30.1 Organization of the Human Body

Key Questions

- ***How is the human body organized?***
- ***What is homeostasis?***

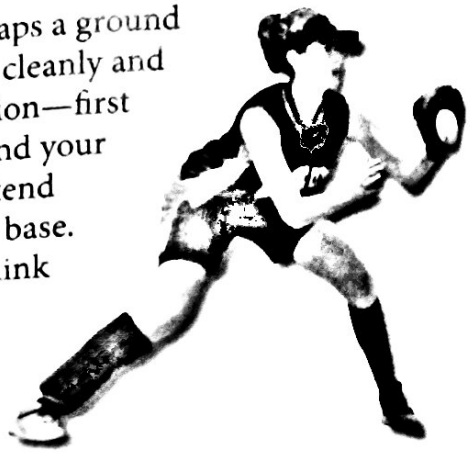
Vocabulary

epithelial tissue
connective tissue
nervous tissue
muscle tissue
homeostasis
feedback inhibition

Taking Notes

Preview Visuals Examine **Figure 30–2.** For each system, describe how you think it interacts with at least one other system.

THINK ABOUT IT The batter slaps a ground ball to the shortstop, who fields it cleanly and throws the ball toward your position—first base. In a single motion, you extend your glove hand, catch the ball, and extend your foot to touch the edge of the base. An easy out, a routine play. But think about how many systems of your body are involved in making this type of "routine" play. How do they all work together?



Organization of the Body

How is the human body organized?

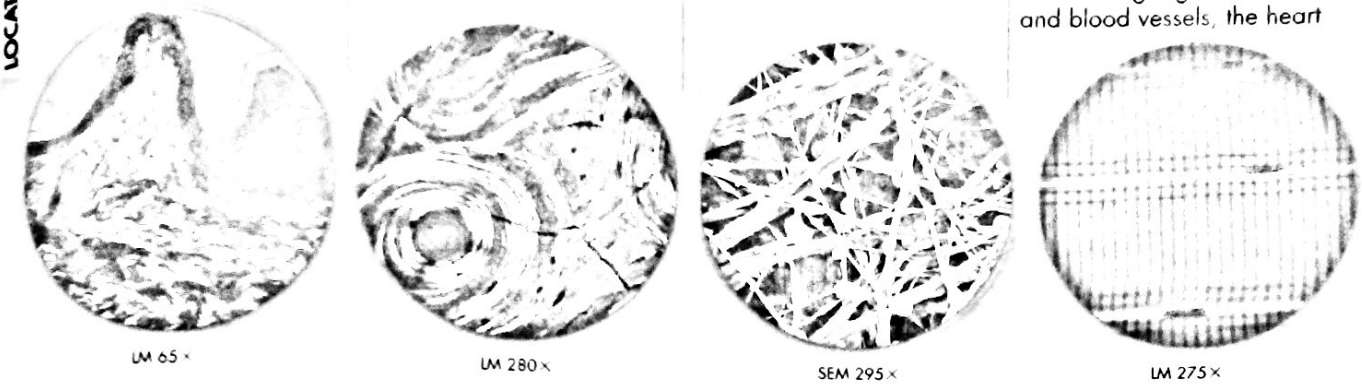
Every cell in the human body is both an independent unit and an interdependent part of a larger community—the entire organism. To complete a winning play, a player at first base has to use her eyes to watch the ball and use her brain to figure out how to position her body. With the support of her bones, muscles move her body to first base. Meanwhile, the player's lungs absorb oxygen, which her blood carries to cells for use during cellular respiration. Her brain monitors the location of the ball and sends signals that guide her glove hand to make the catch.

How can so many individual cells and parts work together so efficiently? One way to answer this question is to study the organization of the human body. **The levels of organization in the body include cells, tissues, organs, and organ systems.** At each level of organization, these parts of the body work together to carry out the major body functions.

Cells A cell is the basic unit of structure and function in living things. As you learned in Chapter 7, individual cells in multicellular organisms tend to be specialized. Specialized cells, such as bone cells, blood cells, and muscle 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 30–1** shows examples of each type of tissue.

