Understanding Cells

Have you ever looked up at the night sky and tried to find other planets in our solar system? It is hard to see them without using a telescope. This is because the other planets are millions of kilometers away. Just like we can use telescopes to see other planets, we can use microscopes to see the basic units of all living things–cells. But people didn't always know about cells. Because cells are so small, early scientists had no tools to study them. It took hundreds of years for scientists to learn about cells.

More than 300 years ago, an English scientist named Robert Hooke built a microscope. He used the microscope to look at cork, which is part of a cork oak tree's bark. What he saw looked like the openings in a honeycomb, as shown in **Figure 1.** The openings reminded him of the small rooms, called cells, where monks lived. He called the structures cells, from the Latin word *cellula* (SEL yuh luh), which means "small rooms."

Figure 1 To Robert Hooke, the cells of cork looked like the openings in a honeycomb.

The Cell Theory

After Hooke's discovery, other scientists began making better microscopes and looking for cells in many other places, such as pond water and blood. The newer microscopes enabled scientists to see different structures inside cells. Matthias Schleiden (SHLI dun), a German scientist, used one of the new microscopes to look at plant cells. Around the same time, another German scientist, Theodor Schwann, used a microscope to study animal cells. Schleiden and Schwann realized that plant and animal cells have similar features. You'll read about many of these features in Lesson 2.

Almost two decades later, Rudolf Virchow (VUR koh), a German doctor, proposed that all cells come from preexisting cells, or cells that already exist. The observations made by Schleiden, Schwann, and Virchow were combined into one **theory.** As illustrated in **Table 1,** *the* **cell theory** *states that all living things are made of one or more cells, the cell is the smallest unit of life, and all new cells come from preexisting cells.* After the development of the cell theory, scientists raised more questions about cells. If all living things are made of cells, what are cells made of?

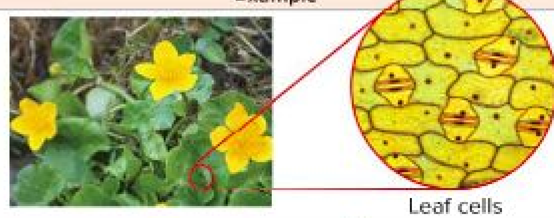
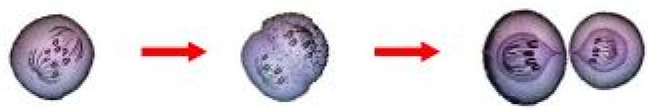
Key Concept Check How did scientists' understanding of cells develop?

REVIEW VOCABULARY

theory
explanation of things or events based on scientific knowledge resulting from many observations and experiments

Table 1 Scientists developed the cell theory after studying cells with microscopes.

Table 1 The Cell Theory

Principle	Example
All living things are made of one or more cells.	
The cell is the smallest unit of life.	This unicellular amoeba is surrounding an algal cell to get food and energy. 
All new cells come from preexisting cells.	

Cell Shape and Movement

You might recall from Lesson 1 that all living things are made up of one or more cells. As illustrated in **Figure 4,** cells come in many shapes and sizes. The size and shape of a cell relates to its job or function. For example, a human red blood cell cannot be seen without a microscope. Its small size and disk shape enable it to pass easily through the smallest blood vessels. The shape of a nerve cell enables it to send signals over long distances. Some plant cells are hollow and make up tubelike structures that carry materials throughout a plant.

The structures that make up a cell also have unique functions. Think about how the players on a football team perform different tasks to move the ball down the field. In a similar way, a cell is made of different structures that perform different functions that keep a cell alive. You will read about some of these structures in this lesson.

