2

Focus

Overview

In this section, students will learn the names and functions of the cell structures, called *organelles,* in a eukaryotic cell.

Bellringer

On the board, write the following:

List three differences between prokaryotic and eukaryotic cells. (Prokaryotic cells have circular DNA, no nucleus, and no membrane-covered organelles. Eukaryotic cells have linear DNA, a nucleus, and membrane-covered organelles.)

Motivate

Discussion — GENERAL

Cellular Activity Ask students if they can feel the flurry of activity within their cells that keeps them alive. (no; But even though students can't feel activity in the cells, they can feel the heat produced by cellular activity. Students are not likely to know this.)

Ask students how they know their cells are working. (The students are alive: they can breathe, digest food, and move.) LS **Logical/ Intrapersonal**

Answer to Reading Check

Plant, algae, and fungi cells have cell walls.

SECTION 2

Eukaryotic Cells

Most eukaryotic cells are small. For a long time after ce were discovered, scientists could not see what was going inside cells. They did not know how complex cells are.

Now, scientists know a lot about eukaryotic cells. These ce have many parts that work together and keep the cell aliv

READING WARM-UP

Objectives

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

Terms to Learn

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

Cell Wall

Some eukaryotic cells have cell walls. A **cell wall** is a rig structure that gives support to a cell. The cell wall is the oute most structure of a cell. Plants and algae have cell walls ma of cellulose (SEL yoo LOHS) and other materials. *Cellulose* is complex sugar that most animals can't digest.

The cell walls of plant cells allow plants to stand upright In some plants, the cells must take in water for the cell wal to keep their shape. When such plants lack water, the cell wal collapse and the plant droops. **Figure 1** shows a cross sectic of a plant cell and a close-up of the cell wall.

Fungi, including yeasts and mushrooms, also have cell wal Some fungi have cell walls made of *chitin* (KIE tin). Oth fungi have cell walls made from a chemical similar to chiti Eubacteria and archaebacteria also have cell walls, but tho walls are different from plant or fungal cell walls.

Reading Check What types of cells have cell walls? (*See the Appendix for answers to Reading Checks.*)

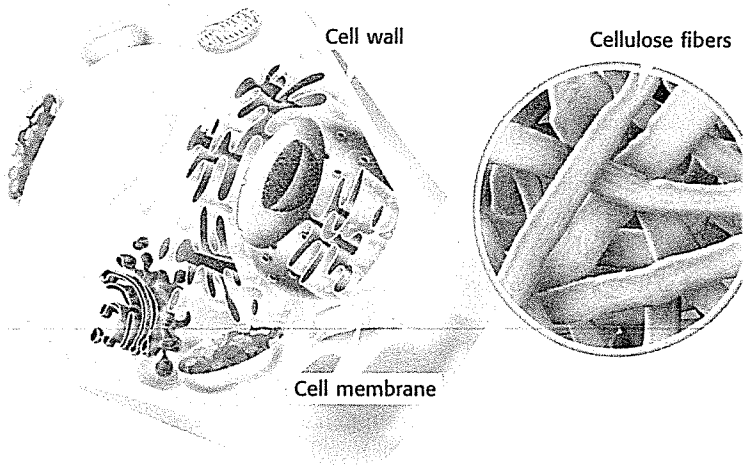


Figure 1 *The cell walls of plant cells help plants retain their shape. Plant cell walls are made of cellulose.*

CHAPTER RESOURCES

Chapter Resource File

- Lesson Plan
- Directed Reading A BASIC
- Directed Reading B SPECIAL NEEDS

Technology

Transparencies
- Bellringer

MISCONCEPTION ALERT

Cells Are Three-Dimensional Students often think of cells as flat. Looking at pictures and even viewing cells in a microscope can reinforce that misconception. Make sure that students understand that even though most cells are very small, they do have three dimensions, and they do take up space.

