1.2

Organisms: Cells to Body Systems

Muscle cells have a specialized structure that allows them to contract.

CAN YOU EXPLAIN IT?

FIGURE 1: A ballerina awaits her cue backstage.

If you have ever performed in front of an audience, you may have experienced the feeling of having "butterflies" in your stomach. When you have a feeling about something going a certain way, you might describe it as a "gut feeling." Where do these sensations come from? Do they come from your stomach, your brain, or both?

Systems within your body interact to help you take in information, make decisions, and carry out tasks. Sometimes these systems carry out tasks without your even knowing it, such as pumping your blood, helping you breathe, and breaking down your food.

Predict How do you think systems within your body interact to produce sensations like "butterflies" in your stomach?

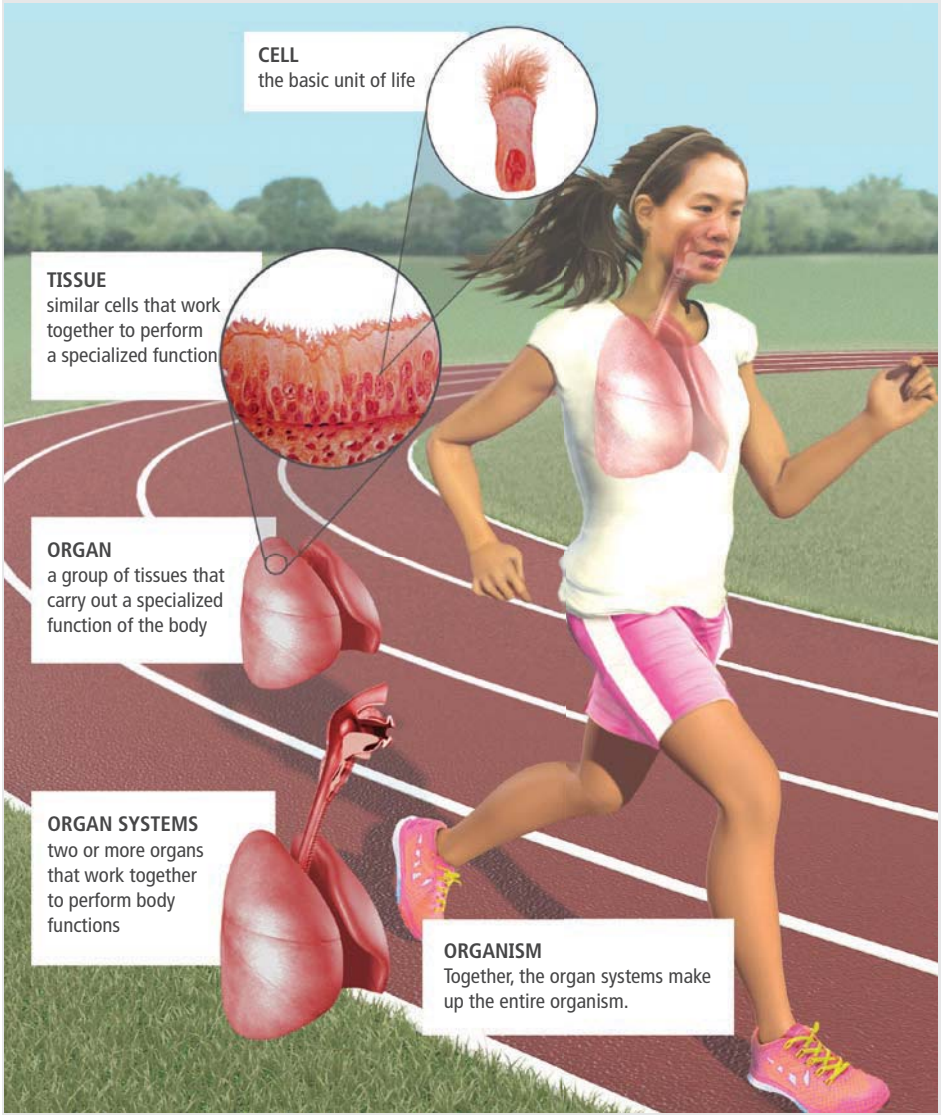
Gather Evidence
As you explore this lesson, gather evidence to explain how systems within your body interact to regulate overall body functions.

Interacting Systems in Organisms

Over the course of a day, you complete many different tasks. Whether you are eating, sleeping, or talking to a friend, systems within your body are interacting at different levels. Scientists organize multicelluar organisms into five basic levels beginning with cells and moving to increasingly complex structures. These five levels of organization are shown in the human respiratory system in Figure 2.

