

Cell Structures

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CHAPTER 1

Cell Structures

Lesson Objectives

- Compare prokaryotic and eukaryotic cells.
- List the organelles of the cell and their functions.
- Discuss the structure and function of the cell membrane and cytosol.
- Describe the structure and function of the nucleus.
- Distinguish between plant and animal cells.

Check Your Understanding

- What is a cell?
- How do we visualize cells?

Vocabulary

- cell wall
- central vacuole
- chloroplast
- chromosome
- cytoplasm
- cytoskeleton
- cytosol
- endoplasmic reticulum (ER)
- eukaryote
- Golgi apparatus
- lysosome
- mitochondria
- nuclear envelope
- nucleus
- organelle
- plasma membrane
- prokaryote
- ribosome
- rough endoplasmic reticulum
- semipermeable
- smooth endoplasmic reticulum
- vesicle

Prokaryotic and Eukaryotic Cells

There are two basic types of cells, prokaryotic cells (**Figure 1.1**), found in organisms called **prokaryotes**, and eukaryotic cells (**Figure 1.2**), found in organisms called **eukaryotes**.

The main difference between eukaryotic and prokaryotic cells is that eukaryotic cells have a **nucleus**, where they store their DNA, or genetic material. The nucleus is membrane-bound, which means it is surrounded by a phospholipid membrane. Prokaryotic cells do not have a "membrane-bound" nucleus. Instead, their DNA floats around inside the cell.

Here are some other key features of eukaryotic cells:

1. They have membrane-bound structures called **organelles**. A list of the main eukaryotic organelles is located in **Table 1.2**.
2. Eukaryotic cells include the cells of fungi, animals, protists, and plants.
3. These cells are more specialized than prokaryotic cells.

Key features of prokaryotic cells include:

1. The cells are usually smaller and simpler than eukaryotic cells.
2. Prokaryotic cells do not have membrane-bound structures.
3. The DNA, or genetic material, forms a single large circle that coils up on itself.
4. Prokaryotic cells belong to the domains Bacteria or Archaea. These two domains were discussed in the *What is a Living Organism?* chapter.

From the above information, are the cells found in your body prokaryotic cells or eukaryotic cells? **Table 1.1** compares prokaryotic and eukaryotic cells.

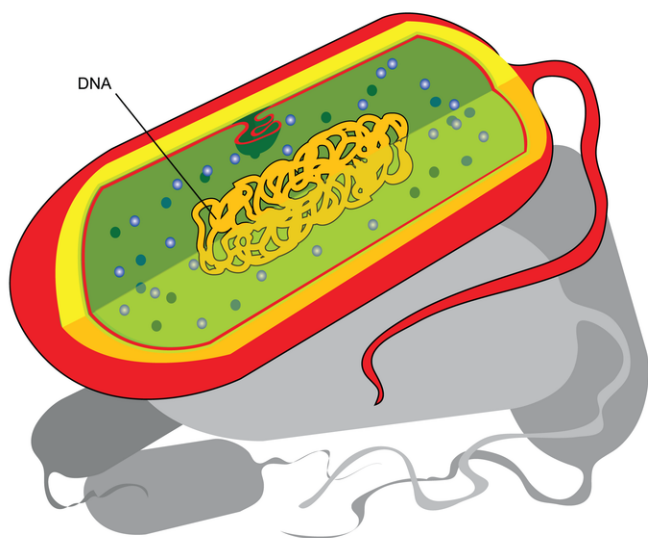
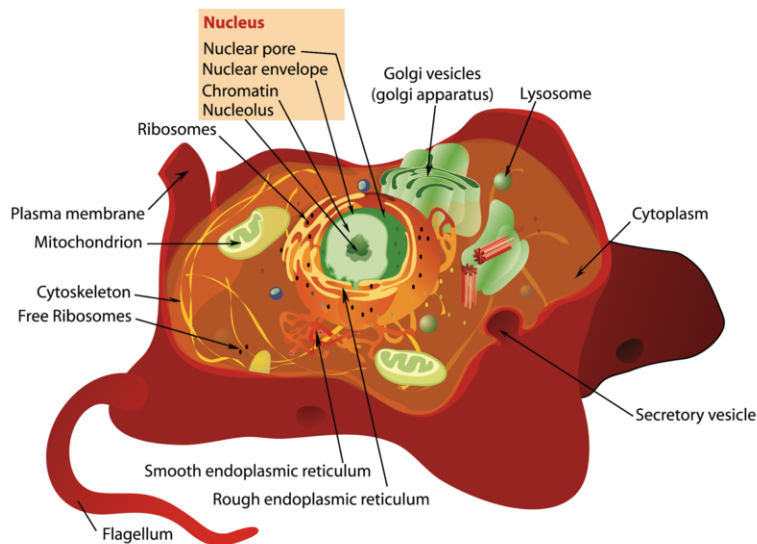


FIGURE 1.1

Prokaryotes do not have a nucleus. Instead, their genetic material is a simple loop of DNA.

