SECTION 2

Eukaryotic Cells

Key Concept Eukaryotic cells have organelles that perform important functions.

What You Will Learn

- Eukaryotic cells have many parts–such as cell membranes, a nucleus, and ribosomes–in common.
- Plant cells and animal cells have some cell parts that are different.

Why It Matters

Learning how organelles function helps you know how cells stay alive.

Vocabulary

- cell wall
- cytoskeleton
- ribosome
- endoplasmic reticulum
- mitochondrion
- chloroplast
- Golgi complex
- vesicle
- lysosome

READING STRATEGY

Graphic Organizer In your **Science Journal,** make a Comparison Table that compares the structure, function, location in the cell, and presence in animal and plant cells of all the organelles discussed in this section.

Even though most cells are small, cells are complex. A eukaryotic cell has many parts that help the cell stay alive. Some eukaryotic cells can be classified as plant cells or animal cells. Compare the plant cell in **Figure 1** with the animal cell in **Figure 2** to see the differences between these two types of cells.

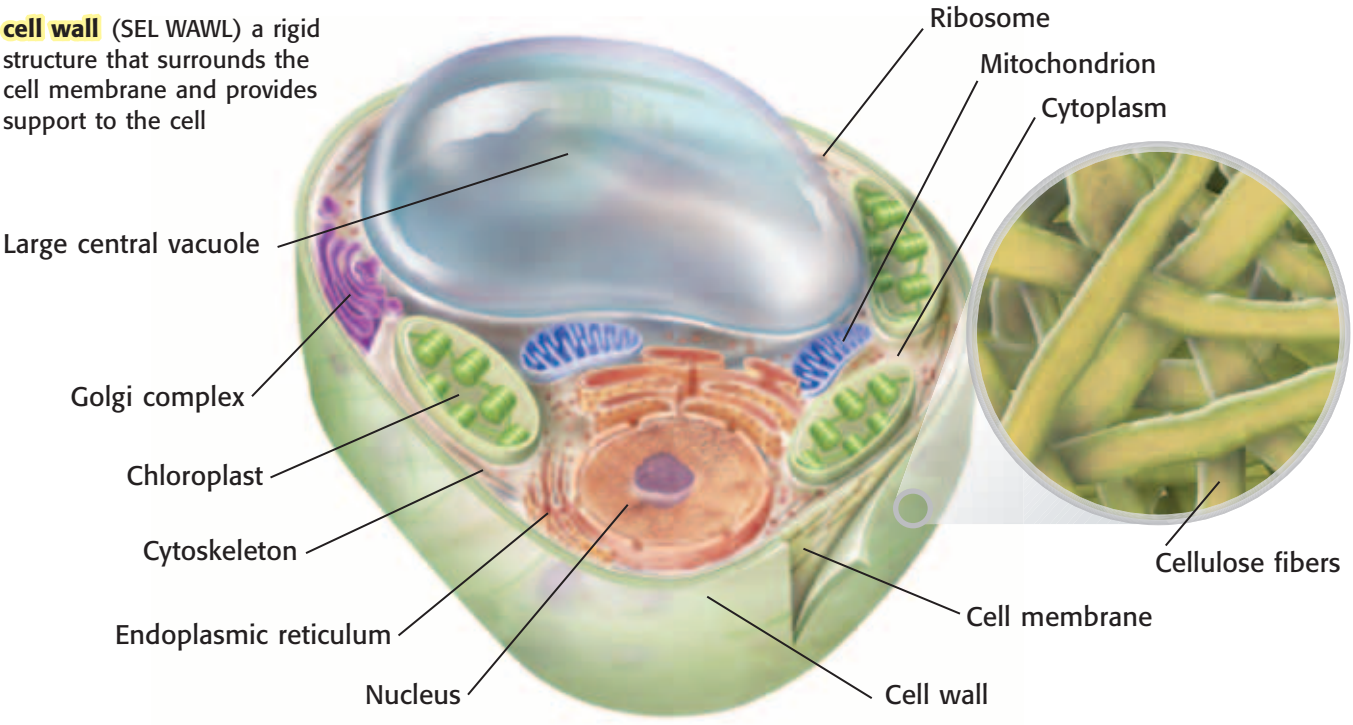
Cell Wall

Plant cells have an outermost structure called a **cell wall.** A cell wall is a rigid structure that gives support to a cell. The cell walls of plants, fungi, archaea, and bacteria can be made of different materials. For example, plants and algae have cell walls made of a complex sugar called *cellulose.* **Figure 1** shows the cellulose fibers in the cell wall of a plant cell. Animal cells do not have cell walls.

