The Cell System

Gather Evidence Make a table to record the name of each organelle or cell structure, its role in the cell system, and a simple visual or analogy representing that organelle. As you read each section, complete the table.

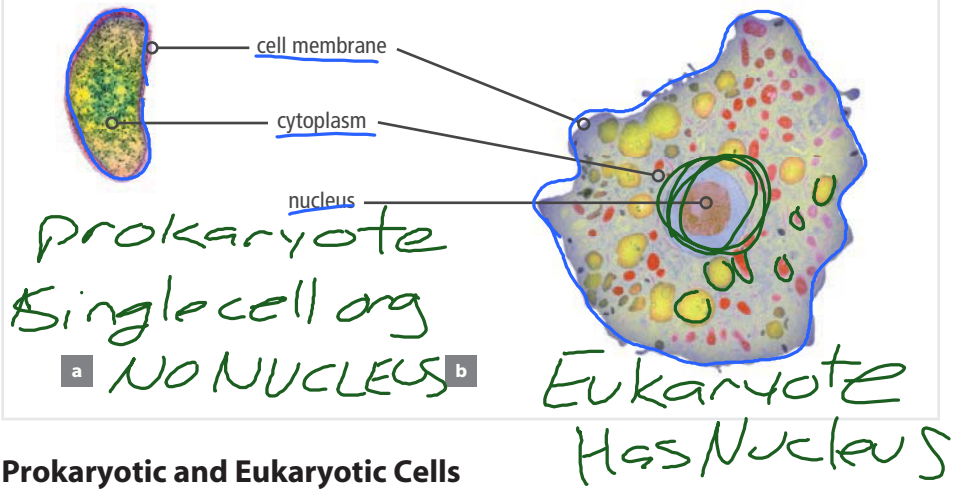
The most basic level of organization in living things is the cell. Organisms may be made up of just one cell, or they may be multicellular. Cells in multicellular organisms are specialized to perform different functions. Your body is made of trillions of cells of many different shapes, sizes, and functions, including long, thin, nerve cells that transmit information as well as short, blocky, skin cells that cover and protect the body. Despite this variety, the cells in your body share many characteristics with one another and with the cells that make up other organisms.

Cell Structure

All cells are enclosed by a cell membrane that controls the movement of materials into and out of the cell. Inside the membrane, a cell is filled with cytoplasm. Cytoplasm is a jelly-like substance that contains dissolved materials such as proteins and sugars. These building blocks are used to make cell structures and can be broken down to release energy used by the cell to do work. Some types of cells also have organelles, which are specialized structures that perform distinct processes within a cell. Most organelles are surrounded by a membrane. In many cells, the largest and most visible organelle is the nucleus, which stores genetic information.

Analyze What is the boundary that separates the cell system from the surrounding environment? Explain the function of this boundary.

FIGURE 11: Basic Cell Structure



Prokaryotic and Eukaryotic Cells

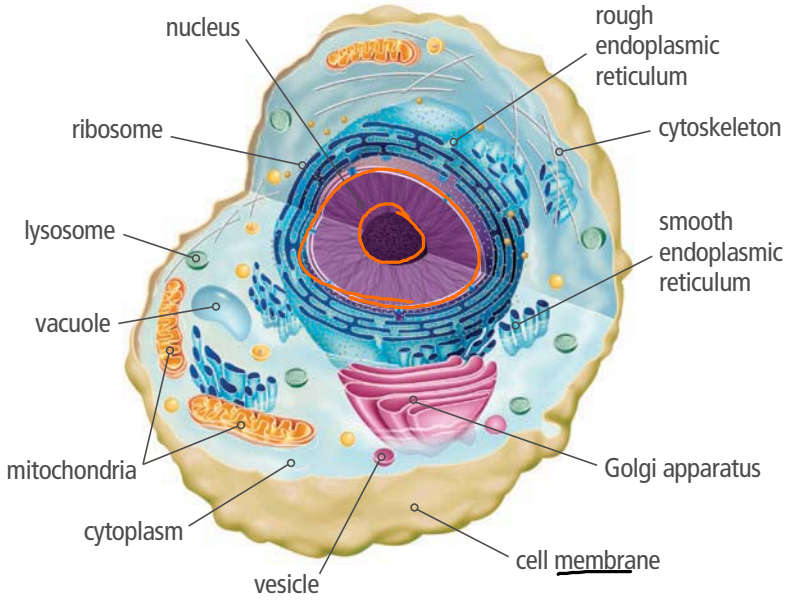
Scientists classify cells into two broad categories based on their internal structures: prokaryotic cells and eukaryotic cells. Prokaryotic cells do not have a nucleus or other membrane-bound organelles. Instead, the cell's DNA is suspended in the cytoplasm. Most prokaryotes are microscopic, single-celled organisms. Eukaryotic cells have a nucleus and other membrane-bound organelles. Eukaryotes may be multicellular or single-celled organisms.