A tissue is a group of similar cells that work together to carry out a specific function. For example, cells in the epithelial tissue of your lungs have tiny hair-like extensions called cilia. Together, these ciliated cells act like a conveyer belt to sweep foreign particles and pathogens out of the lungs. Groups of tissues form organs such as the lungs, sinuses, and nose. Each of these organs has a specialized function in the body. Multiple organs interact to carry out whole-body functions. In the respiratory system, the nose and sinuses filter, moisten, and warm the air before it enters the lungs.

FIGURE 2: Multicellular organisms have a hierarchical structural organization. Each system, such as the respiratory system, is made up of interacting components.



Collaborate Describe a task you perform each day that requires different systems within your body to interact.

Analyze How do structures in the respiratory system interact to protect the lungs? How might a sinus infection affect the rest of the respiratory system?

Organ Systems

An organ system is two or more organs that work together to perform body functions. Organ systems interact to help the organism maintain internal stability, or homeostasis. For example, the muscular system interacts with the circulatory system to help pump your blood and deliver oxygen and nutrients to cells. Some of the components and functions of organ systems in the human body are shown in Figure 3.

FIGURE 3: Organ Systems in the Human Body

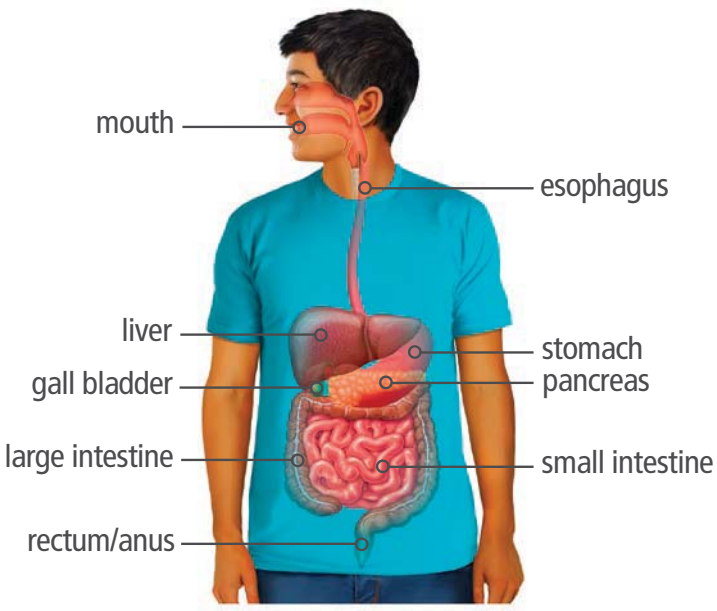
System	Organs and Other Components	Primary Functions
Circulatory	heart, blood vessels, blood, lymph nodes, lymphatic vessels	transports oxygen, nutrients, hormones, and wastes; helps regulate body temperature; collects fluid lost from blood vessels and returns it to the circulatory system
Digestive	mouth, pharynx, esophagus, stomach, small and large intestines, pancreas, gall bladder, liver	breaks down and absorbs nutrients, salts, and water; transfers digested materials to the blood; eliminates some wastes
Endocrine	hypothalamus, pituitary, thyroid, parathyroids, adrenal glands, pancreas, ovaries, testes	produces hormones that act on target tissues in other organs to influence growth, development, and metabolism; helps maintain homeostasis
Excretory	skin, kidneys, bladder	filters blood and eliminates waste products; helps maintain homeostasis
Immune	white blood cells, thymus, spleen	protects against disease; stores and generates white blood cells
Integumentary	skin, hair, nails, sweat and oil glands	protects against infection, UV radiation; regulates body temperature
Muscular	skeletal, smooth and cardiac muscles	produces voluntary and involuntary movements; helps to circulate blood and move food through the digestive system
Nervous	brain, spinal cord, peripheral nerves	regulates body's response to changes in internal and external environment; processes information
Reproductive	*male*: testes, penis, associated ducts and glands *female*: ovaries, fallopian tubes, uterus, vagina	produces and transports reproductive cells; provides the environment for embryonic development in females
Respiratory	nose, nasal cavity, pharynx, trachea, lungs	brings in oxygen for cells, expels carbon dioxide and water vapor
Skeletal	bones, cartilage, ligaments, tendons	supports and protects vital organs; allows movement; stores minerals; bone marrow is site of red blood cell production

Analyze Many organ systems interact with the circulatory system. If a person's circulatory system did not function properly, how might other systems, such as the respiratory and digestive systems, be affected? How would homeostasis, or internal stabilty, be affected by these system imbalances?

Organs

Organ systems can carry out complex functions, because they are made up of organs that work together within the system. An organ is a group of tissues that carry out a specialized function of the body. Figure 4 shows the organs in the digestive system.

FIGURE 4: Organs are components that make up a body system, such as the digestive system. In general, an organ system is made up of organs specific to the function of that system.