Standards Check **What is one characteristic that distinguishes plant cells from animal cells?** 7.1.b

cell wall (SEL WAWL) a rigid structure that surrounds the cell membrane and provides support to the cell

Figure 1 A Plant Cell



Cell Membrane

All cells have a cell membrane made up of proteins and lipids. 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 has two layers of phospholipids, shown in **Figure 2.** A *phospholipid* is a type of lipid. Each phospholipid has a *hydrophobic,* or "water fearing," end and a *hydrophilic,* or "water loving," end. The "water fearing" ends are on the inside of the cell membrane. The "water loving" ends form the outer part of the membrane. This structure makes it difficult for materials to pass through the membrane. Not allowing materials to pass through is one way the cell membrane protects the cell.

Some materials, such as nutrients and wastes, must pass through the cell membrane. These materials are able to pass through passageways made of proteins. Nutrients move into the cell—and wastes move out of the cell—through these protein passageways.

Standards Check **How does the cell membrane protect the cell?** 7.1.a

Quick Lab

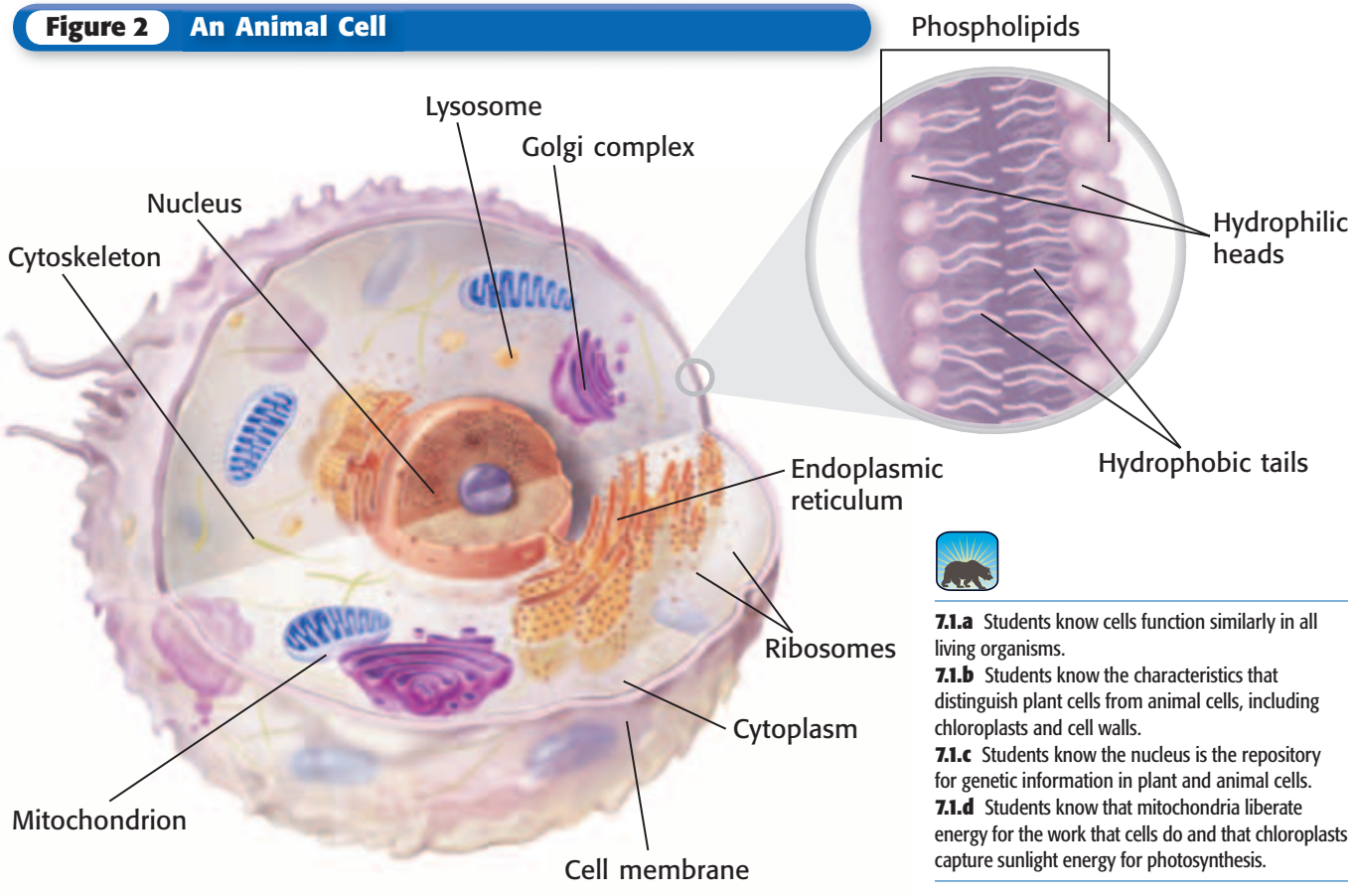
Cell Diagrams

7.1.b
7.7.d

1. Draw an outline of a plant cell and an animal cell on **separate pieces of paper.**
2. As you read about eukaryotic cells, use **colored pencils** to add the correct cell parts to each cell. Label the cell parts.
3. Which cell parts are found in both plant cells and animal cells?
4. Which cell parts are found either in plant cells or in animals cells but not in both types of cells?

20 min

Figure 2 **An Animal Cell**



