

CHAPTER

8

Single-Celled Organisms and Viruses

the **BIG** idea

Bacteria and protists have the characteristics of living things, while viruses are not alive.

Key Concepts

SECTION

1

Single-celled organisms have all the characteristics of living things.

Learn about characteristics shared by all living things.

SECTION

2

Bacteria are single-celled organisms without nuclei.

Learn about the characteristics of bacteria and archaea.

SECTION

3

Viruses are not alive but affect living things.

Learn about the structure of viruses and how they affect cells.

SECTION

4

Protists are a diverse group of organisms.

Learn about protists and how they affect the environment.

FCAT Practice

Prepare and practice for the FCAT

- Section Reviews, pp. 260, 267, 274, 281
- Chapter Review, pp. 282–284
- FCAT Practice, p. 285

CLASSZONE.COM

- Florida Review: Content Review and FCAT Practice

How can you tell if these structures, magnified 2800×, are alive?

EXPLORE the BIG idea

Where Can You Find Microscopic Life?

Make a list of places where you might find living things that are too small to be seen by your unaided eye. Then use a hand lens, magnifying glass, or microscope, to investigate some of the places on your list.

Observe and Think What do you think microscopic organisms look like? Why can microscopic life be found in so many places?



How Quickly Do Bacteria Multiply?

Tape a funnel to the top of a two-liter bottle. Place one bean in the funnel. After one minute, drop two more beans into the funnel. Continue adding beans to the bottle every minute, adding twice as many beans as you did before. When it is time to add 64 beans, use 1/8 of a cup, and then continue to double the amounts.

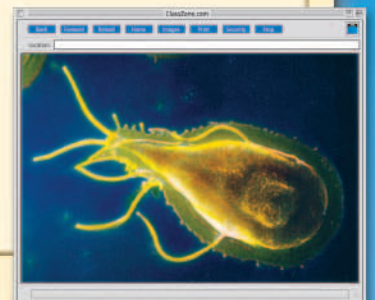
Observe and Think How long did it take to fill the bottle?



Internet Activity: Microscopic Life and You

Go to ClassZone.com to learn about the single-celled organisms.

Observe and Think What types of organisms live in the human body?



Kingdom Protista Code: MDL039

Getting Ready to Learn

CONCEPT REVIEW

- All living things interact with their environment to meet their needs.
- The cell is the fundamental unit of life.
- All cells need energy to function.

VOCABULARY REVIEW

matter p. 49
molecule p. 58

See *Glossary* for definitions.

cell, organism, species



Content Review and FCAT Practice

TAKING NOTES

MAIN IDEA WEB

Write each new blue heading in a box. Then write notes in boxes around the center box that give important terms and details about that blue heading.

SCIENCE NOTEBOOK

They are organized, with an outside and an inside.

They increase in size.

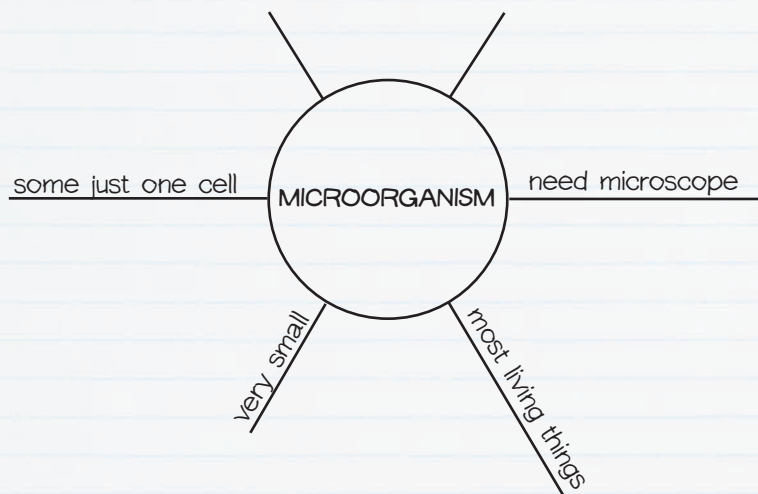
Living things share common characteristics.

They reproduce and form other organisms like themselves.

They respond to changes in the environment.

VOCABULARY STRATEGY

Place each vocabulary term at the center of a **description wheel diagram**. Write some words describing it on the spokes.



See the *Note-Taking Handbook* on pages R45–R51.

8.1

KEY CONCEPT

Single-celled organisms have all the characteristics of living things.



Sunshine State STANDARDS

SC.F.1.3.7: The student knows that behavior is a response to the environment and influences growth, development, maintenance, and reproduction.

SC.G.1.3.3: The student understands that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.



FCAT VOCABULARY

virus p. 260

VOCABULARY

microorganism p. 256

kingdom p. 257

binary fission p. 258



BEFORE, you learned

- All cells are made of the same elements
- Cells capture and release energy in order to survive
- Energy is used to move materials into and out of cells



NOW, you will learn

- About the various sizes of organisms
- About characteristics that are shared by all living things
- About needs shared by all organisms

EXPLORE Organisms

What living things are in the room with you?

PROCEDURE

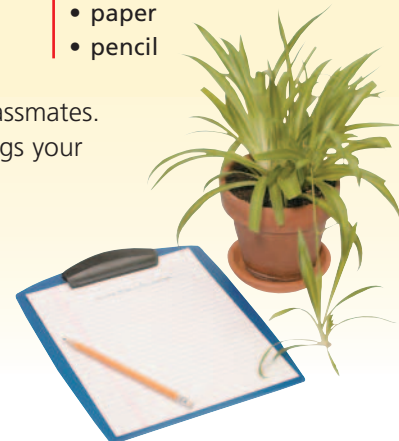
- 1 Make a list of all the living things that are in your classroom.
- 2 Compare your list with the lists of your classmates. Make one list containing all the living things your class has identified.

MATERIALS

- paper
- pencil

WHAT DO YOU THINK?

- How did you identify something as living?
- Were you and your classmates able to see all the living things on your list?



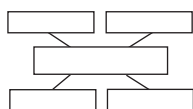
Living things come in many shapes and sizes.

You can spot mushrooms in many places while walking through a forest. Scientists have discovered mushrooms that come from the same individual fungus more than 5 kilometers (3 miles) apart in an Oregon forest. Most of this honey mushroom fungus is below ground, stretching over an area covering more than 1600 football fields. This mushroom is one of the largest known living things on Earth.

Many other living things share the soil in the Oregon forest. Earthworms, insects, and many other organisms that are too small to be seen with a naked eye, also live there. For every living thing that is large enough to be seen, there are often countless numbers of smaller living things that share the same living space.

MAIN IDEA WEB

Make a web of the important terms and details about the main idea: *Living things come in many shapes and sizes.*



The honey mushroom fungus is one example of an organism. You, too, are an organism, and tiny bacteria living inside your body are also organisms. In fact, any living thing can be called an organism.

When you think of living things, you probably begin with those you can observe—plants, animals, and fungi such as mushrooms. However, most living things are too small to observe without a microscope. Even the tiniest organisms are made of cells. Very small organisms are called **microorganisms**. Many microorganisms are made of just one cell.

READING TIP

The prefix *micro-* means “very small.” Therefore, *microscope* means “very small scope” and *microorganism* means “very small organism.”

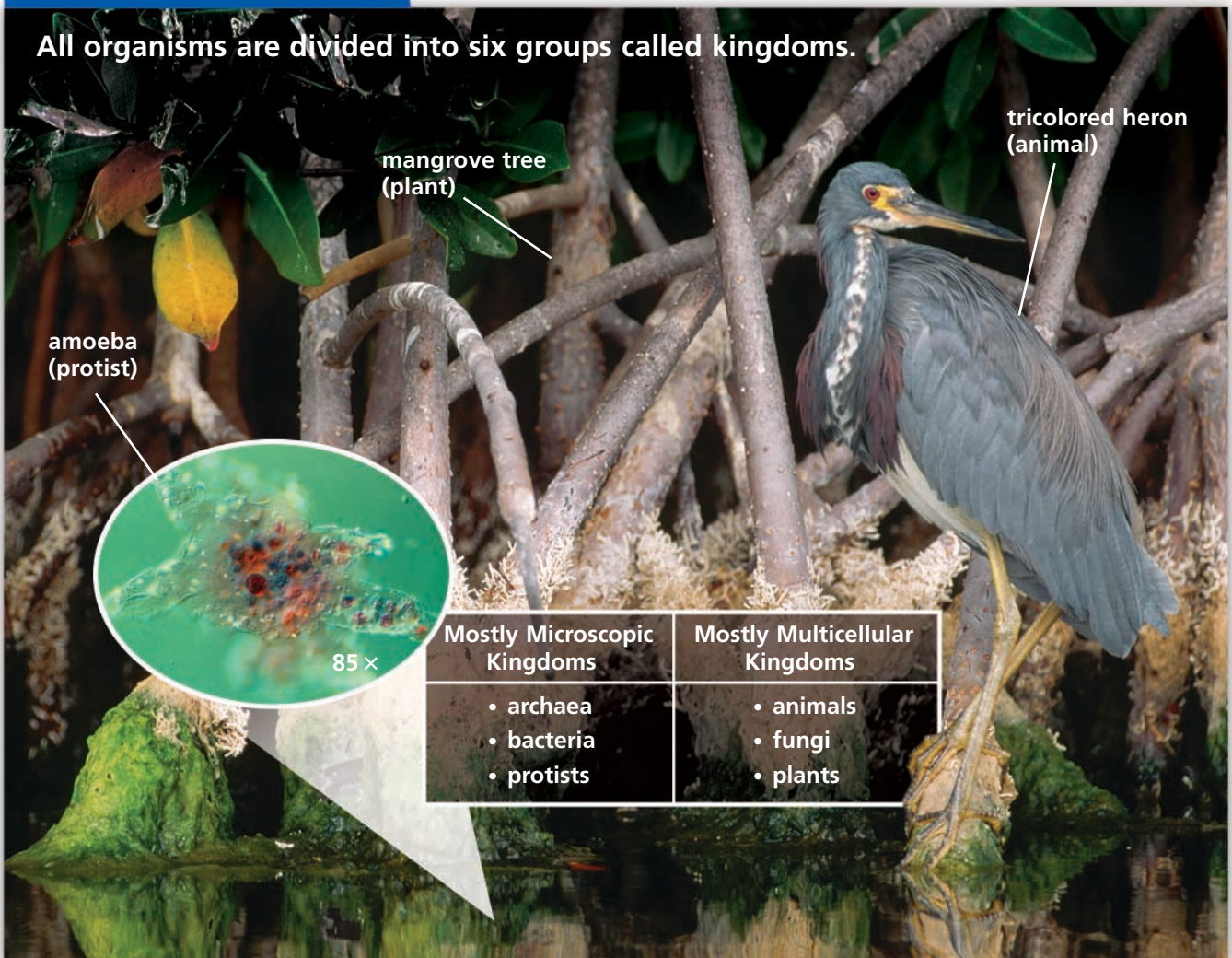
CHECK YOUR READING

Compare and contrast the words *microorganism* and *organism*.