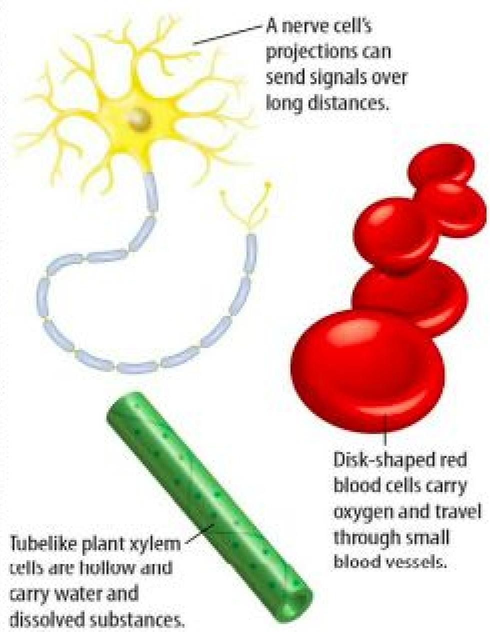
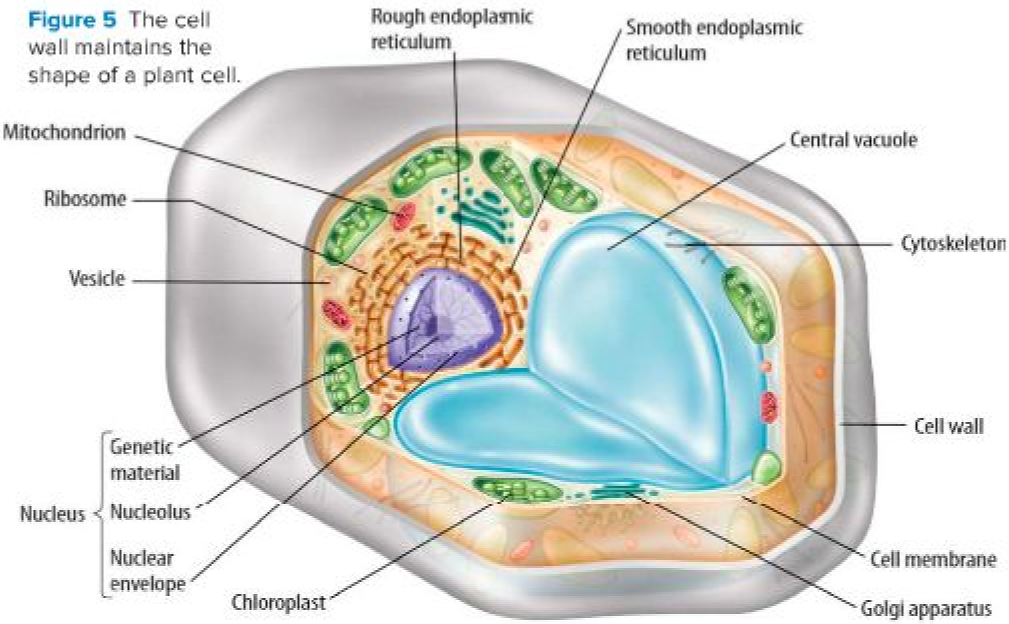


Figure 4 The shape of a cell relates to the function it performs.

Plant Cell

Animation

Figure 5 The cell wall maintains the shape of a plant cell.



ACADEMIC VOCABULARY

function
(noun) the purpose for which something is used

Cell Membrane

Although different types of cells perform different **functions**, all cells have some structures in common. As shown in **Figure 5** and **Figure 6**, every cell is surrounded by a protective covering called a membrane. *The* **cell membrane** *is a flexible covering that protects the inside of a cell from the environment outside a cell.* Cell membranes are mostly made of two different macromolecules–proteins and a type of lipid called phospholipids. Think again about a football team. The defensive line tries to stop the other team from moving forward with the football. In a similar way, a cell membrane protects the cell from the outside environment.

Reading Check What are cell membranes made of?

Cell Wall

Every cell has a cell membrane, but some cells are also surrounded by a structure called the cell wall. Plant cells such as the one in **Figure 5**, fungal cells, bacteria, and some types of protists have cell walls. *A* **cell wall** *is a stiff structure outside the cell membrane.* A cell wall protects a cell from attack by viruses and other harmful organisms. In some plant cells and fungal cells, a cell wall helps maintain the cell's shape and gives structural support.