**FIGURE 1.2**

Eukaryotic cells contain a nucleus (where the DNA lives, and surrounded by a membrane) and various other special compartments surrounded by membranes, called organelles. For example, notice in this image the mitochondria, lysosomes, and peroxisomes.

TABLE 1.1: Comparison of Prokaryotic and Eukaryotic Cells

Feature	Prokaryotic cells	Eukaryotic cells
DNA	Single “naked” circle; plasmids	In membrane-enclosed nucleus
Membrane-enclosed organelles	No	Yes
Examples	Bacteria	Plants, animals, fungi

The Plasma Membrane and Cytosol

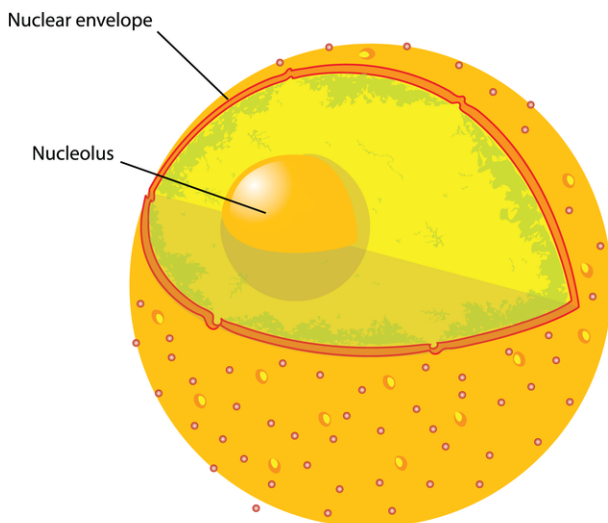
Both eukaryotic and prokaryotic cells have walls around them that separate them from other cells and make sure the parts of the cell do not just float away. This wall is called a plasma membrane. The **plasma membrane** is made of a double layer of lipids, known as phospholipids. The function of the plasma membrane, also known as the cell membrane, is to control what goes in and out of the cell.

Some molecules can go through the cell membrane and enter and leave the cell, but some cannot. "Permeable" means that anything can cross a barrier. An open door is completely permeable to anything that wants to enter or exit through the door. The plasma membrane is **semipermeable**, meaning that some things can enter the cell and some things cannot.

The inside of eukaryotic and prokaryotic cells also both contain a jelly-like substance called **cytosol**. Cytosol is composed of water and other molecules, including enzymes that speed up the cell's chemical reactions. Everything in the cell - the nucleus and the organelles - sit in the cytosol, like fruit in a Jell-o mold. The term **cytoplasm** refers to the cytosol and all of the organelles, but not the nucleus.

TABLE 1.2: Some Eukaryotic Organelles

Organelle	Function
Ribosomes	Involved in making proteins
Golgi apparatus	Packages proteins and some polysaccharides
Mitochondria	Where ATP is made
Smooth Endoplasmic Reticulum	Makes lipids
Chloroplast	Makes sugar (photosynthesis)
Lysosomes	Digests macromolecules

**FIGURE 1.3**

In eukaryotic cells, the DNA is kept in a nucleus. The nucleus is surrounded by a double plasma membrane called the nuclear envelope. Within the nucleus is the *nucleolus* (smaller yellow ball).

Organelles in the Cytoplasm: The Cell Factory

A cell is like a factory. Just as a factory is made up of many people and machines, a cell has many different parts, each with a special role. The different parts of the cell are called **organelles**, which means "small organs." All organelles are found in eukaryotic cells, but most are NOT found in prokaryotic cells. Pay attention to which ones are included in prokaryotic cells.

