

Eukaryotic Cells

Even though most cells are small, cells are still complex. A eukaryotic cell has many parts that help the cell stay alive.

Plant cells and animal cells are two types of eukaryotic cells. These two types of cells have many cell parts in common. But plant cells and animal cells also have cell parts that are different. Compare the plant cell in **Figure 1** and the animal cell in **Figure 2** to see the differences between these two types of cells.

What You Will Learn

- Identify the different parts of a eukaryotic cell.
- Explain the function of each part of a eukaryotic cell.

Vocabulary

cell wall	mitochondrion
ribosome	Golgi complex
endoplasmic reticulum	vesicle
	lysosome

READING STRATEGY

Reading Organizer As you read this section, make a table comparing plant cells and animal cells.

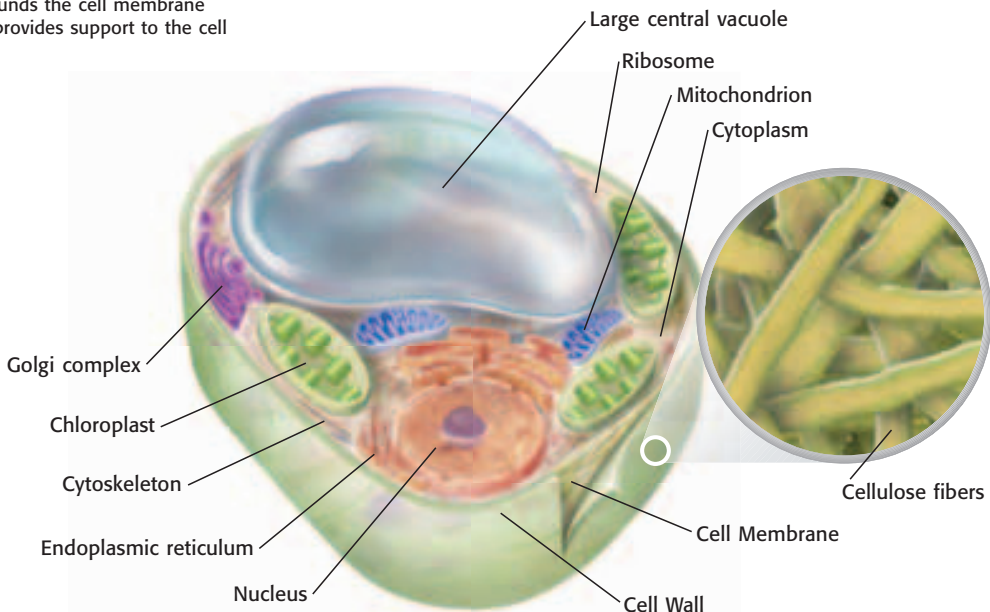
Cell Wall

Plant cells have an outermost structure called a **cell wall**. A cell wall is a rigid structure that gives support to a cell. Plants and algae have cell walls made of a complex sugar called *cellulose*. **Figure 1** shows the cellulose fibers in a plant cell wall.

Fungi, including yeasts and mushrooms, also have cell walls. Fungi have cell walls made of a complex sugar called *chitin* (KIE tin) or of a chemical similar to chitin. Prokaryotic cells such as bacteria and archaea also have cell walls, but those cell walls are different from those of plants or fungi.

cell wall a rigid structure that surrounds the cell membrane and provides support to the cell

Figure 1 Plant Cell



Cell Membrane

All cells have a cell membrane. The *cell membrane* is a protective barrier that encloses a cell. It separates the cell's contents from the cell's environment. The cell membrane is the outermost structure in cells that lack a cell wall. In cells that have a cell wall, the cell membrane lies just inside the cell wall.

The cell membrane contains proteins, lipids, and phospholipids. *Lipids*, which include fats and cholesterol, are a group of compounds that do not dissolve in water. The cell membrane has two layers of phospholipids (FAHS foh LIP idz), shown in **Figure 2**. A *phospholipid* is a lipid that contains phosphorus. Lipids are “water fearing,” or *hydrophobic*. Lipid ends of phospholipids form the inner part of the membrane. Phosphorus-containing ends of the phospholipids are “water loving,” or *hydrophilic*. These ends form the outer part of the membrane.

Some of the proteins and lipids control the movement of materials into and out of the cell. Some of the proteins form passageways. Nutrients and water move into the cell, and wastes move out of the cell, through these protein passageways.

