If you look closely, you can see that these frogs and crocodiles are made up of small, plastic building blocks. Similarly, living organisms also are made of small building blocks. The building block of all living things is the cell.

**Science Journal** List features common to small, plastic building blocks. Predict whether plastic building blocks or cells have the greater number of features in common.
**Start-Up Activities**

**Launch Lab**

**Observe Onion Cells**
An active, organized world is inside you and in all other living things. Yet it is a world that you usually can’t see with just your eyes. Make the magnifier in the lab below to help you see how living things are organized.

1. Complete a safety worksheet.
2. Cut a 2-cm hole in the middle of an index card. Tape a piece of plastic wrap over the hole.
3. Turn down about 1 cm of the two shorter sides of the card, then stand it up.
4. Place a piece of onion skin on a microscope slide, then put it directly under the hole in the card.
5. Put a drop of water on the plastic wrap. Look through the water drop and observe the piece of onion. Draw what you see.
6. **Think Critically** In your Science Journal, describe how the onion skin looked when viewed with your magnifier.

**Foldables Study Organizer**

**Compare Cells** Make the following Foldable to help you see how plant and animal cells are similar and different.

**STEP 1** Fold a vertical sheet of paper in half from top to bottom.

**STEP 2** Fold in half from side to side with the fold at the top.

**STEP 3** Unfold the paper once. Cut only the fold of the top flap to make two tabs. **Turn** the paper vertically and **draw** on the front tabs as shown.

**Read and Write** Before you read the chapter, write what you know about each of these cells. As you read the chapter, add to or correct what you have written under the tabs. Compare and contrast the two types of cells.

**ScienceOnline**

Preview this chapter’s content and activities at fl6.msscience.com
Importance of Cells

A cell is the smallest unit of life in all living things. Cells are important because they are organized structures that help living things carry on the activities of life, such as the breakdown of food, movement, growth, and reproduction. Different cells have different jobs in living things. Some plant cells help move water and other substances throughout the plant. White blood cells, found in humans and many other animals, help fight diseases. Plant cells, white blood cells, and all other cells are alike in many ways.

Cell Theory

Because most cells are small, they were not observed until microscopes were invented. In 1665, scientist Robert Hooke, using a microscope that he made, observed tiny, boxlike things in a thin slice of cork, as shown in Figure 1. He called them cells because they reminded him of the small, box-like rooms called cells, where monks lived.

Throughout the seventeenth and eighteenth centuries, scientists observed many living things under microscopes. Their observations led to the development of the cell theory. The three main ideas of the cell theory are:

1. All living things are made of one or more cells.
2. The cell is the basic unit of life in which the activities of life occur.
3. All cells come from cells that already exist.
**The Microscopic Cell** All the living things pictured in Figure 2 are made up of cells. The smallest organisms and greatest number of organisms on Earth are **bacteria**. They are one-celled organisms, which means each is only one cell.

**Reading Check** How many cells does each bacterium have?

Larger organisms are made of many cells. These cells work together to complete all of the organism’s life activities. The living things that you see every day—trees, dogs, insects, people—are many-celled organisms. Your body contains more than 10 trillion (10,000,000,000,000) cells.

**Microscopes** Scientists have viewed and studied cells for about 350 years. In that time, they have learned a lot about cells. Better microscopes have helped scientists learn about the differences among cells. Some modern microscopes allow scientists to study the small features that are inside cells and viruses.

The microscope used in most classrooms is called a compound light microscope. In this type of microscope, light passes through the object you are looking at and then through two or more lenses. The lenses enlarge the image of the object. How much an image is enlarged depends on the powers of the eyepiece and the objective lens. The power—a number followed by an \( \times \)—is found on each lens. For example, a power of 10\( \times \) means that the lens can magnify something to ten times its actual size. The magnification of a microscope is found by multiplying the powers of the eyepiece and the objective lens.

**Activity** Make a pamphlet describing one virus and how it depends on a living organism.

**Science Online**

**Topic: Viruses**

Viruses could not be seen until the electron microscope (EM) was invented. Visit fl6.msscience.com for Web links to information about electron microscopes and viruses.

| Human cells are similar to other animal cells, like those in cats and turtles. |

| E. coli—a bacterium—is a one-celled organism. |

| Plant cells are different from animal cells. Infer how the cells in this rose plant differ. |

**Figure 2** All living things are made up of cells.
What are cells made of?

As small as cells are, they are made of even smaller parts, each doing a different job. A cell can be compared to a bakery. The activities of a bakery are inside a building. Electricity is used to run the ovens and other equipment, power the lights, and heat the building. The bakery’s products require ingredients such as dough, sugar, and fillings, that must be stored, assembled, and baked. The bakery’s products are packaged and shipped to different locations. A manager is in charge of the entire operation. The manager makes a plan for every employee of the bakery and a plan for every step of making and selling the baked goods.

