35–1 Human Body Systems

As the missed shot bounces high in the air, one of the defenders decides to take a chance. She breaks for the other end of the court. Another defender grabs the rebound, glances upcourt, and throws a long, arching pass toward the basket. Wide open, her teammate grabs the pass, dribbles, and leaps into the air, laying the basketball carefully off the backboard and into the unguarded basket. The buzzer goes off, and the game is over.

Guide for Reading

Key Concepts
- How is the human body organized?
- What is homeostasis?

Vocabulary
specialized cell
epithelial tissue
connective tissue
nervous tissue
muscle tissue
homeostasis
feedback inhibition

Reading Strategy: Predicting Before you read, use **Figure 35–2** to predict how many organ systems help to regulate body temperature. As you read, look for evidence to support your prediction.

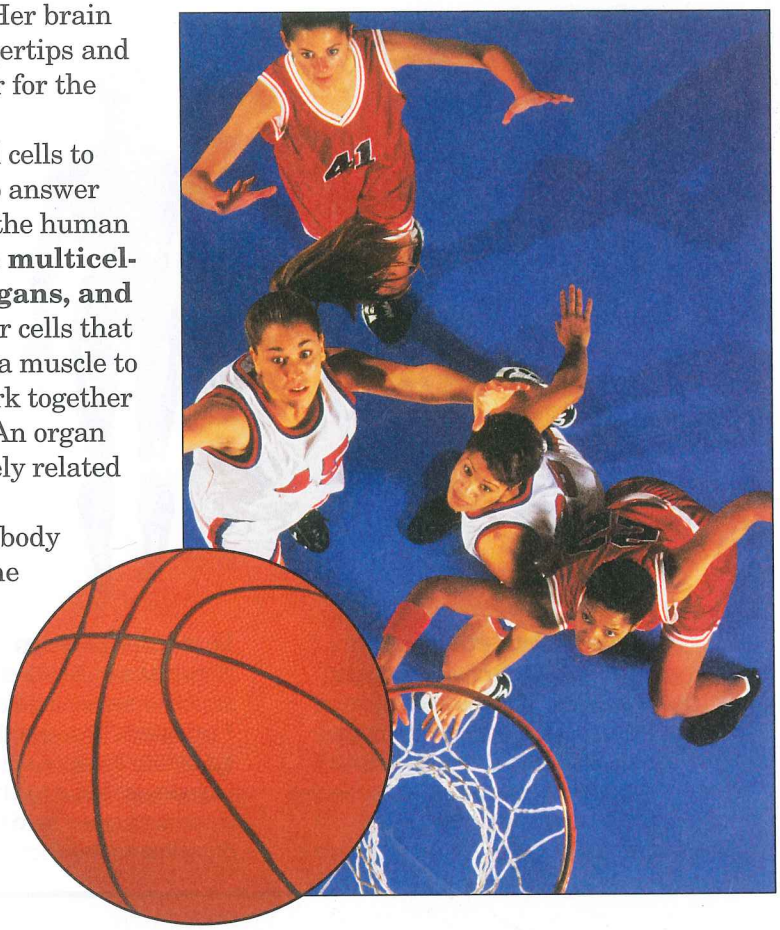
Organization of the Body

Teamwork is a wonderful thing! Anyone watching the end of this game would be impressed at the way these two players worked together to make the winning play. But the real teamwork on this play involved a much larger number of players—the nearly one hundred trillion cells that make up the human body.

Every cell in the human body is both an independent unit and an interdependent part of a larger community—the entire organism. To make a winning basket, a basketball player has to use her eyes to watch the play and her brain to figure out how to score. With the support of her bones, her muscles propel her body up the court. As she sprints for a pass, her lungs absorb oxygen, which her blood carries to her cells. Her brain monitors the sensation of the ball on her fingertips and sends signals that guide her body into the air for the final play.