:ell Membrane

ll cells have a cell membrane. The *cell membrane* is a protective arrier that encloses a cell. It separates the cell's contents from ıe cell's environment. The cell membrane is the outermost :ructure in cells that lack a cell wall. In cells that have a cell 'all, the cell membrane lies just inside the cell wall.

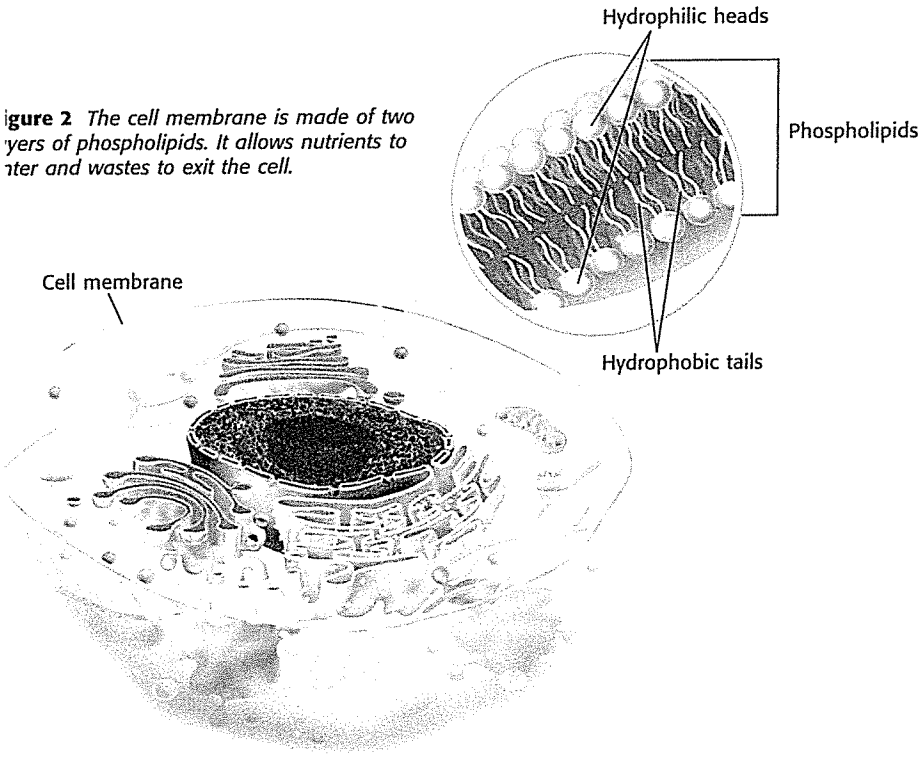
The cell membrane contains proteins, lipids, and phospho-pids. *Lipids,* which include fats and cholesterol, are a group of ɔmpounds that do not dissolve in water. The cell membrane has vo layers of phospholipids (FAHS foh LIP idz), shown in **Figure 2.** A *hospholipid* is a lipid that contains phosphorus. Lipids are "water :aring," or *hydrophobic.* Lipid ends of phospholipids form the ıner part of the membrane. Phosphorus-containing ends of the hospholipids are "water loving," or *hydrophilic.* These ends form ıe outer part of the membrane.

Some of the proteins and lipids control the movement of ıaterials into and out of the cell. Some of the proteins form assageways. Nutrients and water move into the cell, and wastes ıove 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.



igure 2 *The cell membrane is made of two 'yers of phospholipids. It allows nutrients to ıter and wastes to exit the cell.*

Homework — GENERAL

Poster Project Have students investigate red blood cells and create a poster comparing red blood cells with other human cells. (RBCs are the only cells in the human body that do not have a nucleus or mitochondria when they are mature. Without a nucleus, RBCs cannot divide and reproduce. They live for only about 120 days, but new RBCs are made by bone marrow at the rate of up to 200 billion per day.) LS **Visual**

Answer to Reading Check

A cell membrane encloses the cell and separates and protects the cell's contents from the cell's environment. The cell membrane also controls movement of materials into and out of the cell.