	Epithelial Tissue	Connective Tissue	Nervous Tissue	Muscle Tissue
FUNCTIONS	Protection, absorption, and excretion of materials	Binding of epithelial tissue to structures, support, and transport of substances	Receiving and transmitting nerve impulses	Voluntary and involuntary movements
LOCATIONS	Skin, lining of digestive system, certain glands	Under skin, surrounding organs, blood, bones	Brain, spinal cord, and nerves	Skeletal muscles, muscles surrounding digestive tract and blood vessels, the heart



LM 65 × LM 280 × SEM 295 × LM 275 ×

FIGURE 30–1 Types of Tissues The four major types of tissues in the human body are epithelial tissue, connective tissue, nervous tissue, and muscle tissue. **Predict** ***Which organ may not contain all four types of tissue?***

▶ ***Epithelial Tissue*** The tissue that lines the interior and exterior body surfaces is called **epithelial tissue.** Your skin and the lining of your stomach are both examples of epithelial tissue.

▶ ***Connective Tissue*** A type of tissue that provides support for the body and connects its parts is **connective tissue.** This type of tissue includes fat cells, bone cells, and even blood cells. Many connective tissue cells produce collagen, a long, tough fiber-like protein that is the most common protein in the body. Collagen gives tissues strength and resiliency, helping them to keep their shape even under pressure.

▶ ***Nervous Tissue*** Nerve impulses are transmitted throughout the body by **nervous tissue.** Neurons, the cells that carry these impulses, and glial cells, which surround and protect neurons, are both examples of nervous tissue.

▶ ***Muscle Tissue*** Movements of the body are possible because of **muscle tissue.** Some muscles are responsible for the movements you control, such as the muscles that move your arms and legs. Some muscles are responsible for movements you cannot control, such as the tiny muscles that control the size of the pupil in the eye.

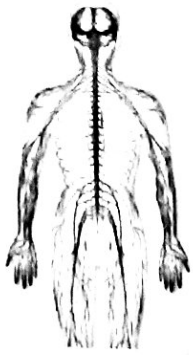
Organs A group of different types of tissues that work together to perform a single function or several related functions is called an organ. The eye is an organ made up of epithelial tissue, nervous tissue, muscle tissue, and connective tissue. As different as these tissues are, they all work together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

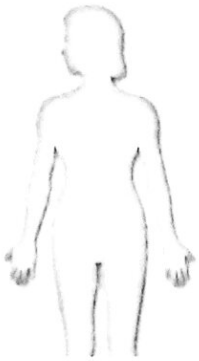
Organ Systems An organ system is a group of organs that perform closely related functions. For example, the brain and spinal cord are organs of the nervous system. The organ systems interact to maintain homeostasis in the body as a whole. The organ systems, along with their structures and main functions, are shown on the next page.

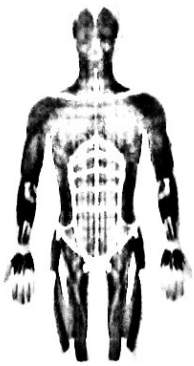
VISUAL SUMMARY

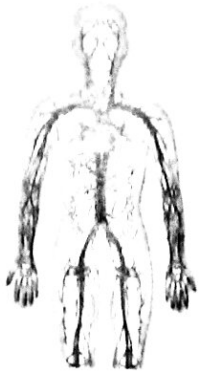
HUMAN BODY SYSTEMS

FIGURE 30–2 Although each of the organ systems shown here has a different set of functions, they all work together, as a whole, to maintain homeostasis.

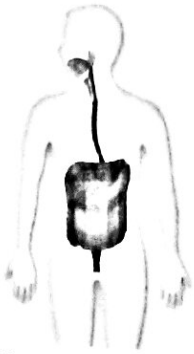


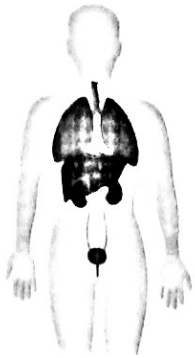


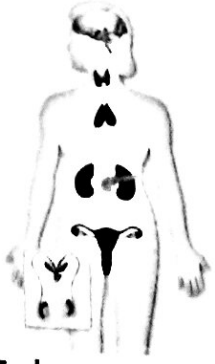


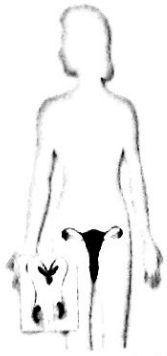


	Nervous System	Integumentary System	Immune/ Lymphatic Systems	Muscular System	Circulatory System	Skeletal System
STRUCTURES	Brain, spinal cord, nerves	Skin, hair, nails, sweat and oil glands	White blood cells, thymus, spleen, lymph nodes, lymph vessels	Skeletal muscle, smooth muscle, cardiac muscle	Heart, blood vessels, blood	Bones, cartilage, ligaments, tendons
FUNCTIONS	Recognizes and coordinates the body's response to changes in its internal and external environments	Guards against infection and injury and ultraviolet radiation from the sun; helps to regulate body temperature	Helps protect the body from disease; collects fluid lost from blood vessels and returns it to the circulatory system	Works with skeletal system to produce voluntary movement; helps to circulate blood and move food through the digestive system	Transports oxygen, nutrients, and hormones to cells; fights infection; removes cell wastes; helps to regulate body temperature	Supports the body; protects internal organs; allows movement, stores mineral reserves; contains cells that produce blood cells









