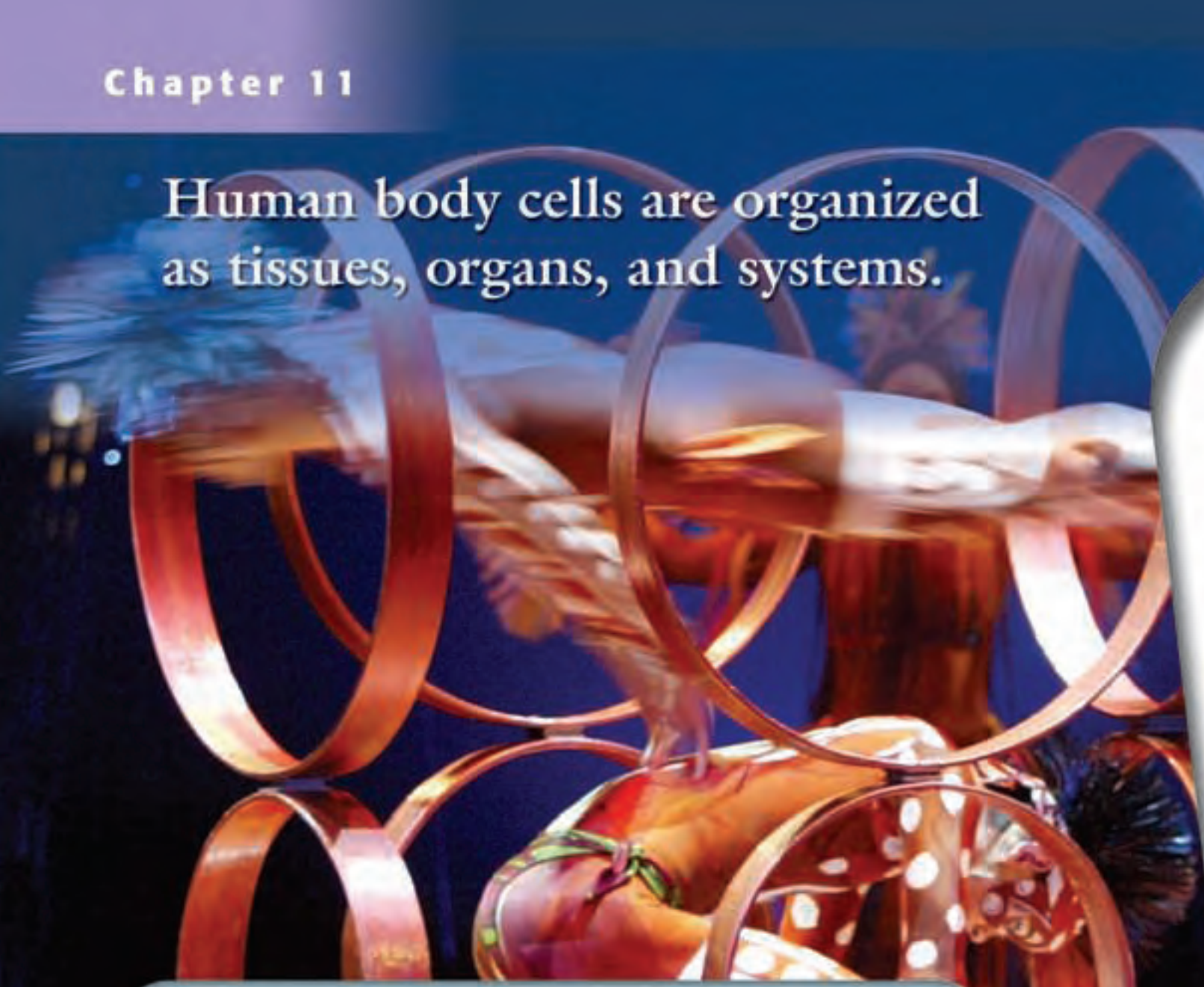
Chapter 11

Human body cells are organized as tissues, organs, and systems.



Most cells of multi-celled living things, such as you, are not in direct contact with the outside environment. How, then, do your cells get the oxygen and the nutrients they need? How are their wastes removed? Imagine that all the cells of your body are organized into different groups, or systems. Each of these systems has its own specific function to perform. For example, one system carries oxygen throughout your body to each cell. A different system provides cells with food. Yet another system removes carbon dioxide that cells produce as a waste product. Still other systems help the body maintain balance, provide protection from disease, and link all the body systems together through an astonishing, complex communications network. Together, the different systems of your body provide its trillions of cells with the matter and energy they need to function.

What You Will Learn

In this chapter, you will

- **investigate** how cells of multicellular organisms are organized as tissues, organs, and systems
- **survey** systems of the human body and investigate certain systems in greater depth

Why It Is Important

A systems approach to studying life can help you appreciate how truly complex and marvellous humans and other multicellular organisms are.