Explain Which of the cells in Figure 11 is a prokaryotic cell, and which is a eukaryotic cell? Cite evidence to support your claim.

Animal Cell Structure

Like your body, eukaryotic cells are highly organized structures. They are surrounded by a protective membrane that receives messages from other cells. They have membrane-bound organelles that perform specific cellular processes, divide certain molecules into compartments, and help regulate the timing of key events.

FIGURE 12: Organelles in the animal cell interact to help the cell carry out functions.



Analyze Describe how the endoplasmic reticulum, mitochondrion, and Golgi apparatus are structurally similar.

The cell is not a random jumble of suspended organelles and molecules. Rather, certain organelles and molecules are anchored to specific sites, depending on the cell type. If the membrane were removed from the cell, the contents would not collapse and ooze out in a puddle. The cytoskeleton gives a cell its shape while at the same time maintaining its flexibility. It is made of small subunits that form long threads, or fibers, that crisscross the entire cell.

Cytoplasm is itself an important contributor to cell structure. In eukaryotes, it fills the space between the nucleus and the cell membrane. The fluid portion, excluding the organelles, consists mostly of water. Water helps maintain the structure of the cell and provides a medium in which chemical reactions can occur.

Nucleus

The nucleus is the storehouse for most of the genetic information, or DNA, in your cells. DNA is like a blueprint with instructions for making proteins, which carry out most of the work in the cell. DNA must be carefully protected, but DNA also must be available for use at the proper times. Molecules that would damage DNA need to be kept out of the nucleus. But many molecules are involved in making proteins from the DNA code, and they need to access the DNA at certain times. The membrane, or nuclear envelope, that surrounds the nucleus has pores that allow only certain molecules to pass between the nucleus and cytoplasm.

Structure and Function What purpose is served by controlled openings in the nuclear membrane?

FIGURE 13: The nucleus has openings called pores.

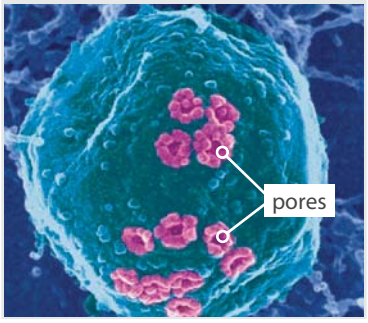
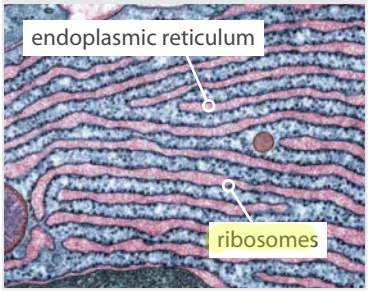


FIGURE 14: Rough ER is so named because it has ribosomes on the surface.



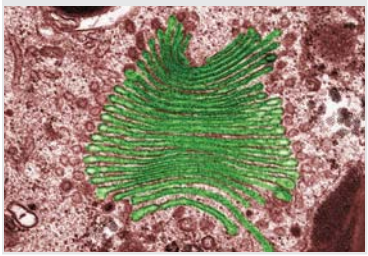
Endoplasmic Reticulum and Ribosomes

A large part of the cytoplasm of most eukaryotic cells is filled by the endoplasmic reticulum. The endoplasmic reticulum, or ER, is an interconnected network of thin, folded membranes. Numerous processes, including the production of proteins, occur both on the surface of the ER and inside the ER. In some regions, the ER is studded with ribosomes, tiny organelles that help make proteins.

Surfaces of the ER that are covered with ribosomes are called rough ER, because they look bumpy when viewed with an electron microscope. Not all ribosomes are bound to the ER; some are suspended in the cytoplasm. In general, proteins made on the ER are either incorporated into the cell membrane or secreted. In contrast, proteins made on suspended ribosomes are typically used in chemical reactions occurring within the cytoplasm. ER that does not have ribosomes on the surface is called smooth ER. Smooth ER performs a variety of specialized functions, such as breaking down drugs and alcohol.