Animal Cell

Animation

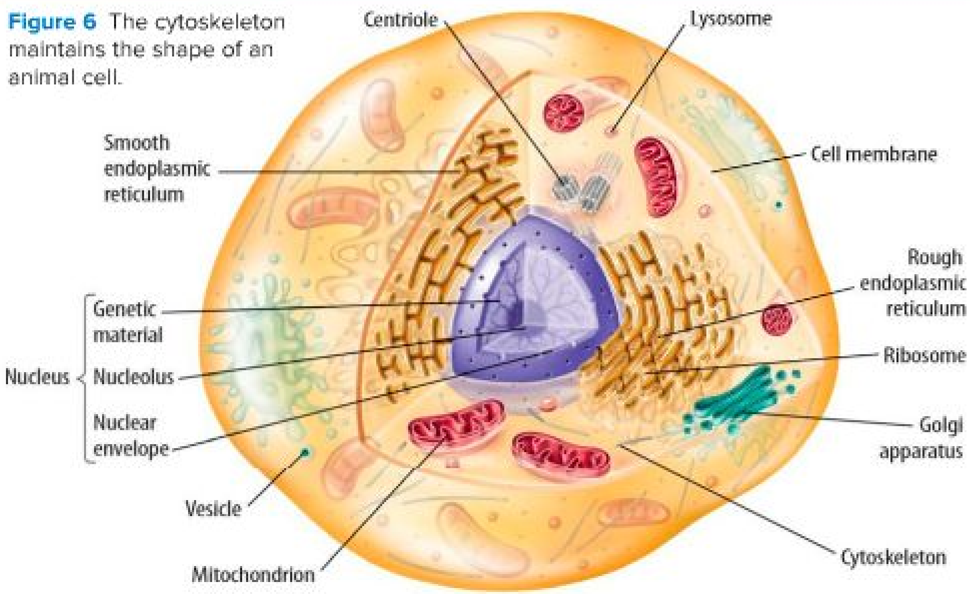


Figure 6 The cytoskeleton maintains the shape of an animal cell.

Visual Check Compare this animal cell to the plant cell in **Figure 5.**

Cell Appendages

Arms, legs, claws, and antennae are all types of appendages. Cells can have appendages too. Cell appendages are often used for movement. Flagella (fluh JEH luh; singular, flagellum) are long, tail-like appendages that whip back and forth and move a cell. A cell can also have cilia (SIH lee uh; singular, cilium) like the ones shown in **Figure 7.** Cilia are short, hairlike structures. They can move a cell or move molecules away from a cell. A microscopic organism called a paramecium (pa ruh MEE shee um) moves around its watery environment using its cilia. The cilia in your windpipe move harmful substances away from your lungs.

Figure 7 Lung cells have cilia that help move fluids and foreign materials.

Cytoplasm and the Cytoskeleton

In Lesson 1, you read that water is the main ingredient in a cell. Most of this water is in the **cytoplasm**, *a fluid inside a cell that contains salts and other molecules*. The cytoplasm also contains a cell's cytoskeleton. *The* **cytoskeleton** *is a network of threadlike proteins that are joined together*. The proteins form a framework inside a cell. This framework gives a cell its shape and helps it move. Cilia and flagella are made from the same proteins that make up the cytoskeleton.

WORD ORIGIN

cytoplasm
from Greek *kytos*, means "hollow vessel"; and *plasma*, means "something molded"

Cell Organelles

As you have just read, organelles are eukaryotic cell structures with specific functions. Organelles enable cells to carry out different functions at the same time. For example, cells can obtain energy from food, store information, make macromolecules, and get rid of waste materials all at the same time because different organelles perform the different tasks.

FOLDABLES

Fold a sheet of paper into a vertical half book. Use it to record information about cell organelles and their functions.

The Nucleus

The largest organelle inside most eukaryotic cells is the nucleus, shown in **Figure 9.** *The* **nucleus** *is the part of a eukaryotic cell that directs cell activities and contains genetic information stored in DNA.* DNA is organized into structures called chromosomes. The number of chromosomes in a nucleus is different for different species of organisms. For example, kangaroo cells contain six pairs of chromosomes. Most human cells contain 23 pairs of chromosomes.