 **Reading Check** What are two functions of a cell membrane?

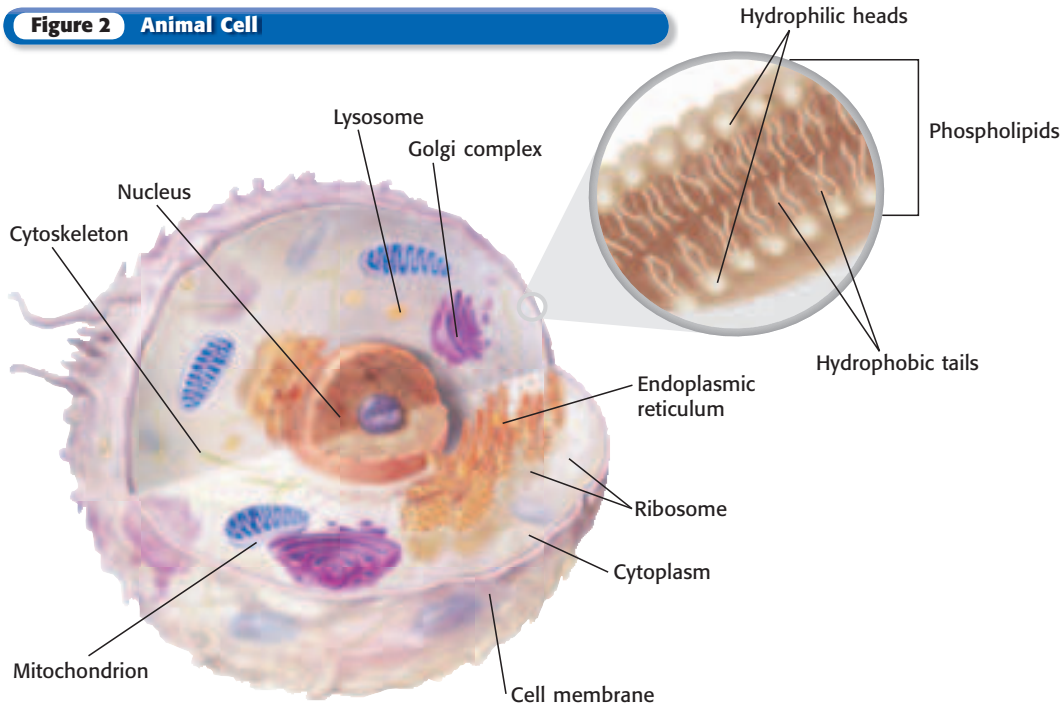
CONNECTION TO Language Arts

**WRITING
SKILL**

The Great Barrier
In your **science**

journal, write a science fiction story about tiny travelers inside a person's body. These little explorers need to find a way into or out of a cell to solve a problem. You may need to do research to find out more about how the cell membrane works. Illustrate your story.

Figure 2 Animal Cell



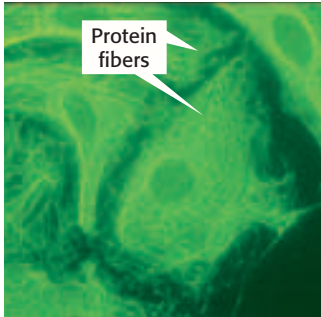


Figure 3 The cytoskeleton, made of protein fibers, helps a cell retain its shape, move in its environment, and move its organelles.

Cytoskeleton

The *cytoskeleton* (SIET oh SKEL uh tuhn) is a web of proteins in the cytoplasm. The cytoskeleton, shown in **Figure 3**, acts as both a muscle and a skeleton. It keeps the cell's membranes from collapsing. The cytoskeleton also helps some cells move.

The cytoskeleton is made of three types of protein. One protein is a hollow tube. The other two are long, stringy fibers. One of the stringy proteins is also found in muscle cells.

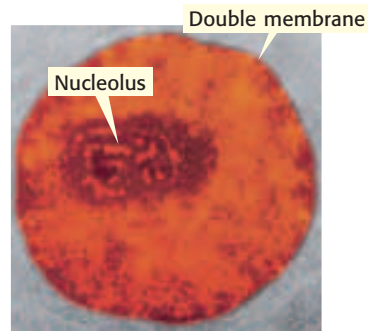
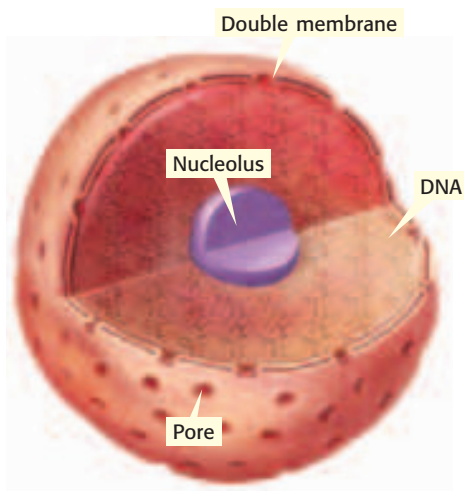
 **Reading Check** What is the cytoskeleton?

Nucleus

All eukaryotic cells have the same basic membrane-bound organelles, starting with the nucleus. The *nucleus* is a large organelle in a eukaryotic cell. It contains the cell's DNA, or genetic material. DNA contains the information on how to make a cell's proteins. Proteins control the chemical reactions in a cell. They also provide structural support for cells and tissues. But proteins are not made in the nucleus. Messages for how to make proteins are copied from the DNA. These messages are then sent out of the nucleus through the membranes.

The nucleus is covered by two membranes. Materials cross this double membrane by passing through pores. **Figure 4** shows a nucleus and nuclear pores. The nucleus of many cells has a dark area called the nucleolus (noo KLEE uh luhs). The *nucleolus* is where a cell begins to make its ribosomes.

Figure 4 The nucleus contains the cell's DNA. Pores allow materials to move between the nucleus and the cytoplasm.



Ribosomes

Organelles that make proteins are called **ribosomes**. Ribosomes are the smallest of all organelles. And there are more ribosomes in a cell than there are any other organelles. Some ribosomes float freely in the cytoplasm. Others are attached to membranes or the cytoskeleton. Unlike most organelles, ribosomes are not covered by a membrane.

Proteins are made within the ribosomes. Proteins are made of amino acids. An *amino acid* is any one of about 20 different organic molecules that are used to make proteins. All cells need proteins to live. All cells have ribosomes.

Endoplasmic Reticulum

Many chemical reactions take place in a cell. Many of these reactions happen on or in the endoplasmic reticulum (EN doh PLAZ mik ri TIK yuh luhm). The **endoplasmic reticulum**, or ER, is a system of folded membranes in which proteins, lipids, and other materials are made. The ER is shown in **Figure 5**.

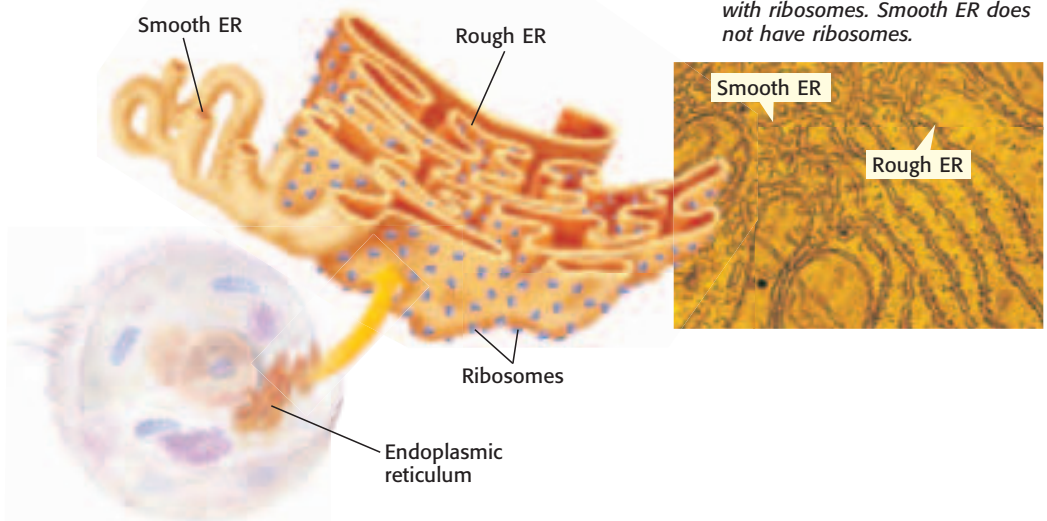
The ER is part of the internal delivery system of the cell. Its folded membrane contains many tubes and passageways. Substances move through the ER to different places in the cell.