7.1.a Students know cells function similarly in all living organisms.
7.1.b Students know the characteristics that distinguish plant cells from animal cells, including chloroplasts and cell walls.
7.1.c Students know the nucleus is the repository for genetic information in plant and animal cells.
7.1.d Students know that mitochondria liberate energy for the work that cells do and that chloroplasts capture sunlight energy for photosynthesis.

Figure 3 *The cytoskeleton is a network of protein fibers that anchors the cell's organelles and other components of its cytoplasm.*

Cytoskeleton

The **cytoskeleton** is a web of proteins in the cytoplasm of some cells. Both plant cells and animal cells have a cytoskeleton. Many of the organelles in cells are attached to the cytoskeleton, as **Figure 3** shows. In an animal cell, the cytoskeleton defines the shape of the cell because the cell does not have a cell wall. Different cells in your body have different shapes because of how their cytoskeleton is arranged.

The cytoskeleton is also used for movement. The cytoskeleton can help objects move around within the cell. Some organisms use their cytoskeleton to form structures that help the organisms move.

cytoskeleton (SIET oh SKEL uh tuhn) the cytoplasmic network of protein filaments that plays an essential role in cell movement, shape, and division

Nucleus

All eukaryotic cells have a membrane-bound nucleus. The *nucleus* is a large organelle in a eukaryotic cell. It contains the cell's DNA. DNA is the genetic material that 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 given by the DNA. These messages are then sent out of the nucleus through the membranes that surround it.