How does the body get so many individual cells to work together so beautifully? You can begin to answer this question by studying the organization of the human body. **The levels of organization in a multicellular organism include cells, tissues, organs, and organ systems.** Tissues are groups of similar cells that perform a single function, such as connecting a muscle to a bone. An organ is a group of tissues that work together to perform a complex function, such as sight. An organ system is a group of organs that perform closely related functions.

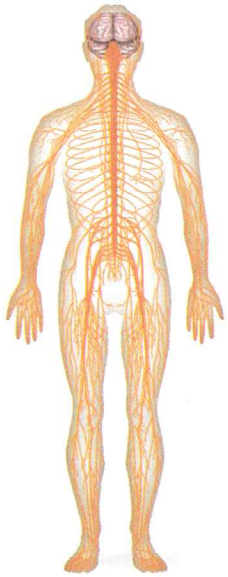
The eleven organ systems of the human body work together to maintain homeostasis in the body as a whole. The organ systems, including their main structures and functions, are shown in **Figure 35–2** on pages 892 and 893.



▶ **Figure 35–1** Each player on a basketball team has a different role, but together the team works toward a common goal—winning the game.

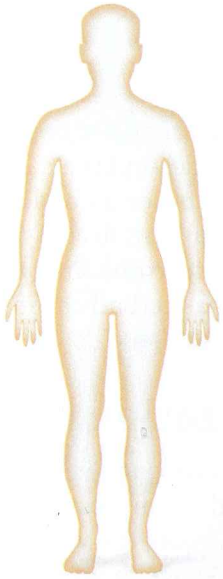
FIGURE 35–2 HUMAN ORGAN SYSTEMS

The levels of organization in the human body include cells, tissues, organs, and organ systems. Although each of the eleven organ systems shown here has a different set of functions, they all work together, as a whole, to maintain homeostasis.



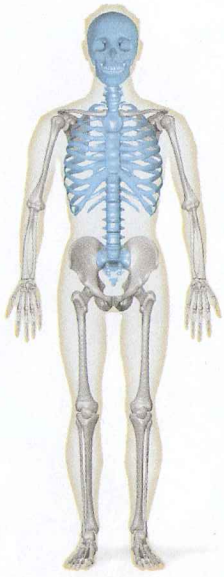
Nervous System

Structures: Brain, spinal cord, peripheral nerves
Function: Recognizes and coordinates the body's response to changes in its internal and external environments



Integumentary System

Structures: Skin, hair, nails, sweat and oil glands
Function: Serves as a barrier against infection and injury; helps to regulate body temperature; provides protection against ultraviolet radiation from the sun

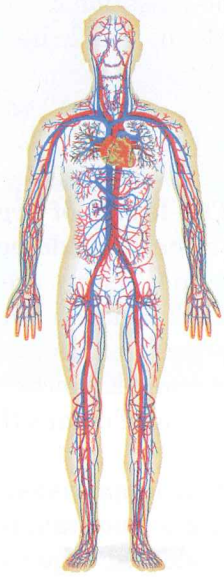


Skeletal System

Structures: Bones, cartilage, ligaments, tendons
Function: Supports the body; protects internal organs; allows movement; stores mineral reserves; provides a site for blood cell formation

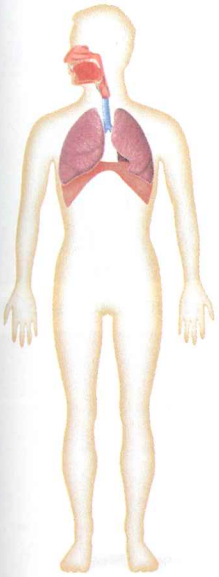
Muscular System

Structures: Skeletal muscle, smooth muscle, cardiac muscle
Function: Works with skeletal system to produce voluntary movement; helps to circulate blood and move food through the digestive system