Endoplasmic reticulum is either rough ER or smooth ER. The part of the ER covered in ribosomes is rough ER. Rough ER is usually found near the nucleus. Ribosomes on rough ER make many of the cell's proteins. The ER delivers these proteins throughout the cell. ER that lacks ribosomes is smooth ER. The functions of smooth ER include making lipids and breaking down toxic materials that could damage the cell.

ribosome cell organelle composed of RNA and protein; the site of protein synthesis

endoplasmic reticulum a system of membranes that is found in a cell's cytoplasm and that assists in the production, processing, and transport of proteins and in the production of lipids

Figure 5 The endoplasmic reticulum (ER) is a system of membranes. Rough ER is covered with ribosomes. Smooth ER does not have ribosomes.



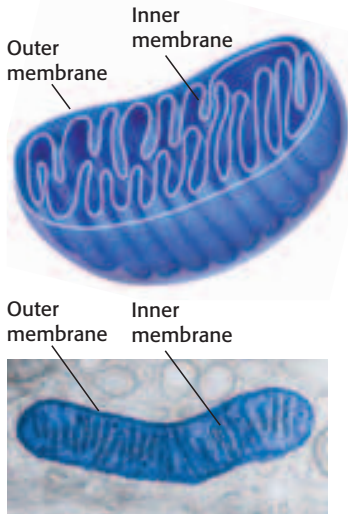
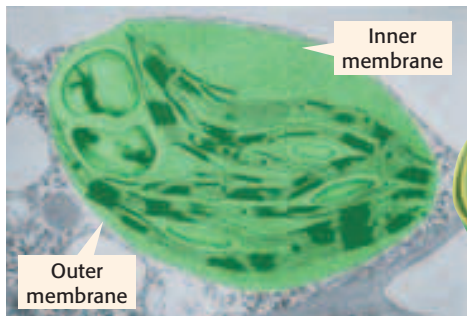


Figure 6 Mitochondria break down sugar and make ATP. ATP is produced on the inner membrane.

mitochondrion in eukaryotic cells, the cell organelle that is surrounded by two membranes and that is the site of cellular respiration


Figure 7 Chloroplasts harness and use the energy of the sun to make sugar. A green pigment—chlorophyll—traps the sun's energy.



Mitochondria

A mitochondrion (MIET oh KAHN drie uhn) is the main power source of a cell. A **mitochondrion** is the organelle in which sugar is broken down to produce energy. Mitochondria are covered by two membranes, as shown in **Figure 6**. Energy released by mitochondria is stored in a substance called **ATP** (adenosine triphosphate). The cell then uses ATP to do work. ATP can be made at several places in a cell. But most of a cell's ATP is made in the inner membrane of the cell's mitochondria.

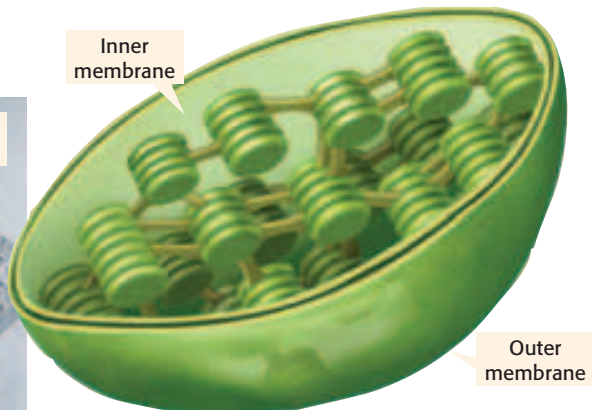
Most eukaryotic cells have mitochondria. Mitochondria are the size of some bacteria. Like bacteria, mitochondria have their own DNA, and mitochondria can divide within a cell.

 **Reading Check** Where is most of a cell's ATP made?

Chloroplasts

Animal cells cannot make their own food. Plants and algae are different. They have chloroplasts (KLAWR uh PLASTS) in some of their cells. **Chloroplasts** are organelles in plant and algae cells in which photosynthesis takes place. Like mitochondria, chloroplasts have two membranes and their own DNA. A chloroplast is shown in **Figure 7**. **Photosynthesis** is the process by which plants and algae use sunlight, carbon dioxide, and water to make sugar and oxygen.

Chloroplasts are green because they contain **chlorophyll**, a green pigment. Chlorophyll is found inside the inner membrane of a chloroplast. Chlorophyll traps the energy of sunlight, which is used to make sugar. The sugar produced by photosynthesis is then used by mitochondria to make ATP.



Golgi Complex

The organelle that packages and distributes proteins is called the **Golgi complex** (GOHL jee KAHM PLEKS). It is named after Camillo Golgi, the Italian scientist who first identified the organelle.

The Golgi complex looks like smooth ER, as shown in **Figure 8**. Lipids and proteins from the ER are delivered to the Golgi complex. There, the lipids and proteins may be modified to do different jobs. The final products are enclosed in a piece of the Golgi complex's membrane. This membrane pinches off to form a small bubble. The bubble transports its contents to other parts of the cell or out of the cell.

Golgi complex cell organelle that helps make and package materials to be transported out of the cell

vesicle a small cavity or sac that contains materials in a eukaryotic cell

Cell Compartments

The bubble that forms from the Golgi complex's membrane is a vesicle. A **vesicle** (VES i kuhl) is a small sac that surrounds material to be moved into or out of a cell. All eukaryotic cells have vesicles. Vesicles also move material within a cell. For example, vesicles carry new protein from the ER to the Golgi complex. Other vesicles distribute material from the Golgi complex to other parts of the cell. Some vesicles form when part of the cell membrane surrounds an object outside the cell.