A living cell operates in a similar way. Like the walls of the bakery, a cell has a boundary. Inside this boundary, the cell’s life activities take place. These activities must be managed. Smaller parts inside the cell can act as storage areas. A cell also has parts that use ingredients such as oxygen, water, minerals, and other nutrients. Some cell parts can release energy or make substances that are necessary for maintaining life. Some substances leave the cell and are used elsewhere in the organism.

Figure 3 These are some of the parts of an animal cell that perform the activities necessary for life. Identify the cell part that converts energy.
Outside a Cell The cell membrane, shown in Figure 3, is a flexible structure that holds a cell together, similar to the walls of the bakery. The cell membrane forms a boundary between a cell and its environment. It also helps control what goes into and comes out of a cell. Some cells, like those in plants, algae, fungi, and many types of bacteria, also have a structure outside the cell membrane called a cell wall, shown in Figure 4. A cell wall helps support and protect these cells.

Inside a Cell The inside of a cell is filled with a gelatinlike substance called cytoplasm (SI tuh pla zum). Approximately two-thirds of the cytoplasm is water, but it also contains many chemicals that are needed by a cell. Like the work area inside the bakery, the cytoplasm is where a cell’s activities take place.

Organelles Except for bacterial cells, cells contain organelles (or guh NELZ) like those in Figure 3 and Figure 4. These specialized cell parts can move around in the cytoplasm and perform activities that are necessary for life. You could think of these organelles as the employees of a cell because each type of organelle does a different job. In bacteria, most cell activities occur in the cytoplasm.

Figure 4 Most plant cells contain the same types of organelles as in animal cells. A plant cell also can have a cell wall and chloroplasts.
The Nucleus  A bakery’s manager follows a business plan so that the business runs smoothly. A business plan describes how the business should operate. These plans could include how many donuts are made and what kinds of pies are baked.

A cell’s hereditary material is like a bakery’s business plan because it controls a cell’s makeup and activities. Most of the hereditary material is a chemical called DNA. DNA contains instructions for an organism’s traits, such as the shape of a plant’s leaves or the color of your eyes. Hereditary material is found in one or many structures called chromosomes (KROH muh zohmz). In a cell with organelles, the hereditary material is in the nucleus. In a cell without a nucleus, like a bacterium, the hereditary material is in the cytoplasm.

Which important chemical determines the traits of an organism?

Storage  Pantries, closets, refrigerators, and freezers store food and other supplies that a bakery needs. Trash cans hold garbage until it can be picked up. In cells, food, water, and other substances are stored in balloonlike organelles in the cytoplasm called vacuoles (VA kyu wohlz). Some vacuoles store wastes until the cell is ready to get rid of them. Plant cells usually have a large vacuole that stores water and other substances.

Energy and the Cell  Electrical energy or the energy in natural gas is converted to heat energy by the bakery’s ovens. The heat then is used to bake the breads and other bakery products. Cells need energy, too.

Cells, except bacteria, have organelles called mitochondria (mi tuh KAHN dree uh)(singular, mitochondrion). An important process called cellular respiration (SEL yuh lur • res puh RAY shun) takes place inside a mitochondrion as shown in Figure 5. Cellular respiration is a series of chemical reactions in which energy stored in food is converted to a form of energy that a cell can use. This energy is released as food and oxygen combine. Waste products of this process are carbon dioxide and water. Cells with mitochondria use the energy from cellular respiration to do most of their work.

Figure 5  Inside a mitochondrion, food energy is changed into a form of energy that a cell can use.

Infer what happens to the water and carbon dioxide produced by mitochondria in human cells.
Nature’s Solar Energy Factories Animals obtain food from their surroundings. A cow grazes in a pasture. A bird pecks at worms, and a dog eats from a bowl. Have you ever seen a plant eat anything? How do plants get energy-rich food?

Plants, algae, and many types of bacteria make food through a process called photosynthesis (foh toh SIHN thuh sus). Most photosynthesis in plants occurs in leaf cells. Inside these cells are green organelles called chloroplasts (KLOR uh plasts). Most leaves are green because their cells contain so many chloroplasts. During plant photosynthesis, as shown in Figure 6, chloroplasts capture light energy and combine carbon dioxide from the air with water to make food. Energy is stored in food. As the plant needs energy, its mitochondria release the food’s energy. The captured light energy is passed to other organisms when they eat organisms that carry on photosynthesis.

Figure 6 Photosynthesis can take place inside the chloroplasts of plant cells.

More Section Review fl6.msscience.com SC.F.1.3.6 SC.F.1.3.5

Gabe Palmer/CORBIS
Observing Algae

You might have noticed mats of green algae growing on a pond or clinging to the walls of the aquarium in your classroom. Why are algae green? Like plants, algae contain organelles called chloroplasts. Chloroplasts contain a green pigment called chlorophyll. It captures light energy that is needed to make food. In this lab, you’ll describe chloroplasts and other organelles in algal cells.

**Real-World Problem**

What organelles can be seen when viewing algal cells under a microscope?

**Goals**

- **Observe** algal cells under a microscope.
- **Identify** cell organelles.