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

Standards Check **What is the function of the nucleus?** 7.1.c

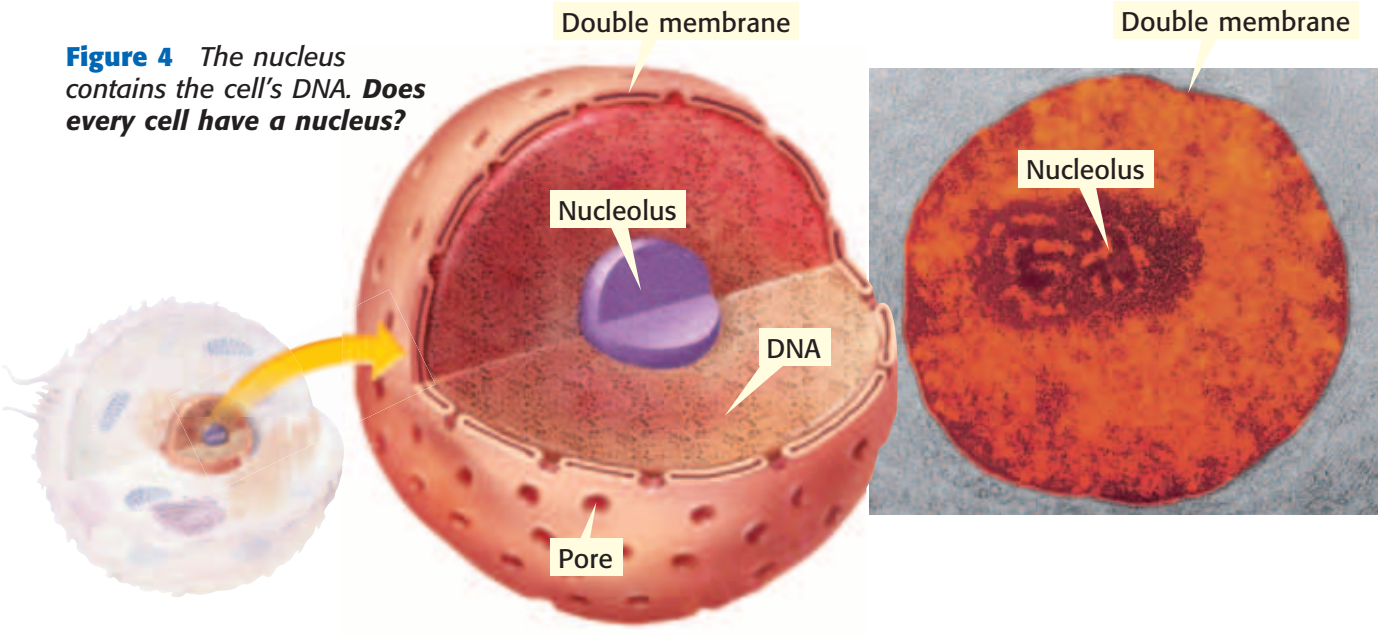


Figure 4 *The nucleus contains the cell's DNA.* ***Does every cell have a nucleus?***

Ribosomes

Organelles that make proteins are called **ribosomes.** Ribosomes are the smallest organelles. And there are more ribosomes than there are any other organelles in a cell. 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.

Ribosomes make proteins by assembling chains of amino acids. An *amino acid* is any of about 20 different organic molecules that are used to make proteins. All cells need proteins to live. Thus, all cells have ribosomes.

ribosome (RIE buh SOHM) a cell organelle composed of RNA and protein; the site of protein synthesis

endoplasmic reticulum (EN doh PLAZ mik ri TIK yuh luhm) 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

Endoplasmic Reticulum

Many chemical reactions take place in a cell. Many of these reactions happen on or in the endoplasmic reticulum. 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.

The endoplasmic reticulum is either rough or smooth. 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 then delivers these proteins throughout the cell. The 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.