A visitor to a mangrove swamp forest can find an amazing variety of organisms. The mangrove trees themselves are the most obvious organisms. Roots from these trees grow above and below the muddy bottom of the forest. Other organisms live in almost every part of the mangrove tree.

Six Kingdoms of Life

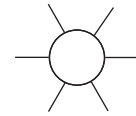
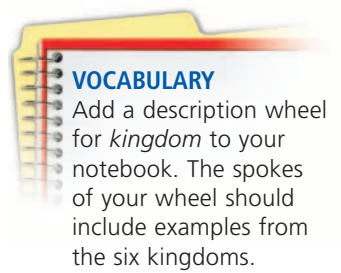
All organisms are divided into six groups called kingdoms.



Mostly Microscopic Kingdoms	Mostly Multicellular Kingdoms
<ul style="list-style-type: none"> • archaea • bacteria • protists 	<ul style="list-style-type: none"> • animals • fungi • plants

A single drop of water from a mangrove swamp may be living space for many microorganisms. The circled photograph on page 256 was taken using a microscope, and shows an amoeba that may be found in the water of the swamp. Larger organisms, such as manatees and fish, swim around the roots of mangrove trees. Birds, such as tri-colored herons and roseate spoonbills, use the branches.

Scientists divide the organisms they identify into groups called **kingdoms**. This unit will cover all of the kingdoms of life, listed in the table on page 256. You are already familiar with plants and animals. Fungi are another kingdom. Fungi include mushrooms found in a forest. The other three kingdoms are composed of mostly microscopic life. You will learn more about microscopic organisms later in this chapter.



Living things share common characteristics.

All living things—from the microorganisms living in a mangrove swamp to the giant organisms living in the open ocean—share similar characteristics. Living things are organized, grow, reproduce, and respond to the environment.

READING TIP

As you read about the four characteristics of all living things, note the examples of how single-celled organisms meet these four standards.

Organization

Cells are the basic unit of all living things. Cells, like all living things, have an inside and an outside. The boundary separating the inside from the outside of an individual cell is called the cell membrane. Within some cells, another structure called the nucleus is also surrounded by a membrane.

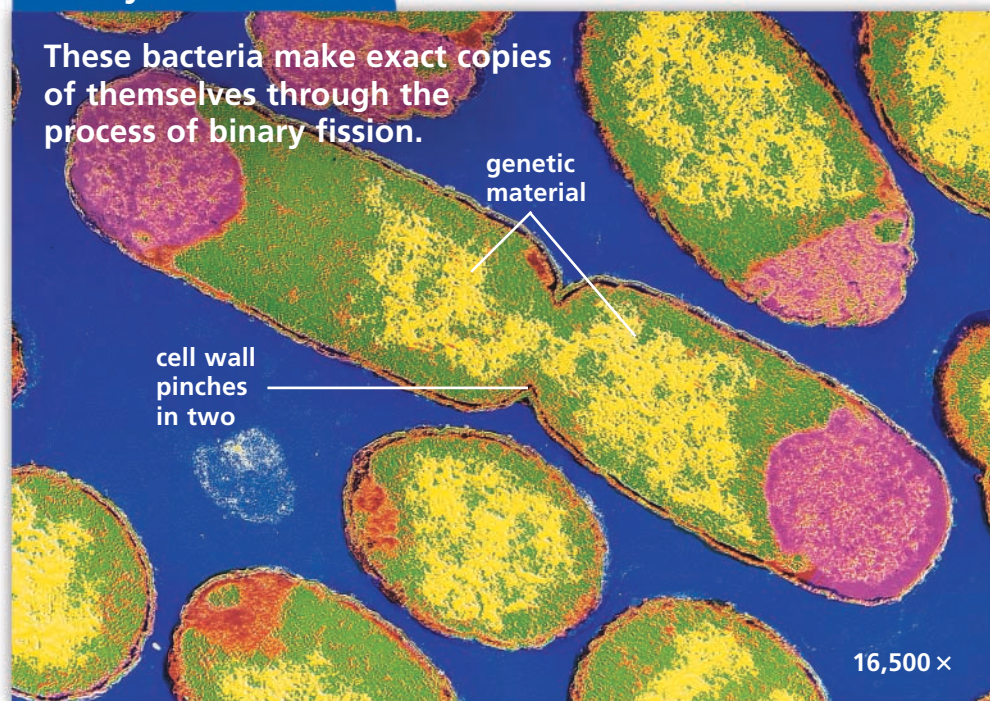
In this chapter, you will read about organisms made of a single cell. Some types of single-celled organisms contain a nucleus and some do not. All single-celled organisms contain everything they need to survive within their one cell. These cells are able to get energy from complex molecules, to move, and to sense their environment. The ability to perform these and other functions is part of their organization.

Growth

Living things increase in size. Organisms made of one cell do not grow as large as organisms made of many cells. But all living things need to get energy. All living things also need to obtain materials to build new structures inside cells or replace worn-out cell parts. As a result, individual cells grow larger over time.

Binary Fission

These bacteria make exact copies of themselves through the process of binary fission.



Reproduction

Living things reproduce, forming other organisms like themselves. Every organism contains genetic material, which is a code contained in a special molecule called DNA. The code contains characteristics of the individual organism. In order to reproduce, an organism must make a copy of this material, which is passed on to its offspring.

Some single-celled organisms reproduce by a process called **binary fission**. In binary fission, material from one cell separates into two cells. The genetic material of the original cell first doubles so that each daughter cell has an exact copy of the DNA of the original cell. You might say that single-celled organisms multiply by dividing. One cell divides into 2 cells, 2 cells divide into 4, 4 into 8, 16, 32, 64, and so on. In some cells, binary fission can take place as often as every 20 minutes.



Describe how a single-celled organism is organized, grows, and reproduces.

Response

Organisms respond to changes in the environment. Even microscopic organisms respond to conditions such as light, temperature, and touch. The ability to respond allows organisms to find food, avoid being eaten, or perform other tasks necessary to survive.



Observe the process of binary fission.

INVESTIGATE Microorganisms

How do these organisms respond to their environment?

PROCEDURE

- 1 Place a drop of the hydra culture on a microscope slide. Using the microscope, find a hydra under medium power and sketch what you see.
- 2 Add a drop of warm water to the culture on the slide. How does the hydra respond? Record your observations.
- 3 Add a drop of the daphnia culture. Record your observations.

WHAT DO YOU THINK?

- Which observations, if any, indicate that hydras respond to their environment?
- Daphnia are organisms. What is the relationship between hydra and daphnia?

CHALLENGE What other experiments could you do to observe the responses of hydra or daphnia to their environment?

SKILL FOCUS
Observing

MATERIALS

- microscope
- slide
- hydra culture
- daphnia culture
- water

TIME
30 minutes



Living things need energy, materials, and living space.

Have you ever wondered why you need to eat food, breathe air, and drink water? All living things need energy and materials. For most organisms, water and air are materials necessary for life.

Food supplies you with energy. You—like all living things—need energy to move, grow, and develop. All animals have systems for breaking down food into usable forms of energy and materials. Plants have structures that enable them to transform sunlight into usable energy. Some microorganisms transform sunlight, while others need to use other organisms as sources of energy.

Most of the activities of living things take place in water. Water is also an ingredient for many of the reactions that take place in cells. In addition, water helps support an organism's body. If you add water to the soil around a wilted plant, you will probably see the plant straighten up as water moves into its cells.

Materials in the air include gases such as carbon dioxide and oxygen. Many of the processes that capture and release energy involve these gases. Some organisms—such as those found around hydrothermal vents—use other chemicals to capture and release energy.

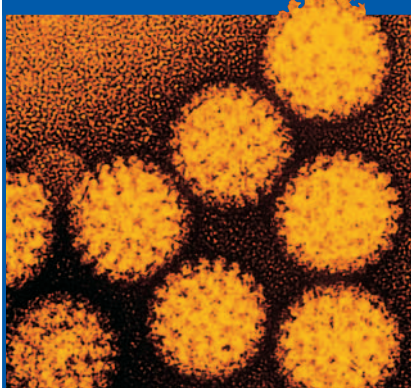
Viruses are not alive.

FLORIDA Content Preview

Viruses cause diseases in humans, which you will read about in grade 8.

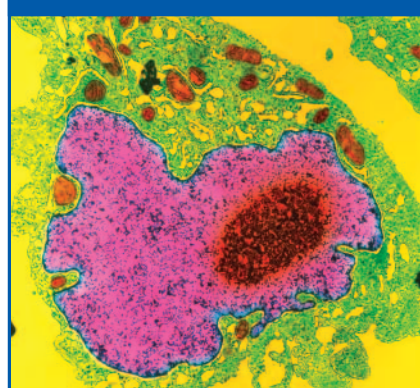
Sometimes it's not easy to tell the difference between a living and a nonliving thing. A **virus** has genetic material enclosed in a protein shell. Viruses have many of the characteristics of living things, including genetic material. However, a virus is not nearly as complex as a cell and is not considered a living thing.

Rotavirus



These viruses contain DNA but do not grow or respond to their environment. 570,000×

Animal Cell



Animal cells grow, reproduce, and respond to external conditions. 4800×

For example, animal cells have structures that allow them to get materials or energy from their environment. Virus particles do not grow once they have formed, and they do not take in any energy. Animal cells can make copies of their genetic material and reproduce by dividing in two. Viruses are able to reproduce only by “taking over” a cell and using that cell to make new viruses. Animal cells also have many more internal structures than viruses. Viruses usually contain nothing more than their genetic material and a protein coat.