The digestive system is a collection of organs that breaks down food into nutrients and energy that can be used by cells. When you eat, the mouth breaks down food mechanically by chewing, and proteins called enzymes in your saliva break down food chemically. Muscles in the esophagus contract to move the chewed food to the stomach. The stomach then uses both mechanical and chemical digestion to break down food into nutrient components that the body absorbs and uses. As muscles in the stomach churn food, it continues to be broken down by gastric juice, which consists of mucus, enzymes, and acid.

The partly digested food passes into the small intestine, where additional digestion takes place. Organs such as the liver and pancreas secrete chemicals into the upper small intestine. These chemicals break food particles into individual nutrients, which are absorbed through the walls of the small intestine and pass into the blood. Any food that remains undigested passes into the large intestine where excess water is absorbed before the solid waste is excreted from the body.

Systems and System Models Make a simple flow chart to illustrate how the organs of the digestive system interact to help you digest food.

Explore Online

Hands-On Lab

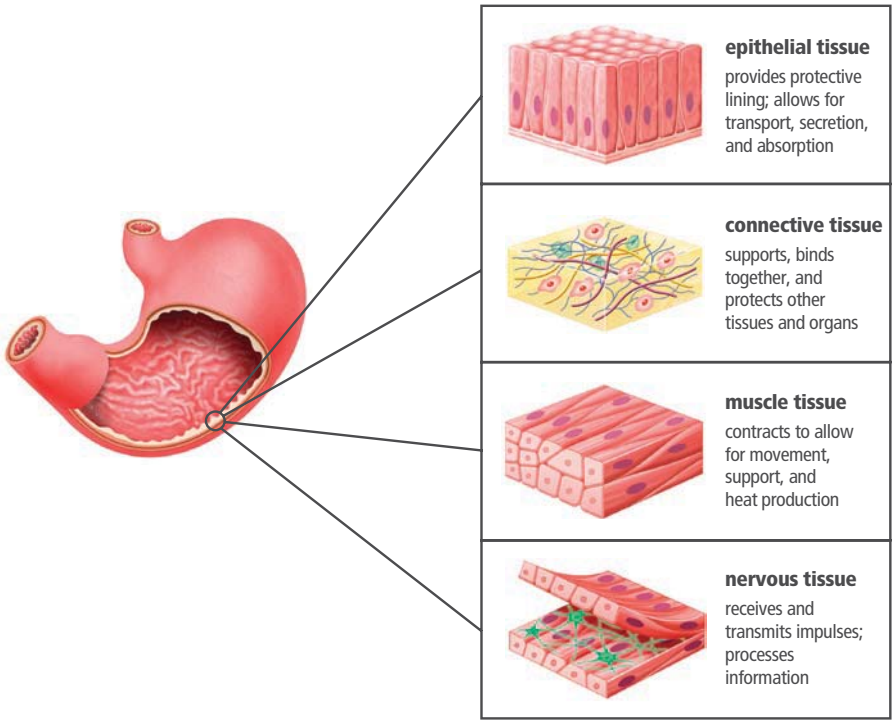
Connecting Form to Function Examine a slice of the roots, stems, and leaves of a plant to explain how their structures relate to their functions.

Predict How might the digestive system and the immune system interact to help protect the body?

Tissues

For an organ such as the stomach to carry out its function of breaking down food, different tissues must work together. A tissue is a group of similar cells that work together to perform a specialized function, usually as part of an organ. In the human body, organs are made up of four general types of tissues—epithelial, connective, muscle, and nervous tissue.

FIGURE 5: Organs such as the stomach are made up of four main types of tissues.



Gather Evidence A tendon is a band of tissue that attaches a muscle to another body part such as a bone. Which type of tissue would tendons most likely contain?

Tissues in the stomach help it carry out its function in the body. Signals from nervous tissue stimulate muscle tissue in the stomach to contract. The walls of the stomach contain three layers of muscle tissue that contract about every 20 seconds. The muscle tissue in the stomach contracts involuntarily, without you having to think about it. The epithelial lining of the stomach is made up of cells that secrete stomach acid and absorb nutrients. The type of epithelial tissue that lines the stomach has column-shaped cells. This type of tissue provides a large amount of surface area for absorption and secretion.