Teach

Demonstration — BASIC

Cell Walls and Cell Membranes

Using a stick and your own hand, you can illustrate the difference between a rigid cell wall, found in plant cells, and a flexible cell membrane, found in human skin cells. Bend the stick, and it will break. Make a fist, and your skin stretches to accommodate the flexing of muscles and bone joints. If we had rigid cell walls, we would find moving extremely difficult. English Language Learners

LS **Visual**

ACTIVITY — BASIC

MATERIALS

FOR EACH GROUP

- food strainer, wire mesh
- gravel (such as gravel used to line aquaria), 250 mL
- marbles (or pebbles), 250 mL
- pan (to place under strainer)
- sand, 250 mL
- water, 250 mL

Cellular Sieve Have students place each material into the strainer, and have them observe and explain the results. Lead students to understand that a cell membrane functions somewhat like the strainer. The cell membrane lets some materials pass through but not others. Also, explain that the process works in both directions.

Teacher's Note: The effects demonstrated by this Activity also apply to the membranes of organelles within the cell.

LS **Kinesthetic/Visual**

Teach, continued

ACTIVITY — BASIC

Drawing Cells Arrange students in pairs. Tell each pair to draw a plant or animal cell based on information presented in the tet. Instruct students not to label the cell's parts. Then, have students echange drawings with another pair. Students should put the proper labels on their classmates' picture. inally , have each group of two pairs compare and discuss each other's work. **Visual/Interpersonal**

Answer to Reading Check

The cytoskeleton is a web of proteins in the cytoplasm. It gives the cell support and structure.

Physical Science — GENERAL

Studying Cells Biophysics uses tools and techniues of physics to study the life processes of cells. Biophysicists are interested in the relationship between a molecule's structure and its function. Sophisticated techniues, such as electron microscopy, -ray diffraction, magnetic resonance spectroscopy, and electrophoresis, allow biophysicists to study the structure of proteins, nucleic acids, and even parts of cells, such as ribosomes. se the teaching transparency Structural ormulas to illustrate molecular structure.
Visual

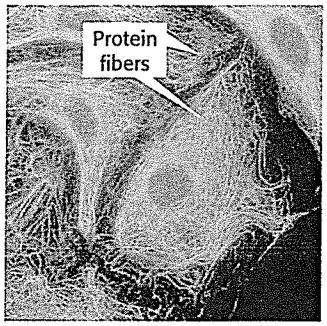


Figure 3 *The cytoskeleton, made of protein fibers, helps a cell retain its shape, move in its environment, and move its organelles.*

Cytoskeleton

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

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

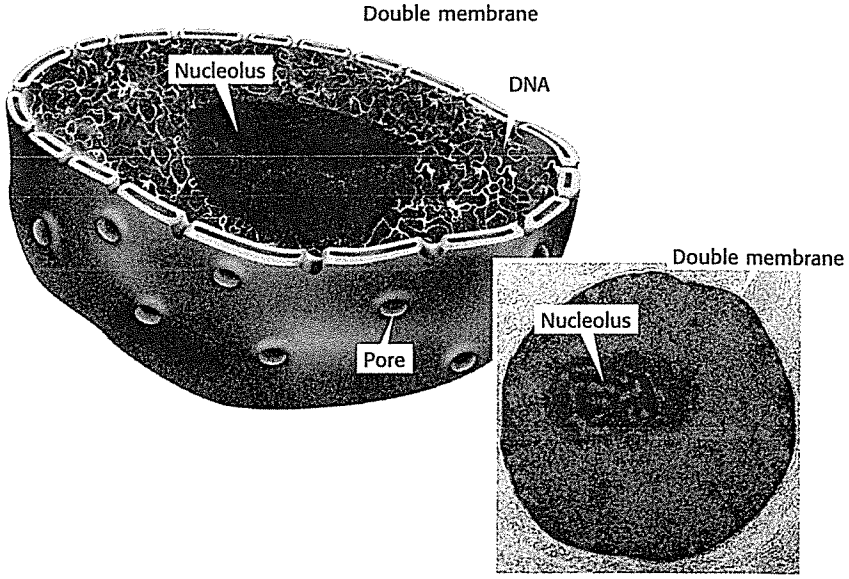
Reading Check What is the cytoskeleton?