Figure 8 The Golgi complex processes proteins. It moves proteins to where they are needed, including out of the cell.

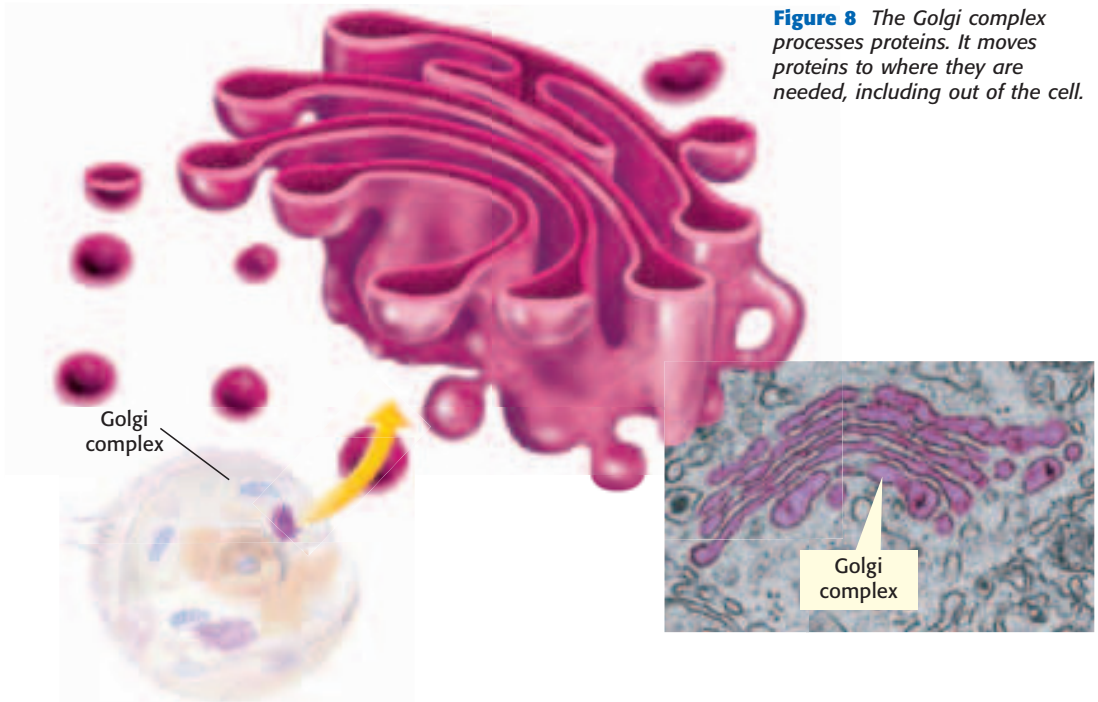
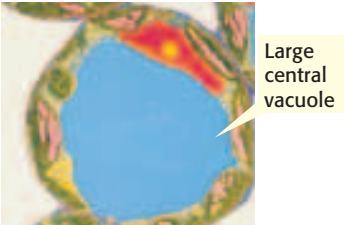
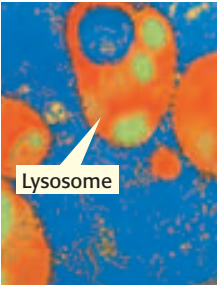


Figure 9
Lysosomes digest materials inside a cell. In plant cells, the large central vacuole stores water.




lysosome a cell organelle that contains digestive enzymes

Cellular Digestion

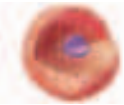


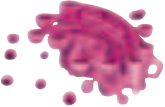

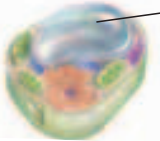


Lysosomes (LIE suh SOHMZ) are vesicles that are responsible for digestion inside a cell. **Lysosomes** are organelles that contain digestive enzymes. They destroy worn-out or damaged organelles, get rid of waste materials, and protect the cell from foreign invaders. Lysosomes, which come in a wide variety of sizes and shapes, are shown in **Figure 9**.

Lysosomes are found mainly in animal cells. When eukaryotic cells engulf particles, they enclose the particles in vesicles. Lysosomes bump into these vesicles and pour enzymes into them. These enzymes digest the particles in the vesicles.

 **Reading Check** Why are lysosomes important?

Vacuoles

A *vacuole* (VAK yoo OHL) is a vesicle. In plant and fungal cells, some vacuoles act like lysosomes. They store digestive enzymes and aid in digestion within the cell. The large central vacuole in plant cells stores water and other liquids. Large central vacuoles that are full of water, such as the one in **Figure 9**, help support the cell. Some plants wilt when their large central vacuoles lose water. **Table 1** shows some organelles and their functions.

Table 1 Organelles and Their Functions	
 <p>Nucleus the organelle that contains the cell's DNA and is the control center of the cell</p>	 <p>Chloroplast the organelle that uses the energy of sunlight to make food</p>
 <p>Ribosome the organelle in which amino acids are hooked together to make proteins</p>	 <p>Golgi complex the organelle that processes and transports proteins and other materials out of cell</p>
 <p>Endoplasmic reticulum the organelle that makes lipids, breaks down drugs and other substances, and packages proteins for Golgi complex</p>	 <p>Large central vacuole the organelle that stores water and other materials</p>
 <p>Mitochondrion the organelle that breaks down food molecules to make ATP</p>	 <p>Lysosome the organelle that digests food particles, wastes, cell parts, and foreign invaders</p>

SECTION Review

Summary

- Eukaryotic cells have organelles that perform functions that help cells remain alive.
- All cells have a cell membrane. Some cells have a cell wall. Some cells have a cytoskeleton.
- The nucleus of a eukaryotic cell contains the cell's genetic material, DNA.
- Ribosomes are the organelles that make proteins. Ribosomes are not covered by a membrane.
- The endoplasmic reticulum (ER) and the Golgi complex make and process proteins before the proteins are transported to other parts of the cell or out of the cell.
- Mitochondria and chloroplasts are organelles that provide chemical energy for the cell.
- Lysosomes are organelles responsible for digestion within a cell. In plant cells, organelles called *vacuoles* store cell materials and sometimes act like large lysosomes.