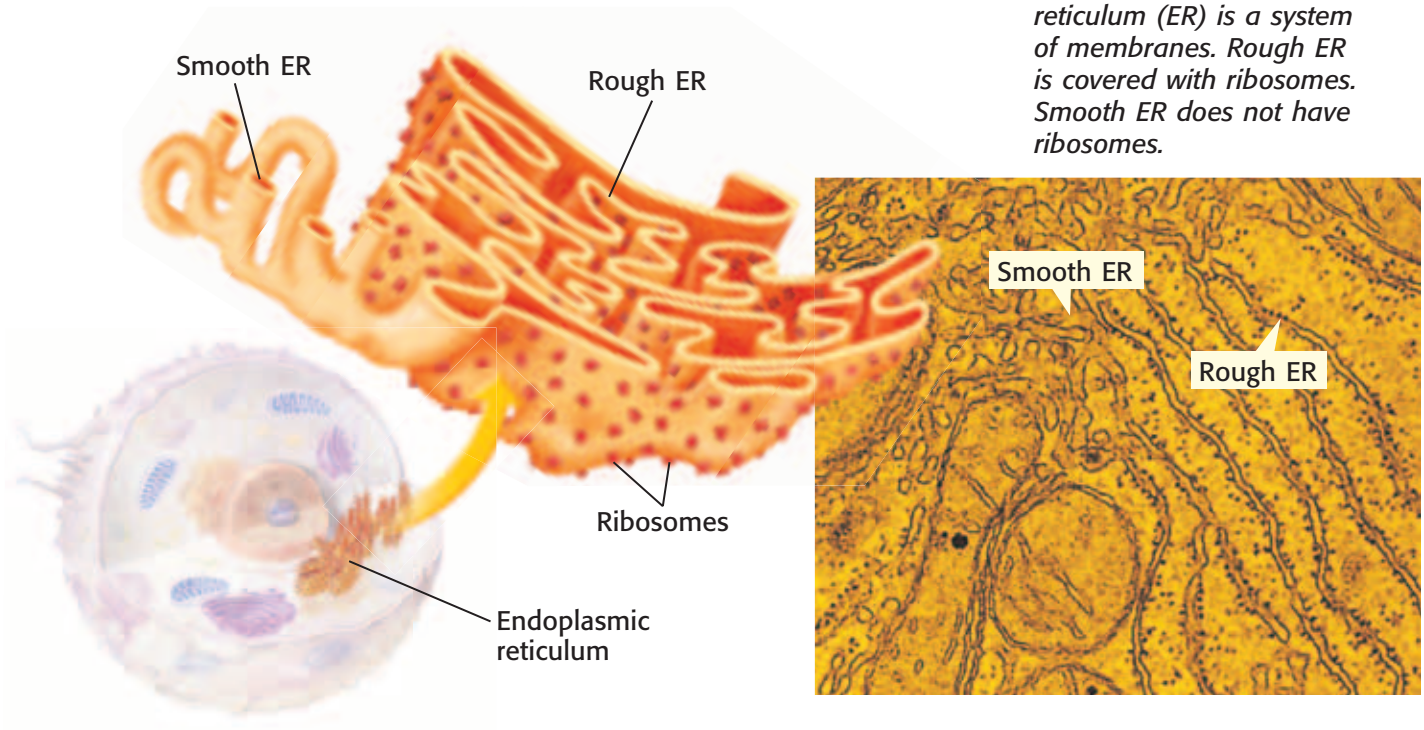


Figure 5 *The endoplasmic reticulum (ER) is a system of membranes. Rough ER is covered with ribosomes. Smooth ER does not have ribosomes.*

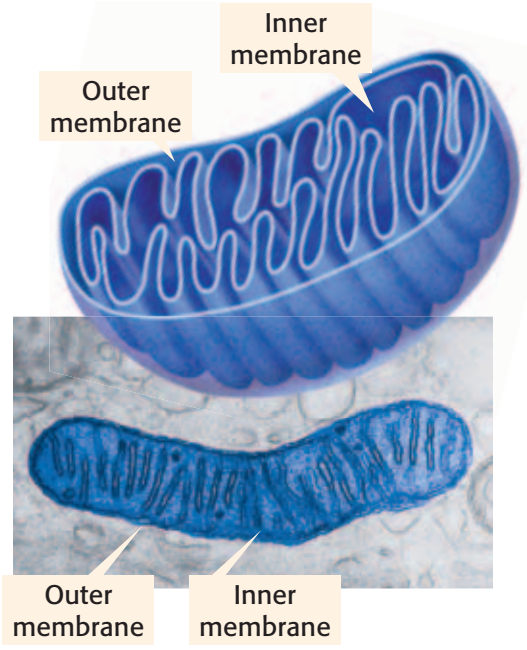


Figure 6 *Mitochondria break down sugar and make ATP. ATP is produced on the inner membrane.*

Mitochondria

A **mitochondrion** is the main power source of a cell. A mitochondrion is the organelle in which sugar is broken down to release energy. Mitochondria are covered by two membranes, as shown in **Figure 6.** Energy released by mitochondria is stored in a substance called *ATP* (**a**denosine **tri**phosphate). 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 on 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.