Nucleus

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

The nucleus is covered by two membranes. Materials cros this double membrane by passing through pores. **Figure 4** show a nucleus and nuclear pores. The nucleus of many cells has dark area called the nucleolus (noo KLEE uh luhs). The *nucleolu* 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.*



CHAPTER RESOURCES

Technology

Transparencies
- *LINK TO PHYSICAL SCIENCE* Structural Formulas

Strategies

- *Developmentally Delayed*
- *Attention Deficit Disorder*
- *Behavior Control Issues*

ave si volunteers line up at the front of the room. Then, write AB order on the board, and ask students to line up correctly. Net, add by last letter of first name, and ask them to line up correctly . Discuss that having DNA in cells is like having complete, specific directions. **Kinesthetic** English Language Learners

ibosomes

:ganelles that make proteins are called **ribosomes.** Ribosomes e the smallest of all organelles. And there are more ribosomes a cell than there are any other organelles. Some ribosomes)at freely in the cytoplasm. Others are attached to membranes the cytoskeleton. Unlike most organelles, ribosomes are not vered by a membrane.

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

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

ndoplasmic Reticulum

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

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

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

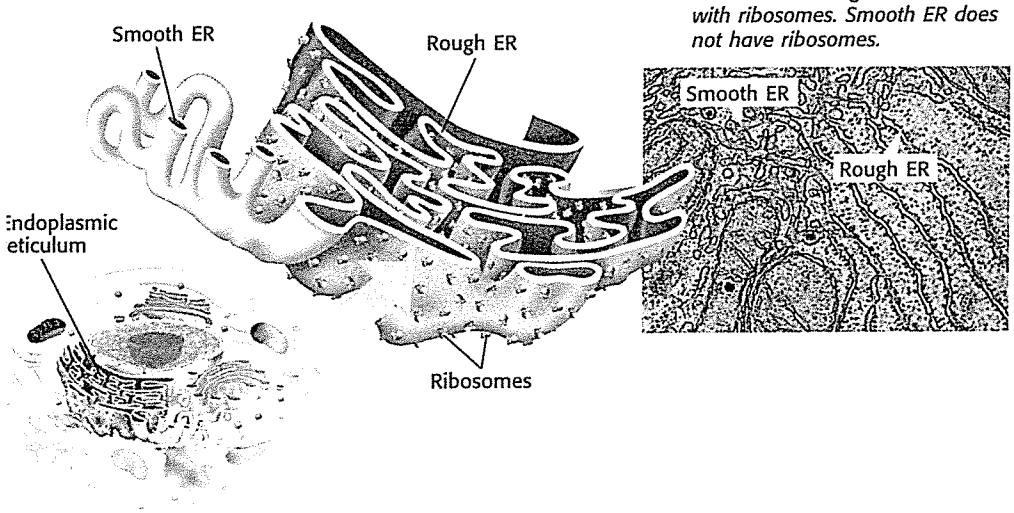


Figure 5 *The endoplasmic reticulum (ER) is a system of membranes. Rough ER is covered with ribosomes. Smooth ER does not have ribosomes.*

Homework — GENERAL

Cell Search Have students search the Internet for images (photomicrographs) of cells. Encourage students to compare images of cells from different types of organisms. Also, have students compare images of the same type of cell made by different microscopes, such as light microscopes, scanning electron microscopes, and transmission electron microscopes. Have students describe the cells that they find. LS **Logical/Visual**