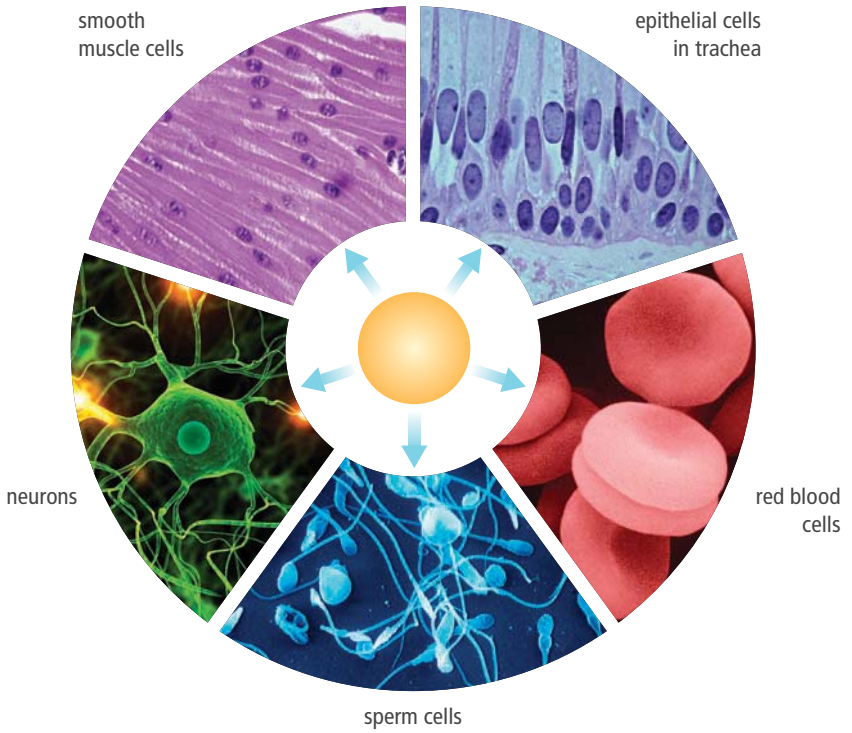
Connective tissue provides support and protection for structures in the body. Some types of connective tissue are fibrous and tough. Other types, such as loose connective tissue, provide support to internal organs and the surrounding blood vessels. The connective tissue that surrounds blood vessels has the property of elasticity. This is important, because as blood pumps through the circulatory system, the vessels within this system must stretch to accommodate blood flow.

Analyze How does nervous tissue interact with muscular tissue in the stomach to break down food? Why is it important for the nervous and digestive systems to work together?

Cells and Cell Differentiation

Humans, like other multicellular organisms, are collections of specialized cells that work together. A cell is the most basic unit of life. The cells that make up an organism arise from a single cell that goes through successive divisions to make new cells. Cell differentiation is the process by which cells become specialized in structure and function.

FIGURE 6: All cells in a multicellular organism arise from a single cell. As the organism develops, cells take on unique structures that help them carry out specialized functions.



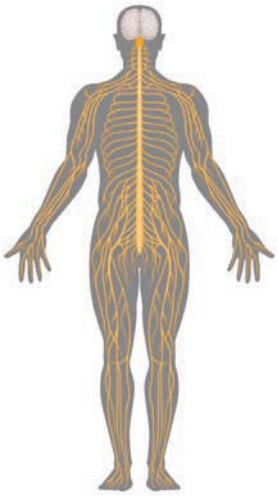
The specialization enabled by differentiation is what allows different types of cells to have different functions. For example, sperm cells have a long tail called a flagellum that allows for movement. Some epithelial cells in the trachea have hair-like extensions called cilia. These structures provide a sweeping motion that helps clear small particles out of the trachea. Neurons have extensions that allow the cell to communicate with many other cells. This allows for the formation of complex, interconnected networks of neurons, such as those in the human brain. Your brain contains billions of neurons with trillions of connections. This allows for communication between the cells of your body, as well as higher functions such as memory and learning.

Language Arts Connection Red blood cells carry oxygen and nutrients to cells. To carry out their function, these cells must bind oxygen and travel through small blood vessels in the circulatory system called capillaries. Capillaries are so narrow that red blood cells must move through them "single file." Write an explanation for how the structure of red blood cells allows them to carry out their function.

Engineering

Nanobots are microscopic robots built on the scale of a nanometer. Engineers are designing nanobots that can help deliver medicine, move through the bloodstream to hard-to-reach areas, and even destory cancer cells. Research a type of nanobot currently under development. How did the purpose of the nanobot affect its design? List some structural features the design has or could have to complete its purpose.

FIGURE 7: The nervous system is made up of the brain, spinal cord, and nerves.



Neurons

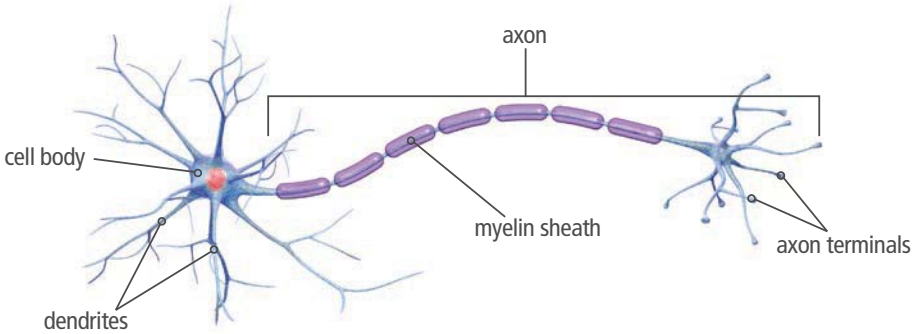
The nervous system is a network of nerves and sensory organs that work together to process information and respond to the environment. The basic unit of the nervous system is the neuron. Neurons are specialized cells that are able to send electrical and chemical signals to help the organism sense information, coordinate a response, and carry out that response.