8.1

Review

KEY CONCEPTS

1. Give examples of organisms that are very large and organisms that are very small.
2. Name four characteristics that all living things share.
3. Name three things that living things must obtain to survive.

CRITICAL THINKING

4. **Synthesize** Give examples of how a common animal, such as a dog, is organized, grows, responds, and reproduces.
5. **Predict** In a certain lake, would you expect there to be more organisms that are large enough to see or more organisms that are too small for you to see? Why?

CHALLENGE

6. **Design** Try to imagine the different structures that a single-celled organism needs to survive in pond water. Then use your ideas to design your own single-celled organism.



MATH TUTORIAL
CLASSZONE.COM

Click on Math Tutorial for more help with interpreting line graphs.

Graphing Growth

If you hold marbles in your hand and drop them into a bowl one at a time, each drop into the bowl adds the same amount. If you plot this growth on a line graph, you will have a straight line.

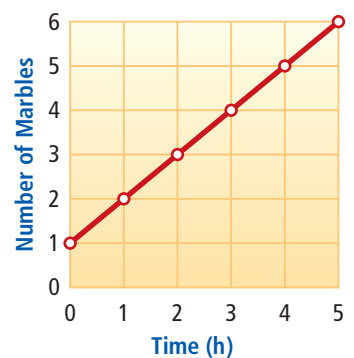
By contrast, a bacterial colony's growth expands exponentially as it grows. All the bacteria divide in two. Every time all the bacteria divide, the colony doubles in size.

EXAMPLE

Compare the two types of growth on a graph.

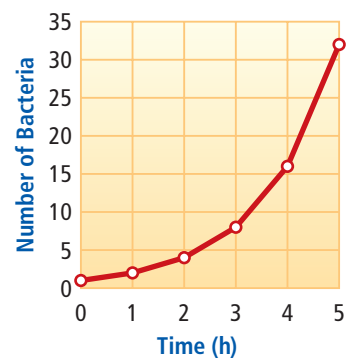
Graph 1. Suppose the marble collection begins with one marble, and after every hour, one marble is added.

The graph shows: $x + 1 = y$
The slope of the line stays the same at each interval.



Graph 2. Suppose a bacterial colony begins with one bacterium, and every hour, a bacterial cell divides, forming two bacteria.

The graph shows: $2^x = y$
The slope gets steeper at each interval.



Examine the graphs and answer the questions.

- How many marbles are in the collection after 3 h? How many bacteria are in the colony after 3 h?
- After 7 h, what number of marbles would show in graph 1? Name the coordinates for this point. What number of bacteria would be shown in graph 2? Name the coordinates.
- Copy the two graphs on graph paper. Extend each graph to 10 h. Plot the growth according to the pattern or formula given.

CHALLENGE Suppose each bacterium lives for 10 h. How many bacteria will be in the colony after 20 h?

8.2

KEY CONCEPT

Bacteria are single-celled organisms without nuclei.

Sunshine State STANDARDS

SC.F.1.3.2: The student knows that the structural basis of most organisms is the cell and most organisms are single cells, while some, including humans, are multicellular.

SC.G.1.3.3: The student understands that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.

FCAT VOCABULARY

producer p. 265

decomposer p. 265

VOCABULARY

bacteria p. 262

archaea p. 264

parasite p. 265

BEFORE, you learned

- Organisms come in all shapes and sizes
- All living things share common characteristics
- Living things may be divided into six kingdoms

NOW, you will learn

- About the simplest living things
- About bacteria and archaea
- That bacteria may help or harm other organisms

THINK ABOUT

Where are bacteria?

Bacteria are the simplest form of life. But that doesn't mean they're not important or numerous. As you look about the room you're sitting in, try to think of places where you might find bacteria. In fact, bacteria are on the walls, in the air, on the floor, and on your skin. It's hard to think of a place where you wouldn't find bacteria. The photograph shows a magnification of bacteria living on a sponge. The bacteria are magnified $580\times$. There are hundreds of millions of bacteria on your skin right now. There are trillions of bacteria that live inside your intestines and help you digest food.



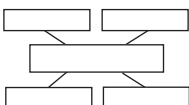
Bacteria and archaea are the smallest living things.

The names of the organisms belonging in the kingdoms Archaea and Bacteria are probably unfamiliar. Yet you actually encounter these organisms every day. Bacteria are everywhere: on your skin, in the ground, in puddles and ponds, in the soil, and in the sea. About 300 species of bacteria are living in your mouth right now.

Bacteria are the simplest kind of life known on Earth. All bacteria are composed of just one cell without a nucleus. Their genetic material is contained in loops within the cell. A bacterium reproduces using binary fission.

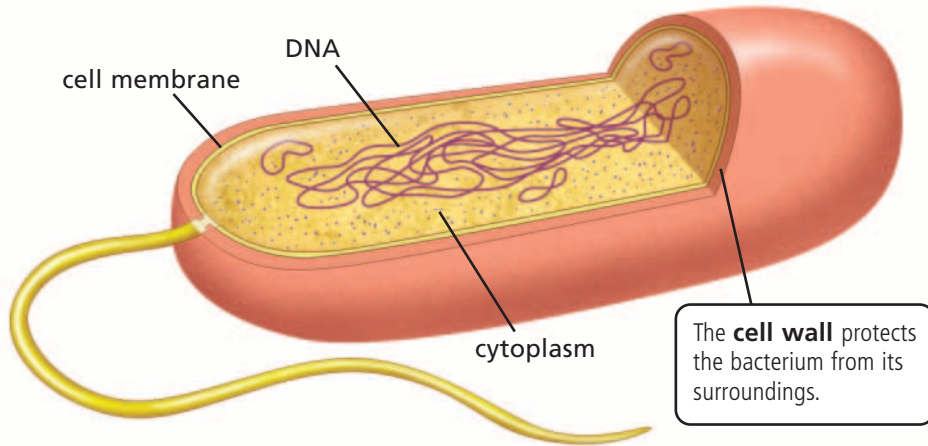
MAIN IDEA WEB

Make a web of the important terms and details about the main idea: *Bacteria and archaea are the smallest living things.* Be sure to include how bacteria are classified.



Bacteria

All bacteria are single cells without nuclei.



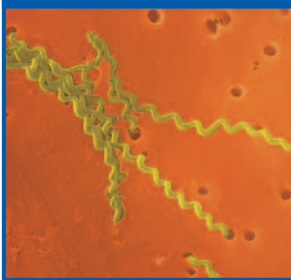
Bacterial cells are different from the cells of other organisms. A bacterial cell is about 1/10 to 1/20 the size of a typical cell from organisms such as animals, plants, fungi, or protists. These four groups include organisms made up of cells with true nuclei. The nucleus is a structure that is enclosed by a membrane and that holds the genetic material.

Despite their small size, bacteria are simple only when compared with more complex cells. Bacteria are much more complex than viruses, because they have many internal structures that viruses do not have. For example, one important feature of most bacteria is a covering called a cell wall, which surrounds and protects the soft cell membrane like a rain jacket. Bacterial cells contain many large molecules and structures that are not found in viruses.

READING TIP

The plural of *bacterium* is *bacteria*, and the plural of *nucleus* is *nuclei*.

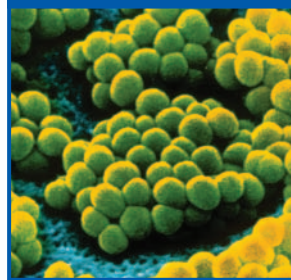
Spiral Bacteria



Rod Bacteria



Round Bacteria



Scientists often classify bacteria by their external shapes.

- Spiral-shaped bacteria occur in single strands.
- Rod-shaped bacteria may occur singly or in chains.
- Round-shaped bacteria may occur singly or in pairs, chains, or clusters.

CHECK YOUR READING

Name two features that all bacteria share.

Archaea and bacteria are found in many environments.



Find out more about the many different types of bacteria.

Two types of single-celled organisms do not have nuclei. Bacteria are the most common and can be found in nearly every environment. Archaea are similar in size to bacteria, but share more characteristics with the cells of complex organisms like plants and animals.

Archaea

Archaea (AHR-kee-uh) are single-celled organisms that can survive in the largest range of environments. These environments may be very hot, very cold, or contain so much of a substance such as salt that most living things would be poisoned. As a result, scientists often group archaea according to where they live.

Methanogens take their name from methane, the natural gas they produce. These archaea die if they are exposed to oxygen. They may live in the dense mud of swamps and marshes, and in the guts of animals such as cows and termites.

Halophiles live in very salty lakes and ponds. Some halophiles die if their water is not salty enough. When a salty pond dries up, so do the halophiles. They can survive drying and begin dividing again when water returns to the pond.

Thermophiles are archaea that thrive in extreme heat or cold. They may live in hot environments such as hot springs, near hot vents deep under the sea, or buried many meters deep in the ice.

READING TIP

The word halophile is formed using the root word *halo-* which means "salt," and the suffix *-phile* which means "love." Therefore, a *halophile* is a "salt lover."

Archaea

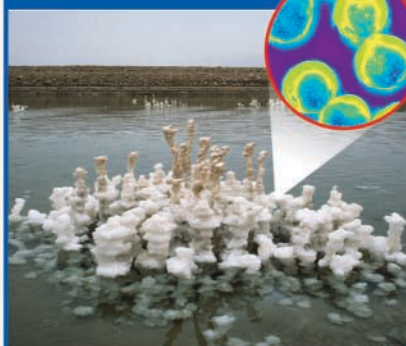
Archaea are organisms that can live in extreme environments.

Methanogens



Methanogens may be found in a cow's stomach where they help with digestion.

Halophiles



Halophiles can be found in extremely salty bodies of water such as the Dead Sea.

Thermophiles



Thermophiles may be found in hot geysers such as this one in Yellowstone National Park.

Bacteria

Most single-celled organisms without a nucleus are classified as bacteria. Bacteria are found in almost every environment and perform a variety of tasks. Some bacteria contain chlorophyll. Using sunlight for energy, these bacteria are an important food source in oceans. These bacteria also release oxygen gas, which animals need to breathe.

CHECK YOUR READING

What are some common traits of bacteria and archaea?

Bacteria without chlorophyll perform different tasks. Some bacteria break down parts of dead plants and animals to help recycle matter. Some bacteria release chemicals into the environment, providing a food source for other organisms. Scientists often group bacteria by the roles they play in the environment. Three of the most common roles are listed below.