Using Key Terms

1. In your own words, write a definition for each of the following terms: *ribosome*, *lysosome*, and *cell wall*.

Understanding Key Ideas

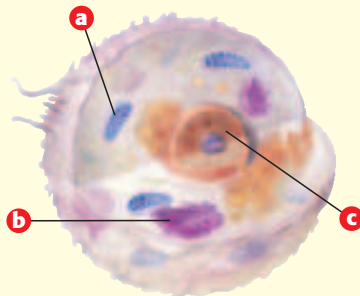
2. Which of the following are found mainly in animal cells?
 - a. mitochondria
 - b. lysosomes
 - c. ribosomes
 - d. Golgi complexes
3. What is the function of a Golgi complex? What is the function of the endoplasmic reticulum?

Critical Thinking

4. **Making Comparisons** Describe three ways in which plant cells differ from animal cells.
5. **Applying Concepts** Every cell needs ribosomes. Explain why.
6. **Predicting Consequences** A certain virus attacks the mitochondria in cells. What would happen to a cell if all of its mitochondria were destroyed?
7. **Expressing Opinions** Do you think that having chloroplasts gives plant cells an advantage over animal cells? Support your opinion.

Interpreting Graphics

Use the diagram below to answer the questions that follow.



8. Is this a diagram of a plant cell or an animal cell? Explain how you know.
9. What organelle does the letter *b* refer to?

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Topic: Eukaryotic Cells

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The Organization of Living Things

What You Will Learn

- List three advantages of being multicellular.
- Describe the four levels of organization in living things.
- Explain the relationship between the structure and function of a part of an organism.

Vocabulary

tissue	organism
organ	structure
organ system	function

READING STRATEGY

Paired Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

In some ways, organisms are like machines. Some machines have just one part. But most machines have many parts. Some organisms exist as a single cell. Other organisms have many—even trillions—of cells.

Most cells are smaller than the period that ends this sentence. Yet, every cell in every organism performs all the processes of life. So, are there any advantages to having many cells?

The Benefits of Being Multicellular

You are a *multicellular organism*. This means that you are made of many cells. Multicellular organisms grow by making more small cells, not by making their cells larger. For example, an elephant is bigger than you are, but its cells are about the same size as yours. An elephant just has more cells than you do. Some benefits of being multicellular are the following:

- **Larger Size** Many multicellular organisms are small. But they are usually larger than single-celled organisms. Larger organisms are prey for fewer predators. Larger predators can eat a wider variety of prey.
- **Longer Life** The life span of a multicellular organism is not limited to the life span of any single cell.
- **Specialization** Each type of cell has a particular job. Specialization makes the organism more efficient. For example, the cardiac muscle cell in **Figure 1** is a specialized muscle cell. Heart muscle cells contract and make the heart pump blood.


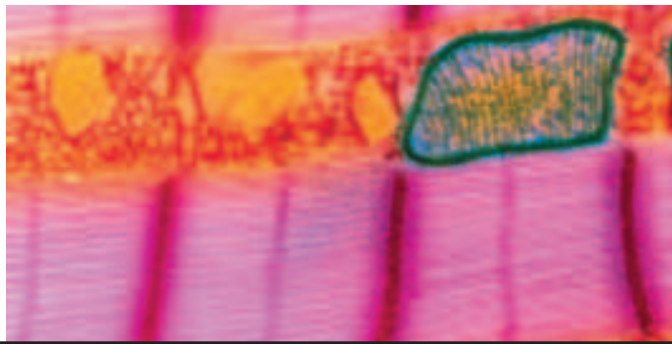
 **Reading Check** List three advantages of being multicellular. (See the Appendix for answers to Reading Checks.)

Figure 1 This photomicrograph shows a small part of one heart muscle cell. The green line surrounds one of many mitochondria, the powerhouses of the cell. The pink areas are muscle filaments.



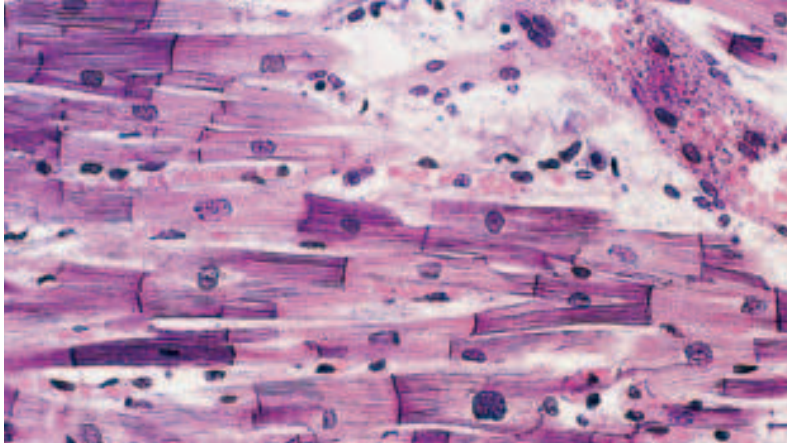


Figure 2 This photomicrograph shows cardiac muscle tissue. Cardiac muscle tissue is made up of many cardiac cells.

Cells Working Together

A **tissue** is a group of cells that work together to perform a specific job. The material around and between the cells is also part of the tissue. The cardiac muscle tissue, shown in **Figure 2**, is made of many cardiac muscle cells. Cardiac muscle tissue is just one type of tissue in a heart.

Animals have four basic types of tissues: nerve tissue, muscle tissue, connective tissue, and protective tissue. In contrast, plants have three types of tissues: transport tissue, protective tissue, and ground tissue. Transport tissue moves water and nutrients through a plant. Protective tissue covers the plant. It helps the plant retain water and protects the plant against damage. Photosynthesis takes place in ground tissue.

Tissues Working Together

A structure that is made up of two or more tissues working together to perform a specific function is called an **organ**. For example, your heart is an organ. It is made mostly of cardiac muscle tissue. But your heart also has nerve tissue and tissues of the blood vessels that all work together to make your heart the powerful pump that it is.