ACTIVITY — GENERAL

Cell Models Students will be making edible models of cells. Students can bring edible items for the cell wall or cell membrane, such as crackers or pita bread. They can also bring items to represent organelles within the cell, such as small pieces of different kinds of candy (the hard candy shell on some candies may represent an organelle's membrane), olives, or other items. Have students explain the way they have represented the cell's structure in food. Pictures of the edible cells can be displayed in the classroom. English Language Learners

LS **Kinesthetic**

CONNECTION to *Chemistry* — ADVANCED

Ribosome Structure Ribosomes make proteins. The structure of ribosomes has been intensely studied. Scientists now know how ribosome structure relates to ribosome function. Have students research and report on how ribosomes work. Their report should include a diagram of ribosome structure and its relationship to ribosome function. LS **Verbal/Visual**

CONNECTION to *Language Arts* — ADVANCED

No Energy? Mitochondrial diseases are a group of illnesses caused by malfunctioning mitochondria. These diseases can be caused by genes in the mitochondria or genes in the cell. Any activity or organ that requires energy is affected by these diseases. Have students conduct Internet or library research on mitochondrial diseases. Have them create a brochure or a pamphlet explaining one or more of these diseases. (Interested students may want to read *A Wind in the Door,* by Madeleine L'Engle, which is a story about a little boy with mitochondrial disease.) LS **Verbal**

Teach, continued

READING STRATEGY — GENERAL

Prediction Guide Before students read this page, ask them if the following statement is true or false: Animal cells are completely different from plant cells. (false; Animal cells and plant cells have many features in common, such as membrane-covered organelles and a cell membrane. The main difference between animal and plant cells is that animal cells do not have a cell wall and they do not have chloroplasts and chlorophyll.)

Have students explain their answer. Then, have them evaluate their answer after they read the page. LS **Logical**

Answer to Reading Check

Most of a cell's ATP is made in the cell's mitochondria.

CONNECTION to *Language Arts* — ADVANCED

Writing **Far-Out Fiction** Have students write a story about an animal whose cells are invaded by chloroplasts. Students should describe how the animal's life processes at the cellular level would be affected. Students may also describe how the animal might use this chloroplast invasion to its advantage. Encourage students to write about an animal other than a mammal (corals might be an interesting subject). LS **Verbal/Logical**

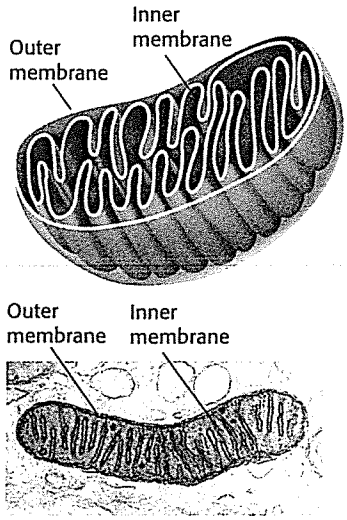


Figure 6 *Mitochondria break down sugar and make ATP. ATP is produced on the inner membrane.*

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

Mitochondria

A mitochondrion (MIET oh KAHN dree uhn) is the ma power source of a cell. A **mitochondrion** is the organe in which sugar is broken down to produce energy. Mit chondria are covered by two membranes, as shown **Figure 6.** Energy released by mitochondria is stored in substance called *ATP* (adenosine triphosphate). The c then uses ATP to do work. ATP can be made at seve places in a cell. But most of a cell's ATP is made in t inner membrane of the cell's mitochondria.