**Materials**

- microscope
- pond water
- microscope slides
- algae
- coverslips
- dropper
- large jars
- colored pencils

**Safety Precautions**

Complete a safety worksheet before you begin.

**WARNING:** Thoroughly wash your hands after you have finished this lab.

**Procedure**

1. Fill the tip of a dropper with pond water and thin strands of algae. Use the dropper to place the algae and a drop of water on a microscope slide.
2. Place a coverslip over the water drop and then place the slide on the stage of a microscope.
3. Using the microscope’s lowest power objective, focus on the algal strands.
4. Once the algal strands are in focus, switch to a higher power objective and observe several algal cells.
5. Draw a colored picture of one of the algal cells, identifying the different organelles in the cell. Label on your drawing the cell wall, chloroplasts, and other organelles you can see.

**Conclude and Apply**

1. **List** the organelles you found in each cell.
2. **Explain** the function of chloroplasts.
3. **Infer** why algal cells are essential to all pond organisms.

Work with three other students to create a collage of algal-cell pictures complete with labeled organelles. Create a bulletin board display about algal cells.
Special Cells for Special Jobs

Choose the right tool for the right job. You might have heard this common expression. The best tool for a job is one that has been designed for that job. For example, you wouldn't use a hammer to saw a board in half, and you wouldn't use a saw to pound in a nail. You can think of your body's cells in a similar way.

Cells that make up many-celled organisms, like you, are specialized. Different kinds of specialized cells work as a team to perform the life activities of a many-celled organism.

Types of Human Cells Your body is made up of many types of specialized cells. The same is true for other animals. Figure 7 shows some human cell types. Notice the variety of sizes and shapes. A cell's shape and size can be related to its function.

Figure 7 Human cells come in different shapes and sizes.
Analyzing Cells

Procedure
1. Complete a safety worksheet.
2. Examine prepared slides of human cells.
3. Draw each type of cell that you observe in your Science Journal. Label cell parts that you can see.

Analysis
1. In what ways were the cells that you observed similar? How were they different?
2. Hypothesize how the cells’ shapes relate to their jobs.

Types of Plant Cells

Like animals, plants also are made of several different cell types, as shown in Figure 8. For instance, plants have different types of cells in their leaves, roots, and stems. Each type of cell has a specific job. Some cells in plant stems are long and tubelike. Together they form a system through which water, food, and other materials move in the plant. Other cells, like those that cover the outside of the stem, are smaller or thicker. They provide strength to the stem.

What do long, tubelike cells do in plants?
Cell Organization

How well do you think your body would work if all the different cell types were mixed together in no particular pattern? Could you walk if your leg muscle cells were scattered here and there, each doing its own thing, instead of being grouped together in your legs? How could you think if your brain cells weren’t close enough together to communicate with each other? Many-celled organisms are not just mixed-up collections of different types of cells. Cells are organized into systems that, together, perform functions that keep the organism healthy and alive.

Applying Math

Solve One-Step Equations

RED BLOOD CELLS Each milliliter of blood contains 5 million red blood cells (RBCs). On average, an adolescent has about 3.5 L of blood. On average, how many RBCs are in an adolescent’s body?

Solution

1. This is what you know: 
   - number of RBCs per 1 mL = 5,000,000
   - 1,000 mL = 1 L
   - average volume of blood in an adolescent’s body = 3.5 L

2. This is what you need to find out: 
   On average, how many RBCs are in an adolescent’s body, N?

3. This is the procedure you need to use: 
   - Use the following equation: 
     \[ N = \left( \text{number of RBCs/1mL} \right) \times \left( \frac{1,000 \text{ mL}}{1 \text{ L}} \right) \times (3.5 \text{ L of blood}) \]
   - Substitute the known values 
     \[ N = (5,000,000 \text{ RBCs/1 mL}) \times \left( \frac{1,000 \text{ mL}}{1 \text{ L}} \right) \times (3.5 \text{ L of blood}) \]
     \[ N = 17,500,000,000 \text{ RBCs} \]
   - On average, there are 17.5 billion red blood cells in an adolescent’s body.

4. Check your answer: 
   Divide 17,500,000,000 RBCs by 1,000 mL/1 L then divide that answer by 3.5 L, and you should get 5,000,000 RBCs/1 mL.

Practice Problems

1. Each milliliter of blood contains approximately 7,500 white blood cells. How many white blood cells are in the average adolescent’s body? [MA.A.3.3.2]

2. There are approximately 250,000 platelets in each milliliter of blood. How many platelets are in the average adolescent’s body? [MA.A.3.3.2]
Organs are two or more tissue types that work together. An organ performs a task that no other organ performs.

Bones are organs that support the body. They also store some minerals and make blood cells.
**Tissues and Organs** Cells that are alike are organized into tissues (TIH shewz). *Tissues* are groups of similar cells that all do the same sort of work. For example, bone tissue is made of bone cells, and nerve tissue is made of nerve cells. Blood, a liquid tissue, includes different types of blood cells.

