LESSON 2

# Cell Structure

**READING TOOL** **Connect to Visuals** As you read, use the figures and diagrams to help you identify and describe each part of the cell, and what the function that part performs. Complete the graphic organizer.

| Cellular Structure | Form and Function |
|---|---|
| Nucleus | |
| Ribosomes | |
| Endoplasmic reticulum | |
| Golgi apparatus | |
| Vacuoles | |
| Lysosomes | |
| Cytoskeleton | |
| Chloroplasts | |
| Mitochondria | |
| Cell wall | |
| Cell membrane | |

# Lesson Summary

## Cell Organization

**KEY QUESTION** *What is the role of the cell nucleus?*

Eukaryotic cells can be divided into the nucleus and the cytoplasm. The **cytoplasm** is the part of the cell outside the nucleus. The interior of a prokaryotic cell, which lacks a nucleus, is also called the cytoplasm. Eukaryotic cells also have many specialized structures that are called **organelles**, which means "little organs."

**Comparing the Cell to a Factory** A eukaryotic cell functions much like a factory. The different organelles of a cell are like specialized machines and assembly lines. Organelles follow instructions and create biological molecules, like the people and machines in a factory create different products.

**The Nucleus** The nucleus is the control center of the cell. The nucleus contains nearly all of the DNA in the cell and, with it, the coded instructions for making proteins and other important molecules. In prokaryotic cells, there is no nucleus, and the DNA is found in the cytoplasm.

The nucleus is surrounded by the nuclear envelope, which is composed of two membranes. The nuclear envelope has thousands of nuclear pores, which allow material such as proteins and other molecules to move in and out of the nucleus. The genetic material in the nucleus is found in chromosomes. Most nuclei also contain a nucleolus, which is a region of the nucleus where ribosome assembly begins.

## Organelles That Build Proteins

**KEY QUESTION** *What organelles help make and transport proteins and other macromolecules?*

Much of the cell is devoted to producing proteins, which are responsible for the synthesis of other macromolecules such as lipids and carbohydrates.

**Ribosomes** Proteins are assembled on ribosomes. **Ribosomes** are small particles of RNA and protein found throughout the cytoplasm in eukaryotes and prokaryotes. Ribosomes produce proteins by following instructions that come from DNA.

**As you read, circle the answers to each Key Question. Underline any words you do not understand.**

### BUILD Vocabulary

**cytoplasm** fluid portion of the cell outside the nucleus

**organelle** specialized structure that performs important cellular functions within a eukaryotic cell

**ribosome** cell organelle consisting of RNA and protein found throughout the cytoplasm in a cell; the site of protein synthesis

**Related Words** The English word *organ* comes from the Latin word "organon," meaning tool or instrument. ☑ **Using this information, explain how an organ and organelles are related.**

## BUILD Vocabulary

**endoplasmic reticulum** internal membrane system found in eukaryotic cells; place where lipid components of the cell membrane are assembled

**Golgi apparatus** organelle in cells that modifies, sorts, and packages proteins and other materials from the endoplasmic reticulum for storage in the cell or release outside the cell

**vacuole** cell organelle that stores materials such as water, salts, proteins, and carbohydrates

**lysosome** cell organelle that breaks down lipids, carbohydrates, and proteins into small molecules that can used by the rest of the cell

**cytoskeleton** network of protein filaments in a eukaryotic cell that gives the cell its shape and internal organization and is involved in movement

**Chloroplast** cell organelle that converts energy from sunlight into chemical energy through the process of photosynthesis

**mitochondrion** cell organelle that converts the chemical energy stored in food into compounds that are more convenient for the cell to use

**cell wall** strong, supporting layer around the cell membrane in most prokaryotes and some eukaryotes

**Related Words** *Plasm* is a root that appears in many biological terms related to cells and living things. It comes from a Greek word that means "something molded."

☑ **What two vocabulary terms in this lesson have *plasm* as a root?**

_____

_____

**Endoplasmic Reticulum** Eukaryotic cells contain an internal membrane system called the **endoplasmic reticulum** (en doh PLAZ mik reh TIK yoo lum), or ER. The portion of the ER involved in making proteins is called the rough ER, due to the ribosomes on its surface. Proteins made on the rough ER include those that will be released, or secreted, from the cell; many membrane proteins; and proteins destined for other specialized locations within the cell. Other proteins are made on ribosomes that are not attached to membranes.

The other part of the ER is called the smooth ER because ribosomes are not found on its surface. The smooth ER produces lipids and is involved in the detoxification of drugs and the synthesis of carbohydrates.

**Golgi Apparatus** In eukaryotic cells, proteins produced in the rough ER move into the **Golgi apparatus**, which appears as a stack of flattened membranes. The proteins are bundled into tiny membrane-enclosed structures called vesicles that bud from the ER and carry the proteins to the Golgi apparatus. The Golgi apparatus modifies, sorts, and packages proteins and other materials from the endoplasmic reticulum for storage in the cell or release from the cell.

# Organelles That Store, Clean Up, and Support

**KEY QUESTION** *What are the functions of vacuoles, lysosomes, and the cytoskeleton?*

Vacuoles, vesicles, lysosomes, and the cytoskeleton represent the cellular factory's storage space, cleanup crew, and support structures.