Skills You Will Use

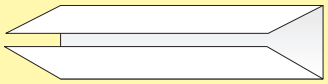
In this chapter, you will

- **identify** the main types of animal tissues
- **research**, describe, and present information about selected human body systems

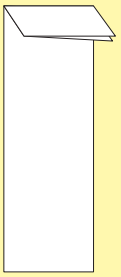
FOLDABLES™
Reading & Study Skills

TO COME

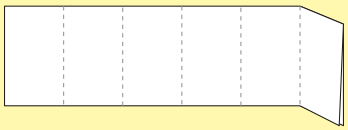
STEP 1 **Fold** one piece of letter size paper widthwise into thirds.



STEP 2 **Fold** down 2.5 cm from the top. (Hint: From the tip of your index finger to your first knuckle is about 2.5 cm.)



STEP 3 **Fold** the rest into fifths.



STEP 4 **Unfold**, lay the paper lengthwise, and draw lines along the folds. **Label** your table as shown.

Systems	Structure	Function
Muscular		
Nervous		
Digestive		
Excretory		
Circulatory		
Respiratory		

Make a Table As you read the chapter, develop a table describing the structures and functions of various human systems.

11.1 Cell Organization

A system is made up of parts that work together as a whole. Each system of the human body consists of organs that are made up of different kinds of tissue. Tissues are themselves made up of many similar cells working together to carry out a specific function.

Key Terms

organ
organ system
system
tissue

Have you ever walked into a bicycle shop like the one in Figure 11.1 and noticed all the bike parts, such as wheels, chains, cables, and brake pads? To understand what these parts do, it is helpful to think of the systems that make up a bicycle, such as the gear system and the brake system. It is the parts of these systems working together that enable a bicycle to function properly.

Figure 11.1 What are the systems that make up a bicycle, and what parts make up each of these systems?

The Characteristics of Systems

All **systems** have the following characteristics.

1. A system is made up of individual parts that work together as a whole.
2. A system is often connected to one or more other systems.
3. If one part of a system is missing or damaged, the system will not function well or may not function at all.

The idea of a system is probably not new to you. Think of the human-made computer system you use and the electrical system that powers it. Scientists use the system idea to study nature, too. For example, scientists study the interaction of living things within ecosystems. (See Figure 11.2 on the next page.)

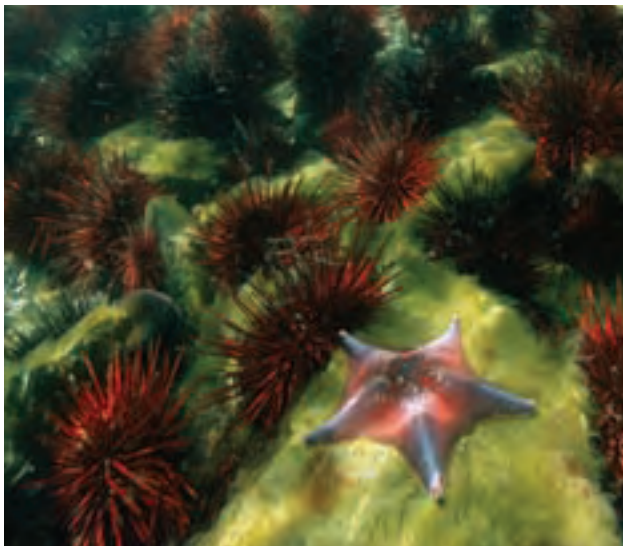


Figure 11.2 The living components of an *ecosystem* include *communities* of *populations* that consist of *individuals*. For example, this individual starfish is shown here among a population of sea urchins. Populations of sea urchins and starfish live together as part of a community that includes populations of algae, fish, otters, and other kinds of organisms.

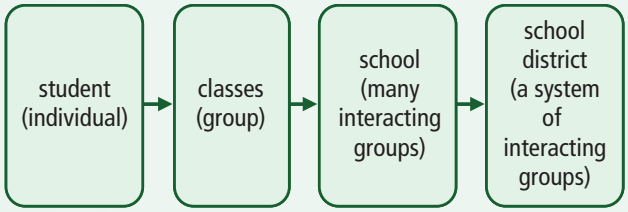
Explore More

Imagine a bicycle that is missing one of its systems. Describe how this would affect the proper functioning of the bike.

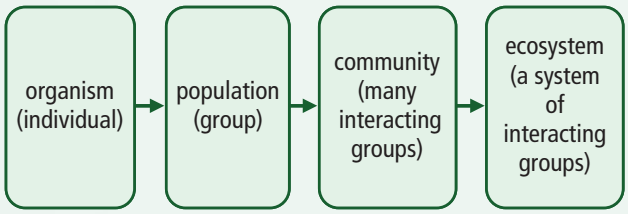
11-1A Represent the Relationship

Think About It

To picture how the cells of your body are organized, think about the way that students are organized in a school district. First, individual students in the same grade are grouped together in classes. Different classes of students together make up a school. Finally, a number of schools are organized into a single school system called a district. You can show how the parts of a school district are related with a flowchart such as this.



You could use a similar flowchart to represent the relationship among the components of an ecosystem such as the one in Figure 11.2.



What to Do

1. Read the following information about the organization of cells in the human body.

Cells that have the same structure and that perform the same function are grouped into tissues. Groups of different tissues interact to form organs. Organs work together as interacting organ systems. Interacting organ systems together make up a multicellular organism.