Another organ is your stomach. It also has several kinds of tissue. In the stomach, muscle tissue makes food move in and through the stomach. Special tissues make chemicals that help digest your food. Connective tissue holds the stomach together, and nervous tissue carries messages back and forth between the stomach and the brain. Other organs include the intestines, brain, and lungs.

Plants also have different kinds of tissues that work together as organs. A leaf is a plant organ that contains tissue that traps light energy to make food. Other examples of plant organs are stems and roots.

tissue a group of similar cells that perform a common function

organ a collection of tissues that carry out a specialized function of the body

MATH PRACTICE

A Pet Protist

Imagine that you have a tiny box-shaped protist for a pet. To care for your pet protist properly, you have to figure out how much to feed it. The dimensions of your protist are roughly $25\ \mu\text{m} \times 20\ \mu\text{m} \times 2\ \mu\text{m}$. If seven food particles per second can enter through each square micrometer of surface area, how many particles can your protist eat in 1 min?

organ system a group of organs that work together to perform body functions

organism a living thing; anything that can carry out life processes independently

structure the arrangement of parts in an organism

function the special, normal, or proper activity of an organ or part

Organs Working Together

A group of organs working together to perform a particular function is called an **organ system**. Each organ system has a specific job to do in the body.

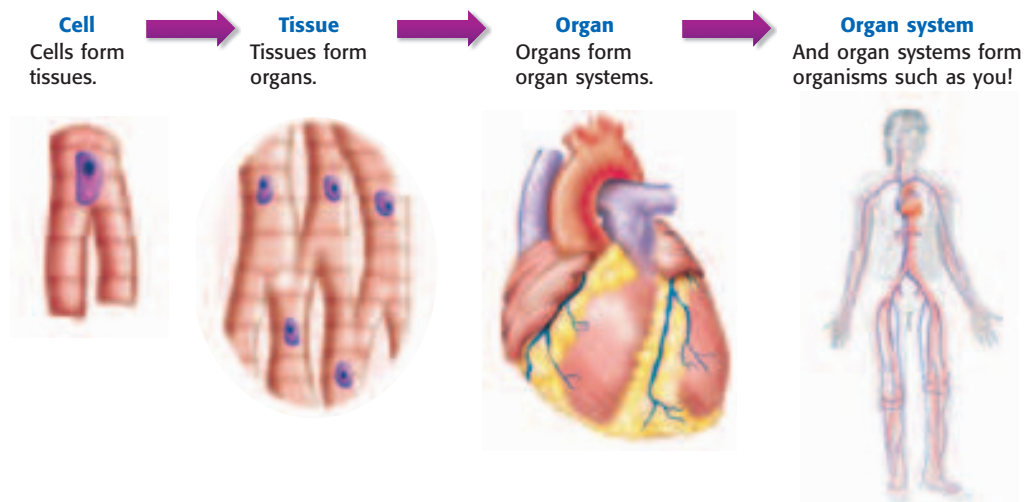
For example, the digestive system is made up of several organs, including the stomach and intestines. The digestive system's job is to break down food into small particles. Other parts of the body then use these small particles as fuel. In turn, the digestive system depends on the respiratory and cardiovascular systems for oxygen. The cardiovascular system, shown in **Figure 3**, includes organs and tissues such as the heart and blood vessels. Plants also have organ systems. They include leaf systems, root systems, and stem systems.

 **Reading Check** List the levels of organization in living things.

Organisms

Anything that can perform life processes by itself is an **organism**. An organism made of a single cell is called a *unicellular organism*. Prokaryotes, most protists, and some kinds of fungi are unicellular. Although some of these organisms live in colonies, they are still unicellular. They are unicellular organisms living together, and all of the cells in the colony are the same. Each cell must carry out all life processes in order for that cell to survive. In contrast, even the simplest multicellular organism has specialized cells that depend on each other for the organism to survive.

Figure 3 Levels of Organization in the Cardiovascular System

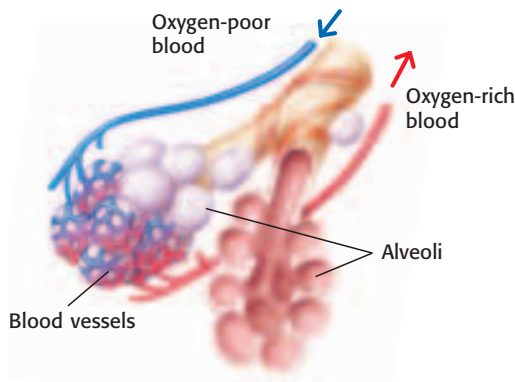


Structure and Function

In organisms, structure and function are related. **Structure** is the arrangement of parts in an organism. It includes the shape of a part and the material of which the part is made. **Function** is the job the part does. For example, the structure of the lungs is a large, spongy sac. In the lungs, there are millions of tiny air sacs called *alveoli*. Blood vessels wrap around the alveoli, as shown in **Figure 4**. Oxygen from air in the alveoli enters the blood. Blood then brings oxygen to body tissues. Also, in the alveoli, carbon dioxide leaves the blood and is exhaled.

The structures of alveoli and blood vessels enable them to perform a function. Together, they bring oxygen to the body and get rid of its carbon dioxide.

Figure 4 The Structure and Function of Alveoli



SECTION Review

Summary

- Advantages of being multicellular are larger size, longer life, and cell specialization.
- Four levels of organization are cell, tissue, organ, and organ system.
- A *tissue* is a group of cells working together. An *organ* is two or more tissues working together. An *organ system* is two or more organs working together.
- In organisms, a part's structure and function are related.

Using Key Terms

- Use each of the following terms in a separate sentence: *tissue*, *organ*, and *function*.

Understanding Key Ideas

- What are the four levels of organization in living things?
 - cell, multicellular, organ, organ system
 - single cell, multicellular, tissue, organ
 - larger size, longer life, specialized cells, organs
 - cell, tissue, organ, organ system

Math Skills

- One multicellular organism is a cube. Each of its sides is 3 cm long. Each of its cells is 1 cm³. How many cells does it have? If each side doubles in length, how many cells will it then have?