Humans and other organisms have three types of neurons: sensory neurons, interneurons, and motor neurons. Sensory neurons detect stimuli and send signals to the brain and the spinal cord. Interneurons in the brain and spinal cord receive and process the information from the sensory neurons and send response signals to motor neurons. Motor neurons act on the signal by stimulating muscles to contract.

Systems and System Models Draw a flow chart illustrating how the three types of neurons would interact to help a person pick up an object.

Most neurons have three main parts: the cell body, one or more dendrites, and an axon, shown in Figure 8. The short, branchlike extensions that extend from the cell body are called dendrites. Dendrites receive electrochemical messages from other cells. The axon is a long extension of the cell that carries electrochemical signals away from the cell body and passes them to other cells. The branched endings of the axon are specialized to transmit electrochemical signals to other cells.

FIGURE 8: The neuron is a specialized cell within the nervous system.



Just as most electric wires are wrapped in an insulating material, many axons are wrapped in a protective covering called a myelin sheath. This covering is formed from a collection of cells that are wrapped around the axon. The myelin sheath protects the axon and helps speed transmission of nerve impulses.

Analyze Diseases such as multiple sclerosis cause the myelin sheath to break down. How would the breakdown of myelin affect the functioning of a neuron?

The nervous system interacts with all the other systems in the body. For example, when you eat, your brain signals your digestive system to start making chemicals and churning your food. Neurons also stimulate muscle tissue in the digestive system to contract, which helps the digestive system move and break down food.

Muscle Cells

Muscles consist of bundles of muscle cells that contract when they are stimulated by the nervous system. A contraction shortens the muscle, causing the bone or tissue to which the muscle is attached to move. Some muscles, such as those in Figure 9, are under voluntary control, so you can choose to move this type of muscle tissue. This type of muscle is called skeletal muscle. Some muscles are under involuntary control, meaning they move in response to nerve signals or hormones, but you do not choose to move them. Smooth muscle in internal organs and cardiac muscle in the heart are under involuntary control.

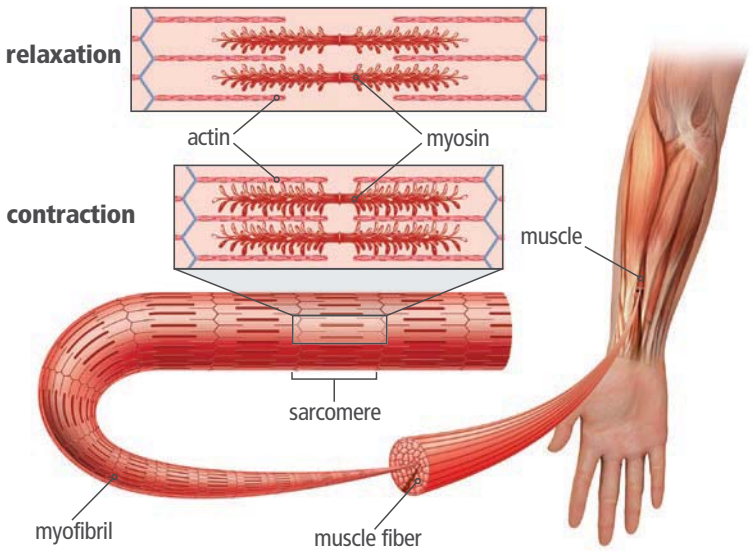
Collaborate With a partner, describe an activity that would require muscles that are under voluntary control and another activity that would require muscles that are under involuntary control.

The specialized structure of muscle cells allows them to contract. Skeletal muscles are made up of long cylindrical bundles that contain muscle fibers. Muscle fibers are bundles of single, thin muscle cells called myofibrils. Each myofibril is made up of several sarcomeres. A sarcomere is the contractile unit of the muscle cell. Sarcomeres contain thin filaments made of actin and thick filaments made of myosin. When a muscle cell is relaxed, actin and myosin are not connected to each other. In contraction, the myosin attaches to the actin and pulls the actin toward the center of the sarcomere. This in turn shortens the sarcomere, and the muscle cell contracts. The contraction of many muscle cells at once shortens the entire muscle.

FIGURE 9: Skeletal Muscles

FIGURE 10: Actin and myosin work together to help a muscle move. During contraction, myosin filaments pull actin filaments toward the center of the sarcomere.

Explore Online



Explain How does the structure of the muscle cell help it carry out its function?