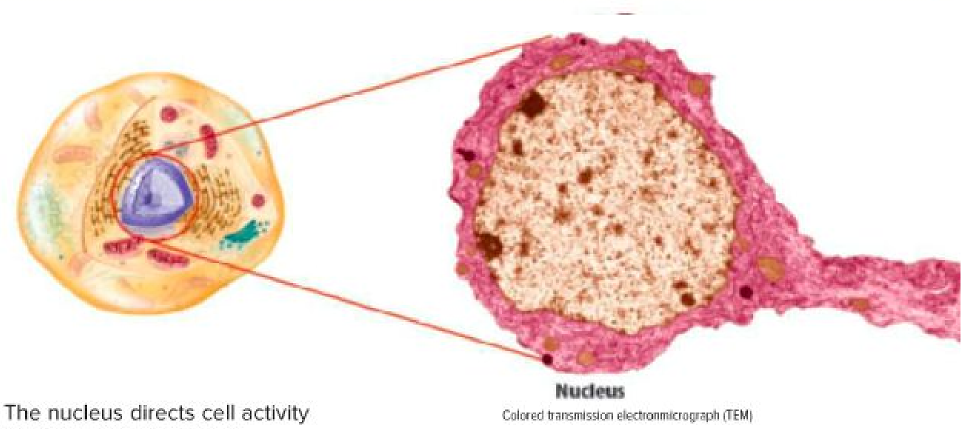


Figure 9 The nucleus directs cell activity and is surrounded by a membrane.

In addition to chromosomes, the nucleus contains proteins and an organelle called the nucleolus (new KLEE uh lus). The nucleolus is often seen as a large dark spot in the nucleus of a cell. The nucleolus makes ribosomes, organelles that are involved in the production of proteins. You will read about ribosomes later in this lesson.

Surrounding the nucleus are two membranes that form a structure called the nuclear **envelope.** The nuclear envelope contains many pores. Certain molecules, such as ribosomes and RNA, move into and out of the nucleus through these pores.

SCIENCE USE V. COMMON USE

envelope
Science Use an outer covering
Common Use a flat paper container for a letter

Reading Check What is the nuclear envelope?

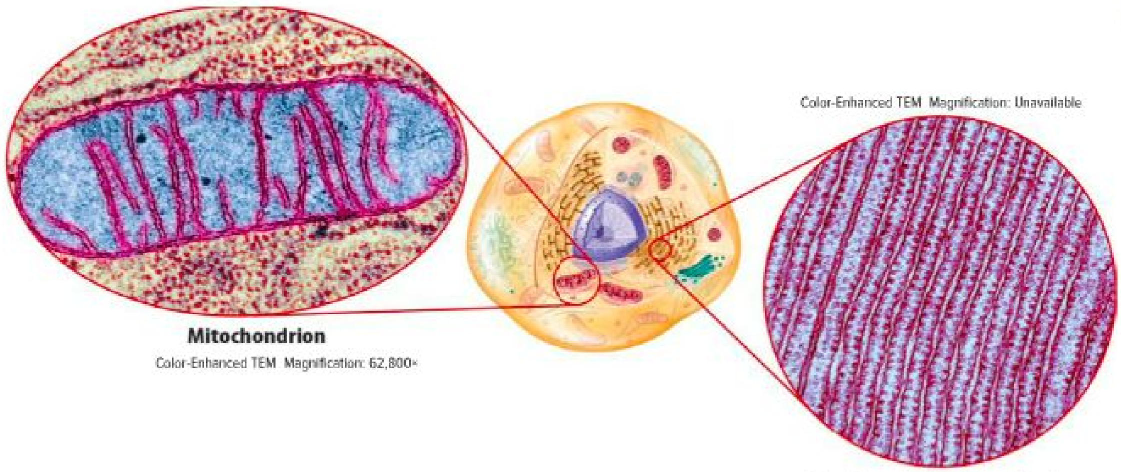


Figure 10 The endoplasmic reticulum is made of many folded membranes. Mitochondria provide a cell with usable energy.

Manufacturing Molecules

You might recall from Lesson 1 that proteins are important molecules in cells. Proteins are made on small structures called ribosomes. Unlike other cell organelles, a ribosome is not surrounded by a membrane. Ribosomes are in a cell's cytoplasm. They also can be attached to a weblike organelle called the endoplasmic reticulum (en duh PLAZ mihk • rih TIHK yuh lum), or ER. As shown in Figure 10, the ER spreads from the nucleus throughout most of the cytoplasm. ER with ribosomes on its surface is called rough ER. Rough ER is the site of protein production. ER without ribosomes is called smooth ER. It makes lipids such as cholesterol. Smooth ER is important because it helps remove harmful substances from a cell.