Circulatory System

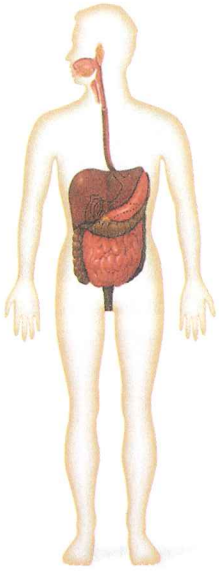
Structures: Heart, blood vessels, blood
Function: Brings oxygen, nutrients, and hormones to cells; fights infection; removes cell wastes; helps to regulate body temperature



Respiratory System

Structures: Nose, pharynx, larynx, trachea, bronchi, bronchioles, lungs

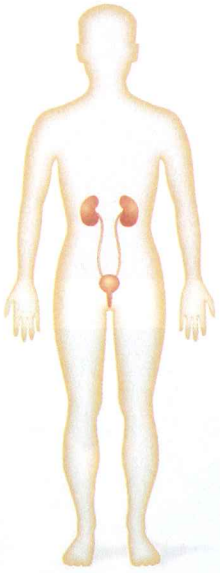
Function: Provides oxygen needed for cellular respiration and removes excess carbon dioxide from the body



Digestive System

Structures: Mouth, pharynx, esophagus, stomach, small and large intestines, rectum

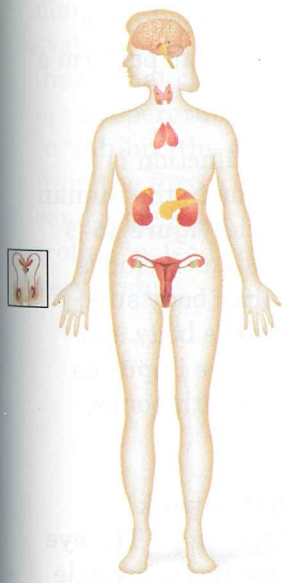
Function: Converts foods into simpler molecules that can be used by the cells of the body; absorbs food; eliminates wastes



Excretory System

Structures: Skin, lungs, kidneys, ureters, urinary bladder, urethra

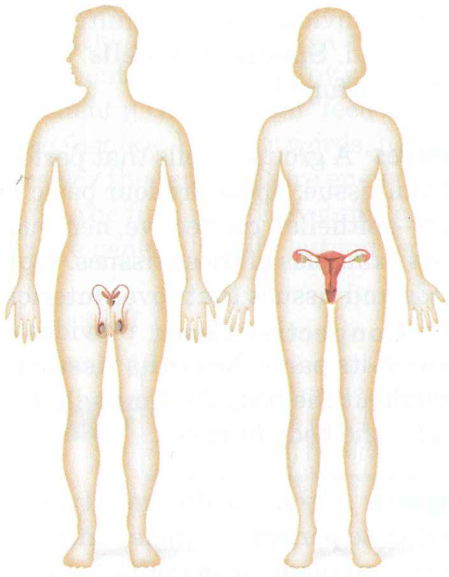
Function: Eliminates waste products from the body in ways that maintain homeostasis



Endocrine System

Structures: Hypothalamus, pituitary, thyroid, parathyroids, adrenals, pancreas, ovaries (in females), testes (in males)

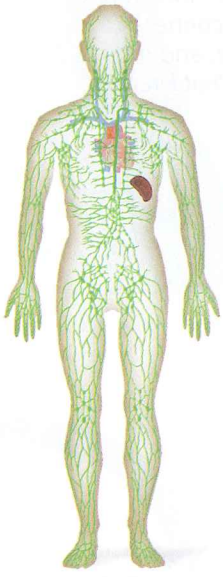
Function: Controls growth, development, and metabolism; maintains homeostasis



Reproductive System

Structures: Testes, epididymis, vas deferens, urethra, and penis (in males); ovaries, Fallopian tubes, uterus, vagina (in females)