Model Construct a model to illustrate how the nervous and digestive systems might interact to produce the sensation of "butterflies in your stomach." Which organs are most likely involved, and how do they interact when you have this feeling?

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.

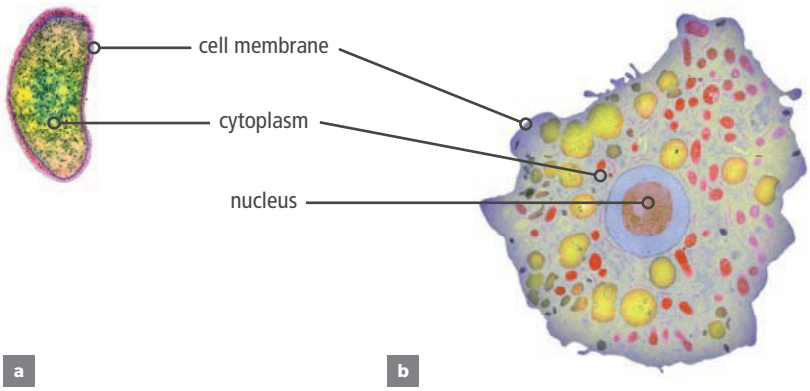
The most basic level of organization in living things is the cell. Organisms may be made up of just one cell, or they may be multicellular. Cells in multicellular organisms are specialized to perform different functions. Your body is made of trillions of cells of many different shapes, sizes, and functions, 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

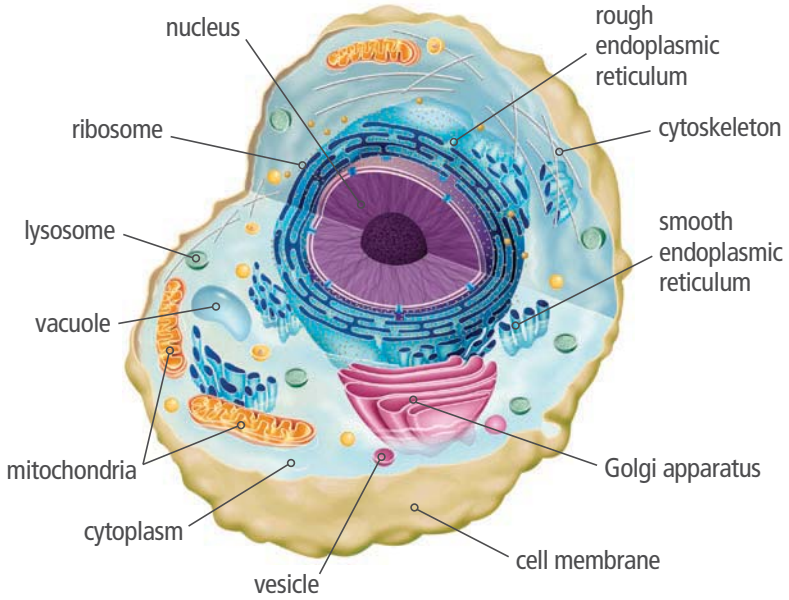
Scientists classify cells into two broad categories based on their internal structures: prokaryotic cells and eukaryotic cells. Prokaryotic cells do not have a nucleus or other membrane-bound organelles. Instead, the cell's DNA is suspended in the cytoplasm. Most prokaryotes are microscopic, single-celled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

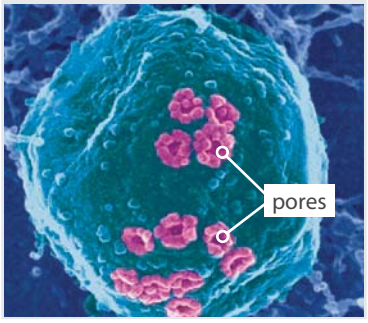
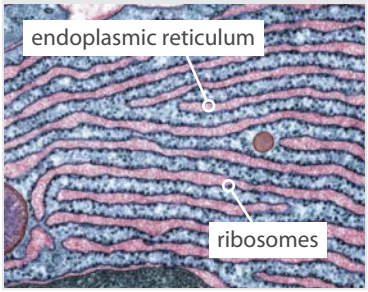


FIGURE 14: Rough ER is so named because it has ribosomes on the surface.



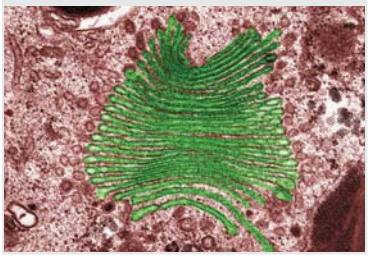
Endoplasmic Reticulum and Ribosomes

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.