As important as individual tissues are, they do not work alone. Different types of tissues working together can form a structure called an *organ* (OR gun). For example, the stomach is an organ that includes muscle tissue, nerve tissue, and blood tissue. All of these tissues work together and enable the stomach to perform its digestive functions. Other human organs include the heart and the kidneys.

**Organ Systems** A group of organs that work together to do a certain job is called an *organ system*. The stomach, mouth, intestines, and liver are involved in digestion. Together, these and several other organs make up the digestive system. Other organ systems found in your body include the respiratory system, the circulatory system, the reproductive system, and the nervous system.

Organ systems also work together, as shown in Figure 9. For example, the muscular system has more than 600 muscles that are attached to bones. The contracting cells of muscle tissue cause your bones, which are part of the skeletal system, to move.

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**Summary**

**Special Cells for Special Jobs**
- Plant and animal cells come in a variety of sizes and shapes.
- The function of an animal cell can be related to its shape and size.
- The leaves, roots, and stems of plants are made of different types of cells to perform different functions.

**Cell Organization**
- Many-celled organisms are organized into tissues, organs, and organ systems.
- Each organ system performs a specific function that, together with other systems, keeps an organism healthy and alive.

**Self Check**

1. **Describe** three types of cells that are found in the human body. SC.F.1.3.6
2. **Compare and contrast** the cells found in a plant’s roots, stems, and leaves. SC.F.1.3.6
3. **Explain** the difference between a cell and a tissue and between a tissue and an organ. SC.F.1.3.4
4. **Think Critically** Why must specialized cells work together as a team? SC.F.1.3.5

**Applying Skills**

5. **Concept Map** Make an events-chain concept map of the different levels of cell organization from cell to organ system. Provide an example for each level of organization. SC.F.1.3.4
Every organism on Earth is made of cells. Some organisms, such as humans, are made of many cells that work together. Most organisms are made of only one cell. These one-celled organisms are found everywhere—in the air you breathe, in the food you eat, in the water you drink, and even in the deep ocean. It may be hard to imagine, but you have huge populations of them living in and on your body that are helpful to you.

For thousands of years people did not know that these one-celled organisms existed. Toward the end of the 17th century, Antonie van Leeuwenhoek, a Dutch merchant, used his simple microscope to look at scrapings from his teeth. His drawings were made about 200 years before it was proven that the tiny organisms he observed were living cells.

**Bacteria**

All bacteria, like the one shown in Figure 10, are one-celled organisms. They usually are smaller than plant and animal cells and contain no membrane-bound organelles. Some bacteria are found as individual cells. Others grow in groups or in long chains of cells. More bacteria exist on Earth than all other organisms combined. Evidence shows that one type of bacteria has existed for billions of years. Cyanobacteria make their own food from sunlight using chlorophyll.
Obtaining Food  Bacteria obtain food in many ways. Some bacteria use energy from sunlight or chemicals to make their own food. Other bacteria must get food from other sources, such as absorbing it from other organisms. Bacteria that absorb nutrients from dead organisms are called decomposers. These bacteria return nutrients to the soil and are important in soil fertility and encouraging plant growth. Some bacteria absorb energy from other living organisms. If the organisms are harmed the bacteria are parasites.

Structure and Function  A bacterium contains cytoplasm surrounded by a cell membrane and a cell wall. Bacterial hereditary material is found in the cytoplasm. Some bacteria have a thick, gel-like capsule around the cell wall. This helps protect the bacterium. Many bacteria that live in moist conditions have whiplike tails that help them move. Some produce a thick wall around themselves in unfavorable conditions. The bacterium can survive for hundreds of years this way. The bacterium that normally inhabit your home and body have three basic shapes—spheres, rods, and spirals—as shown in Figure 11.

Types of Bacteria  There are two main groups of bacteria. Archaeabacteria (ar kee bak TIHR ee uh) live in harsh environments where few other organisms can live, such as areas with high levels of salt and hot and acidic environments. These bacteria are classified by the environment that they live in. Eubacteria live in less harsh conditions. They can be classified by the condition that they grow in, composition of the cell wall, how they obtain food, and the wastes they produce.
Harmful Bacteria Some bacteria are pathogens—organisms that cause disease. Bacteria that normally grow in your mouth can cause tooth decay. As shown in Figure 12, these bacteria grow on the surface of your teeth and use sugar as food. As they break down the sugar, an acid is produced that damages the enamel of your teeth. Bacteria then decay the softer parts of your teeth.

Many bacteria produce poisons called toxins as they grow in your body or in the food you eat. Botulism, a type of food poisoning, is caused by a bacterium that survives in canned food.

Helpful Bacteria Some bacteria produce chemicals called antibiotics that limit the growth of or kill other bacteria. Millions of bacteria live on your skin and in all other parts of your body. Many of these bacteria are harmless, and they limit the growth of harmful bacteria. Some bacteria help your body produce vitamins needed for survival.