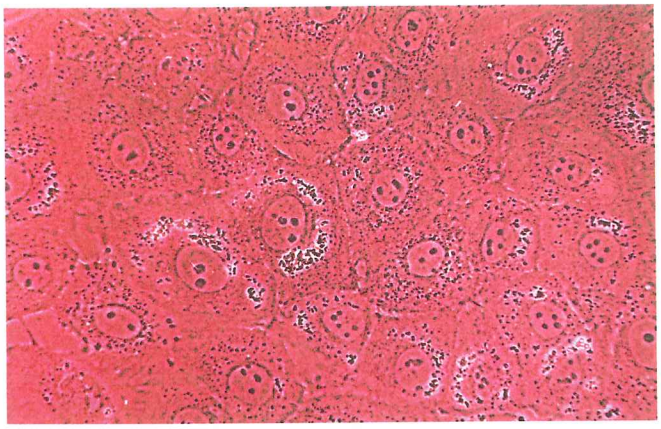
Function: Produces reproductive cells; in females, nurtures and protects developing embryo



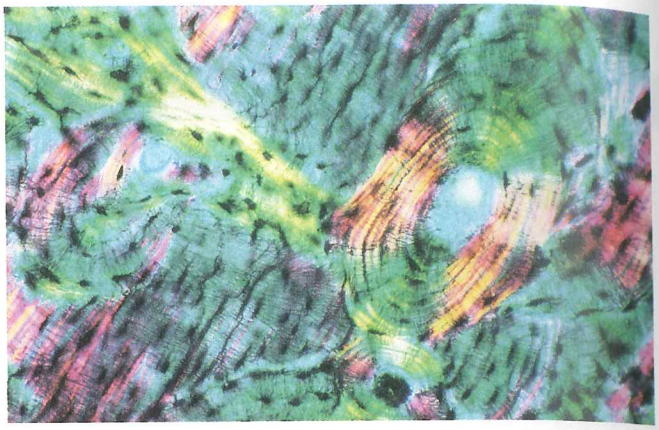
Lymphatic/Immune Systems

Structures: White blood cells, thymus, spleen, lymph nodes, lymph vessels

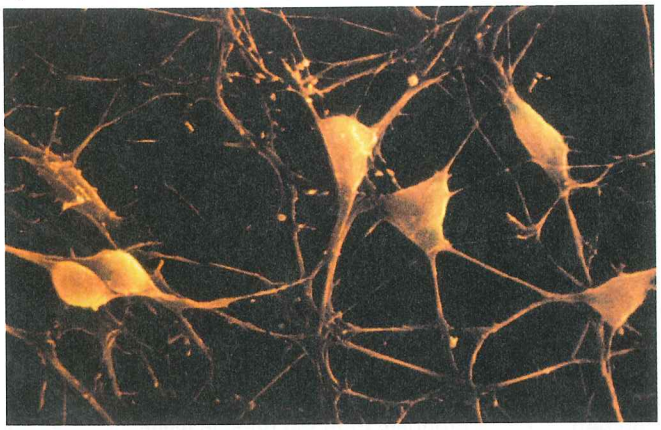
Function: Helps protect the body from disease; collects fluid lost from blood vessels and returns the fluid to the circulatory system



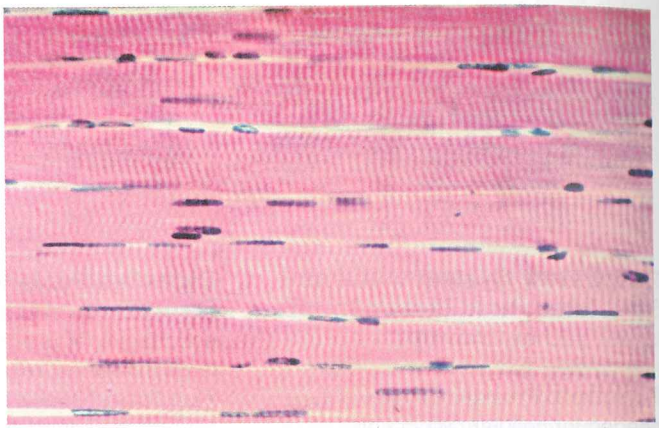
Epithelial Tissue (magnification: 6000×)