Standards Check **Why are mitochondria important for cells?** 7.1.d

mitochondrion (MIET oh KAHN dree uhn) in eukaryotic cells, the cell organelle that is surrounded by two membranes and that is the site of cellular respiration

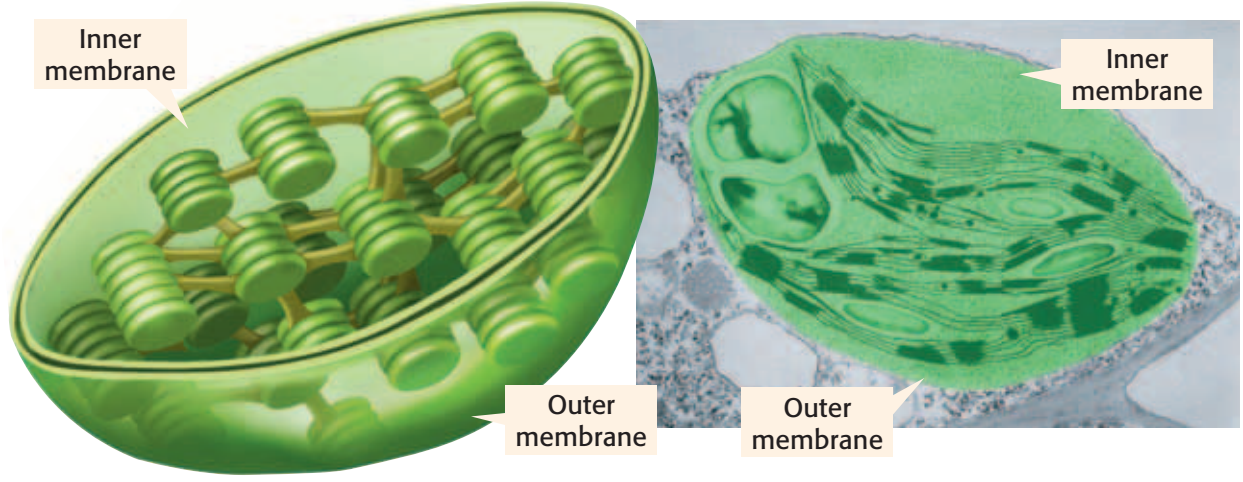
chloroplast (KLAWR uh PLAST) an organelle found in plant and algae cells where photosynthesis occurs

Chloroplasts

Animal cells cannot make their own food. Plant cells are different. Some of them have chloroplasts. **Chloroplasts** are organelles in which photosynthesis takes place. They are found in plant, algae, and some prokaryotic cells. Like mitochondria, chloroplasts have two membranes and their own DNA. A chloroplast is shown in **Figure 7.** *Photosynthesis* is the process by which cells, such as plant cells, use sunlight, carbon dioxide, and water to make sugar and oxygen.

Chloroplasts are green because they contain *chlorophyll,* a green pigment. Chlorophyll is found in an internal membrane system within a chloroplast. Chlorophyll traps the energy of sunlight. This energy is used to make sugar. The sugar produced by photosynthesis is then used by mitochondria to make ATP.