2. Create a flowchart to represent the relationship among the components of the human organism.
3. Add the following words or phrases to your flowchart.
   - individual
   - group
   - many interacting groups
   - a system of interacting groups

What Did You Find Out?

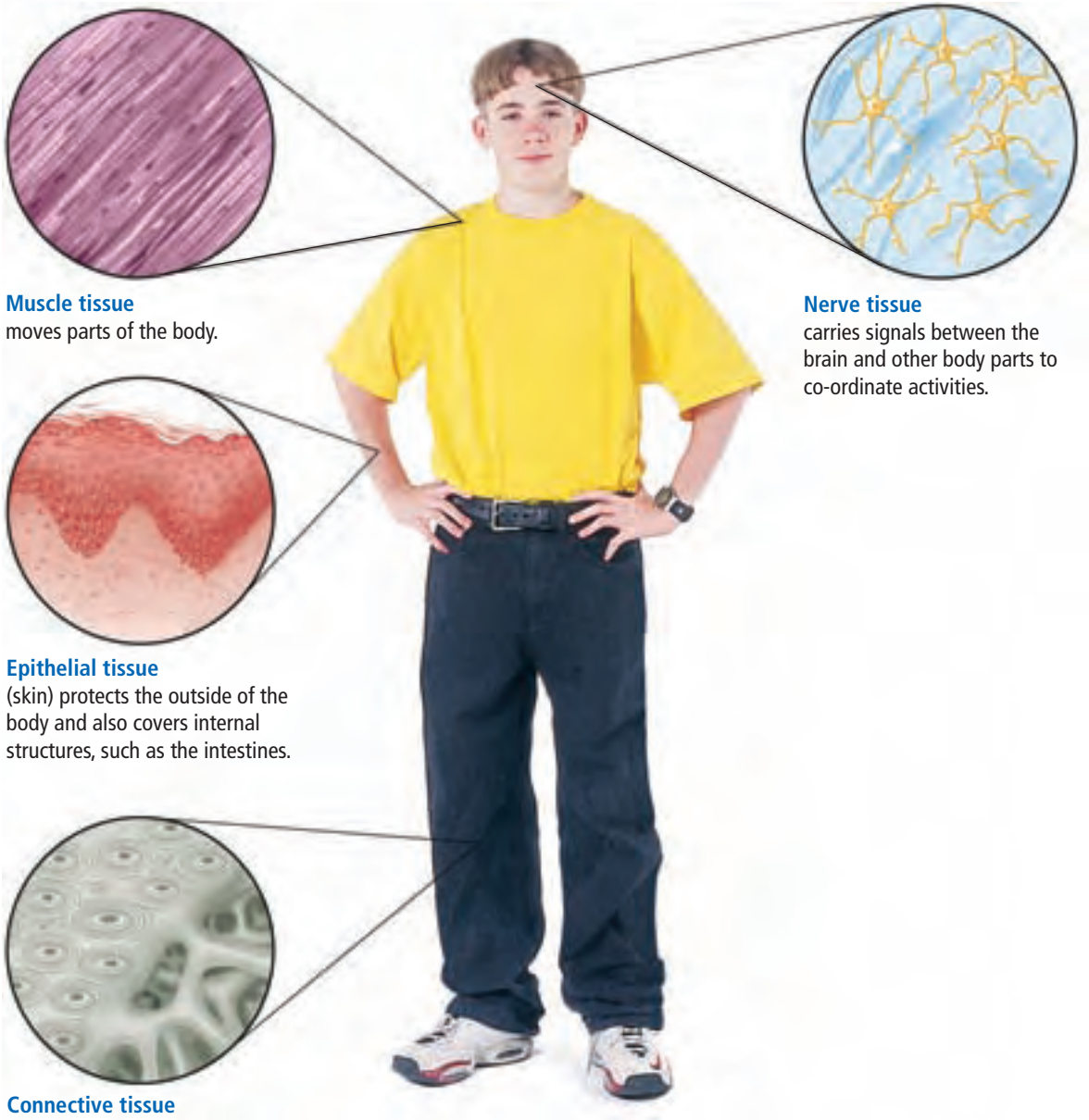
1. Interpret your flowchart. In other words, explain how the parts that make up the human organism are related.

Tissues Are Groups of Similar Cells

Tissues are groups of similar cells. All multicellular organisms—not just humans—have tissues. You saw an example of this in Chapter 10 when you observed onion skin. Onion skin is a tissue that is made of sheets of thin, tightly packed cells. These specialized skin cells form a layer of tissue that covers and protects the onion. Figure 11.3 shows the main types of tissues found in most animals, such as you. These tissues are classified according to the functions they perform.

internet connect

Onion skin tissue is a type of tissue called epidermal tissue. Go to **www.discoveringscience8.ca** to investigate other kinds of tissues that plants have.



Muscle tissue
moves parts of the body.

Nerve tissue
carries signals between the brain and other body parts to co-ordinate activities.

Epithelial tissue
(skin) protects the outside of the body and also covers internal structures, such as the intestines.