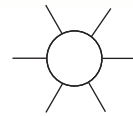
Bacteria that transform energy from sunlight into energy that can be used by cells are called **producers**. These bacteria are a food source for organisms that cannot make their own food.

Decomposers get energy by breaking down materials in dead or decaying organisms. Decomposers help other organisms reuse materials found in decaying matter.

Some bacteria live in a very close relationship either inside or on the surface of other organisms. Some of these bacteria may have no effect on their host organisms or host cells. Some bacteria help their hosts. Other bacteria are **parasites**, organisms that harm their hosts.

VOCABULARY

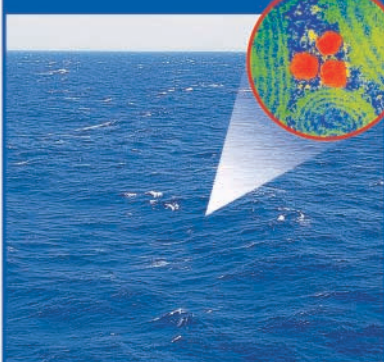
Be sure to add description wheels for *producer*, *decomposer*, and *parasite* to your notebook.



Bacteria

Three roles bacteria play in the environment are shown below.

Producers



Cyanobacteria in Earth's oceans provide oxygen for animals to breathe.

Decomposers



Some bacteria break down dead wood into materials used by other organisms.

Parasites



Staphylococcus bacteria cause infections such as these boils in humans.

Bacteria may help or harm other organisms.

Some bacteria, such as producers and decomposers, are helpful to other organisms. But other bacteria can be harmful. These bacteria can cause diseases in animals and plants.

Helpful Bacteria

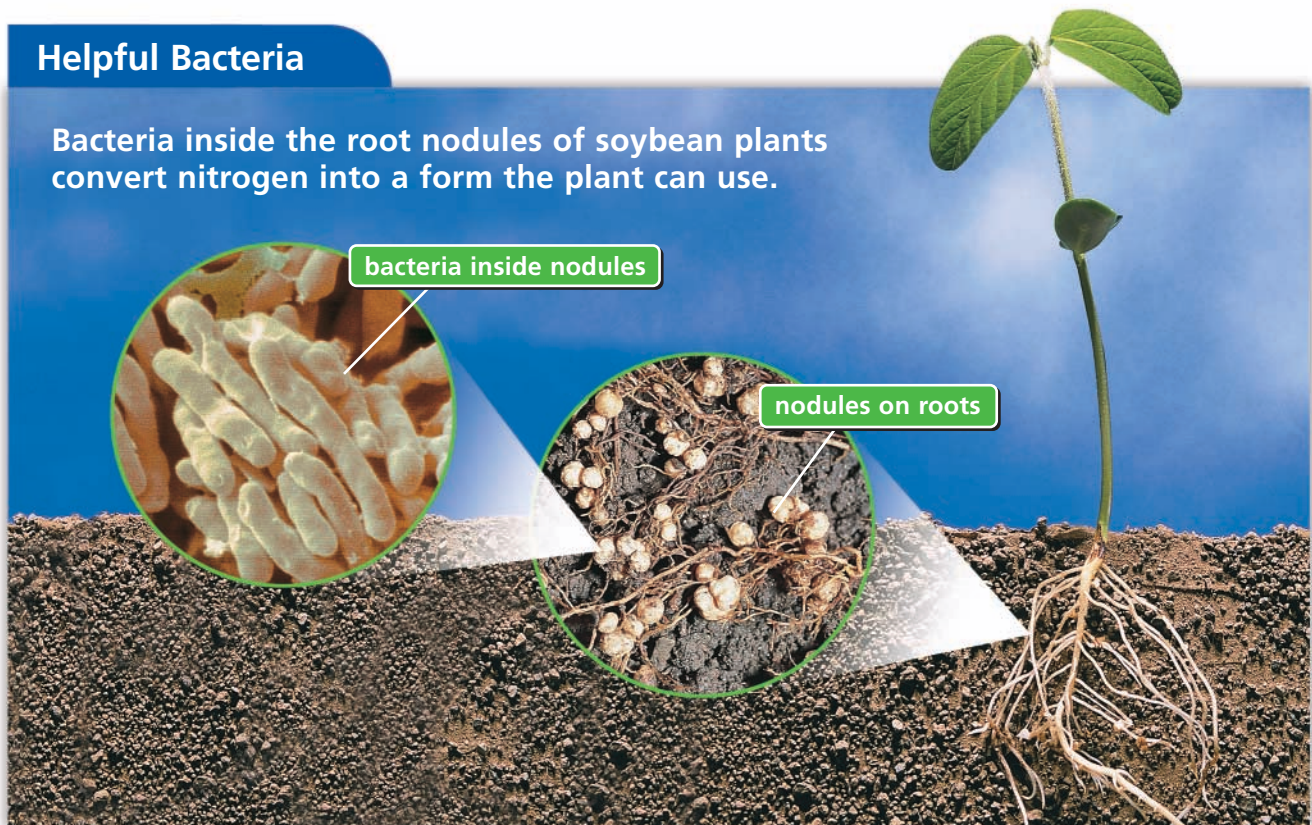
One shovelful of ordinary soil contains trillions of bacteria, and every fallen leaf or dead animal is covered with bacteria. These bacteria break down the matter in dead bodies and waste materials. These broken-down materials are then available for other organisms to build their bodies.

Cities use bacteria to break down sewage. Bacteria in sewage-treatment plants live on the material dissolved in liquid sewage. These bacteria help make the water clean enough to be released into rivers or oceans. Other bacteria are used to clean up oil spills by decomposing oil suspended on the ocean's surface.

Bacteria can also change materials that do not come from living things and make them available for other organisms. For example, some bacteria can convert nitrogen gas to nitrogen compounds. This process, called nitrogen fixation, makes nitrogen available to plants in a form that is useful to them. Plants use this nitrogen in making proteins, which are an important part of every cell.

Helpful Bacteria

Bacteria inside the root nodules of soybean plants convert nitrogen into a form the plant can use.



Like bacteria, certain types of archaea are helpful to other organisms. Animals that eat plants such as grass often depend on archaea. Methanogens help break down the cellulose in cell walls. Termites and cows are two examples of animals that can digest cellulose because of the archaea in their stomachs.

CHECK YOUR READING

Name two helpful roles that bacteria can play in the environment.

Harmful Bacteria

Not all bacteria are helpful to other organisms. Scientists first discovered that bacteria cause some diseases in the late 1800s. Much of the scientific research into harmful bacteria developed because bacteria cause disease in humans. Tuberculosis, cholera, and infant diarrhea are examples of disease caused by bacteria. Bacteria also may cause disease in many other animals and in plants.

Bacteria can cause the symptoms of disease in three ways.

- They can invade parts of the body, multiplying in body tissues and dissolving cells.
- They can poison the body with chemicals they produce and release.
- They can poison the body with chemicals that are part of the bacteria themselves.

One way to fight bacterial disease is with vaccinations. Vaccines help individual organisms prepare to fight diseases they might encounter in the future. Humans, as well as cats and dogs, get vaccinations for bacterial diseases.



Bacterial wilt caused disease in this pumpkin.

8.2 Review

KEY CONCEPTS

1. Explain why bacteria are classified as living cells but viruses are not.
2. Name two main groups of bacteria.
3. Describe three ways that bacteria affect other organisms.

CRITICAL THINKING

4. **Visualize** Draw a diagram of a bacterium. Label the parts of the cell.
5. **Predict** Where in your neighborhood would you find most of the bacteria that cause decomposition?

CHALLENGE

6. **Analyze** Parasitic bacteria do not usually kill their hosts, at least not quickly. For a parasite, why is it better not to kill the host?

CHAPTER INVESTIGATION



Bacteria

OVERVIEW AND PURPOSE People routinely wash themselves to keep clean. You probably take a bath or shower every day, and you also wash your hands. Your hands may appear to be perfectly clean, but appearances can be deceiving. Your hands pick up bacteria from the objects you touch. You cannot see or feel these microscopic organisms, but they are there, on your skin. In this activity you will

- sample bacteria in your environment
- sample bacteria on your hands

▶ Problem

Write It Up

Do you pick up bacteria from your environment?

▶ Hypothesize

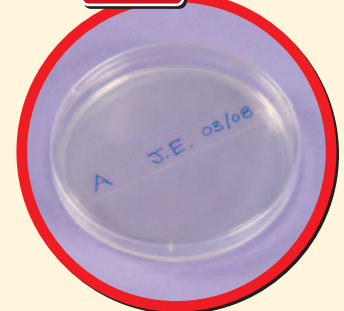
Write It Up

Write a hypothesis about whether bacteria in your environment are transferred to your skin. Your hypothesis should take the form of an “If . . . , then . . . , because . . .” statement.

▶ Procedure

- 1 Make a data table in your **Science Notebook** like the one shown on page 269.
- 2 Obtain three agar petri dishes. Be careful not to accidentally open the dishes.
- 3 Remove the lid from one dish and gently press two fingers onto the surface of the agar. Close the lid immediately. Tape the dish closed. Mark the tape with the letter A. Include your initials and the date. Mark your hand as the source in Table 1. Wash your hands.

step 3



MATERIALS

- 3 covered petri dishes with sterile nutrient agar
- marker
- tape
- everyday object, like a coin or eraser
- sterile cotton swab
- hand lens

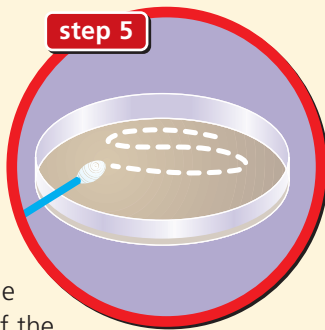
for Challenge:

- 1 covered petri dish with sterile nutrient agar
- sterile swab



4 Choose a small object you handle every day, such as a coin or an eraser. Remove the lid from the second petri dish and swipe the object across the agar. You can instead use a sterile swab to rub on the object, and then swipe the swab across the agar. Close the lid immediately. Tape and mark the dish B, as in step 3. Include the source in Table 1.

5 Choose an area of the classroom you have regular contact with, for example, the top of your desk or the classroom door. Use a clean swab to rub the area and then swipe the swab across the agar of the third petri dish. Tape and mark the dish as C, following the instructions in step 3. Dispose of the swab according to your teacher's instructions.