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

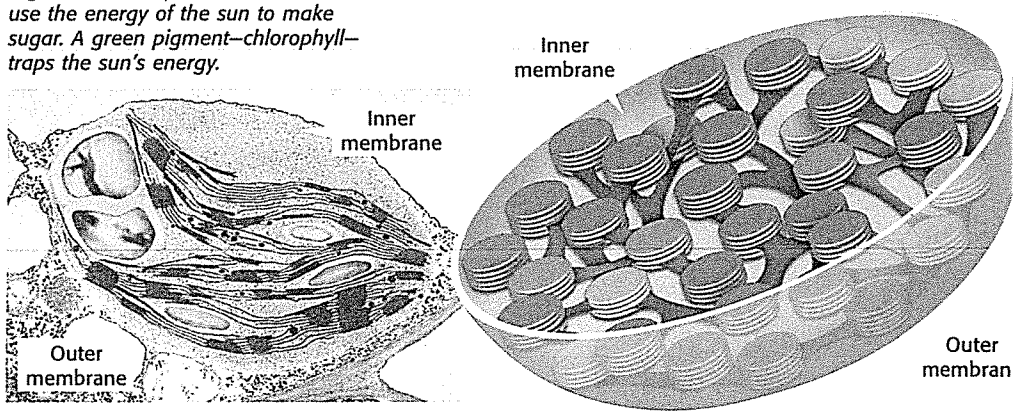
Reading Check Where is most of a cell's ATP made?

Chloroplasts

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

Chloroplasts are green because they contain *chlor phyll,* a green pigment. Chlorophyll is found inside t inner membrane of a chloroplast. Chlorophyll traps t energy of sunlight, which is used to make sugar. T sugar produced by photosynthesis is then used by mit chondria to make ATP.

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



SCIENTISTS AT ODDS

Acquiring Genomes Dr. Lynn Margulis knew that mitochondria and chloroplasts have their own DNA and divide by binary fission. She proposed that these organelles were once bacteria that entered organisms and became parts of those cells. Other scientists disagreed, but research proved Dr. Margulis right. Now, Margulis proposes that all eukaryotes developed as a result of genetic mergers between different kinds of organisms. And other scientists disagree. Only more research will settle the debate.

Is That a Fact!

About 100 eukaryotic species do not have mitochondria. *Giardia* is a freshwater protist that lacks mitochondria. *Giardia* can make people sick if they drink water from an infected lake or stream.

olgi Complex

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

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

ell Compartments

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

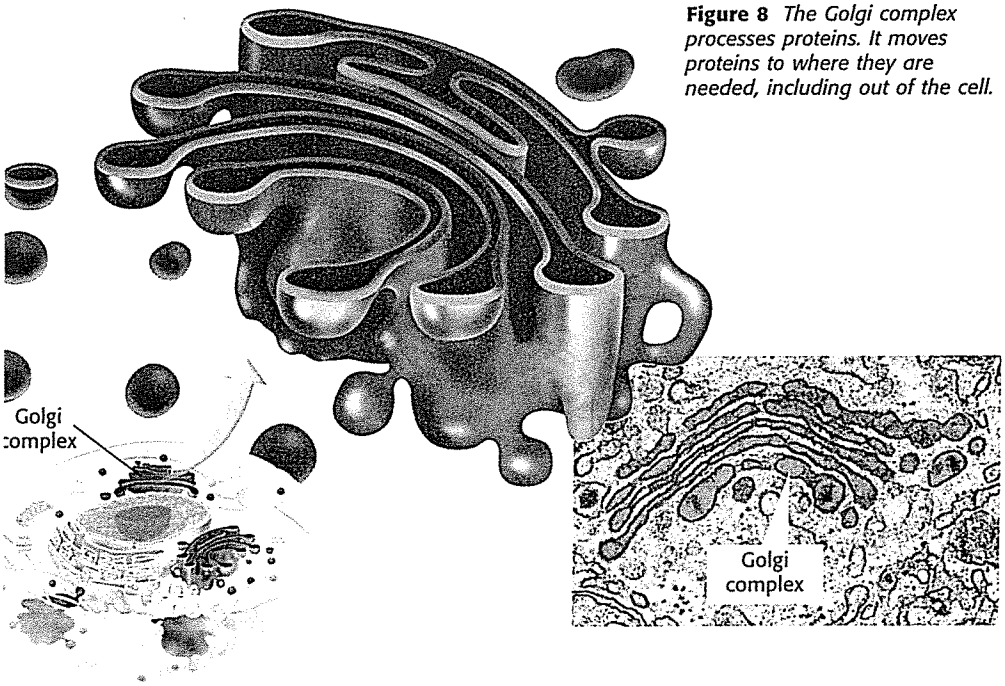


Figure 8 *The Golgi complex processes proteins. It moves proteins to where they are needed, including out of the cell.*