Bacteria help to produce many of the foods you eat, such as yogurt, cheese, chocolate, vinegar, and sauerkraut. All foods contain some bacteria until the food is sterilized by heating it to high temperatures to kill harmful bacteria. Pasteurization is the process used to kill harmful bacteria with the minimum effect on the flavor of the product, as shown in Figure 13. Milk, fruit juices, and many other foods are pasteurized.

Why are some foods pasteurized?

Other uses in industry are to make medicines, vitamins, alcohol, cleansers, adhesives and food thickeners. In some landfills, bacteria are used to break down wastes into simpler, harmless substances. These bacteria are also used in sewage-treatment plants, septic systems, and to clean up oil spills.

Nitrogen is needed by every organism, but the nitrogen in Earth’s atmosphere is not usable. Certain bacteria that live on the roots of some plants can combine nitrogen with other chemicals so it can be used by organisms.

Figure 12 One important bacteria that has been found to cause tooth decay is Streptococcus mutans.

Figure 13 Most milk is pasteurized by heating it to at least 71.6°C for only 15 s. In the process, milk flows continuously past a heat exchanger. Identify the type of energy commonly used to sterilize food.
Protists

A protist is a one- or many-celled organism that lives in moist or wet surroundings. Unlike bacteria, protists’ cells have a membrane-bound nucleus and other membrane-bound structures in their cytoplasm.

Funguslike Protists Many funguslike protists spend part of their lives as one-celled organisms and part of their lives as many-celled organisms. Slime molds, water molds, and downy mildews are examples of funguslike protists. They are all decomposers or parasites. The decomposers return nutrients and add organic matter to the soil.

Animal-like Protists One-celled, animal-like protists are called protozoans. They often are separated into groups based on how they move from place to place. Many use one or more whiplike tails. Others have short, threadlike structures that extend from the cell membrane. Still others move by using a temporary extension of their cytoplasm.

Plantlike Protists Some protists share many traits with plants. These plantlike protists are known as algae. Algae can be one-celled or many-celled. An example of many-celled algae is seaweed. Algae usually are grouped by their structure and the pigments that they contain. All algae can make their own food and produce oxygen because they contain chlorophyll. Table 1 lists the characteristics of each group. In which group would you place the protist pictured below?

### Table 1 Characteristics of Protist Groups

<table>
<thead>
<tr>
<th>Funguslike</th>
<th>Animal-like</th>
<th>Plantlike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decomposers or parasites</td>
<td>Obtain food from the environment</td>
<td>Produce own food; contain chlorophyll</td>
</tr>
<tr>
<td>Spend part of their lives as one-celled organisms, part as many-celled organisms</td>
<td>Like animals, most do not have cell walls.</td>
<td>Many have cell walls like plants.</td>
</tr>
<tr>
<td></td>
<td>Most can move from place to place.</td>
<td>Many-celled forms remain attached to surfaces with rootlike structures.</td>
</tr>
</tbody>
</table>
Harmful Protists  Some protists harm crops, wildlife, or cause disease. Probably the most well-known disease caused by a protozoan is malaria. Figure 14 shows how the protozoan is carried by mosquitoes and transferred to humans. Malaria kills more than one million people each year. More than a million people in Ireland died from the potato famine caused by a water mold. Other funguslike protists cause disease in fish and other plants and animals.

Algae are a food source for many organisms. However, sometimes algae grow uncontrolled, called an algal bloom. As the bacteria break down the wastes of the algae, the oxygen in the water is used up. This causes fish and other organisms to die. The toxins in the water also can cause humans who drink the water or swim in it to become sick.

Helpful Protists  You probably have used a protist or its product today and not even realized it. Algae or their products are used in toothpaste, ice cream, and pudding. Some are used to make fertilizers, and some produce the sparkle that makes road lines visible at night.

Protists, such as algae and protozoans, are important as food for animals. Algae also produce oxygen, making it possible for animals to live in the water. Termites have protozoans in their digestive system that contain bacteria. These bacteria produce substances that help the termite digest wood. Some funguslike protists are important for enriching the soil, enabling plants to grow.

Topic: Malaria  Visit fl6.msscience.com for Web links to information about malaria.

Activity  Mark on a map where malaria is a problem. Indicate countries that have the highest number of cases.

What are some impacts of protists?

Figure 14  *Plasmodium*, a protozoan, causes the disease malaria. It spends part of its life cycle in mosquitoes and part in humans.

**Explain the life cycle of Plasmodium.**
Fungi

Do you like fungi on your pizza? You do if you like mushrooms. Fungi were once considered plants. Their cells have cell walls, and some fungi are anchored to the soil. Unlike plants, fungi cells do not contain chlorophyll and cannot produce their own food. Most fungi are decomposers, but some are parasites. Most species of fungi are many-celled. Their cells have at least one nucleus and other organelles. Fungi reproduce using structures called spores. These spores spread from place to place and grow a new fungus. Fungi are very common in warm, humid places, such as tropical forests, on your shower curtain, or between your toes. Fungi are classified using several methods, but the structure and type of its reproductive structures are a good starting point. There are three main types of fungi, as shown in Figure 15.

