

The **BIG Idea**
Structure and Function

Q How do the systems of the human body work together?

Chapter Preview

1 Body Organization and Homeostasis

Discover How Does Your Body Respond?

Try This How Is a Book Organized?

2 The Skeletal System

Discover Hard as a Rock?

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3 The Muscular System

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Skills Lab A Look Beneath the Skin

4 The Skin


Discover What Can You Observe About Skin?

Try This Sweaty Skin

Analyzing Data SPF Ratings

Design Your Own Lab Sun Safety



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Chapter Project

Design and Build a Hand Prosthesis

A prosthesis is an artificial device that replaces a human body part. Designing artificial replacements, such as prosthetic hands, can be a challenging task. This is because even a simple act, such as picking up a pen, involves a complex interaction of body parts.

Your Goal To design, build, and test a replacement for a human hand

Your prosthesis must

- grasp and lift a variety of objects
- be activated by pulling a cord or string
- spring back when the cord is released
- be built following the safety guidelines in Appendix A

Plan It! Before you design your prosthetic hand, study the human hand. Watch how the fingers move to pick up objects. Make a list of devices that mimic the ability of the hand to pick up objects. Examples include tongs, tweezers, pliers, and chopsticks. Then, choose materials for your hand and sketch your design. When your teacher has approved your design, build and test your prosthetic hand.



Body Organization and Homeostasis

Reading Preview

Key Concepts

- What are the levels of organization in the body?
- What is homeostasis?

Key Terms

- cell • cell membrane
- nucleus • cytoplasm
- tissue • muscle tissue
- nervous tissue
- connective tissue
- epithelial tissue
- organ • organ system
- homeostasis • stress

Target Reading Skill

Outlining An outline shows the relationship between main ideas and supporting ideas. As you read, make an outline about body organization and homeostasis. Use the red headings for the main ideas and the blue headings for the supporting ideas.

Body Organization and Homeostasis

- I. Cells
 - A. Structures of cells
 - B.
- II. Tissues

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Discover Activity

How Does Your Body Respond?

1. Stack one book on top of another one.
2. Lift the two stacked books in front of you so the lowest book is about level with your shoulders. Hold the books in this position for 30 seconds. While you are performing this activity, note how your body responds. For example, how do your arms feel at the beginning and toward the end of the 30 seconds?
3. Balance one book on the top of your head. Walk a few steps with the book on your head.



Think It Over

Inferring List all the parts of your body that worked together as you performed the activities in Steps 1 through 3.

The bell rings—lunchtime! You hurry down the noisy halls to the cafeteria. The unmistakable aroma of hot pizza makes your mouth water. At last, you balance your tray of pizza and salad while you pay the cashier. You look around the cafeteria for your friends. Then, you walk to the table, sit down, and begin to eat.

Think about how many parts of your body were involved in the simple act of getting and eating your lunch. Every minute of the day, whether you are eating, studying, walking, or even sleeping, your body is busily at work. Each part of the body has a specific job to do. And all the different parts of your body usually work together so smoothly that you don't even notice them.

This smooth functioning is due partly to the way in which the body is organized. **The levels of organization in the human body consist of cells, tissues, organs, and organ systems.** The smallest unit of organization is the cell. The next largest unit is tissue; then, organs. Finally, the organ system is the largest unit of organization.

Cells

A **cell** is the basic unit of structure and function in a living thing. Complex organisms are composed of many cells in the same way a brick building is composed of many bricks. The human body contains about 100 trillion cells. Cells are quite tiny, and most cannot be seen without a microscope.

Structures of Cells Most animal cells, including those in the human body, have a structure similar to the cell in Figure 1. The **cell membrane** forms the outside boundary of the cell. Inside the cell membrane is a large structure called the nucleus. The **nucleus** is the control center that directs the cell's activities and contains the information that determines the cell's form and function. When the cell divides, or reproduces, this information is passed along to the newly formed cells. The material within a cell apart from the nucleus is called the **cytoplasm** (SYT uh plaz um). The cytoplasm is made of a clear, jellylike substance containing many cell structures called organelles.