SCIENTISTS AT ODDS

Is It There or Not? Many scientists did not believe Golgi's claims about the organelle he observed and described. Those scientists thought that Golgi just saw tiny globs of the staining material. The existence of the organelle that was eventually named the *Golgi complex* was finally confirmed in the mid-1950s with the aid of the electron microscope.

Cultural Awareness — GENERAL

Golgi and His Organelle Camillo Golgi was born in 1843 in the small town Corteno, in the northern Italian province of Lombardy. He received a medical degree in 1865. Although he was a psychiatrist, he was interested in the microscopic nature of the nervous system. He discovered the "black reaction," which is a method of staining tissue using silver nitrate so that the tissue can be viewed clearly with a microscope. In 1897, using this method, Golgi saw the cellular structures we know today as the Golgi complex. For his work, Golgi shared the Nobel Prize for Medicine in 1906. Golgi died in 1926 at the age of 83. LS **Verbal**

Homework — GENERAL

Writing **Ornery Organelles** The organelles in a cell are rebelling against the nucleus. They all think that they work too hard, and they want to take a vacation. Have students write a dialogue between the nucleus and the other organelles. Tell students to help each organelle present a case for why it needs a rest, and then have the nucleus explain what would happen if even one of them took time off. LS **Verbal/Logical** PORTFOLIO

Close

Reteaching — BASIC

Organelles and Their Functions Give students a table similar to the table on this page, but leave the boxes blank. Have students work in pairs to fill in both the illustrations and the text of the table. LS Interpersonal/Visual

Quiz — GENERAL

1. Why do scientists sometimes say that some plant cell vesicles are just large lysosomes? (because these vesicles store digestive enzymes and aid in cellular digestion)
2. What is the difference between the cytoskeleton and the cytoplasm? (The cytoplasm is the fluid—and almost all of its contents—inside a cell, and the cytoskeleton is a web of proteins in the cytoplasm that gives the cell shape and may help the cell move.)

Alternative Assessment — GENERAL

Cell Model Have students create a cell using a shoe box for the cell wall. Any material readily available can be used for the cell parts. Parts can be hung on a string, glued to the box, or attached by any method the student chooses. The boxes can be displayed in the classroom. English Language Learners LS Kinesthetic

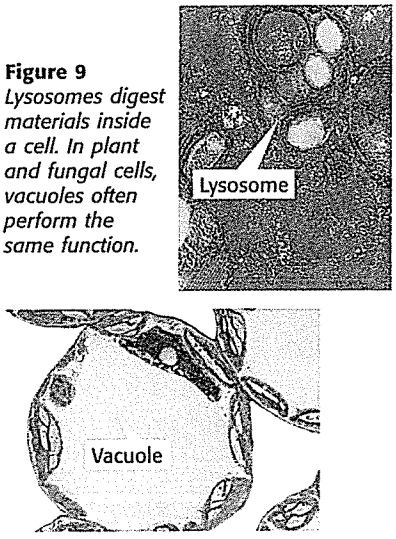


Figure 9 *Lysosomes digest materials inside a cell. In plant and fungal cells, vacuoles often perform the same function.*

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 large vesicle. In plant and fungal cells, some vacuoles act like large lysosomes. They store digestive enzymes and aid in digestion within the cell. Other vacuoles in plant cells store water and other liquids. Vacuoles that are full of water, such as the one in **Figure 9,** help support the cell. Some plants wilt when their vacuoles lose water. **Table 1** shows some organelles and their functions.