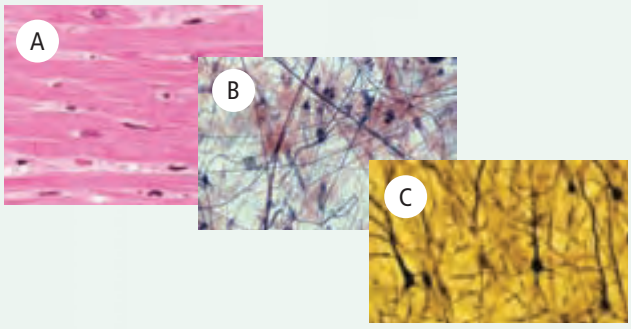
Connective tissue
(bone) connects and supports different parts of the body. May be solid, like this bone tissue, or fluid like blood. Blood transports substances throughout the body. Other connective tissue forms loose, fibrous sheets between body parts.

Figure 11.3 The main types of tissues that make up humans and other animals

11-1B Looking at Animal Tissues

Find Out ACTIVITY

These photos show human tissues observed under a compound light microscope. Your teacher also might use a flex camera to show prepared slides of other body tissues.



What to Do

1. Images A, B, and C show bone tissue, nerve tissue, and muscle tissue. Label each type of tissue.
2. Do the same with additional tissue images if they are provided.

What Did You Find Out?

1. Which tissue was easiest to identify? Why?
2. How does the structure (shape) of the tissue appear to relate to its function in the body?

Organs are Groups of Tissues

Organs are distinct structures that perform specific functions. Each organ in the body is made up of two or more types of tissues that work together. For example, Figure 11.4 shows the main tissues that make up your stomach. Other examples of organs are the lungs, heart, and kidneys.

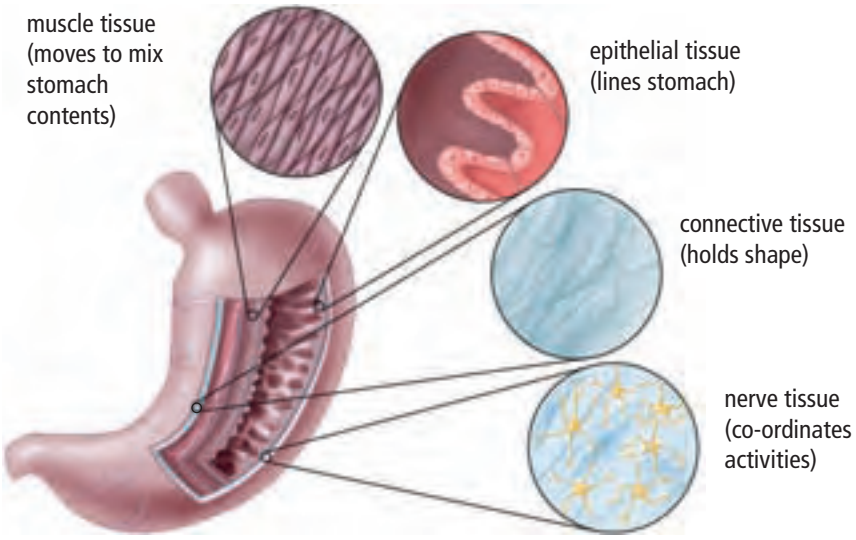


Figure 11.4 The stomach is an organ that is made up of different kinds of tissues.

Organ Systems are Groups of Organs

Organs are organized into **organ systems** to perform activities that help the body as a whole. For example, your stomach is part of a group of organs that form your digestive system. Other organs of this system include your mouth, small intestine, and anus. The function of the digestive system is to break down food and remove solid waste.

Reading Check

1. What is a system?
2. What happens if one part of a system is missing or damaged?
3. How are tissues related to cells?
4. How are organs related to tissues?

Science Watch

Pig Parts for People?

A 13-year-old lies seriously ill in hospital. He must get a new kidney immediately or he will die. No suitable human kidneys are available. His surgeon has a solution, but she must convince the ethics board of the hospital that it is a good decision.

Thousands of Canadians are waiting for kidney transplants because they have kidney disease. Kidney disease occurs in young people most often because of a bacterial or viral infection. In adults, kidney disease is usually caused by hereditary factors, diabetes, or high blood pressure.

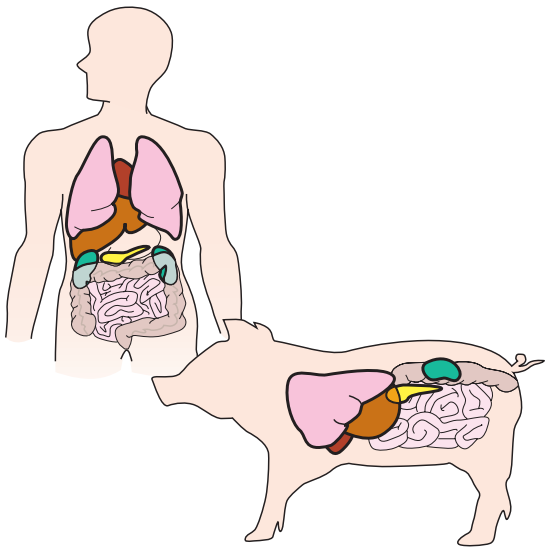
The number of successful organ transplants increases each year as techniques to match donors and organ recipients improve. However, the recipient's white blood cells might attack the foreign tissue of the donated organ and reject it. Patients must take powerful drugs to prevent organ rejection.