6 Place the agar plates upside down in a dark, warm place for two to three days. **CAUTION: Do not open the dishes. Wash your hands when you have finished.**

Observe and Analyze



- 1. OBSERVE** Observe the dishes with the hand lens. You may want to pull the tape aside, but do not remove the covers. Include a description of the bacteria in Table 1. Are the bacteria in one dish different from the others?
- 2. OBSERVE** Observe the amounts of bacterial growth in each dish and record your observations in Table 1. Describe the amount of growth in relative terms, using words such as *most*, *least*, or *moderate*. Which dish has the most bacterial growth? the least growth?
- 3.** Return the petri dishes to your teacher for disposal. **CAUTION: Do not open the dishes. Wash your hands thoroughly with warm water and soap when you have finished.**

Conclude



- 1. INFER** Why is it necessary for the agar to be sterile before you begin the experiment?
- 2. INFER** What function does the agar serve?
- 3. INTERPRET** Compare your results with your hypothesis. Do your observations support your hypothesis?
- 4. IDENTIFY LIMITS** What limits are there in making a connection between the bacteria in dish A and those in dishes B and C?
- 5. EVALUATE** Why is it important to keep the petri dishes covered?
- 6. APPLY** Why is it important to use separate petri dishes for each sample?

Investigate Further

CHALLENGE Contamination can be a problem in any experiment involving bacteria, because bacteria are everywhere. Obtain a petri dish from your teacher. Swipe a sterile swab on the agar and place the agar plate upside down in a dark, warm place for two to three days. Do the results of this test make you reevaluate your other lab results?

Bacteria

Table 1. Observations of Bacteria

Petri Dish	Source	Description of Bacteria	Amount of Bacteria
A	hand		
B			
C			

8.3

KEY CONCEPT

Viruses are not alive but affect living things.

Sunshine State STANDARDS

SC.H.1.3.2: The student knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.

SC.H.1.3.6: The student recognizes the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations.

VOCABULARY

host cell p. 272

BEFORE, you learned

- Most organisms are made of a single cell
- Living things share common characteristics
- Viruses are not living things

NOW, you will learn

- About the structure of viruses
- How viruses use a cell's machinery to reproduce
- How viruses affect host cells

EXPLORE Viruses

How were viruses discovered?

PROCEDURE

- 1 Fill a small container with mixed sesame seeds and salt.
- 2 Holding the sieve over the paper plate, pour the mixture into the sieve.
- 3 Gently shake the sieve until nothing more falls through.
- 4 Using a hand lens, examine the material that fell through the sieve and the material that stayed in the sieve.

MATERIALS

- small container
- sesame seeds
- table salt
- small kitchen sieve
- paper plate
- hand lens

WHAT DO YOU THINK?

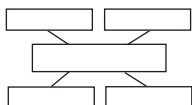
- What is the most important difference between the particles that got through the sieve and the particles that remained behind?
- How could you change your sieve to make it not let through both kinds of particles?



Viruses share some characteristics with living things.

MAIN IDEA WEB

Remember to make a web of the important terms and details about the main idea: *Viruses share some characteristics with living things.*



In the late 1800s, scientists such as Louis Pasteur showed that some small organisms can spoil food and cause disease. Once the cause was found, scientists looked for ways to prevent spoilage and disease. One method of prevention they found was removing these harmful organisms from liquids.

Bacteria may be removed from liquids by pouring the liquid through a filter, like a coffee filter or a sieve. To remove bacteria, a filter must have holes smaller than one millionth of a meter in diameter.

INVESTIGATE Viruses

How do infections spread?

PROCEDURE

- 1 Get a cup of sample liquid from your teacher. Pour half the liquid from your cup into the cup of a classmate, then pour the same amount back into the original cup. Your cup should then contain a mixture of the liquids from both cups.
- 2 Repeat step 1 with at least two other classmates.
- 3 Drop one drop of solution A into your paper cup. If it changes color, you are “infected.” If you were “infected,” add drops of solution B until your liquid turns clear again. Count how many drops it takes to “cure” you.

WHAT DO YOU THINK?

- If you were “infected,” can you figure out who “infected” you?
- If you were not “infected,” is it possible for anyone who poured liquid into your cup to be “infected”?

CHALLENGE Only one person in your class started out with an “infection.” Try to figure out who it was.

SKILL FOCUS
Analyzing

MATERIALS

- paper cup
- sample liquid
- solution A
- solution B

TIME
30 minutes



When a filter had removed all of the harmful organisms from a liquid, the liquid no longer caused any illnesses. This method worked when there was only bacteria in the liquid. Sometimes filtering did not prevent disease. Something much smaller than bacteria was in the liquid. Scientists called these disease-causing particles viruses, from the Latin word for “slimy liquid” or “poison.”



RESOURCE CENTER
CLASSZONE.COM

Learn more about viruses.

CHECK YOUR READING

How does the size of viruses compare with the size of bacteria?

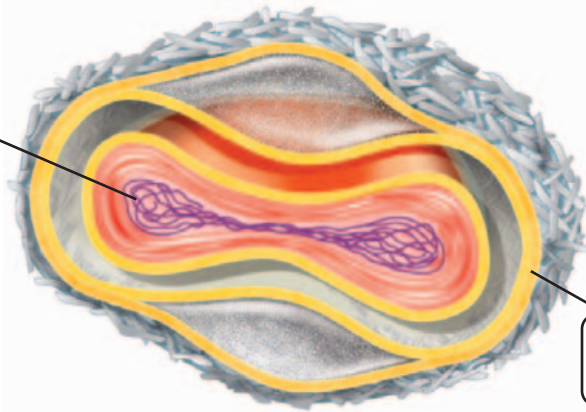
Scientists have learned much about viruses, and can even make images of them with specialized microscopes. Viruses consist of genetic material contained inside a protective protein coat called a capsid. The protein coat may be a simple tube, such as the coat of an ebola virus, or have many layers, such as the smallpox virus shown on page 272.

Viruses may come in many shapes and sizes, but all viruses consist of a capsid and genetic material. Viruses are able to use living cells to get their DNA copied and so can produce new viruses, a characteristic that makes them similar to living things. Also the protein coat is similar to a cell’s outer membrane. But viruses do not grow, and viruses do not respond to changes in their environment. Therefore, viruses are not living organisms.

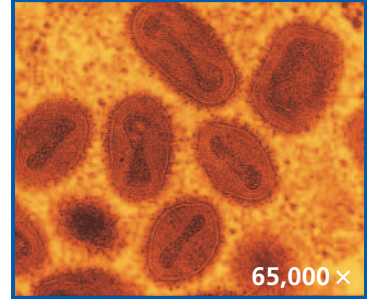
Virus

All viruses, including this smallpox virus, contain genetic material surrounded by a capsid.

The **genetic material** stores information the virus needs to make copies of itself.



Smallpox Virus



The **capsid** protects the genetic material and gives shape to the virus.

Viruses multiply inside living cells.



See how viruses infect and multiply within bacteria.

Remember that all living things reproduce. Viruses cannot reproduce by themselves, which is one of the ways they are different from living things. However, viruses can use materials within living cells to make copies of themselves. The cells that viruses infect in order to make copies are called **host cells**. Despite their tiny size, viruses have the ability to cause a lot of damage to cells of other organisms.

One of the best studied viruses infects bacteria. It's called a bacteriophage (bak-TEER-ee-uh-FAYJ), which comes from the Latin for "bacteria eater." Some of the steps that a bacteriophage goes through to multiply are shown in the illustration on page 273.

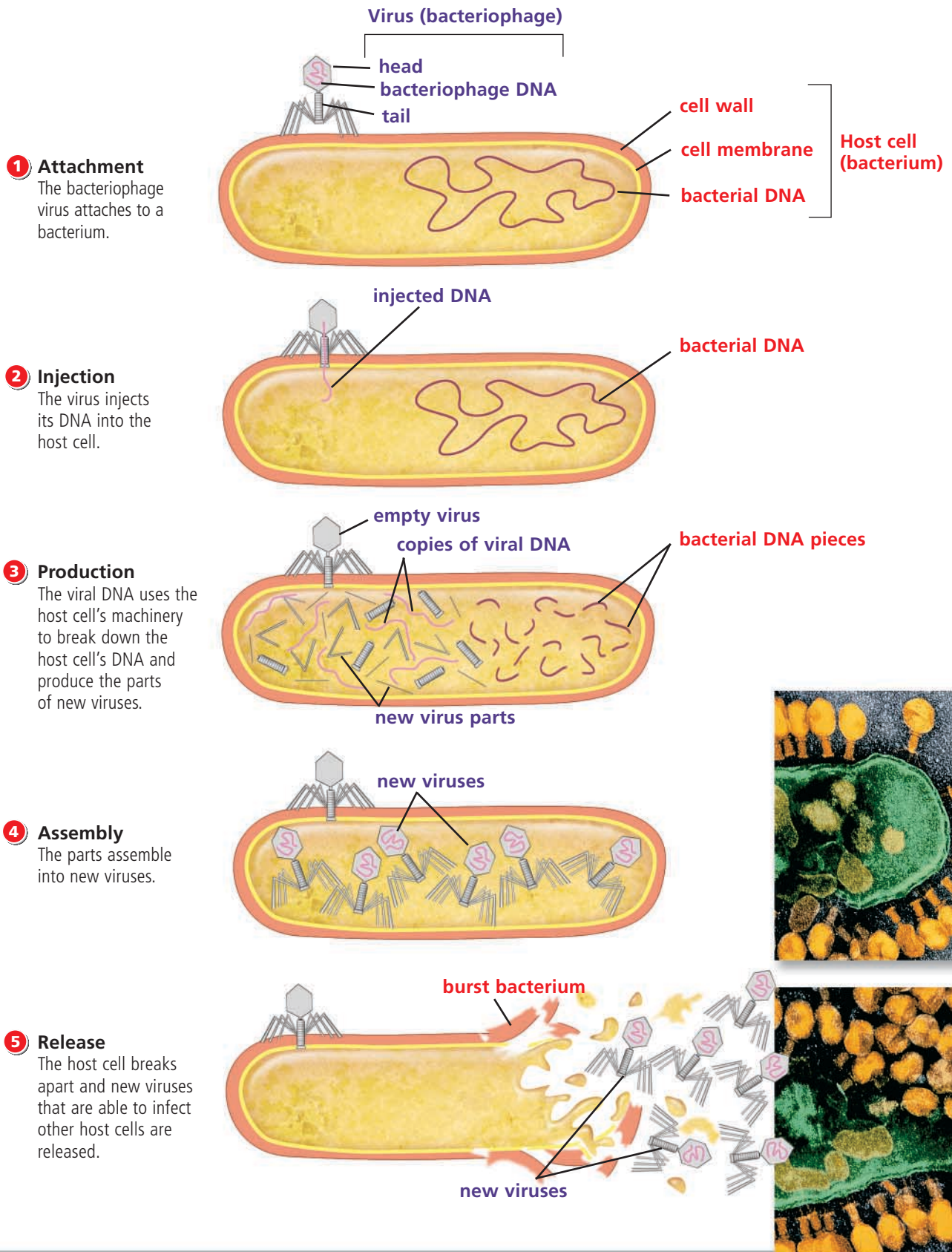
- 1 Attachment** The virus attaches to the surface of a bacterium.
- 2 Injection** The virus injects its DNA into the bacterium.
- 3 Production** Using the same machinery used by the host cell for copying its own DNA, the host cell makes copies of the viral DNA.
- 4 Assembly** New viruses assemble from the parts that have been created.
- 5 Release** The cell bursts open, releasing 100 or more new viruses.