Below are the main organelles found in cells:

1. The nucleus of a cell is like a safe containing the factory's trade secrets, including information about how to build thousands of proteins.
2. The **mitochondria** are powerhouses that create ATP (adenosine triphosphate), which provides the energy needed to power chemical reactions. Plant cells have special organelles called **chloroplasts** that capture energy from the sun and store it in the bonds of sugar molecules, using a process called photosynthesis (**Figure 1.4**). (The cells of animals and fungi do not photosynthesize and do not have chloroplasts.)
3. The **vacuoles** are like storage centers. Plant cells have larger ones than animal cells because they need to store water and other nutrients.
4. The **lysosomes** are like the recycling trucks that carry waste away from the factory. Inside lysosomes are enzymes that break down old molecules into parts that can be recycled into new ones.
5. Eukaryotic cells also contain a skeleton-like structure called the **cytoskeleton**. Like our bony skeleton, a cell's cytoskeleton gives the cell its shape and helps the cell to move. What part of a factory would act like a cytoskeleton?
6. In both eukaryotes and prokaryotes, **ribosomes** are where proteins are made. Ribosomes are like the machines in the factory that produce the factory's main product. Proteins are the main product of the cell.
7. Some ribosomes can be found on folded membranes called the endoplasmic reticulum (ER). If the ER is covered with ribosomes, it looks bumpy and is called **rough endoplasmic reticulum**. If the ER does not contain ribosomes, it is smooth and called the **smooth endoplasmic reticulum**. Proteins are made on the rough ER. Lipids are made on the smooth ER.
8. The **Golgi apparatus**, works like a mail room. The Golgi apparatus receives the proteins from the rough ER,

puts "shipping addresses" on the proteins, packages them up in vesicles, and then sends them to the right place in the cell.

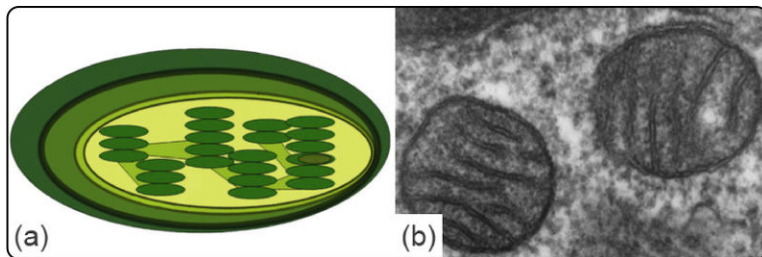


FIGURE 1.4

Diagram of chloroplast (a) and electron microscope image of two mitochondria (b). Chloroplasts and mitochondria provide energy to cells. If the bar at the bottom of the electron micrograph image is 200 nanometers, what is the diameter of one of the mitochondria?

Differences between Plant and Animal Cells

Even though plants and animals are both eukaryotes, plant cells differ in some ways from animal cells. First, plant cells have a large central vacuole that holds a mixture of water, nutrients, and wastes. A plant cell's vacuole can make up 90% of the cell's volume. In animal cells, vacuoles are much smaller.

Second, plant cells have a cell wall, while animal cells do not. A **cell wall** gives the plant cell strength and protection.

A third difference between plant and animal cells is that plants have several kinds of organelles called **plastids**. There are several kinds of plastids, including chloroplasts, needed for photosynthesis; **leucoplasts**, which store starch and oil; and brightly colored **chromoplasts**, which give some flowers and fruits their yellow, orange, or red color. You will learn more about chloroplasts and photosynthesis in the chapter titled *Cell Functions*. Under a microscope one can see plant cells more clearly (**Figure 1.5** and **Figure 1.6**).