Reading Check Contrast smooth ER and rough ER.

Processing Energy

All living things require energy in order to survive. Cells process some energy in specialized organelles. Most eukaryotic cells contain hundreds of organelles called mitochondria (mi tuh KAHN dree uh; singular, mitochondrion), shown in Figure 10. Some cells in a human heart can contain a thousand mitochondria.

Like the nucleus, a mitochondrion is surrounded by two membranes. Energy is released during chemical reactions that occur in the mitochondria. This energy is stored in high-energy molecules called ATP–adenosine triphosphate (uh DEH nuh seen • tri FAHS fayt). ATP is the fuel for cellular processes such as growth, cell division, and material transport.

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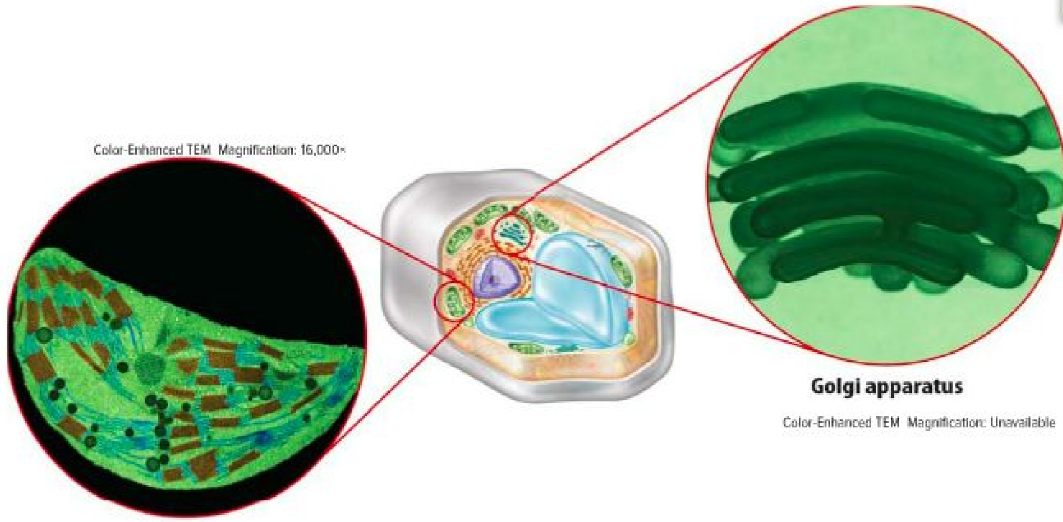

Plant cells and some protists, such as algae, also contain organelles called chloroplasts (KLOR uh plasts), shown in **Figure 11.** **Chloroplasts** *are membrane-bound organelles that use light energy and make food–a sugar called glucose–from water and carbon dioxide in a process known as photosynthesis* (foh toh SIHN thuh sus). The sugar contains stored chemical energy that can be released when a cell needs it. You will read more about photosynthesis in Lesson 4.

Figure 11 Plant cells have chloroplasts that use light energy and make food. The Golgi apparatus packages materials into vesicles.

Reading Check Which types of cells contain chloroplasts?

Processing, Transporting, and Storing Molecules

Near the ER is an organelle that looks like a stack of pancakes. This is the Golgi (GAWL jee) apparatus, shown in **Figure 11.** It prepares proteins for their specific jobs or functions. Then it packages the proteins into tiny, membrane-bound, ball-like structures called vesicles. Vesicles are organelles that transport substances from one area of a cell to another area of a cell. Some vesicles in an animal cell are called lysosomes. Lysosomes contain substances that help break down and recycle cellular components.

Some cells also have saclike structures called vacuoles (VA kyuh wohlz). Vacuoles are organelles that store food, water, and waste material. A typical plant cell usually has one large vacuole that stores water and other substances. Some animal cells have many small vacuoles.

Key Concept Check What is the function of the Golgi apparatus?