**Vacuoles and Vesicles** Many cells contain **vacuoles**, which are large, saclike, membrane-enclosed structures. Vacuoles store materials like water, salts, proteins, and carbohydrates. Many plant cells have a single, large central vacuole. The pressure of the liquid in the central vacuole helps plants to support structures such as leaves and stems. In addition to vacuoles, most eukaryotic cells contain smaller membrane-enclosed structures called vesicles. Vesicles store and move materials between organelles, as well as to and from the cell surface.

**Lysosomes** **Lysosomes** break down lipids, proteins, and carbohydrates into small molecules that can be used by the cell. Lysosomes also break down and remove organelles and other things in the cell that are no longer needed. Lysosomes are found in animal cells and in some plant cells.

**The Cytoskeleton** Eukaryotic cells have a network of protein filaments called the **cytoskeleton**. The cytoskeleton helps to transport materials within the cell. The cytoskeleton helps the cell maintain its shape and is involved in movement.

***Microfilaments*** Microfilaments are threadlike structures made from a protein called actin. They form a tough, flexible framework that supports the cell. Microfilaments also help cells move.

***Microtubules*** Microtubules are hollow structures made from proteins called tubulins. In some cells they maintain cell shape. They are important in cell division, forming a structure called the mitotic spindle that separates chromosomes. Organelles called centrioles are also made from tubulins. Centrioles help to organize cell division in animal cells, but are not found in plant cells. Microtubules also help to build projections from the cell surface such as cilia (singular: *cilium*) and flagella (singular: *flagellum*) that allow cells to swim through liquid.

## Organelles That Capture and Release Energy

**KEY QUESTION** *What are the functions of chloroplasts and mitochondria?*

**Chloroplasts** Plants and some other organisms contain chloroplasts (KLAWR uh plasts). **Chloroplasts** capture the energy from sunlight and convert it into chemical energy stored in food during photosynthesis. Chloroplasts are surrounded by two membranes and contain large stacks of additional membranes that contain the green pigment chlorophyll.

**Mitochondria** Nearly all eukaryotic cells, including plants, contain mitochondria (myt oh KAHN dree uh; singular *mitochondrion*). **Mitochondria** convert the chemical energy stored in food molecules into compounds that are more convenient for the cell to use. As with chloroplasts, mitochondria are surrounded by two membranes. The inner membrane is folded up inside the mitochondrion. All or nearly all of our mitochondria are inherited from our mothers.

Chloroplasts and mitochondria contain some of their own genetic information in the form of small DNA molecules. These organelles probably originated from prokaryotic cells that became part of eukaryotic cells in a mutualistic relationship. Genetic changes in human mitochondria can affect human health.

## Cellular Boundaries

**KEY QUESTION** *What is the function of the cell membrane?*

**Cell Walls** The **cell wall** lies outside the cell membrane and supports, shapes, and protects the cell. Most prokaryotes and some eukaryotes, including plants and fungi, have cell walls. Animal cells do not have cell walls. Cell walls allow water, oxygen, carbon dioxide, and other substances to pass through. Cell walls provide much of the strength plants need to stand.

**READING TOOL**

**Academic Words**

**network** A network is a system of connected things. In a previous chapter you learned about food webs, which are another type of network.

☑ **Based upon what you know about networks, explain why computers are more useful when they are connected to the internet.**

## BUILD Vocabulary

**lipid bilayer** flexible double-layered sheet that makes up the cell membrane and forms a barrier between the cell and its surroundings

**selectively permeable** property of biological membranes that allows some substances to pass across it while others cannot; also called semipermeable membrane

**Prefixes** The prefix *bi-* means "two." A bicycle has two wheels, and a lipid bilayer has two layers, or sheets, of lipids. ☑ **The cell membrane is a lipid bilayer, but a cell has only one cell membrane. Which organelles in this lesson have a double membrane?**

_____

_____

_____

## Cell Membranes

All cells have cell membranes. Cell membranes are made up of a double-layered sheet called a **lipid bilayer**. The cell membrane regulates what enters and leaves the cell and also protects and supports the cell.

### *The Properties of Lipids*

Lipids have oily fatty chains that are attached to chemical groups that interact with water. The fatty acid portions of the lipid are hydrophobic (hy druh FOH bik), or "water hating," while the other end is hydrophilic (hy druh FIL ik), or "water loving." When the lipids are in water, their hydrophobic "tails" cluster together while the hydrophilic "heads" are attracted to water. This results in a lipid bilayer, with the fatty acid tails forming the interior of the membrane. Many substances can cross cell membranes, but some substances are too large or too strongly charged to cross the lipid bilayer. Cell membranes are **selectively permeable** (or semipermeable), meaning that some substances can cross the membrane and others cannot.

### *The Fluid Mosaic Model*

Proteins are embedded in the lipid bilayer of most cell membranes. Carbohydrate molecules are attached to many of these proteins. The proteins in the lipid bilayer can move around, "floating" among the lipids. Scientists describe the cell membrane as a "fluid mosaic." A mosaic is a type of art made up of different materials, just as the membrane is made up of different kinds of molecules. Some of these proteins form channels and pumps that move substances across the cell membrane. Some proteins attach to the cytoskeleton, enabling cells to use their membranes to move or change shape. Many of the carbohydrate molecules help cells to identify each other.

### Visual Reading Tool: Eukaryotic Cell Structure

Write the name of the numbered structures.