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



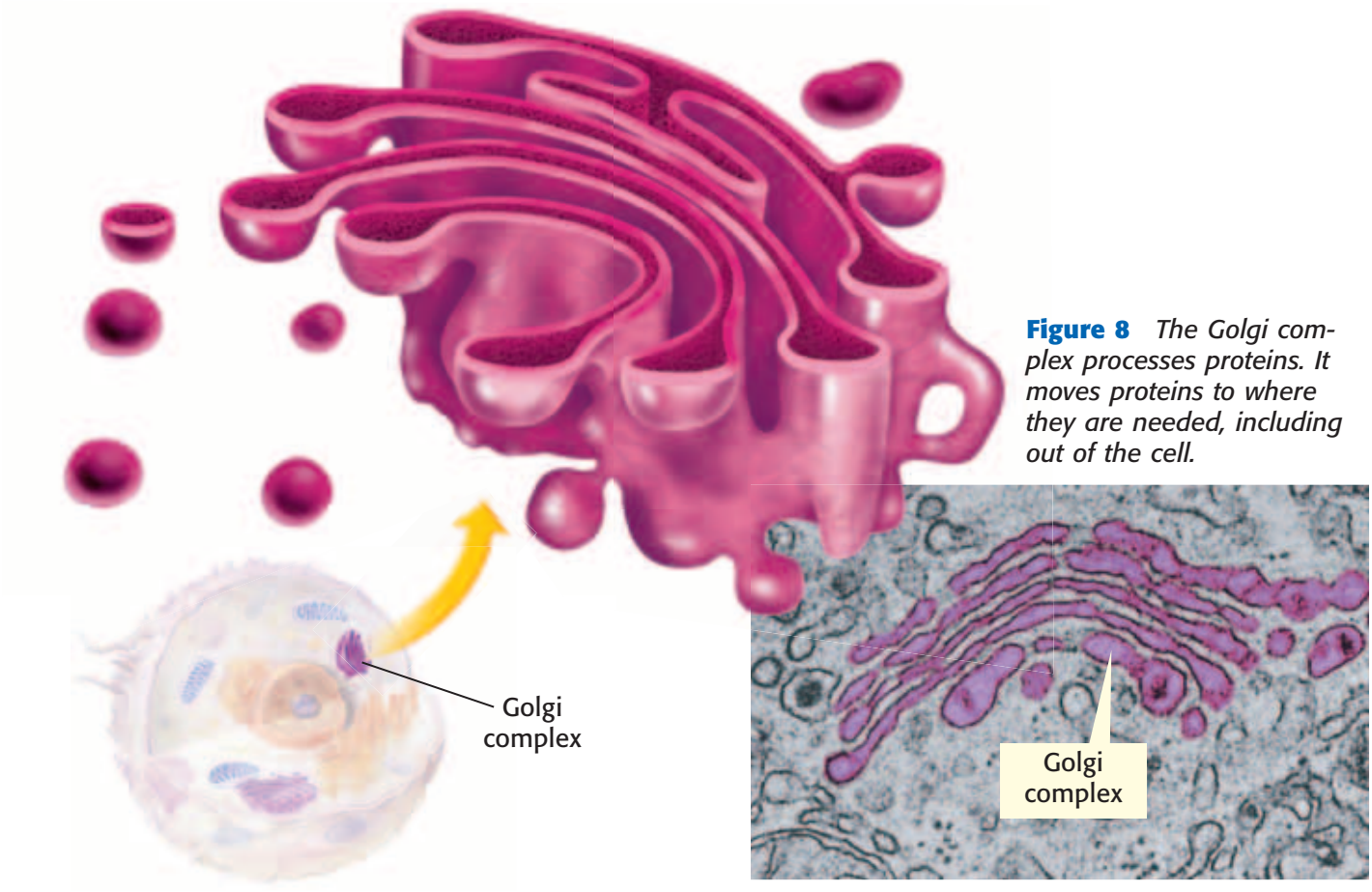


Figure 8 *The Golgi complex processes proteins. It moves proteins to where they are needed, including out of the cell.*

Golgi Complex

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

The Golgi complex, shown in **Figure 8,** looks like smooth ER. 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 (GOHL jee KAHM PLEKS) a cell organelle that helps make and package materials to be transported out of the cell

vesicle (VES i kuhl) a small cavity or sac that contains materials in a eukaryotic cell

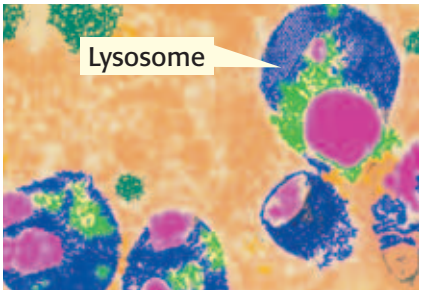
Cell Compartments

The bubble that forms from the Golgi complex's membrane is one example of a vesicle. A **vesicle** 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 proteins from the ER to the Golgi complex. Other vesicles carry material from the Golgi complex to other parts of the cell. Some vesicles form when part of the cell membrane surrounds an object that is outside the cell.

INTERNET ACTIVITY

Cell World

What would a cell look like from the inside? Create a brochure inviting tourists to visit various parts of the cell. Go to **go.hrw.com,** and type in the keyword HY7CELW.



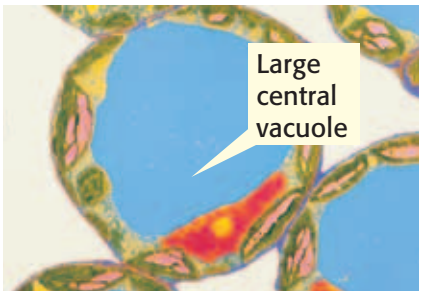


Figure 9 *Lysosomes digest materials inside a cell. In plant cells, the large central vacuole stores water.*

lysosome (LIE suh SOHM) a cell organelle that contains digestive enzymes

Lysosomes

Lysosomes are vesicles found mainly in animal cells. Lysosomes contain digestive enzymes. They are responsible for digestion inside a cell. Lysosomes destroy worn-out or damaged organelles, get rid of waste materials, and engulf foreign invaders. The foreign invaders are digested, and most of them are no longer harmful to the cell.