Explain Neurons have special proteins in their cell membranes that allow them to generate electrical current. Are these proteins most likely produced by ribosomes on the rough ER or ribosomes suspended in the cytoplasm? Explain your answer.

FIGURE 15: The Golgi apparatus processes and delivers proteins.

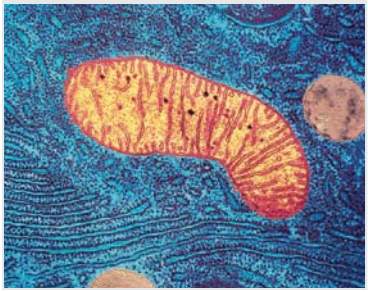


Golgi Apparatus

After a protein has been made, part of the ER pinches off to form a vesicle surrounding the protein. Protected by the vesicle, the protein can be safely transported to the Golgi apparatus. The Golgi apparatus consists of stacks of membrane-enclosed spaces that process, sort, and deliver proteins. Its membranes contain structures called enzymes that make additional changes to proteins. The Golgi apparatus also packages proteins. Some of the packaged proteins are stored within the Golgi apparatus for later use. Some are transported to other organelles within the cell. Still others are carried to the membrane and secreted outside the cell.

Collaborate Discuss this question with a partner: If the cell were compared to a nonliving system, such as a warehouse that ships products to customers, what would be an appropriate analogy for the Golgi apparatus?

FIGURE 16: Mitochondria provide energy to the cell.



Mitochondria

Mitochondria supply energy to the cell. Mitochondria are bean shaped and have a double membrane, similar to nuclei. Within the inner membrane, a series of chemical reactions converts molecules from the food you eat into usable energy. Unlike most organelles, mitochondria have their own ribosomes and DNA. This fact suggests that mitochondria were originally free-living prokaryotes that were taken in by larger cells.

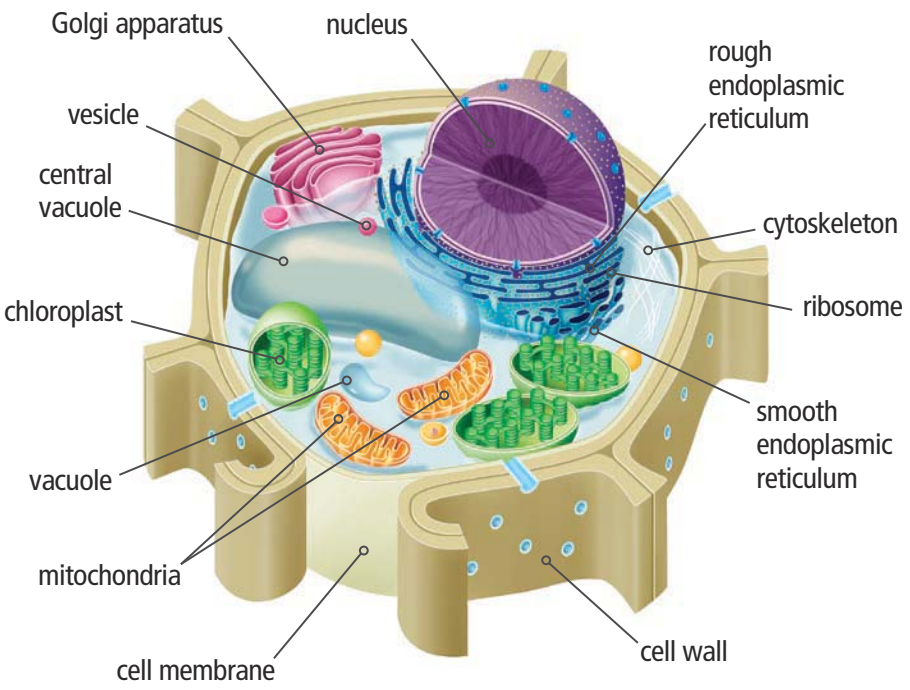
Predict Which would you predict would have more mitochondria–a muscle cell or a skin cell? Explain your answer.

Other structures in the animal cell include lysosomes and centrioles. Lysosomes are membrane-bound organelles that contain special proteins called enzymes. These enzymes break down and recycle old, worn-out cell parts. Centrioles are involved in cell division, and they will be discussed in further detail in another lesson.