The problem for people with kidney disease is that donated organs are in short supply. Pigs may be the solution. Pigs could offer an endless supply of organs for humans in the future. Pig organs are similar in size to human organs, and pigs reproduce quickly. Most importantly, scientists can change pig cells genetically so that a human body will not recognize pig organs as foreign tissue.

Transplanting an organ from one species into another is called xenotransplantation. *Xeno* is pronounced ZEENO and means "foreign" in Greek. The major concern with xenotransplantation is the risk of transferring an animal disease to the patient, who could transfer it to others. The disease would be new to humans so we would not have the natural ability to fight off this disease.

We will not know for certain if xenotransplantation is dangerous until experiments are done on humans. Laws controlling xenotransplantation may require patients to agree to certain life restrictions to prevent the possible transmission of diseases. These could include never having children, never travelling outside the country, and being monitored by authorities for as long as they live.

At present, about 20 percent of all people on waiting lists die before a suitable organ is found. Despite concerns, xenotransplantation offers hope to the thousands of patients on transplant waiting lists in Canada.

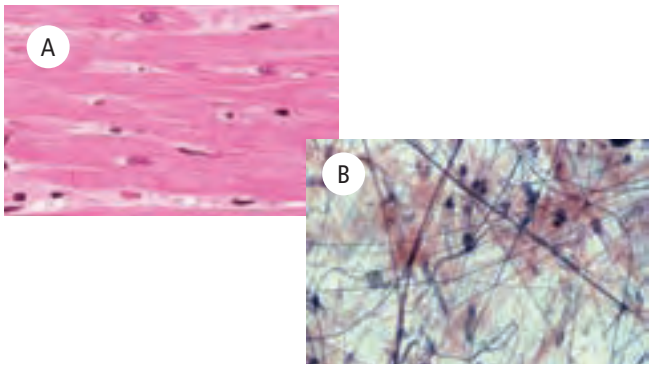


Questions

1. Why are scientists considering pigs for human organ transplants?
2. What major concerns do scientists have about xenotransplantation?
3. The 13-year-old patient will die within the next few days without a new kidney. Do you think his doctor should recommend xenotransplantation of pig kidneys? Why or why not?

Checking Concepts

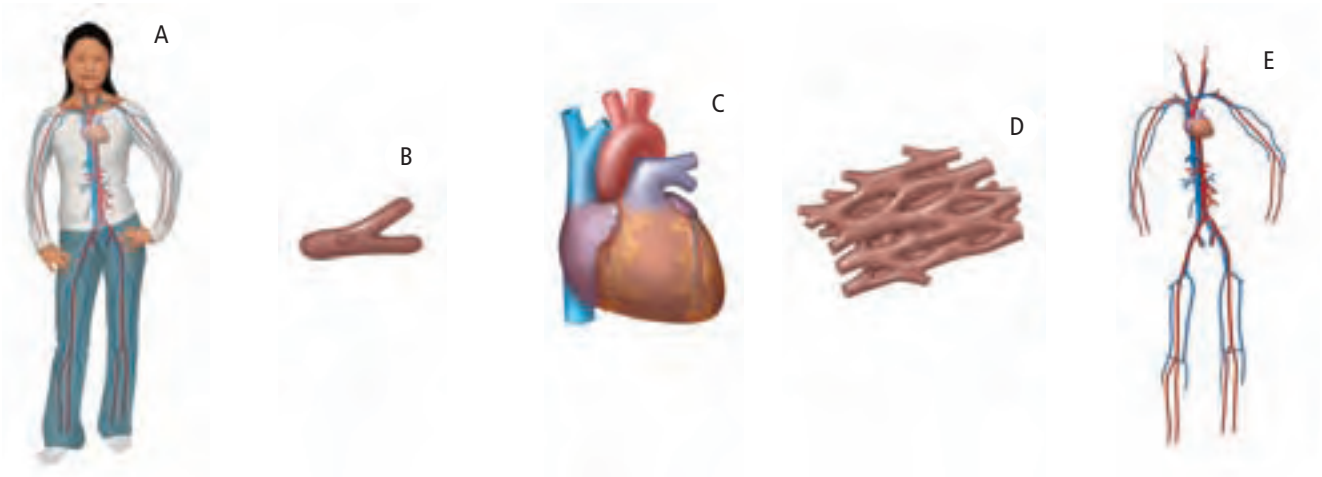
1. What are the three characteristics of a system?
2. How is a bicycle an example of a human-made system?
3. Match the following two images of tissue to the correct function.



   (a) holds together and supports other tissues
   (b) transfers signals in the body
   (c) assists in body movement
4. What is the difference between an organ and a tissue?

Understanding Key Ideas

5. Think of a human-made system not discussed in this textbook. Describe this system and explain how the three characteristics of a system are represented in your example.
6. Think of a natural system not discussed in this textbook. Describe this system and explain how the three characteristics of a system are represented in your example.
7. Imagine that you have been asked to make a model of each type of body tissue as part of a lesson for pre-school children. Select an appropriate material that you think is a suitable model for each type of tissue, and explain your choices.
8. Place the letters for the five pictures below into the sequence that correctly shows the organization of a human from cell to organism. Then explain how these levels of organization are related.