Connective Tissue (magnification: about 50×)



Nervous Tissue (magnification: 1100×)



Muscle Tissue (magnification: 150×)

▲ **Figure 35–3** The four major types of tissues in the human body are epithelial tissue, connective tissue, nervous tissue, and muscle tissue. **Inferring** *What kind of tissue is bone?*

Cells A cell is the basic unit of structure and function in living things. Individual cells in multicellular organisms tend to be specialized. **Specialized cells** are uniquely suited to perform a particular function.

Tissues A group of cells that perform a single function is called a tissue. There are four basic types of tissue in the human body—epithelial, connective, nervous, and muscle. **Figure 35–3** shows examples of these tissues. **Epithelial tissue** includes glands and tissues that cover interior and exterior body surfaces. **Connective tissue** provides support for the body and connects its parts. **Nervous tissue** transmits nerve impulses throughout the body. And **muscle tissue,** along with bones, enables the body to move.

Organs A group of different types of tissues that work together to perform a single function is called an organ. The eye is an organ made up of epithelial tissue, nervous tissue, muscle tissue, and connective tissue. As different as these tissues are, they all work together for a single function—sight.

Organ Systems An organ system is a group of organs that perform closely related functions. For example, the brain is one of the organs of the nervous system, which gathers information about the outside world and coordinates the body's response.

CHECKPOINT *What is the role of nervous tissue?*

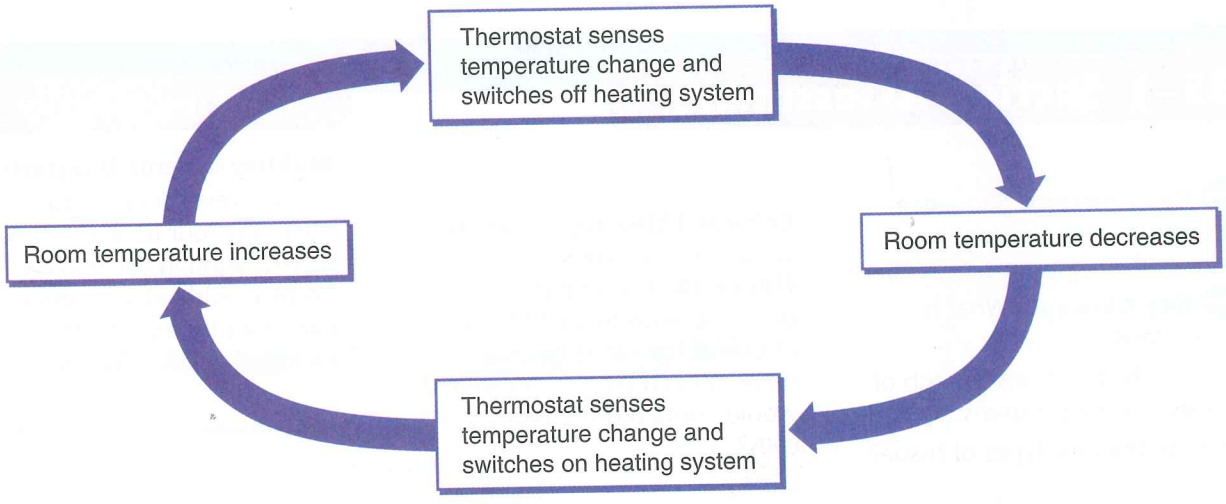
Maintaining Homeostasis

You can get a glimpse of the interrelationship of your body systems when you breathe deeply after climbing a steep hill or when your blood clots to seal a cut. Behind the scenes, your organ systems are working constantly to do something that few people appreciate—maintain a controlled, stable environment. This process is called **homeostasis,** which means "keeping things in balance." **Homeostasis is the process by which organisms keep internal conditions relatively constant despite changes in external environments. Homeostasis in the body is maintained by feedback loops.**