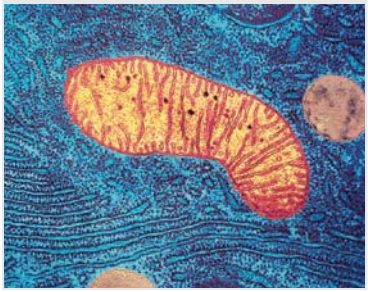


Golgi Apparatus

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.

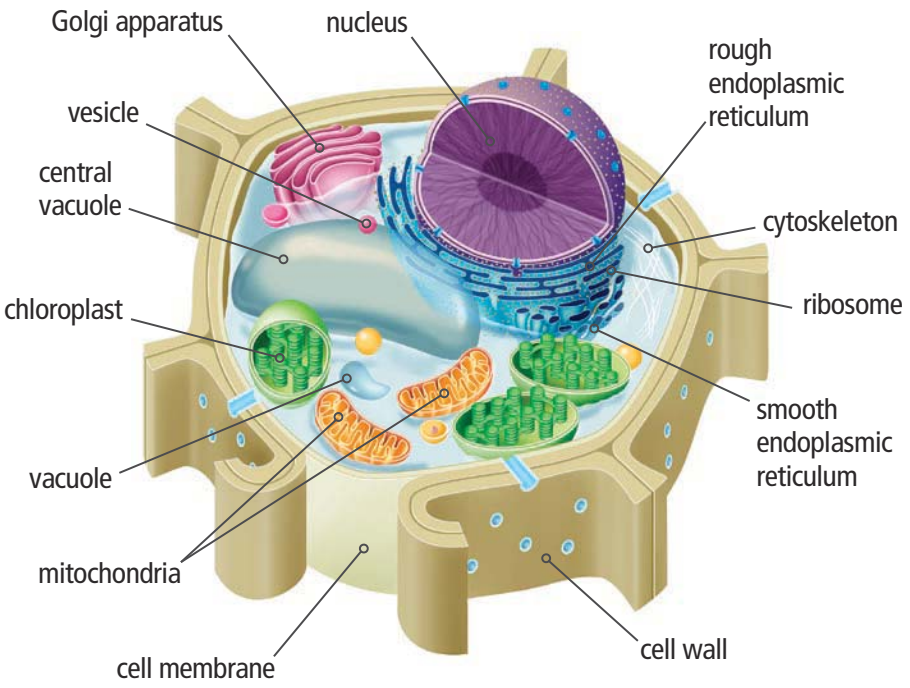
Predict Which would you predict would have more mitochondria–a muscle cell or a skin cell? Explain your answer.

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.



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?

Explore Online

Hands-On Lab

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

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.

FIGURE 19: Chloroplasts carry out photosynthesis.

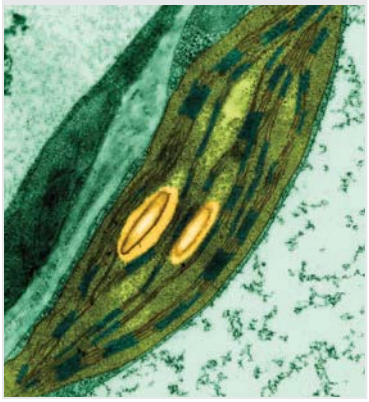
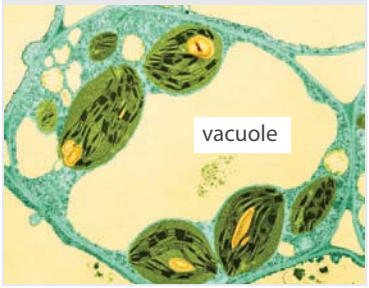


FIGURE 20: The vacuole stores materials needed by the cell.



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.

Engineering

Modeling Interacting Body Systems

In this lesson, you have learned about body systems and how they interact in organisms. Now it is your turn to model interacting body systems within an organism. In this activity, you will create a model to show how systems within an organism interact to carry out a task of your choice.

FIGURE 21: Body systems interact to help keep you healthy.

Define the Systems

Decide on a task that interests you, such as running, playing video games, or talking to a friend. Think about the body systems that are likely involved in completing that task. For example, the man in Figure 21 is drinking water to rehydrate after being in the sun. His integumentary system, or skin, sweats to keep him from overheating. As he loses water through sweat, his nervous system processes information from the body and sends signals that make the man feel thirsty. To quench his thirst, the man drinks water, which eventually reaches his digestive system. Water passes across cell membranes and eventually into his blood, which transports it to his cells.

Select an Appropriate Model

Select the type of model you would like to use to illustrate the interactions among your systems. Types of models include conceptual models, physical models, mathematical models, and computer models. Your model should use media and materials effectively. It should show that you understand the concepts that you are illustrating and capture the audience's interest.