Viruses have proteins on their surfaces that look like the proteins that the host cell normally needs. The virus attaches itself to special sites on the host that are usually reserved for these proteins.

Not every virus makes copies in exactly the same way as the bacteriophage. Some viruses stay inside their host cells. Others use the host cell as a factory that produces new viruses one at a time. These viruses may not be as harmful to the infected organism because the host cell is not destroyed.

Making New Viruses

Viruses, such as this bacteriophage, use cells to make new viruses.





Rows of hospital beds are filled with Massachusetts influenza patients in 1918.

Viruses may harm host cells.

A host cell does not often benefit from providing living space for a virus. The virus uses the cell's material, energy, and processes. In many cases, after a virus has made many copies of itself, the new viruses burst out of the host cell and destroy it.

Harmful viruses cause huge problems. Viruses that cause diseases such as polio, smallpox, diphtheria, or AIDS have had a major impact on human history. About 25 million people died of influenza in an outbreak that occurred just after World War I.

In the photograph, nurses work to ease the symptoms of infected patients. The most infectious patients were enclosed in tents. Others were made as comfortable as possible on beds outside. Since viruses such as influenza can spread quickly, the camp was isolated from the rest of the community.

Plant viruses can stunt plant growth and kill plants. When plant viruses invade crop plants, they can cause much economic damage, decreasing food production. Plants, animals, bacteria, and all other living things are capable of being infected by viruses.

Today, scientists are discovering ways to use viruses in a positive way. Scientists use viruses to insert certain pieces of genetic material into living cells. For example, the portion of genetic material that allows some marine organisms to produce a chemical that glows can be inserted into tissue samples to help scientists study the samples.

8.3 Review

KEY CONCEPTS

1. What are the two parts that every virus has?
2. Why are viruses not considered to be living things?
3. Explain how copies of viruses are produced.

CRITICAL THINKING

4. **Compare and Contrast** What features do viruses and cells have in common? How are they different?
5. **Explain** Summarize the steps by which a bacteriophage makes new viruses.

CHALLENGE

6. **Synthesize** What characteristics of viruses can make them so dangerous to humans and other living organisms?

TULIPOMANIA

The Virus and the Tulip

The people of Holland around the 1620s were trading fortunes and farmland for one beautiful flower. Tulips had arrived from Turkey by way of Vienna, and interest in the flower spread through Holland like a fever. In a frenzy called “tulipomania,” collectors paid as much as 5400 guilders, the price of a city house, for just one tulip bulb—but not any ordinary tulip.

Broken Flower Bulbs

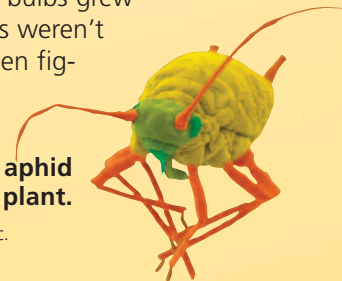
Tulip traders searched for tulips with patterns, stripes, or feathery petals. These plants were called broken bulbs. Within a field of colored tulips, suddenly an odd or patterned flower grew. Once a color break showed up, it stayed with that flower’s line into each new generation, until the line died off. And die off it did. The patterned petals were caused by a virus inside the plant, and the virus caused the flowers to weaken. The blooms got smaller in each generation.

The Mystery Source

While the trade in tulips rose, growers tried many tricks to produce the crazy patterns. Still, the broken bulbs grew rarely and randomly, or so it seemed. Viruses weren’t discovered until 300 years later. Scientists then figured out that a virus had caused the broken bulbs.

A small leaf-eating insect called an aphid had carried the virus from plant to plant.

© Dennis Kunkel/Dennis Kunkel Microscopy, Inc.



Back Down to the Ground

Like any goldrush, tulipomania crashed. People lost fortunes and fought over claims. In 1637, the government stopped all trading. Today, tulips with striped and feathery patterns grow around the world, but the patterns observed are not caused by viruses. Still, every now and then, a strange looking bulb appears. Instead of prizing it, growers remove it. They don’t want a field of virus-infested, weakened plants.

EXPLORE

- OBSERVE** Look at tulips in a garden catalog, and find breeds with patterns. Observe the tulip closely. Draw or paint the modern flower and label its name.
- CHALLENGE** Viruses can produce sickness, but they have other effects too. Do research on viruses to list some effects of viruses that have value to scientists, doctors, or other people.

Patterns in these tulips are part of the genetic make-up of the flowers.

KEY CONCEPT

8.4

Protists are a diverse group of organisms.

Sunshine State STANDARDS

SC.F.1.3.2: The student knows that the structural basis of most organisms is the cell and most organisms are single cells, while some, including humans, are multicellular.

SC.F.1.3.5: The student explains how the life functions of organisms are related to what occurs within the cell.

SC.G.1.3.3: The student understands that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.

VOCABULARY

algae p. 277

plankton p. 279

protozoa p. 280

BEFORE, you learned

- Organisms are grouped into six kingdoms
- Bacteria are single-celled organisms without a nucleus
- Viruses are not living things

NOW, you will learn

- About characteristics of protists
- About the cell structure of protists
- How protists get their energy

THINK ABOUT

Where can protists be found?

Protists include the most complex single-celled organisms found on Earth. Fifty million years ago, a spiral-shelled protist called a nummulitid was common in some oceans. Even though its shell was the size of a coin, the organism inside was microscopic and single celled. When the organism died, the shells accumulated on the ocean floor. Over millions of years, the shells were changed into the rock called limestone. This limestone was used to build the great pyramids of Egypt. Some of the most monumental structures on Earth would not exist without organisms made of just a single cell.



Most protists are single celled.

When Anton van Leeuwenhoek began using one of the world's first microscopes, he looked at pond water, among other things. He described, in his words, many "very little animalcules." Some of the organisms he saw probably were animals—microscopic but multicellular animals. However, many of the organisms Leeuwenhoek saw moving through the pond water had only a single cell. Today, more than 300 years later, scientists call these single-celled organisms protists.

Protists include all organisms with cells having nuclei and not belonging to the animal, plant, or fungi kingdoms. In other words, protists may be considered a collection of leftover organisms. As a result, protists are the most diverse of all the kingdoms.

INVESTIGATE Protists

What lives in pond water?

PROCEDURE

- 1 Using a dropper, place one small drop of pond water in the center of a slide. Try to include some of the material from the bottom of the container.
- 2 Gently place a cover slip on the drop of water.
- 3 Observe the slide with a hand lens first.
- 4 Starting with low power, observe the slide with a microscope. Be sure to follow microscope safety procedures as outlined by your teacher. Carefully focus up and down on the water. If you see moving organisms, try to follow them by gently moving the slide.

WHAT DO YOU THINK?

- Describe and draw what you could see with the hand lens.
- Describe and draw what you could see with the microscope.
- Compare your observations with those of other students.

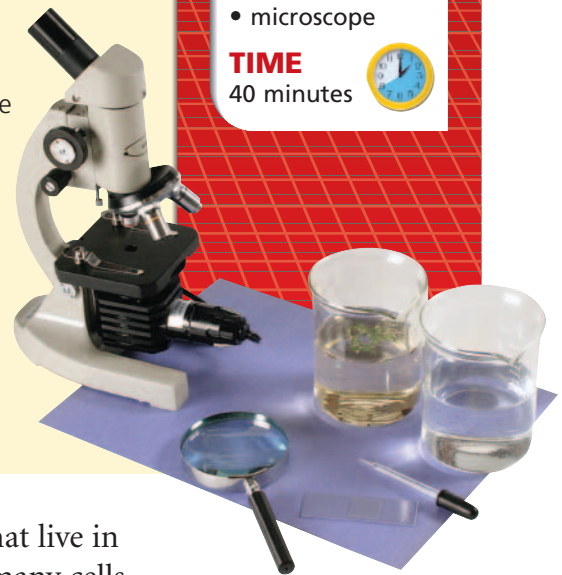
CHALLENGE Choose one organism that moves and observe it for some time. Describe its behavior.

SKILL FOCUS
Observing

MATERIALS

- dropper
- pond water
- slide
- cover slip
- hand lenses
- microscope

TIME
40 minutes



Most protists are single-celled, microscopic organisms that live in water. However, protists also include some organisms with many cells. These many-celled organisms have simpler structures than animals, plants, or fungi. They also have fewer types of cells in their bodies.

CHECK YOUR READING

Why are protists considered the most diverse group of organisms?

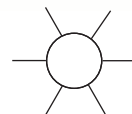
The group of protists you're probably most familiar with is seaweeds. At first glance, seaweed looks like a plant. On closer inspection scientists see that it has a simpler structure. Some seaweeds called kelp can grow 100 meters long.

The name **algae** applies to both multicellular protists and single-celled protists that use sunlight as an energy source. Both seaweed and diatoms are types of algae. Slime molds are another type of multicellular protist.

Given the many different types of organisms grouped together as protists, it is no surprise that protists play many roles in their environments. Algae are producers. They obtain energy from sunlight. Their cells provide food for many other organisms. These protists also produce oxygen, which is beneficial to many other organisms. Both of these roles are similar to those played by plants. Other protists act as parasites and can cause disease in many organisms, including humans.