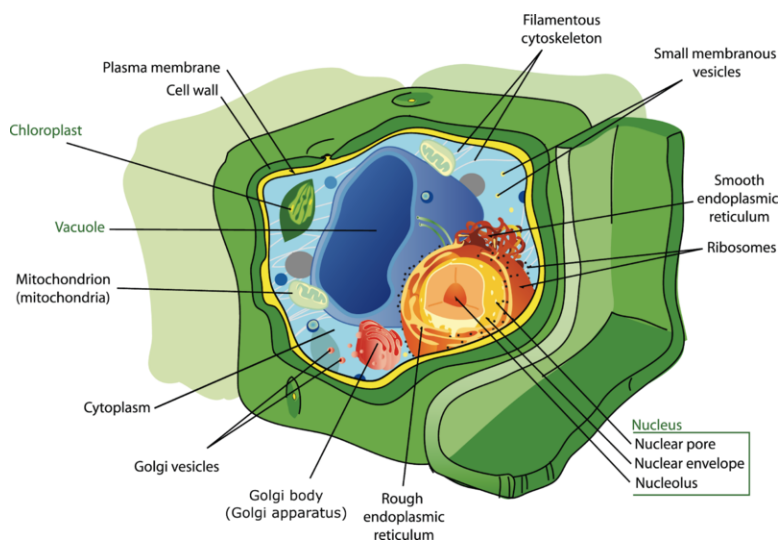
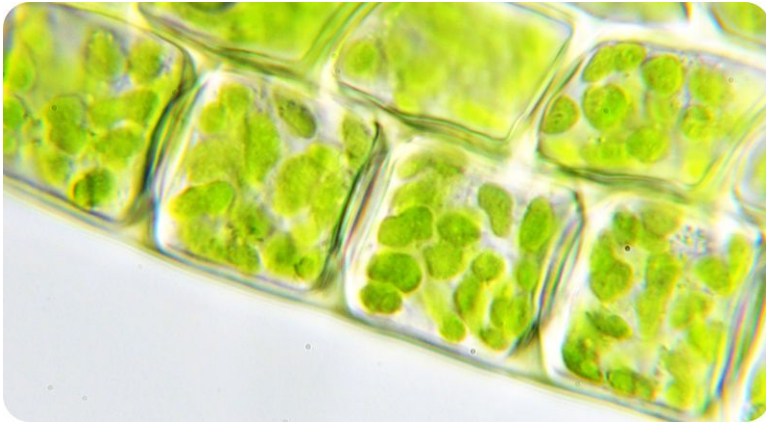


FIGURE 1.5

A plant cell has several features that make it different from an animal cell, including a cell wall, huge vacuoles, and several kinds of plastids, including chloroplasts (which photosynthesize).

**FIGURE 1.6**

This photo of plant cells taken with a light microscope shows green chloroplasts, as well as a cell wall around each cell.

Lesson Summary

- Prokaryotic cells lack a nucleus; eukaryotic cells have a nucleus.
- Each component of a cell has a specific function.
- Plant cells are different from animal cells. For example, plant cells contain plastids, cell walls, and large vacuoles.

Review Questions

Recall

1. What are the two basic types of cells?
2. What are organelles?
3. Discuss the main differences between prokaryotic cells and eukaryotic cells.

Apply Concepts

4. What is the plasma membrane and what is its role?
5. Why is the mitochondria known as the powerhouse of the cell?

Think Critically

6. Why does photosynthesis not occur in animal cells?

Further Reading / Supplemental Links

- Baeuerle, Patrick A. and Landa, Norbert. *The Cell Works: Microexplorers*. Barron's; 1997, Hauppauge, New York.

- Sneddon, Robert. *The World of the Cell: Life on a Small Scale*. Heinemann Library; 2003, Chicago.
- Wallace, Holly. *Cells and Systems*. Heinemann Library; 2001, Chicago.

Points to Consider

- Think about what molecules would need to be transported into cells.
- Discuss why you think it would be important for some molecules to be kept out of a cell.

References

1. Mariana Ruiz Villarreal (User:LadyofHats/Wikimedia Commons). http://commons.wikimedia.org/wiki/File:Prokaryote_cell_diagram.svg . Public Domain
2. Mariana Ruiz Villarreal (User:LadyofHats/Wikimedia Commons). http://commons.wikimedia.org/wiki/File:Animal_cell_structure.svg . Public Domain
3. Mariana Ruiz Villarreal (User:LadyofHats/Wikimedia Commons). http://commons.wikimedia.org/wiki/File:Diagram_human_cell_nucleus.svg . Public Domain
4. (a) User:It'sJustMe/Wikipedia; (b) Louisa Howard. (a) <http://commons.wikimedia.org/wiki/File:Chloroplast-new.jpg>; (b) http://commons.wikimedia.org/wiki/File:Mitochondria%2C_mammalian_lung_-_TEM_%282%29.jpg . Public Domain
5. Mariana Ruiz Villarreal (User:LadyofHats/Wikimedia Commons). http://commons.wikimedia.org/wiki/File:Plant_cell_structure_svg.svg . Public Domain
6. Kelvin Song. http://commons.wikimedia.org/wiki/File:Moss_chloroplasts_100%C3%97_objective_oblique.jpg . CC BY 3.0