryotic cells.
7. Draw and a label a bacterial cell.
8. Describe three different methods that bacteria have for locomotion and nutrition.
9. Explain four ways that bacteria are used in industry.
10. The names of bacteria often give clues about their shape and arrangement. Read about these prefixes:
    - *diplo* - two
    - *tetra* - four
    - *strepto* - chain
    - *staphylo* - clumps

    Draw what these bacteria would probably look like:
    a. tetracoccus
    b. diplobacillus
    c. streptobacillus
    d. staphylococcus

Section 7.3

11. Create a chart to compare protozoans, bacteria, and viruses including these characteristics: cell type, size, structures, nutrition, locomotion, ways helpful, ways harmful.
12. How do viruses trick cells so that it can enter?
13. How do antibodies work to stop further infection?
14. Why do scientists need to make new vaccinations each year?

Math and Writing Skills

Section 7.1

1. Write a letter to a friend from the perspective of one of these protozoans: amoeba, paramecium, or euglena. Tell your friend about what you have been up to recently. Be creative.
2. Create an acrostic for one of the groups or examples of protozoans. An acrostic is a series of lines in which certain letters, usually the first in each line, form a word or message when read in order.

Section 7.2

3. A bacterium divides once every half an hour. How many bacteria would there be after 3 hours?
4. How large are eukaryotic cells? Remember that eukaryotic cells are 10 times larger than bacteria cells, which range from 1 to 5 micrometers in length.
5. Your friend thinks that the world would be a better place without bacteria. Convince him that bacteria are vital to life on Earth using at least three specific examples.

Section 7.3

6. If a virus was enlarged 10,000 times, it would be the size of a grain of salt. How tall would you be if you were enlarged 10,000 times?
7. How do you think computer viruses got their names? Compare and contrast computer viruses and viruses.
8. Write a public service announcement for a radio show that teaches young children how to stay healthy during cold and flu season.
9. Interview your parents or family members to find out what kind of vaccinations you have had and when you received them.

Chapter Project

Bacteria vs. Viruses

Bacteria and viruses are discussed daily on TV news reports, in the newspapers, and in magazines. How are bacteria and viruses alike? How are they different? You could make lists of characteristics, but a list isn't always helpful when you are trying to learn concepts. A *graphic organizer* is a chart, diagram, or illustration that presents information in a visual way to help you understand ideas and concepts. For this project, create your own graphic organizer to show how bacteria and viruses are alike and how they are different. Draw your graphic organizer on a computer or sketch it neatly on poster board. The blank organizer to the right is a suggestion - you can use this idea or come up with a graphic organizer of your own.