Pause and Reflect

Many people think of their skin as just a body covering. How do you think skin (epithelial) cells are important to the body?

11.2 Introducing Human Body Systems

The human body is made up of eleven systems that, working independently and together, support and maintain the function of the whole body.

Key Terms

circulatory system
digestive system
endocrine system
excretory system
immune system
integumentary system
muscular system
nervous system
reproductive system
respiratory system
skeletal system

Imagine a system that can:

- pump fluids for years and years without stopping or slowing down
- gather and release energy from the fuel it needs to run
- reuse and recycle some of its wastes and eliminate the rest
- manufacture some of the materials it needs to function
- send and receive messages almost instantly
- protect itself from invaders
- repair parts of itself that have worn out or stopped working
- make other functioning machines that are similar to itself
- move itself from one place to another

One day, scientists expect that human-made systems such as the one shown in Figure 11.5 will possess some—perhaps many—of these abilities. However, what if you want such a system now? If so, simply look in the mirror. The human body is quite likely the most sophisticated living system on Earth.

In the next activity, you will work with a team to find out about one organ system of the human body. Table 11.1, which gives a brief overview of all the major organ systems of the human body, follows on pages 428 to 430. Then, in Chapter 12, you will explore the ways in which body systems work independently and together to support and maintain the health of the whole body. You will also consider factors that can result in unhealthy body systems.

Figure 11.5 The current model of the Asimo humanoid robot is able to recharge its own batteries, step out of the way of an oncoming person, and work with other Asimo robots to perform simple tasks. Compared with human systems, however, even the most advanced robot is currently about as complex as an insect.

11-2A Teamwork

Find Out ACTIVITY

Working together on a project that has many parts or ideas often is faster and more efficient than working on it by yourself. In this activity, your class will be divided into teams to find out and present information about human body systems.

What to Do

1. Each team will be assigned one of the following organ systems:
   - circulatory system
   - digestive system
   - excretory system
   - muscular system
   - nervous system
   - respiratory system
2. Decide how the class will evaluate each group's presentation. At a minimum, each team's presentation must answer the following questions:
   - What is the function of the organ system?
   - Which organs are part of the system?
   - How do the organs of the system work together to enable the system to perform its function?
3. Decide how the members of your team will obtain the information it needs.
4. Use your library, the Internet, and any other resources you think are useful to find the information your team needs. Research your team's organ system.
5. Decide how the members of your team will coordinate and present the results of its research. For instance, your team could choose to:
   - deliver a lecture with charts and graphs
   - write a play and act the roles of tissues, cells, and organs
   - construct a three-dimensional model
   - create a multimedia display

Table 11.1 The Eleven Human Body Systems

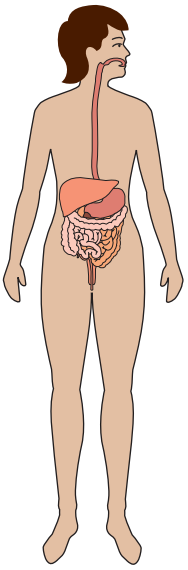
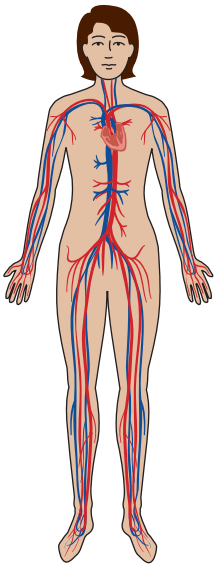
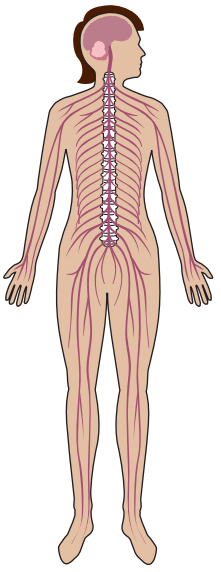
	Digestive System	Circulatory System	Nervous System
Main Functions	• Takes in food and breaks it down into its component nutrients • Absorbs nutrients • Eliminates solid wastes	• Transports blood, nutrients, oxygen, and liquid and gaseous wastes	• Controls and coordinates body activities • Senses and responds to internal and external changes
Main Organs and Tissues	 • mouth • esophagus • stomach • gall bladder • liver • pancreas • small intestine • large intestine • anus	 • heart • arteries • veins • capillaries • blood (tissue)	 • brain • spinal cord • nerves (tissue)