Critical Thinking

- Applying Concepts** Explain the relationship between structure and function. Use alveoli as an example. Be sure to include more than one level of organization.
- Making Inferences** Why can multicellular organisms be more complex than unicellular organisms? Use the three advantages of being multicellular to help explain your answer.

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Chapter Review

USING KEY TERMS

Complete each of the following sentences by choosing the correct term from the word bank.

cell	organ
cell membrane	prokaryote
organelles	eukaryote
cell wall	tissue
structure	function

- 1 A(n) ____ is the most basic unit of all living things.
- 2 The job that an organ does is the ____ of that organ.
- 3 Ribosomes and mitochondria are types of ____.
- 4 A(n) ____ is an organism whose cells have a nucleus.
- 5 A group of cells working together to perform a specific function is a(n) ____.
- 6 Only plant cells have a(n) ____.

UNDERSTANDING KEY IDEAS

Multiple Choice

- 7 Which of the following best describes an organ?
 - a. a group of cells that work together to perform a specific job
 - b. a group of tissues that belong to different systems
 - c. a group of tissues that work together to perform a specific job
 - d. a body structure, such as muscles or lungs
- 8 The benefits of being multicellular include
 - a. small size, long life, and cell specialization.
 - b. generalized cells, longer life, and ability to prey on small animals.
 - c. larger size, more enemies, and specialized cells.
 - d. longer life, larger size, and specialized cells.
- 9 In eukaryotic cells, which organelle contains the DNA?
 - a. nucleus
 - b. Golgi complex
 - c. smooth ER
 - d. vacuole
- 10 Which of the following statements is part of the cell theory?
 - a. All cells suddenly appear by themselves.
 - b. All cells come from other cells.
 - c. All organisms are multicellular.
 - d. All cells have identical parts.
- 11 The surface area-to-volume ratio of a cell limits
 - a. the number of organelles that the cell has.
 - b. the size of the cell.
 - c. where the cell lives.
 - d. the types of nutrients that a cell needs.
- 12 Two types of organisms whose cells do not have a nucleus are
 - a. prokaryotes and eukaryotes.
 - b. plants and animals.
 - c. bacteria and archaea.
 - d. single-celled and multicellular organisms.

Short Answer

- 13 Explain why most cells are small.
- 14 Describe the four levels of organization in living things.
- 15 What is the difference between the structure of an organ and the function of the organ?
- 16 Name two functions of a cell membrane.
- 17 What are the structure and function of the cytoskeleton in a cell?

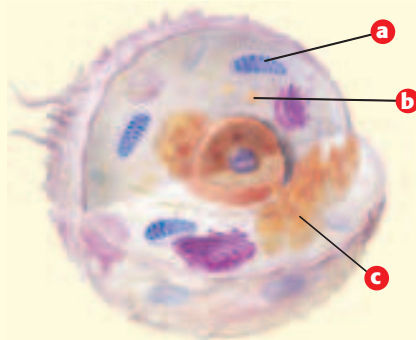
CRITICAL THINKING

- 18 **Concept Mapping** Use the following terms to create a concept map: *cells, organisms, Golgi complex, organ systems, organs, nucleus, organelle, and tissues.*
- 19 **Making Comparisons** Compare and contrast the functions of the endoplasmic reticulum and the Golgi complex.
- 20 **Identifying Relationships** Explain how the structure and function of an organism's parts are related. Give an example.
- 21 **Evaluating Hypotheses** One of your classmates states a hypothesis that all organisms must have organ systems. Is your classmate's hypothesis valid? Explain your answer.
- 22 **Predicting Consequences** What would happen if all of the ribosomes in your cells disappeared?

- 23 **Expressing Opinions** Scientists think that millions of years ago the surface of the Earth was very hot and that the atmosphere contained a lot of methane. In your opinion, which type of organism, a bacterium or an archaeon, is the older form of life? Explain your reasoning.

INTERPRETING GRAPHICS

Use the diagram below to answer the questions that follow.



- 24 What is the name of the structure identified by the letter *a*?
- 25 Which letter identifies the structure that digests food particles and foreign invaders?
- 26 Which letter identifies the structure that makes proteins, lipids, and other materials and that contains tubes and passageways that enable substances to move to different places in the cell?



Standardized Test Preparation

READING

Read each of the passages below. Then, answer the questions that follow each passage.

Passage 1 Exploring caves can be dangerous but can also lead to interesting discoveries. For example, deep in the darkness of Cueva de Villa Luz, a cave in Mexico, are slippery formations called *snottites*. They were named snottites because they look just like a two-year-old's runny nose. If you use an electron microscope to look at them, you see that snottites contain prokaryotes; thick, sticky fluids; and small amounts of minerals produced by the prokaryotes. As tiny as they are, these prokaryotes can build up snottite structures that may eventually turn into rock. Formations in other caves look like hardened snottites. The prokaryotes in snottites are acidophiles. Acidophiles live in environments that are highly acidic. Snottite prokaryotes produce sulfuric acid and live in an environment that is similar to the inside of a car battery.

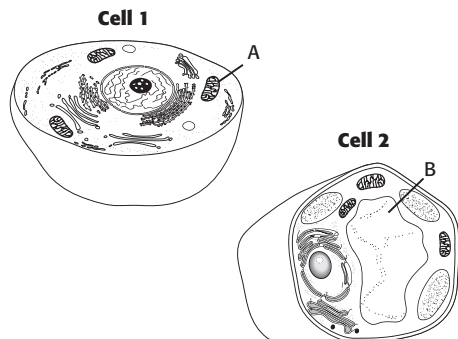
- Which statement best describes snottites?
 - Snottites are prokaryotes that live in car batteries.
 - Snottites are rock formations found in caves.
 - Snottites were named for a cave in Mexico.
 - Snottites are made of prokaryotes, sticky fluids, and minerals.
- Based on this passage, which conclusion about snottites is most likely to be correct?
 - Snottites are found in caves everywhere.
 - Snottite prokaryotes do not need sunlight.
 - You could grow snottites in a greenhouse.
 - Snottites create prokaryotes in caves.
- What is the main idea of this passage?
 - Acidophiles are unusual organisms.
 - Snottites are strange formations.
 - Exploring caves is dangerous.
 - Snottites are slippery prokaryotes.