Functions of Cells Cells carry on the processes that keep organisms alive. Inside cells, for example, molecules from digested food undergo chemical reactions that release energy for the body's activities. Cells also grow and reproduce. And they get rid of waste products that result from these activities.



Reading Checkpoint

What is the function of the nucleus?

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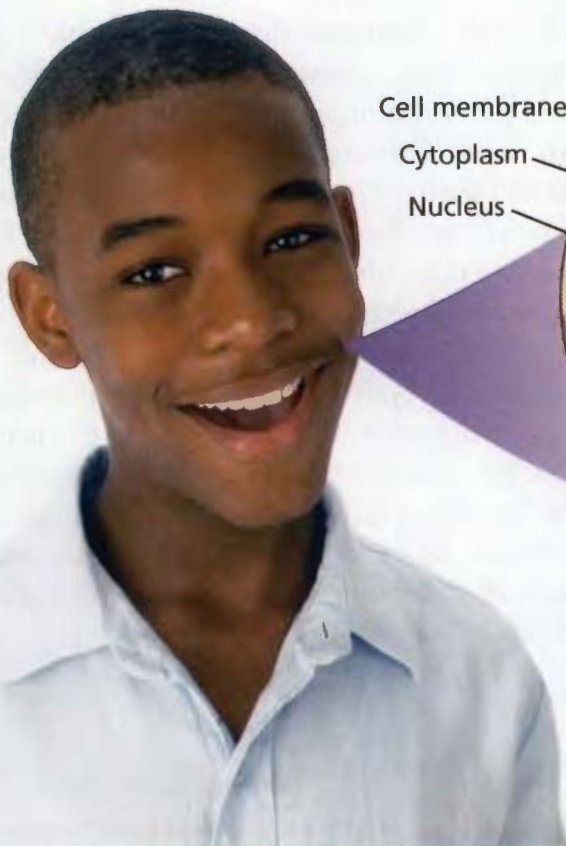
Try This Activity

How Is a Book Organized?

In this activity, you will analyze the levels of organization in a book.

1. Examine this textbook to see how it is subdivided—into chapters, sections, and so on.
2. Make a concept map that shows this pattern of organization. Place the largest subdivision at the top of the map and the smallest at the bottom.
3. Compare the levels of organization in this textbook to those in the human body.

Making Models Which level of organization in the textbook represents cells? Which represents tissues? Organs? Organ systems?



Cell from inner lining of cheek

Cell membrane
Cytoplasm
Nucleus

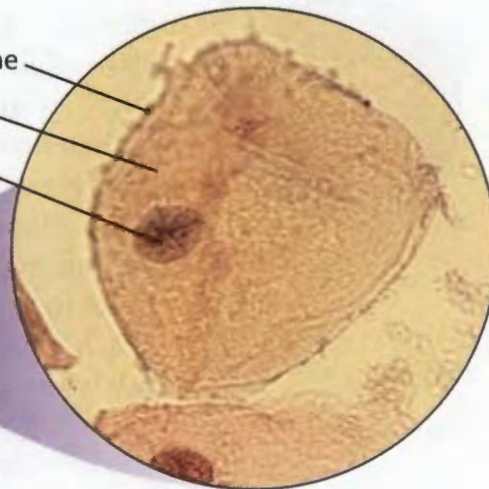


FIGURE 1

Cell Structure

Your body is made of trillions of tiny structures called cells. **Interpreting Photographs** What structure forms the outside boundary of the cell?

FIGURE 2

Types of Tissues

Your body contains four kinds of tissues: muscle, nervous, connective, and epithelial.

Comparing and Contrasting *How is the function of nervous tissue different from that of epithelial tissue?*

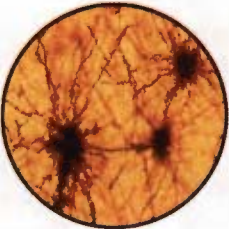
Muscle Tissue

Every movement you make depends on muscle tissue. The muscle tissue shown here allows your body to move.