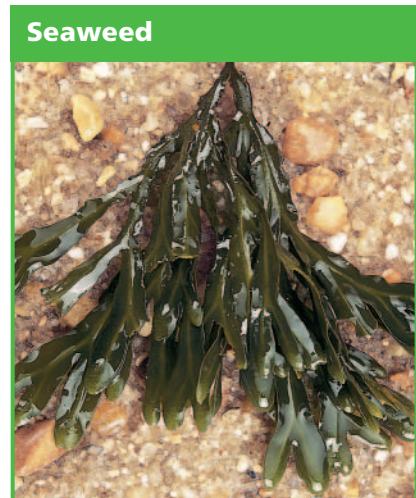
VOCABULARY

Be sure to make a description wheel for *algae* and add to it as you read this section.



Diversity of Protists

Protists come in a variety of shapes and sizes.

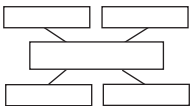


Protists live in any moist environment, including both freshwater and saltwater, and on the forest floor. Some protists move around in the water, some simply float in place, and some stick to surfaces. The photographs above show a small sample of the large variety of organisms that are called protists.

Seaweed is a multicellular protist that floats in the water and can be found washed up on beaches. Slime molds are organisms that attach to surfaces, absorbing nutrients from them. Diatoms are single-celled algae that float in water and are covered by hard shells. Euglena are single-celled organisms that can move like animals but also get energy from sunlight.

MAIN IDEA WEB

Remember to make a web of the important terms and details about the main idea: *Protists obtain their energy in three ways.* Include examples of each method of obtaining energy.



Protists obtain their energy in three ways.

Protists can be classified by their way of getting energy. Some protists capture sunlight and convert it to usable energy. Another group of protists gets its energy from eating other organisms. A third group gets energy by absorbing materials and nutrients from its environment.

Some protists, such as the euglena in the upper left photograph, can even switch from one mode of life to another. They swim rapidly through pond water like animals. If they receive enough sunlight, they look green and make their own food like plants. But if they are left in the dark long enough, they absorb nutrients from their environment like fungi.



Explain how the organisms in the photographs above get their energy.

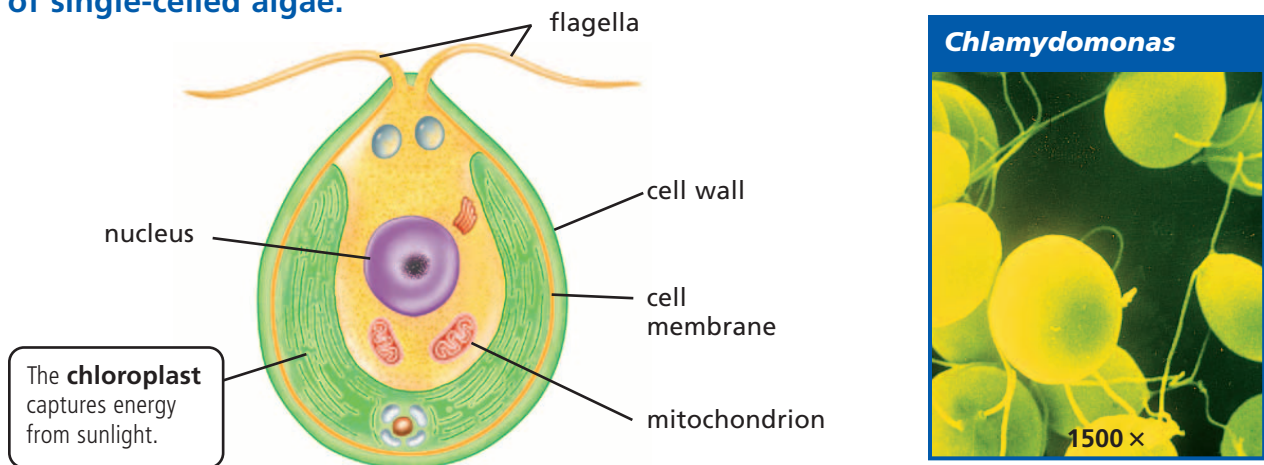
Algae

Plantlike protists, called algae, get energy from sunlight. Like plants, they use the Sun's energy, water, and carbon dioxide from the air or water. Algae contain chlorophyll, a green pigment that they use to capture the Sun's energy. In the process of transforming energy from sunlight, algae release oxygen gas into the air. This important process, which is called photosynthesis, also takes place in plants and some bacteria. Organisms that perform photosynthesis also supply much of the food for other organisms.

Diatoms are examples of single-celled algae. Like all algae, a diatom contains a nucleus which holds its genetic material. Diatoms also have chloroplasts, which are the energy-producing centers that contain chlorophyll.

Algae

Algae are plantlike protists. *Chlamydomonas* is an example of single-celled algae.

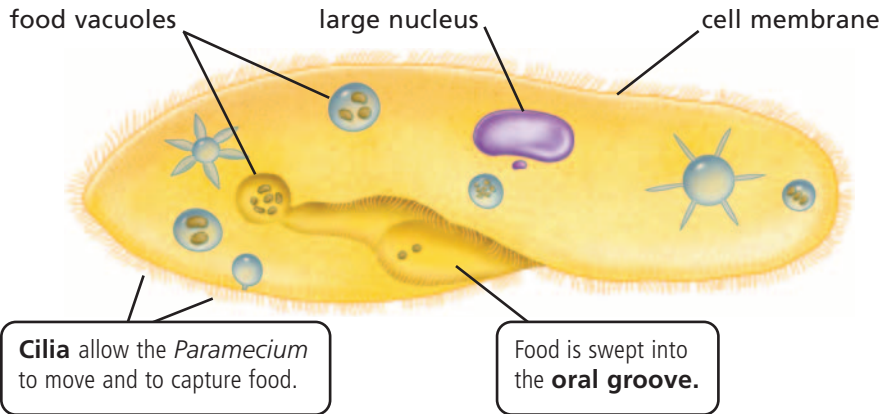


Another type of algae, called volvox, are microscopic colonies of nearly identical cells. These cells, arranged in a hollow ball, look like some single-celled algae. Sometimes cells break off from the hollow ball to form new colonies. The new colonies will eventually escape the parent colony. Colonial organisms such as volvox are the simplest kind of multicellular organisms. Seaweed is another example of multicellular algae.

All organisms that drift in water are called **plankton**. Plankton include the young of many animals and some adult animals, as well as protists. Plankton that perform photosynthesis are called phytoplankton (plantlike plankton). Phytoplankton include algae and the cyanobacteria you learned about earlier. Phytoplankton live in all of the world's oceans and produce most of the oxygen animals breathe.

Protozoa

Protozoa, such as this *Paramecium*, are animal-like protists.



Protozoa

Protists that eat other organisms, or decaying parts of other organisms, are animal-like protists, or **protozoa**. They include many forms, all single-celled. Protozoa cannot use sunlight as a source of energy and they must move around to obtain the energy they need to survive. Certain chemicals in protozoa can recognize when a particle of food is nearby. The food particle is usually another organism or a part of one. The protozoan ingests the food and breaks it down to obtain energy.

Some animal-like protists swim rapidly, sweeping bacteria or other protists into a groove that looks like a mouth. One example, called a paramecium, is shown above. A paramecium moves about using thousands of short wavy strands called cilia.

Another group of protozoa swim with one or more long whiplike structures called flagella. A third group of protozoa has very flexible cells. Organisms such as the amoeba ooze along surfaces. When it encounters prey, the amoeba spreads out and wraps around its food.

A number of protists live as parasites, some of which cause disease in animals, including humans. One of the world's most significant human diseases, malaria, is caused by a protist. A mosquito carries the parasite from human to human. When the mosquito bites an infected human, it sucks up some of the parasite in the blood. When that same mosquito bites another human, it passes on some of the parasite. Within a human host, the parasite goes through a complex life cycle, eventually destroying red blood cells.

REMINDER

A parasite is an organism that lives inside or on another organism and causes the organism harm.

CHECK YOUR READING

How do protozoa and algae differ in the way they obtain energy?

Decomposers

Protists that absorb food from their environment can be called funguslike protists. These protists take in materials from the soil or from other organisms and break materials down in order to obtain energy. They are called decomposers.

The term *mold* refers to many organisms that produce a fuzzy-looking growth. Most of the molds you might be familiar with, like bread mold, are fungi. But three groups of protists are also called molds. These molds have structures that are too simple to be called fungi, and they are single celled for a portion of their lives. One example of a funguslike protist is water mold, which forms a fuzzy growth on food. This food may be decaying animal or plant tissue or living organisms. Water molds live mainly in fresh water.

Slime molds live on decaying plants on the forest floor. One kind of slime mold consists of microscopic single cells that ooze around, eating bacteria. When their food is scarce, however, many of the cells group together to produce a multicellular colony. The colony eventually produces a reproductive structure to release spores. Wind can carry spores about, and they sprout where they land.

A walk in a moist forest might give you a chance to see a third kind of mold. This organism looks like a fine net, like lace, several centimeters across, on rotting logs. These slime molds are not multicellular, but instead one giant cell with many nuclei. They are the plasmodial slime molds.



Plasmodial slime mold may grow on decaying wood after a period of rainy weather.

CHECK YOUR READING

How do funguslike protists get energy?

8.4 Review

KEY CONCEPTS

1. What are two characteristics of protists?
2. What feature do all protists have in common?
3. What are the three different types of protists?

CRITICAL THINKING

4. **Provide Examples** Some protists are dependent on other organisms and cannot live independently. Other protists are independent and have organisms that depend on them. Give an example of each.

CHALLENGE

5. **Hypothesize** Scientists are considering reclassifying protists into many kingdoms. How might they decide how many kingdoms to use and how to place organisms within these kingdoms?

8

Chapter Review

the **BIG** idea

Bacteria and protists have the characteristics of living things, while viruses are not alive.



FLORIDA REVIEW
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Content Review and
FCAT Practice

KEY CONCEPTS SUMMARY

1 Single-celled organisms have all the characteristics of living things.

Scientists divide organisms into six **kingdoms**. All living things, including **microorganisms**, are organized, grow, reproduce, and respond to the environment.