Passage 2 The world's smallest mammal may be a bat about the size of a jelly bean. The scientific name for this tiny animal, which was unknown until 1974, is *Craseonycteris thonglongyai*. It is so small that it is sometimes called the *bumblebee bat*. Another name for this animal is the *hog-nosed bat*. Hog-nosed bats were given their name because one of their distinctive features is a piglike muzzle. Hog-nosed bats differ from other bats in another way: they do not have a tail. But, like other bats, hog-nosed bats do eat insects that they catch in mid-air. Scientists think that the bats eat small insects that live on the leaves at the tops of trees. Hog-nosed bats live deep in limestone caves and have been found in only one country, Thailand.

- According to the passage, which statement about hog-nosed bats is most accurate?
 - They are the world's smallest animal.
 - They are about the size of a bumblebee.
 - They eat leaves at the tops of trees.
 - They live in hives near caves in Thailand.
- Which of the following statements describes distinctive features of hog-nosed bats?
 - The bats are very small and eat leaves.
 - The bats live in caves and have a tail.
 - The bats live in Thailand and are birds.
 - The bats have a piglike muzzle and no tail.
- From the information in this passage, which conclusion is most likely to be correct?
 - Hog-nosed bats are similar to other bats.
 - Hog-nosed bats are probably rare.
 - Hog-nosed bats can sting like a bumblebee.
 - Hog-nosed bats probably eat fruit.

INTERPRETING GRAPHICS

The diagrams below show two kinds of cells. Use these cell diagrams to answer the questions that follow.

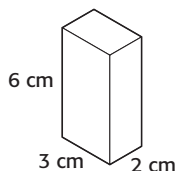


- What is the name of the organelle labeled A in Cell 1?
 - endoplasmic reticulum
 - mitochondrion
 - vacuole
 - nucleus
- What type of cell is Cell 1?
 - a bacterial cell
 - a plant cell
 - an animal cell
 - a prokaryotic cell
- What is the name and function of the organelle labeled B in Cell 2?
 - The organelle is a vacuole, and it stores water and other materials.
 - The organelle is the nucleus, and it contains the DNA.
 - The organelle is the cell wall, and it gives shape to the cell.
 - The organelle is a ribosome, where proteins are put together.
- What type of cell is Cell 2? How do you know?
 - prokaryotic; because it does not have a nucleus
 - eukaryotic; because it does not have a nucleus
 - prokaryotic; because it has a nucleus
 - eukaryotic; because it has a nucleus

MATH

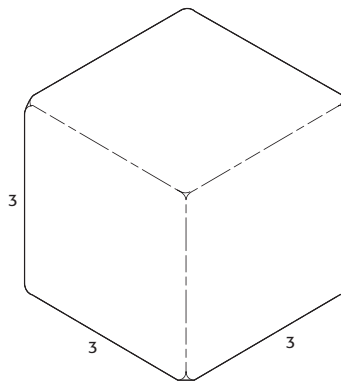
Read each question below, and choose the best answer.

- What is the surface area-to-volume ratio of the rectangular solid shown in the diagram below?



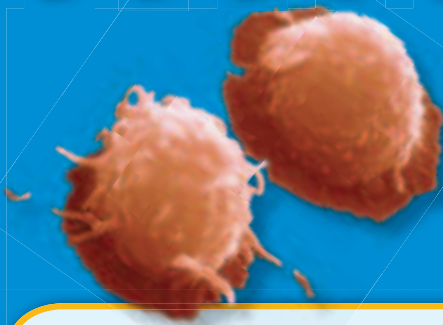
- 0.5:1
- 2:1
- 36:1
- 72:1

- Look at the diagram of the cell below. Three molecules of food per cubic unit of volume per minute are required for the cell to survive. One molecule of food can enter through each square unit of surface area per minute. What will happen to this cell?



- The cell is too small, and it will starve.
- The cell is too large, and it will starve.
- The cell is at a size that will allow it to survive.
- There is not enough information to determine the answer.

Science in Action



Scientific Discoveries

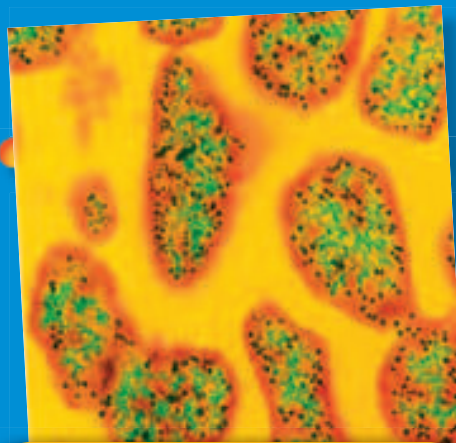
Discovery of the Stem Cell

What do Parkinson's disease, diabetes, aplastic anemia, and Alzheimer's disease have in common? All of these diseases are diseases for which stem cells may provide treatment or a cure. Stem cells are unspecialized cells from which all other kinds of cells can grow. And research on stem cells has been going on almost since microscopes were invented. But scientists have been able to culture, or grow, stem cells in laboratories for only about the last 20 years. Research during these 20 years has shown scientists that stem cells can be useful in treating—and possibly curing—a variety of diseases.

Language Arts **ACTiViTy**

WRITING SKILL

Imagine that you are a doctor who treats diseases such as Parkinson's disease. Design and create a pamphlet or brochure that you could use to explain what stem cells are. Include in your pamphlet a description of how stem cells might be used to treat one of your patients who has Parkinson's disease. Be sure to include information about Parkinson's disease.



Weird Science

Extremophiles

Are there organisms on Earth that can give scientists clues about possible life elsewhere? Yes, there are! These organisms are called *extremophiles*, and they live where the environment is extreme. For example, some extremophiles live in the hot volcanic thermal vents deep in the ocean. Other extremophiles live in the extreme cold of Antarctica. But these organisms do not live only in extreme environments. Research shows that extremophiles may be abundant in plankton in the ocean. And not all extremophiles are archaea; some extremophiles are bacteria.

Social Studies **ACTiViTy**

Choose one of the four types of extremophiles. Do some research about the organism you have chosen and make a poster showing what you learned about it, including where it can be found, under what conditions it lives, how it survives, and how it is used.