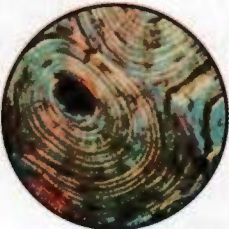
Nervous Tissue

Nervous tissue, such as the brain cells shown here, enables you to see, hear, and think.



Connective Tissue

Connective tissue, such as the bone shown here, connects and supports parts of your body.



Epithelial Tissue

Epithelial tissue, such as the skin cells shown here, covers the surfaces of your body and lines your internal organs.



Tissues

The next largest unit of organization in your body is a tissue. A **tissue** is a group of similar cells that perform the same function. The human body contains four basic types of tissue: muscle tissue, nervous tissue, connective tissue, and epithelial tissue. To see examples of each of these tissues, look at Figure 2.

Like the muscle cells that form it, **muscle tissue** can contract, or shorten. By doing this, muscle tissue makes parts of your body move. While muscle tissue carries out movement, **nervous tissue** directs and controls the process. Nervous tissue carries electrical messages back and forth between the brain and other parts of the body. Another type of tissue, **connective tissue**, provides support for your body and connects all its parts. Bone tissue and fat are connective tissues.

The surfaces of your body, inside and out, are covered by **epithelial tissue** (ep uh THEE lee ul). Some epithelial tissue, such as your skin, protects the delicate structures that lie beneath it. The lining of your digestive system consists of epithelial tissue that allows you to digest and absorb the nutrients in your food.



Reading Checkpoint

What is the job of muscle tissue?

Organs and Organ Systems

Your stomach, heart, brain, and lungs are all organs. An **organ** is a structure that is composed of different kinds of tissue. Like a tissue, an organ performs a specific job. The job of an organ, however, is generally more complex than that of a tissue. The heart, for example, pumps blood throughout your body, over and over again. The heart contains all four kinds of tissue—muscle, nervous, connective, and epithelial. Each type of tissue contributes to the organ's overall job of pumping blood.

Each organ in your body is part of an **organ system**, which is a group of organs that work together to perform a major function. Your heart is part of your circulatory system, which carries oxygen and other materials throughout the body. Besides the heart, blood vessels are major structures in the circulatory system. Figure 3 shows some of the major organ systems in the human body.

FIGURE 3

Organ Systems

The human body is made up of eleven organ systems. Eight of the systems are shown here.

Interpreting Diagrams Which two systems work together to get oxygen to your cells?



Circulatory System
Transports materials to and from cells.



Skeletal System
Supports and protects the body.



Digestive System
Breaks down food and absorbs nutrients.



Nervous System
Detects information from the environment and controls body functions.



Endocrine System
Controls many body processes by means of chemicals.



Respiratory System
Takes in oxygen and eliminates carbon dioxide.



Muscular System
Enables movement of the body and internal organs.



Excretory System
Removes wastes.

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Homeostasis

The different organ systems work together and depend on one another. When you ride a bike, you use your muscular and skeletal systems to steer and push the pedals. But you also need your nervous system to direct your arms and legs to move. Your respiratory, digestive, and circulatory systems work together to fuel your muscles with the energy they need. And your excretory system removes the wastes produced while your muscles are hard at work.

All the systems of the body work together to maintain **homeostasis** (hoh mee oh STAY sis), the body's tendency to keep an internal balance. **Homeostasis is the process by which an organism's internal environment is kept stable in spite of changes in the external environment.**

Homeostasis in Action To see homeostasis in action, all you have to do is take your temperature when the air is cold. Then, take it again in an overheated room. No matter what the temperature of the air around you, your internal body temperature will be close to 37°C. Of course, if you become sick, your body temperature may rise. But when you are well again, it returns to 37°C.

Maintaining Homeostasis Your body has various ways of maintaining homeostasis. For example, when you are too warm, you sweat. Sweating helps to cool your body. On the other hand, when you are cold, you shiver. Shivering occurs when your muscles rapidly contract and relax. This action produces heat that helps keep you warm. Both of these processes help your body maintain homeostasis by regulating your temperature.