**Reading Check**

**What are the characteristics of fungi?**

**Club Fungi** Mushrooms, shelf fungi, puffballs, and toadstools are all examples of club fungi. The spores of these fungi are produced in a club-shaped part found on the reproductive structure. On the bottom of the cap of a mushroom, you will see structures called gills. If you use a microscope to look at a gill, you will see spores hanging from these club-shaped parts.

**Sac Fungi** Yeasts, molds, morels, and truffles are all types of sac fungi. The spores are produced in little saclike parts of the reproductive structure. This group also includes examples of one-celled fungi, the yeasts.
Zygospore Fungi  The fuzzy, black mold that you sometimes find growing on old bread or a piece of fruit is a zygospore fungus. Spores are produced in large, round, reproductive structures growing from the body of the fungus. As the reproductive structures split open, hundreds of spores are released into the air. They will grow into new fungi if the conditions are right.

Other Fungi  Some fungi have never been observed undergoing reproduction, or don’t go through sexual reproduction. These fungi are called imperfect. They have an imperfect life cycle. Several diseases in humans, including athlete’s foot, are caused by fungi in this group.

Lichens  Some fungi live in close associations with other organisms. A lichen (LI kun) is formed when a fungus and either a green alga or a cyanobacterium live together. The alga or cyanobacterium gets a warm, moist, protected place to live, and the fungus gets the food made by the alga or cyanobacterium. The colorful organisms in Figure 16 are lichens.

Lichens that grow in the surface cracks of a rock play an important role in the formation of soil. As lichens grow, they release acids as part of their metabolism. The acids help break down the rock. As bits of rock accumulate and lichens die and decay, soil is formed. Lichens also are indicators of the quality of the environment because they are sensitive to pollutants present in rain and air.

Classify How might lichens be classified?

How do lichens help form soil?
Fungi and Plants  An association exists between certain plants and fungi. The fungi form a web around the roots of the plants. The plants provide the fungi with food, helping the plant roots absorb water and nutrients. Scientists have found these webs around the roots of about 90 percent of the plants they have studied. Some plants cannot grow unless these webs are present.

Harmful Fungi  Fungi can cause diseases in plants and animals. Dutch Elm disease and chestnut blight are caused by sac fungi, and they wiped out hundreds of millions of these trees in the twentieth century. Many other crops are destroyed by rusts and smuts each year. Fungi can spoil food, as you might have noticed on food in the back of the refrigerator. Fungi also can cause disease in humans, such as athlete’s foot and ringworm.

Helpful Fungi  Fungi are important in the environment because they break down organic matter and return useful chemicals to the soil to be used by plants. They are nature’s recyclers. Many fungi are eaten, and they also are important in producing foods. Yeasts and other fungi are used to produce bread and some cheeses. Another important use of fungi is in the production of antibiotics. Fungi naturally produce antibiotics to prevent bacteria from growing near them. These are used in medicines, such as penicillin.

Self Check
1. Explain why bacteria, protists, and fungi are classified separately.  
2. Identify why bacteria, protists, and fungi are important to the environment.
3. Compare and contrast the ways that bacteria, protists, and fungi obtain food.
4. List two ways each that bacteria, protists, and fungi are harmful.
5. Think Critically If an imperfect fungus were found to produce spores on clublike structures, how would the fungus be reclassified? 

Summary

**Bacteria**
- Bacteria are prokaryotic, one-celled organisms.
- Archaebacteria can survive in extreme conditions; Eubacteria grows in less harsh environments.

**Protists**
- Protists are eukaryotic. They can be one- or many-celled.
- Protists can be funguslike, animal-like, or plantlike.

**Fungi**
- Fungi are eukaryotic. Most are many-celled, but some are one-celled.
- Club fungi, sac fungi, zygospore fungi are some types of fungi.

Applying Skills
6. Solve One-Step Equations  Air may have more than 3,500 bacteria per cubic meter. Use this number to estimate the number of bacteria in the air in your classroom.
**Goals**

- **Design** an investigation to show where water moves in a plant.
- **Observe** how long it takes water to move in a plant.

**Possible Materials**
- fresh stalk of celery with leaves
- clear drinking glass
- scissors
- red food coloring
- water

**Safety Precautions**

Complete a safety worksheet before you begin.

**WARNING:** Use care when handling sharp objects such as scissors. Avoid getting red food coloring on your clothing.

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**Water Movement in Plants**

### Real-World Problem

When you are thirsty, you can sip water from a glass or drink from a fountain. Plants must get their water in other ways. In most plants, water moves from the soil into cells in the roots. Where does water travel in a plant?

### Form a Hypothesis

Based on what you already know about how a plant functions, state a hypothesis that explains where water travels in a plant.

### Test Your Hypothesis

#### Make a Plan

1. As a group, agree upon a hypothesis and decide how you will test it. Identify which results will support the hypothesis.

2. **List** the steps you will need to take to test your hypothesis. Be specific. Describe exactly what you will do in each step. List your materials.