Table 11.1 The Eleven Human Body Systems—continued

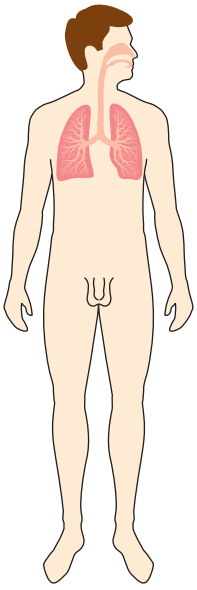
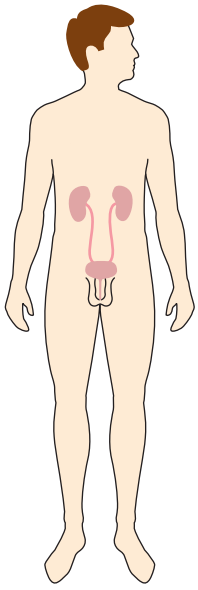
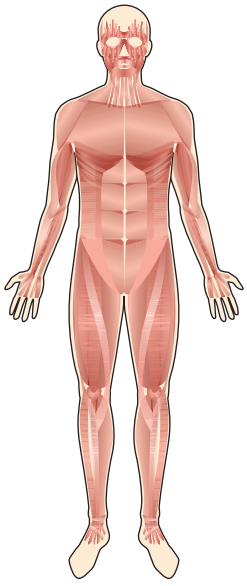
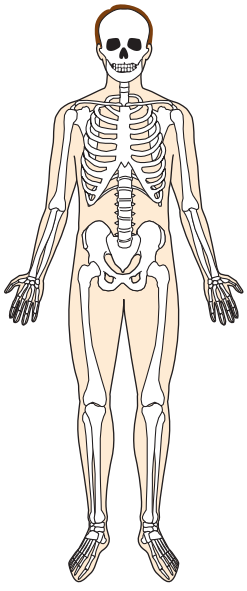
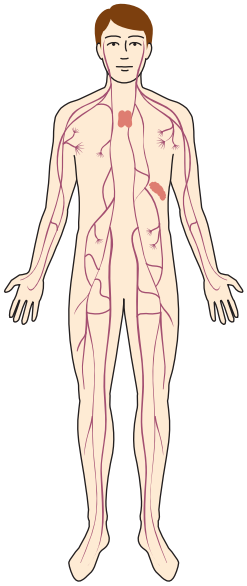
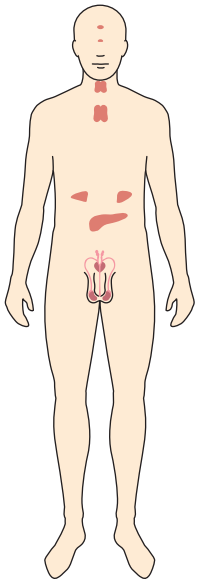
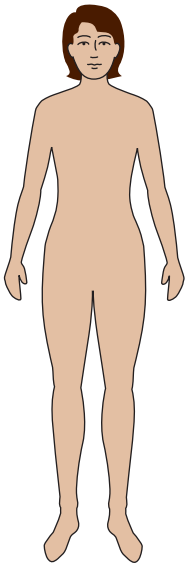
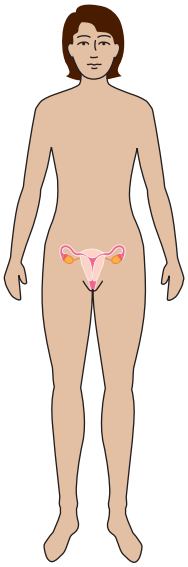
	Respiratory System	Excretory System	Muscular System	Skeletal System
Main Functions	• Controls breathing • Exchanges gases (oxygen and carbon dioxide) in lungs and tissues	• Removes liquid and gaseous wastes from the body • Maintains the volume and composition of body fluids	• Enables certain organs (such as the heart and stomach) to contract and relax • Works with the skeletal system to move parts of the body	• Supports the body • Protects some internal organs • Works with muscles to move parts of the body
Main Organs and Tissues	 • nose • trachea • lungs	 • kidneys • ureters • bladder • urethra • skin	 • muscle (tissue)	 • bone (tissue)

Table 11.1 The Eleven Human Body Systems—continued

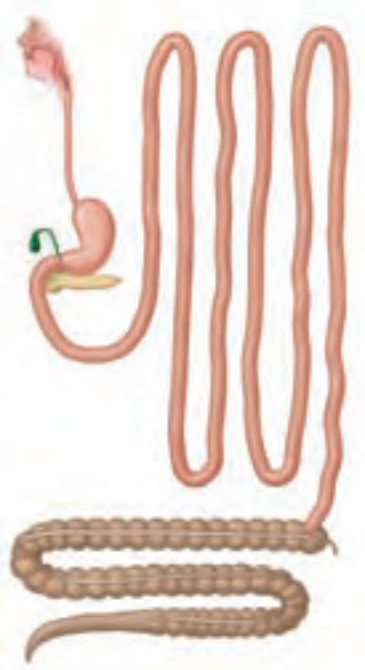
	Immune System	Endocrine System	Integumentary System	Reproductive System
Main Functions	• Defends the body against diseases and infections	• Manufactures and releases hormones	• Serves as a waterproof protective barrier between the external environment and the body's internal environment	• Producing specialized cells (sperm and eggs) that, in combination, result in the growth and development of offspring
Main Organs and Tissues	 • lymph nodes • lymph vessels • lymph (tissue)	 • glands • ducts	 • skin	 • female: ovaries, oviducts (Fallopian tubes), uterus, vagina • male: testes, penis, various glands and vessels

Checking Concepts

1. Name six systems of the human body.
2. Identify the system of the body to which each of the following organs belongs.
   (a) arteries
   (b) liver
   (c) kidneys
   (d) nose
   (e) mouth
3. Name the organ system that provides your body with matter and energy for all the life activities of the cells of your body.
4. Identify the body system represented in the following illustrations.