FIGURE 4

Maintaining Homeostasis

Regardless of the surrounding temperature, your body temperature remains fairly constant at about 37°C. Sweating (left) and shivering (right) help regulate your body temperature.

Applying Concepts *What is the term for the body's tendency to maintain a stable internal environment?*



Stress and Homeostasis Sometimes, things can happen to disrupt homeostasis. As a result, your heart may beat more rapidly or your breathing may increase. These reactions of your circulatory and respiratory systems are signs of stress. **Stress** is the reaction of your body to potentially threatening, challenging, or disturbing events.

Think about what happens when you leave the starting line in a bike race. As you pedal, your heart beats faster and your breathing increases. What is happening in your body? First, your endocrine system releases a chemical called adrenaline into your bloodstream. Adrenaline gives you a burst of energy and prepares your body to take action. As you pedal, your muscles work harder and require more oxygen. Oxygen is carried by the circulatory system, so your heart beats even faster to move more blood to your muscles. Your breath comes faster and faster, too, so that more oxygen can get into your body. Your body is experiencing stress.

If stress is over quickly, your body soon returns to its normal state. Think about the bike race again. After you cross the finish line, you continue to breathe hard for the next few minutes. Soon, however, your breathing and heart rate return to normal. The level of adrenaline in your blood returns to normal. Thus, homeostasis is restored after just a few minutes of rest.



**Reading
Checkpoint**

What is stress?

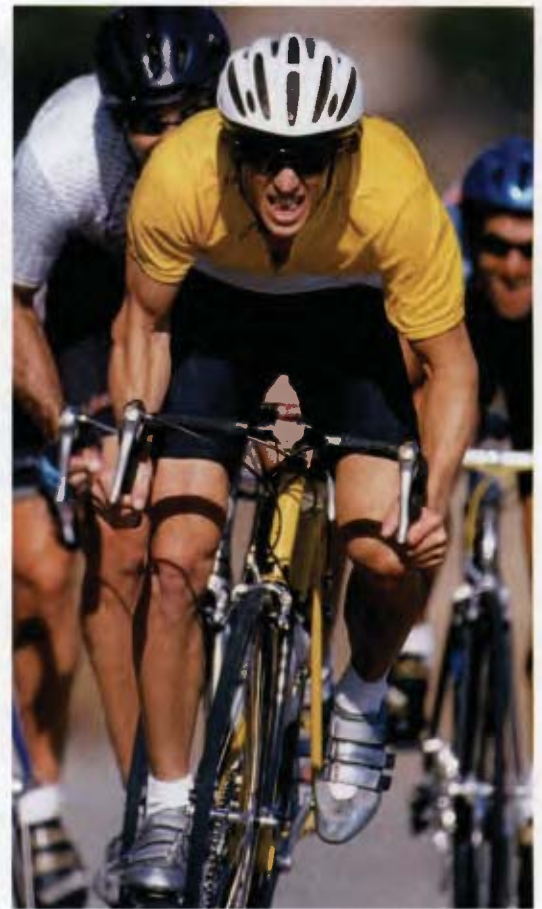


FIGURE 5
Stress

Your body reacts to stress, such as the start of a bike race, by releasing adrenaline and carrying more oxygen to body cells.

Section 1 Assessment

Target Reading Skill Outlining Use the information in your outline to help you answer the questions below.

Reviewing Key Concepts

- a. Identifying** List the four levels of organization in the human body from smallest to largest. Give an example of each level.
- b. Comparing and Contrasting** What is the difference between tissues and organs?
- c. Applying Concepts** What systems of the body are involved when you prepare a sandwich and then eat it?

- a. Defining** What is homeostasis?
- b. Explaining** How does stress affect homeostasis?
- c. Relating Cause and Effect** Describe what happens inside your body as you give an oral report in front of your class.

Writing in Science

Summary Write a paragraph that explains what body systems are involved when you sit down to do your homework. Be sure to begin your paragraph with a topic sentence and include supporting details.