Table 1 Organelles and Their Functions

Nucleus the organelle that contains the cell's DNA and is the control center of the cell	**Chloroplast** the organelle that uses the energy of sunlight to make food
Ribosome the organelle in which amino acids are hooked together to make proteins	**Golgi complex** the organelle that processes and transports proteins and other materials out of cell
Endoplasmic reticulum the organelle that makes lipids, breaks down drugs and other substances, and packages proteins for Golgi complex	**Vacuole** the organelle that stores water and other materials
Mitochondria the organelle that breaks down food molecules to make ATP	**Lysosome** the organelle that digests food particles, wastes, cell parts, and foreign invaders

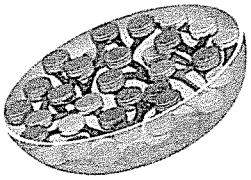
Answer to Reading Check

Lysosomes destroy worn-out organelles, attack foreign invaders, and get rid of waste material from inside the cell.

ACTIVITY — BASIC

Vacuole Model You can make a demonstration model of a vacuole within a cell by filling a balloon with water or air and putting it inside a clear plastic storage bag. Show that the vacuole is part of the cell and is distinct within the cell. You can demonstrate that cells are full of motion and activity by moving the balloon around inside the bag. English Language Learners LS Visual

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 energy-producing organelles.
- Lysosomes are organelles responsible for digestion within a cell. In plant cells, organelles called *vacuoles* store cell materials and sometimes act like large lysosomes.

sing Key Terms

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

nderstanding Key Ideas

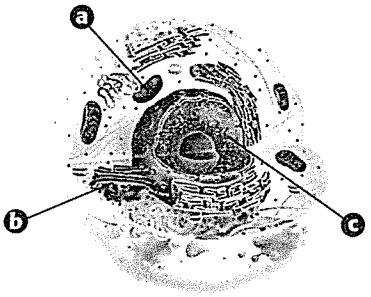
2. Which of the following are found mainly in animal cells?
   a. mitochondria
   b. lysosomes
   c. ribosomes
   d. Golgi complexes
3. What is the function of a Golgi complex? What is the function of the endoplasmic reticulum?

ritical 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?

SCILINKS. NSTA
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For a variety of links related to this chapter, go to www.scilinks.org

Topic: Eukaryotic Cells
SciLinks code: HSM0541

CHAPTER RESOURCES

Chapter Resource File

- Section Quiz GENERAL
- Section Review GENERAL
- Vocabulary and Section Summary GENERAL
- SciLinks Activity GENERAL

Technology

Transparencies
- Organelles and Their Functions

Answers to Section Review

1. Sample answer: Ribosomes are organelles where amino acids are joined together to make proteins. Lysosomes are organelles that carry out cellular digestion. The cell wall is the outermost structure in cells of plants, fungi, and algae.
2. b
3. Sample answer: Golgi complex: packages and distributes proteins within a cell; endoplasmic reticulum: a series of folded membranes on which lipids, proteins, and other materials are made, and through which those materials are delivered to other places in the cell
4. Sample answer: Plant cells have cell walls, but animal cells do not. Plant cells have chloroplasts, which animal cells do not have. Plant cells do not seem to have small lysosomes (they have large vacuoles instead), which animal cells do have.
5. Sample answer: Ribosomes are the organelles where proteins are made. All cells need protein in order to live.
6. Sample answer: Mitochondria are organelles that produce most of a cell's energy. If its mitochondria were destroyed, a cell would eventually die because it would not be able to produce enough energy to survive.
7. Sample answer: I think plants have an advantage over animals because plants can make their own food just by using sunlight and other nutrients. Animals have to wait for plants to grow in order to get food.
8. This diagram is of an animal cell; the first clue is that the cell has no cell wall.
9. the Golgi complex