3. **Prepare** a data table in your Science Journal to record your observations.

4. **Read** the entire investigation to make sure all steps are in logical order.

5. **Identify** all constants, variables, and controls of the investigation.

#### Follow Your Plan

1. Make sure your teacher approves your plan before you start.

2. Carry out the investigation according to the approved plan.

3. While doing the investigation, record your observations and complete the data tables in your Science Journal.
**Analyze Your Data**

1. **Compare** the color of the celery stalk before, during, and after the investigation.
2. **Compare** your results with those of other groups.
3. Make a drawing of the cut stalk. Label your drawing.
4. What was your control in this investigation? What were your variables?

**Conclude and Apply**

1. **Explain** whether the results of this investigation supported your hypothesis.
2. **Infer** why only some of the plant tissue is red.
3. **Explain** what you would do to improve this investigation.
4. **Predict** if other plants have tissues that move water.

**Inquiry Extension**

Certain kinds of plants can be used to clean up soil contaminated with toxic waste. Infer how this process might work and draw a diagram showing what happens to the contaminants in the soil.

**Communicating Your Data**

Write a report about your investigation. Include illustrations to show how the investigation was performed. Present your report to your class.
In Chicago, a young woman named Kelly is cooking pasta on her stove. Her clothes catch fire from the gas flame and, in the blink of an eye, 80 percent of her body is severely burned. Will she survive?

Just 20 years ago, the answer to this question probably would have been “no.” Fortunately for Kelly, science has come a long way in recent years. Today, there’s a very good chance that Kelly might lead a long and healthy life.

Like the brain or the heart, the skin is an organ. In fact, it is the body’s largest organ, about 1/12 of your total body weight. Composed of protective layers, skin keeps your internal structure safe from damage, infection, and temperature changes.

Today, just as farmers can grow crops of corn and wheat, scientists can grow human skin. How?

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**Tissue Engineers**

Scientists, called tissue engineers, take a piece of skin (no bigger than a quarter) from an undamaged part of the burn victim’s body. The skin cells are isolated, mixed with special nutrients, and then they multiply in a culture dish.

After about two to three months, the tissue engineers can harvest sheets of new, smooth skin. These sheets, as large as postcards, are grafted onto the victim’s damaged body and promote additional skin growth.

By grafting Kelly’s own skin on her body rather than using donor skin—skin from another person or from an animal—doctors avoid at least three potential complications. First, donor skin may not even be available. Second, Kelly’s body might perceive the new skin cells from another source to be a danger, and her immune system might reject—or destroy—the transplant. Finally, even if the skin produced from a foreign source is accepted, it may leave extensive scarring.

**Tissue Testing**

What else can tissue engineers grow? They produce test skin—skin made in the lab and used to test the effects of cosmetics and chemicals on humans. This skin is eliminating the use of animals for such tests. Also, tissue engineers are working on ways to replace other body parts such as livers, heart valves, and ears, that don’t grow back on their own.

**Safety List**

Visit the link shown to the right or your media center to learn about fire safety tips, including kitchen safety and escape routes in your home. Make a list and share it with your family.
Chapter 2: Study Guide

Reviewing Main Ideas

Section 1  The World of Cells

1. The cell theory states that all living things are made of one or more cells, the cell is the basic unit of life, and all cells come from other cells.

2. The microscope is an instrument that enlarges the image of an object.

3. All cells are surrounded by a cell membrane and contain hereditary material and cytoplasm. Plant cells have a cell wall outside the cell membrane. Cells, except bacteria, contain organelles.

4. The nucleus directs the cell’s activities. Chromosomes contain DNA that determines what kinds of traits an organism will have. Vacuoles store substances.

5. In mitochondria, the process of cellular respiration combines food molecules with oxygen. This series of chemical reactions releases energy for the cell’s activities.

6. The energy in light is captured and stored in food molecules during the process of photosynthesis. Plants, algae, and some bacteria make their own food by photosynthesis.

Section 2  The Different Jobs of Cells

1. Many-celled organisms are made up of different kinds of cells that perform different tasks.

2. Many-celled organisms are organized into tissues, organs, and organ systems that perform specific jobs to keep an organism alive.

Section 3  Bacteria, Protists, and Fungi

1. Most organisms are one-celled.

2. There is great diversity among one-celled organisms.

3. Some bacteria, protists, and fungi are helpful in the environment and to humans, and some are harmful.

Visualizing Main Ideas

Copy and complete the following concept map on the parts of a plant cell.

Parts of a Plant Cell

- Cell membrane
  - surrounded by
  - protected by
- Cytoplasm
  - inside the cell
  - types of
  - controls activities
  - storage
  - makes food
  - energy
  - Mitochondria

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CHAPTER STUDY GUIDE 61
Explain the difference between the terms in the following sets.

1. mitochondria—chloroplast
2. tissue—organ
3. cell membrane—nucleus
4. nucleus—organelle
5. cytoplasm—nucleus
6. vacuole—mitochondria
7. organelle—organ
8. cell wall—cell membrane
9. protist—algae
10. antibiotic—pasteurization
11. bacteria—protist
12. photosynthesis—algae

Choose the word or phrase that best answers the question.