A Nonliving Example One way to understand homeostasis is to look at a nonliving system that also keeps environmental conditions within a certain range. The heating system of a house is a perfect example. In most houses, heat is supplied by a furnace that burns oil or natural gas. When the temperature within the house drops below a set point, a sensor in a device called a thermostat switches the furnace on. Heat produced by the furnace warms the house. When the temperature rises above the set point, the thermostat switches the furnace off. Because the furnace runs only when it is needed, the temperature of the house is kept within a narrow range.

A heating system like the one described is said to be controlled by feedback inhibition. **Feedback inhibition,** or negative feedback, is the process in which a stimulus produces a response that opposes the original stimulus. **Figure 35–4** summarizes the feedback inhibition process in a home heating system. When the furnace is switched on, it produces a product (heat) that changes the environment of the house (by raising the air temperature). This environmental change then "feeds back" to "inhibit" the operation of the furnace. In other words, heat from the furnace eventually raises the temperature enough to send a feedback signal to switch the furnace off. Systems controlled by feedback inhibition are generally fully automated and very stable.

Figure 35–4 Homeostasis is the process by which organisms keep internal conditions relatively constant despite changes in external environments. A home heating system uses a feedback loop to maintain a stable, comfortable environment within a house.



In the Body Could biological systems achieve homeostasis through feedback inhibition? Absolutely. All that is needed is a system that regulates some aspect of the cellular environment and that can respond to feedback from its own activities by switching on or off as needed.

Maintenance of homeostasis requires the integration of all organ systems at all times. One example is the maintenance of a stable body temperature. The body regulates temperature by a mechanism that is remarkably similar to that of a home heating system. A part of the brain called the hypothalamus contains nerve cells that monitor both the temperature of the skin at the surface of the body and the temperature of organs in the body's core. The temperature of the core is generally higher than the temperature of the skin.

If the nerve cells sense that the core temperature has dropped much below 37°C, the hypothalamus produces chemicals that signal cells throughout the body to speed up their activities. Heat produced by this increase in cellular activity causes a gradual rise in body temperature, which is detected by nerve cells in the hypothalamus. This feedback inhibits the production of the chemicals that speed up cellular activity and keeps body temperature from rising to a dangerous level.

Have you ever been so cold that you began to shiver? If your body temperature drops well below its normal range, the hypothalamus releases chemicals that signal muscles just below the surface of the skin to contract involuntarily—to "shiver." These muscle contractions release heat, which helps the body temperature to rise back toward the normal range.

If body temperature rises too far above 37°C, the hypothalamus slows down cellular activities, minimizing the production of heat. This is one of the main reasons you may feel tired and sluggish on a hot day. The body also responds to high temperatures by producing sweat, which helps to cool the body surface by evaporation. Because heat from the body's core is carried by the blood to the skin, evaporation at the body surface also helps to lower the temperature of the core. When this temperature returns to its set point, the body stops producing sweat.

Word Origins

Thermometer comes from the Greek words *therme,* meaning "heat," and *metron,* meaning "measure." So, thermometer means an instrument used to measure heat. **If *hypo-* is Greek for "under," what does *hypothermia* mean?**

35–1 Section Assessment

1. **Key Concept** Sequence the levels of organization in multicellular organisms.
2. **Key Concept** What is homeostasis?
3. Describe the functions of each of the eleven organ systems.
4. What are the four types of tissue?
5. **Critical Thinking Inferring** Look at the nervous tissue in **Figure 35–3.** Compare the cells of the nervous tissue to the cells of one of the other types of tissue. Which parts of an animal would contain these types of cells?

Thinking Visually

Making a Venn Diagram
Draw a Venn diagram to relate the four basic levels of organization in the human body. Provide at least three examples for each level included in your diagram.