Conduct Research

Research to learn more about how the body systems interact to carry out the task that you chose. As you search for information, keep track of your sources to submit with your final model. Be sure to use sources that are reliable. For example, government and educational institutions are more reliable than personal websites. With your final model, submit a list of resources in the format specified by your teacher.

Make a Model

Your model should include text and media that illustrate how systems interact at different levels to help an organism carry out a task. Consider the levels of organization involved, such as cells, tissues, organs, and organ systems. The model should also demonstrate how energy, materials, and information flow within and between systems in the organism.

Language Arts Connection Present your model to your peers. Explain how it illustrates interactions between systems required to carry out the task you chose. Consider using illustrations, simulations, or demonstrations to explain the processes involved clearly.

A multimedia presentation combines text, sounds, and images. A successful multimedia presentation includes:

- a clear and consistent focus;
- ideas that are presented clearly and logically;
- graphics, text, music, video, and sounds that support key points; and
- an organization that is appropriate to its purpose and audience.

PLANT TISSUES AND CELLS | COMPARING PROKARYOTES AND EUKARYOTES | Go online to choose one of these other paths.

Lesson Self-Check

CAN YOU EXPLAIN IT?

FIGURE 22: A ballerina awaits her cue backstage.

Recent research has shown that the nervous system and digestive system are very closely connected. Nerves not only send signals to the digestive system to function when needed, but the digestive system sends signals to the nervous system. In fact, scientists refer to the portion of the nervous system associated with the gut as our "second brain," because it can operate without any input from the brain to continue the digestive process. The second brain contains around 100 million neurons, more than the spinal cord or the peripheral nervous system. Thus, part of our emotions may be tied to the nerves in our digestive system.

Explain Use your model of the nervous and digestive systems and the evidence you have gathered in your Evidence Notebook to construct an explanation of how sensations, such as "butterflies" in the stomach, might arise. Which organs do you think are communicating, how are they communicating, and what is the function of this communication?

1. State your claim.
2. Summarize the evidence you have gathered to support your claim, and explain your reasoning.
3. Use your model to illustrate your claim. Revise the model as needed based on new evidence you gathered.

CHECKPOINTS

Check Your Understanding

1. Which of the following correctly describes the relationship between tissues and organs?

- **a.** Several organs interact to help a tissue carry out a specialized function.
- **b.** One type of specialized tissue is found in each organ.
- **c.** Organs are made up of different types of tissue that work together.
- **d.** Tissues compete with each other to carry out the main function of the organ.

2. Which of the following organ systems must work together to bring oxygen to the body's cells? Select all correct answers.

- **a.** digestive system
- **b.** skeletal system
- **c.** immune system
- **d.** respiratory system
- **e.** circulatory system

3. The word *organ* comes from the Latin word *organum*, meaning "instrument" or "implement." Describe how this meaning relates to the definition of a living organ.

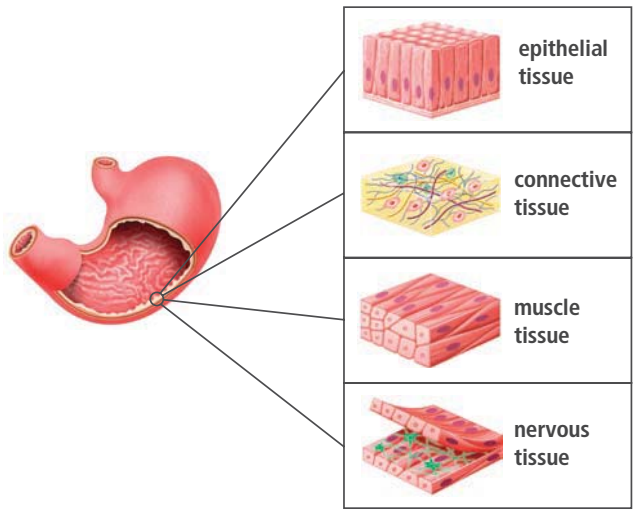
4. Draw a diagram to show the relationship between cells, organs, tissues, organ systems, and organisms. Include media and text in your diagram.

5. Explain how the structure of a plant cell helps the plant system maintain its shape.

6. Which organelles are found in plant cells but not animal cells? How are these structures related to functions at the organism level?

7. List the main organ systems that would interact to help a person play the violin, and explain how they would work together to help the person complete this task.

FIGURE 23: Organs such as the stomach are made up of four main types of tissues.



8. How do the four types of tissue shown in Figure 23 interact to help the stomach carry out its function of breaking down food?

MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main idea from this lesson:

Systems in organisms interact at different levels to carry out functions necessary for life.

Remember to include the following information in your study guide:

- Use examples that model main ideas.
- Record explanations for the phenomena you investigated.
- Use evidence to support your explanations. Your support can include drawings, data, graphs, laboratory conclusions, and other evidence recorded throughout the lesson.

Consider how the information in this lesson can help you model interactions within and between systems at different levels.