Understanding Key Ideas

5. Two organ systems provide the body with a means for transferring fluid (liquid and gaseous) wastes from its internal environment to the external environment. Name these two organ systems.
6. The illustration shows organs of one of the body systems, presented in an unusual manner.
   (a) Name the body system.
   (b) The organs of this body system are linked together so that materials can enter the internal environment of the body from the external environment and exit the internal environment of the body back into the external environment. Is this the only body system that connects the external and internal environments? Examine the illustrations on pages 428 to 430 to help you support your answer.
   (c) Examine the illustration of this body system on page 428. Explain how a system that is about 8 m long can fit inside your body.



Pause and Reflect

The proper functioning of the whole body requires the proper functioning of each of its body systems. Based on your current understanding of the body's organ systems, organize these systems into three or four groups. Explain your reasoning.

Prepare Your Own Summary

In this chapter, you studied how the cells of multicellular organisms are organized, and you surveyed the different organ systems of the human body. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 10 for help with using graphic organizers.) Use the following headings to organize your notes:

1. Systems
2. Organization of Cells of the Human Body
3. Survey of Human Body Systems

Checking Concepts

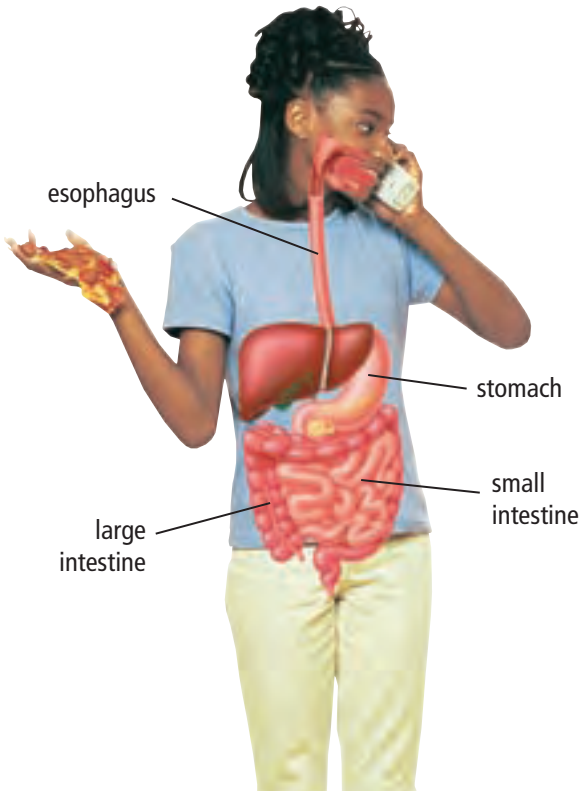
1. In Chapter 10, you learned how to operate a microscope. Use the characteristics of systems to explain why a microscope is an example of a system.

2. Draw a flowchart that shows the following terms in their correct order from least inclusive (simplest) to most inclusive (most complex): tissues, organ systems, organism, organ, cells.
3. Define and state one example from the human body for each term in question 3.
4. Identify the main function for each of the following body systems:
   (a) circulatory
   (b) digestive
   (c) excretory
   (d) muscular
   (e) nervous
   (f) respiratory

Understanding Key Ideas

5. A plant such as a tree is a multicellular organism. Do you think a tree has tissues, organs, and organ systems like humans and other animals do? Give reasons and include examples to explain your answer.
6. Think about the functions of the different systems of the human body. Also think about the main functions of the different organelles of a cell. Explain how the needs of the cells of the human body are related to the functions of the body systems.

7. When you swallow a chewed-up mouthful of food, it moves to the stomach through a vertical tube called the esophagus. From the stomach, food passes through the twists and turns of the folded-up small intestine, and then it passes through the vertical and horizontal lengths of the large intestine. In order for food to move through these different types and orientations of tubes, the tissues that make up these organs must contract (squeeze) and then relax. (Think of moving a marble along a length of rubber tubing by squeezing the part of the tubing just behind the marble repeatedly.)



   (a) The esophagus, small intestine, and large intestine are different organs. Is it possible that they are made of the same kind of tissue? Explain why or why not.
   (b) Name one type of tissue that would probably make up these organs. Explain your choice.
   (c) One of the functions of the stomach is to mix and churn swallowed food with acid and saliva. Infer at least one type of tissue that you would expect to make up the stomach.

8. The chemical reactions that release energy from the food you eat take place in the mitochondria of cells. Muscle cells have many more mitochondria than the cells of most other organs. Explain why this does or does not surprise you.

Pause and Reflect

In the next chapter, you will explore ways in which body systems are related. Based on your current understanding of human body systems, suggest at least one way that you think each of the following systems are related.

- digestive and circulatory
- circulatory and respiratory
- respiratory and digestive