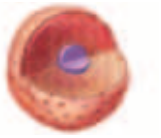
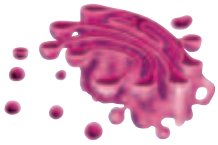
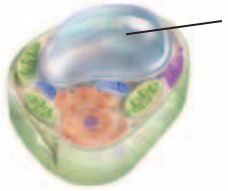
When eukaryotic cells engulf particles, they enclose the particles in vesicles. Lysosomes, shown in blue in **Figure 9,** bump into the vesicles, shown in purple, and pour enzymes into them. These enzymes digest the particles in the vesicles.

Standards Check **Why are lysosomes important?** 7.1.a

Vacuoles

A *vacuole* (VAK yoo OHL) is another type of vesicle found in cells. 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 a plant cell 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. Some organelles and their functions are shown in **Table 1.**

Table 1 Organelles and Their Functions

 **Nucleus** the organelle that contains the cell's DNA	 **Chloroplast** the organelle that uses sunlight, carbon dioxide, and water to make food
 **Ribosome** the organelle upon which amino acids are hooked together to make proteins	 **Golgi complex** the organelle that processes and transports materials within and out of the cell
 **Endoplasmic reticulum** the organelle that makes lipids, breaks down toxic substances, and packages proteins for the Golgi complex	 **Large central vacuole** the organelle that stores water and other materials
 **Mitochondrion** the organelle that breaks down food molecules to make ATP	 **Lysosome** the organelle that digests wastes, cell parts, and foreign invaders

SECTION Review

7.1.a, 7.1.b, 7.1.c, 7.1.d

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, the large central vacuole stores cell materials and sometimes acts like a large lysosome.
- Plant cells have cell parts that are not found in animal cells. Plant cells have cell walls, chloroplasts, and a large central vacuole.

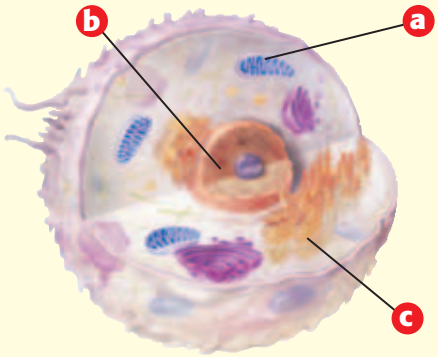
Using Vocabulary

1. Write an original definition for *mitochondria, nucleus,* and *cell wall.*

Understanding Concepts

2. **Listing** What are two functions of the cytoskeleton in animal cells?
3. **Describing** What is the function of the Golgi complex? What is the function of the endoplasmic reticulum?
4. **Comparing** Describe three ways in which plant cells differ from animal cells.
5. **Applying** Every cell needs ribosomes. Explain why.

INTERPRETING GRAPHICS Use the diagram below to answer the next two questions.



6. **Identifying** Is this a diagram of a plant cell or an animal cell? Explain how you know.
7. **Describing** What is the function of the organelle labeled "b"?

Critical Thinking

8. **Predicting Consequences** A certain virus attacks the mitochondria in cells. What would happen to a cell if all of its mitochondria were destroyed?
9. **Expressing Opinions** Do you think that having chloroplasts gives plant cells an advantage over animal cells? Support your opinion.

Math Skills

10. **Making Calculations** There are 11 foreign invaders and 4 lysosomes in Cell A. If it takes each lysosome 1 h to digest 1 foreign invader, how long will it take to digest all of the foreign invaders?

Challenge

11. **Making Inferences** Amoebas are single-celled eukaryotes. An amoeba moves by creating an extension of the cell. The cytoplasm from the rest of the cell flows into the extension. Given what you know about cell parts, determine which cell part inside of an amoeba is most likely used to make the extension.

Internet Resources

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

Topic: Eukaryotic Cells

SciLinks code: HY70541