Plants



Animals



Protists



Fungi



Archaea



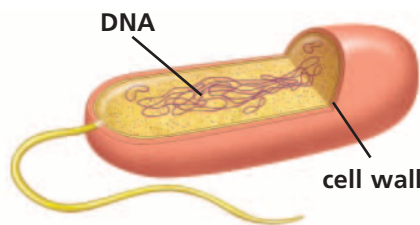
Bacteria

VOCABULARY

microorganism p. 256
kingdom p. 257
binary fission p. 258
virus p. 260

2 Bacteria are single-celled organisms without nuclei.

- Bacteria and archaea are the smallest living things.
- Archaea and bacteria are found in many environments.
- Bacteria may help or harm other organisms.

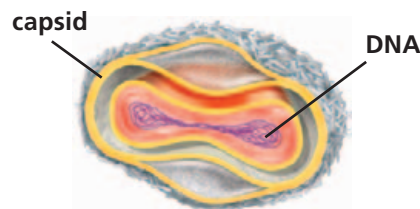


VOCABULARY

bacteria p. 262
archaea p. 264
producer p. 265
decomposer p. 265
parasite p. 265

3 Viruses are not alive but affect living things.

A virus consists of genetic material enclosed in a protein coat. Viruses cannot reproduce on their own, but they use materials within living cells to make copies of themselves.



VOCABULARY

host cell p. 272

4 Protists are a diverse group of organisms.



Plantlike **algae** get energy from sunlight.



Funguslike protists are decomposers.



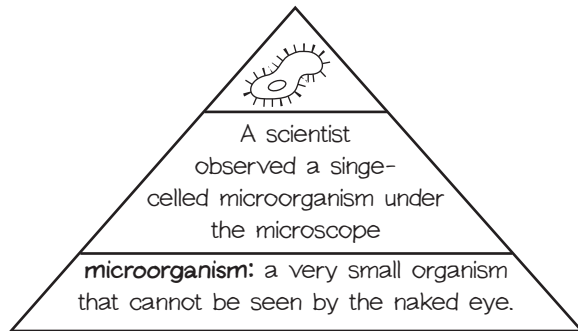
Protozoa, or animal-like protists, eat other organisms.

VOCABULARY

algae p. 277
plankton p. 279
protozoa p. 280

Reviewing Vocabulary

Draw a triangle for each of the terms listed below. Define the term, use it in a sentence, and draw a picture to help you remember the term. An example is completed for you.



1. binary fission
2. producer
3. virus
4. host cell

Describe how the vocabulary terms in the following pairs of words are related to each other. Explain the relationship in a one- or two-sentence answer. Underline each vocabulary term in your answers.

5. archaea, bacteria
6. microorganism, organism
7. decomposers, parasite
8. protists, algae

Reviewing Key Concepts

Multiple Choice Choose the letter of the best answer.

9. Which group is *not* a microscopic kingdom?
 - a. fungi
 - b. bacteria
 - c. archaea
 - d. protists

10. What happens in binary fission?
 - a. DNA is combined into one cell.
 - b. The daughter cells differ from the parent cell.
 - c. Material from one cell is divided into two cells.
 - d. One cell divides into four exact cells.
11. Which is a characteristic of a virus?
 - a. obtains energy from sunlight
 - b. responds to light and temperature
 - c. doesn't contain DNA
 - d. reproduces only within cells
12. Which is the simplest type of organism on Earth?
 - a. protists
 - b. bacteria
 - c. viruses
 - d. parasites
13. Which statement about bacteria is *not* true?
 - a. Bacteria reproduce using binary fission.
 - b. Bacteria do not have a nucleus.
 - c. Bacteria do not contain genetic material.
 - d. Bacteria are either rod-, round-, or spiral-shaped.
14. Archaea that can survive only in extreme temperatures are the
 - a. methanogens
 - b. halophiles
 - c. thermophiles
 - d. bacteria
15. A fluid containing weakened disease-causing viruses or bacteria is
 - a. a filter
 - b. a diatom
 - c. a bacteriophage
 - d. a vaccine
16. Which group of protists are decomposers?
 - a. diatoms
 - b. molds
 - c. protozoa
 - d. plankton

17. Which obtains energy by feeding on other organisms?

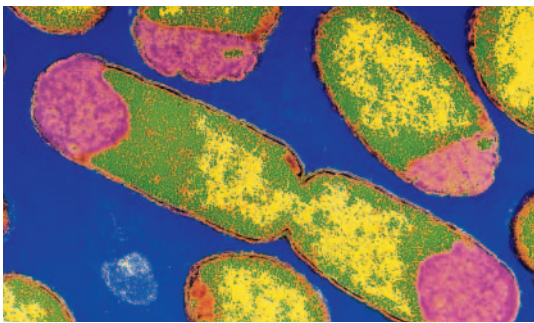
- a. amoeba
- b. algae
- c. phytoplankton
- d. mushroom

Short Response Write a short response to each question.

- 18. Briefly describe the characteristics that all living things share.
- 19. How are some bacteria harmful to humans?
- 20. What are plankton?

Thinking Critically

- 21. **APPLY** Imagine you are a scientist on location in a rain forest in Brazil. You discover what you think might be a living organism. How would you be able to tell if the discovery is a living thing?
- 22. **COMMUNICATE** What process is shown in this photograph? Describe the sequence of events in the process shown.



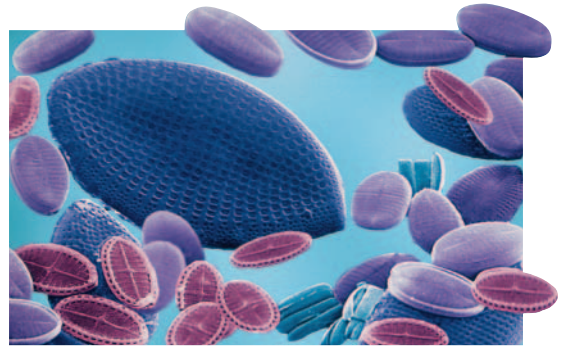
- 23. **CLASSIFY** Why are archaea classified in a separate kingdom from bacteria?
- 24. **ANALYZE** Why are some bacteria considered “nature’s recyclers”? Explain the role that these bacteria play in the environment.
- 25. **CALCULATE** A bacterium reproduces every hour. Assuming the bacteria continue to reproduce at that rate, how many bacteria will there be after 10 hours? Explain how you know.

26. **HYPOTHESIZE** A student conducts an experiment to determine the effectiveness of washing hands on bacteria. He rubs an unwashed finger across an agar plate, then washes his hands and rubs the same finger across a second plate. What hypothesis might the student make for this experiment? Explain.

- 27. **COMPARE AND CONTRAST** Describe three ways that viruses differ from bacteria.
- 28. **ANALYZE** A scientist has grown cultures of bacteria on agar plates for study. Now the scientist wants to grow a culture of viruses in a laboratory for study. How might this be possible? Give an example.
- 29. **PROVIDE EXAMPLES** How are protists both helpful and harmful to humans? Give examples in your answer.

the BIG idea

30. **INFER** Look again at the picture on pages 252–253. Now that you have finished the chapter, how would you change or add details to your answer to the question on the photograph?

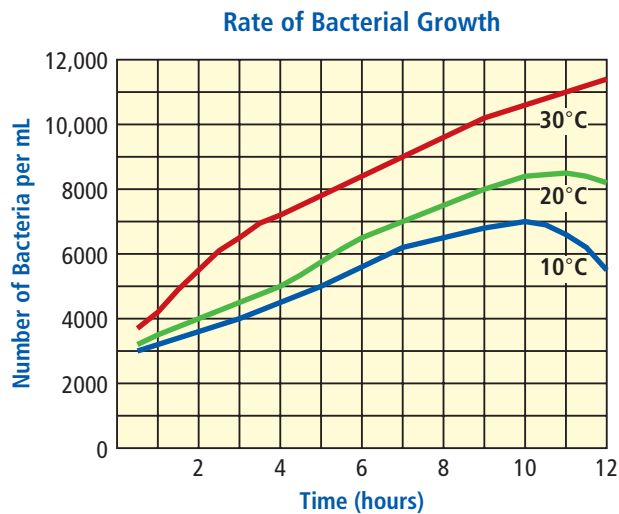


UNIT PROJECTS

Evaluate all the data, results, and information from your project folder. Prepare to present your project. Be ready to answer questions posed by your classmates about your results.

Analyzing Data

The graph below shows growth rates of bacteria at different temperatures.



Study the graph. Then answer the following questions.

GRIDDED RESPONSE

- At which temperature did growth of bacteria occur at the greatest rate?
- How much, per milliliter, did the rate of bacterial growth increase between 2 hours and 8 hours at 30°C?

MULTIPLE CHOICE

- Which statement is true about the growth rate of bacteria at 10°C?
 - Bacteria grew rapidly at first, then declined after 6 hours.
 - Bacteria growth increased at a steady rate.
 - Bacteria grew slowly, then declined rapidly after 10 hours.
 - Bacteria showed neither an increase nor decrease in growth rate.
- What is the concentration of bacteria at a temperature of 20°C after 4 hours?
 - about 5000 per mL
 - about 6000 per mL
 - about 7000 per mL
 - about 8000 per mL

FCAT Tip

When answering multiple-choice questions, read the question and each possible answer carefully before making your choice.

- During which hour was the concentration of bacteria at 20°C the greatest?
 - hour 2
 - hour 4
 - hour 8
 - hour 10
- What conclusion can be drawn from the data in the graph?
 - The rate of bacterial growth is the greatest at the highest temperature.
 - The rate of bacterial growth is the least at the highest temperature.
 - The rate of bacterial growth is the greatest at the lowest temperature.
 - The rate of bacterial growth does not change depending on the temperature.

EXTENDED RESPONSE

- A scientist wants to test the effect of temperature on the same bacteria shown in the graph at higher temperatures. The scientist tests the growth rate of bacteria at 50°C, 75°C, and 100°C. Based on the information in the graph and your knowledge of bacteria, what results might the scientist get? Explain your reasoning.
- Antibiotics are drugs that are used to inhibit the growth of bacterial infections. A scientist wants to test the ability of three different antibiotics to control the growth of a certain type of bacteria. The scientist has isolated the bacteria in test tubes. Each antibiotic is prepared in a tablet form. Design an experiment that will test the effectiveness of the antibiotic tablets on the bacteria. Your experiment should include a hypothesis, a list of materials, a procedure, and a method of recording data.