13. Which controls what enters and leaves the cell?
   A) mitochondrion
   B) cell membrane
   C) vacuole
   D) nucleus

14. Which letter is the gelatinlike substance in a cell that contains water and chemicals?
   A) A
   B) B
   C) C
   D) D

15. Which organisms can be plantlike, animal-like, or funguslike?
   A) bacteria
   B) fungi
   C) protists
   D) lichens

16. Which term accurately describes the stomach?
   A) organelle
   B) organ system
   C) organ
   D) tissue

17. What does photosynthesis make for a plant?
   A) food
   B) organs
   C) water
   D) tissues

18. What does DNA do?
   A) makes food
   B) determines traits
   C) converts food to energy
   D) stores substances

19. Decomposition of organic materials is an important role of which organisms?
   A) protozoans
   B) algae
   C) plants
   D) fungi

20. What cell structure helps support plants?
   A) cell membrane
   B) cell wall
   C) vacuole
   D) nucleus
21. **Predict** what would happen to a cell if the cell membrane were solid and waterproof.

22. **Describe** what might happen to a cell if all its mitochondria were removed.  

23. **Explain** why cells are called the units of life.

24. **Infer** what kinds of animal cells might have many mitochondria present.

25. **Distinguish** between a bacterium and a plant cell.

26. **Compare and contrast** photosynthesis and cellular respiration.

27. **Make and Use Tables** Copy and complete this table about the functions of the following cell parts: nucleus, cell membrane, mitochondrion, chloroplast, and vacuole.

28. **Concept Map** Make an events-chain concept map of the following from simple to complex: small intestine, circular muscle cell, human, and digestive system.

29. **Identify and Manipulate Variables and Controls** Describe an experiment you might do to determine whether water moves into and out of cells.

30. **Recognize Cause and Effect** Why is the brick-like shape of some plant cells important?

31. **Infer** why brushing and flossing your teeth help prevent tooth decay.

32. **Skit** Working with three or four classmates, develop a short skit about how a living cell works. Have each group member play the role of a different cell part.

33. **Make a Poster** Find or draw pictures on a poster to show the importance of bacteria, protists, or fungi to life on Earth. Be sure to include helpful and harmful examples.

34. **Magnification** A microscope has an eyepiece with a power of 10× and an objective lens with a power of 40×. What is the magnification of the microscope?

35. **Viruses** Use a computer to make a line graph of the following data. At 37°C there are 1.0 million viruses; at 37.5°C, 0.5 million; at 37.8°C, 0.25 million; at 38.3°C, 0.1 million; and at 38.9°C, 0.05 million.

36. **Plant Food Production** Light is necessary for plants to make food. Using the graph above, determine which plant produced the most food. How much light was needed by the plant every day to produce the most food?
A newly discovered type of bacteria is a producer. How does it most likely obtain energy?

A. It uses light energy to make food.
B. It uses light energy to make nitrogen.
C. It uses dead organisms as a source of chemical energy.
D. It uses living organisms as a source of chemical energy.

The diagram below shows an animal cell. Which letter represents where most of the cell’s hereditary material is found?

F. A
G. B
H. C
I. D

Which choice shows the levels of organization in the human body from simplest to most complex?

A. muscle tissue → muscle cell → stomach → digestive system
B. muscle cell → stomach → digestive system → muscle tissue
C. digestive system → muscle cell → muscle tissue → stomach
D. muscle cell → muscle tissue → stomach → digestive system

The diagram below shows cells in two types of tissue taken from the same person.

Which best explains why these cells look different?

F. They have different functions.
G. They get energy in different ways.
H. They were formed at different times.
I. They contain different sets of chromosomes.
5 A certain type of bacteria is able to combine nitrogen from the air with other chemicals. What is the main way in which this activity benefits other types of organisms?

A. It removes harmful pollutants from the atmosphere.
B. It produces substances that slow the growth of pathogens.
C. It converts an important nutrient into a form that plants can use.
D. It breaks down dead material and removes it from the environment.

6 The table below shows the number of hours it takes a population of a certain type of bacteria to double at various temperatures.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Number of Hours Required for Population to Double</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>15.6</td>
</tr>
<tr>
<td>10.0</td>
<td>5.9</td>
</tr>
<tr>
<td>35.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

One test tube containing a sample of 100 of the bacteria is kept at 5.0°C. A second test tube containing a sample of 100 of the bacteria is kept at 35.0°C. How many hours sooner will the population in the second test tube reach 200 bacteria than the population in the first test tube?

7 Describe the main ideas of the cell theory.

8 The diagram below shows an organelle from a cell.

**PART A** Name this organelle and describe its function.

**PART B** Name an organism that would have this type of organelle in at least some of its cells. Explain how you know that the organism you chose has this type of organelle.

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Get Enough Sleep Do not “cram” the night before the test. It can confuse you and make you tired.