Plant Cell Structure

Plant cells have many of the same organelles as animal cells, but they also have some distinct differences. Two important differences are structures that enable plant cells to capture light energy from the sun and to have a more rigid support structure.

FIGURE 17: Plant cells have specialized structures that carry out specific functions, such as protecting the cell and capturing energy.



Explore Online

Hands-On Lab

Comparing Cells Use a microscope to investigate the similarities and differences between plant and animal cells.

Explain What organelles do plant cells have that animal cells do not have? What do you think is the function of each of these organelles?

Cell Wall

Plants, algae, fungi, and most bacteria have a cell wall that surrounds the cell membrane. The cell wall is a rigid layer that gives protection, support, and shape to the cell. The cell walls of multiple cells can adhere to each other to help support an entire organism. For instance, much of the wood in a tree trunk consists of dead cells whose cell walls continue to support the entire tree.

Analyze The cell walls of plant cells have openings, or channels. How is this structure most likely related to the proper functioning of the plant system?

FIGURE 18: The cell wall provides protection and support for the cell.

Image Credits: (b) ©Ed Reschke/Peter Arnold/Getty Images

FIGURE 19: Chloroplasts carry out photosynthesis.

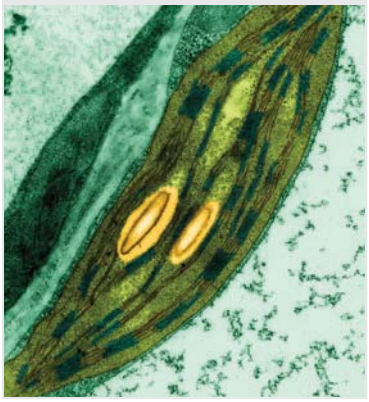
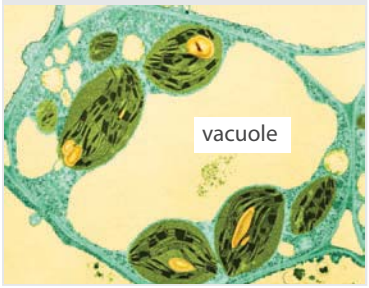


FIGURE 20: The vacuole stores materials needed by the cell.



Chloroplast

Chloroplasts are organelles that carry out photosynthesis, a series of complex chemical reactions that convert light energy from the sun into energy-rich molecules the cell can use. Like mitochondria, chloroplasts are highly compartmentalized. They have both an outer membrane and an inner membrane. Also like mitochondria, chloroplasts have their own ribosomes and DNA. Scientists have hypothesized that they, too, were originally free-living prokaryotes that were taken in by larger cells.

Collaborate Where do you think the most chloroplasts are found in the plant system–in leaves, the stem, or the root? Use evidence to support your answer.

Vacuole

A vacuole is a fluid-filled sac used for the storage of materials needed by a cell. These materials may include water, nutrients, and salts. Most animal cells have many small vacuoles. The central vacuole, shown in Figure 20, is a structure unique to plant cells. It is filled with a watery fluid that strengthens the cell and helps to support the entire plant. The central vacuole also may contain other substances, including toxins that would harm predators, waste products that would harm the cell itself, and pigments that give color to cells, such as those in the petal of a flower.

Analyze When a plant wilts, its leaves shrivel. How is this phenomenon related to the function of the vacuole in the plant system?

Explaining the Cell System Boundary

Predict How do you think the structure of the cell membrane allows for some materials to move into the cell, while other materials are kept out?

The cell membrane is an important structure for cell function. The cell membrane, or plasma membrane, forms a boundary that separates the organelles within the cell from the environment outside of the cell. The cell membrane also controls the passage of materials into and out of a cell. The complex, double-layer structure of the membrane makes it possible for the cell to selectively pass materials, such as nutrients, water, and waste, in and out of the cell. In this way, the cell membrane maintains stable conditions within the cell, even when conditions in the surrounding environment change.

In addition, the structure of the cell membrane allows the cell to communicate with other cells. For example, a neuron has specialized structures in its cell membrane that help it send and receive chemical and electrical signals. The membrane's structure helps the cell carry out its function within the nervous system, and the nervous system helps the organism interpret information from their environment and respond accordingly.

Explain Make a claim for how the organization in eukaryotic cells allows these cells to perform specialized functions within an organism. How do the components of the cell system interact to help it carry out specific tasks and interact with other systems in the body? Use evidence and examples to support your claim.