	Respiratory System	Digestive System	Excretory System	Endocrine System	Reproductive System
STRUCTURES	Nose, pharynx, larynx, trachea, bronchi, bronchioles, lungs	Mouth, pharynx, esophagus, stomach, small and large intestines, rectum	Skin, lungs, liver, kidneys, ureters, urinary bladder, urethra	Hypothalamus, pituitary, thyroid, parathyroids, adrenals, pancreas, ovaries (in females), testes (in males)	Testes, epididymis, vas deferens, urethra, and penis (in males), ovaries, Fallopian tubes, uterus, vagina (in females)
FUNCTIONS	Brings in oxygen needed for cellular respiration and removes excess carbon dioxide from the body	Breaks down food; absorbs nutrients; eliminates wastes	Eliminates waste products from the body	Controls growth, development, and metabolism; maintains homeostasis	Produces gametes, in females, nurtures and protects developing embryo

Homeostasis

What is homeostasis?

Some things are easy to observe. When you run or swim or even write the answer to a test question, you can see your body at work. But behind the scenes, your body's systems are working constantly to do something that is difficult to see and that few people appreciate—maintaining a controlled, stable internal environment. This stable environment is called **homeostasis,** which means "similar standing."

Homeostasis describes the relatively constant internal physical and chemical conditions that organisms maintain despite changes in internal and external environments. Homeostasis may not be obvious, but for a living organism, it's literally a matter of life or death.

Feedback Inhibition If you've ever watched someone driving a car down a relatively straight road, you may have noticed how the person constantly moves the wheel left or right, adjusting direction to keep the vehicle in the middle of the lane. In a certain sense, that's how the systems of the body work, too, keeping internal conditions within a certain range, and never allowing them to go too far to one side or the other.

▶ ***A Nonliving Example*** One way to understand homeostasis is to look at a nonliving system that automatically keeps conditions within a certain range like a home heating system. In most homes, heat is supplied by a furnace that burns oil or natural gas. When the temperature within the house drops below a set point, a thermostat sensor 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, keeping the temperature within a narrow range.

A system like this 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 30–3** 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 high enough to trigger a feedback signal that switches the furnace off. Systems controlled by feedback inhibition are generally very stable.

In Your Notebook *Describe another example of a nonliving system that requires constant adjustment.*

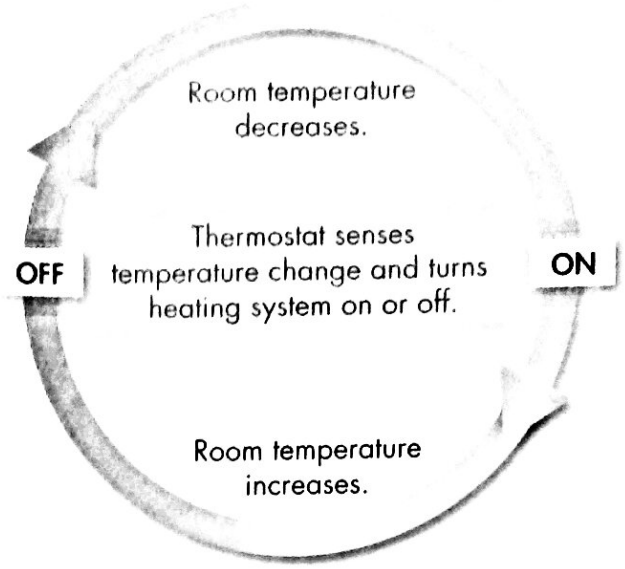


FIGURE 30–3 Feedback Inhibition
A home heating system uses a feedback loop to maintain a stable, comfortable environment within a house.
Interpret Diagrams ***What is the stimulus in this feedback loop?***

BUILD Vocabulary

ACADEMIC WORDS The noun **inhibition** means "the act of blocking the action of." Therefore, feedback inhibition refers to a response that blocks further actions of a stimulus.

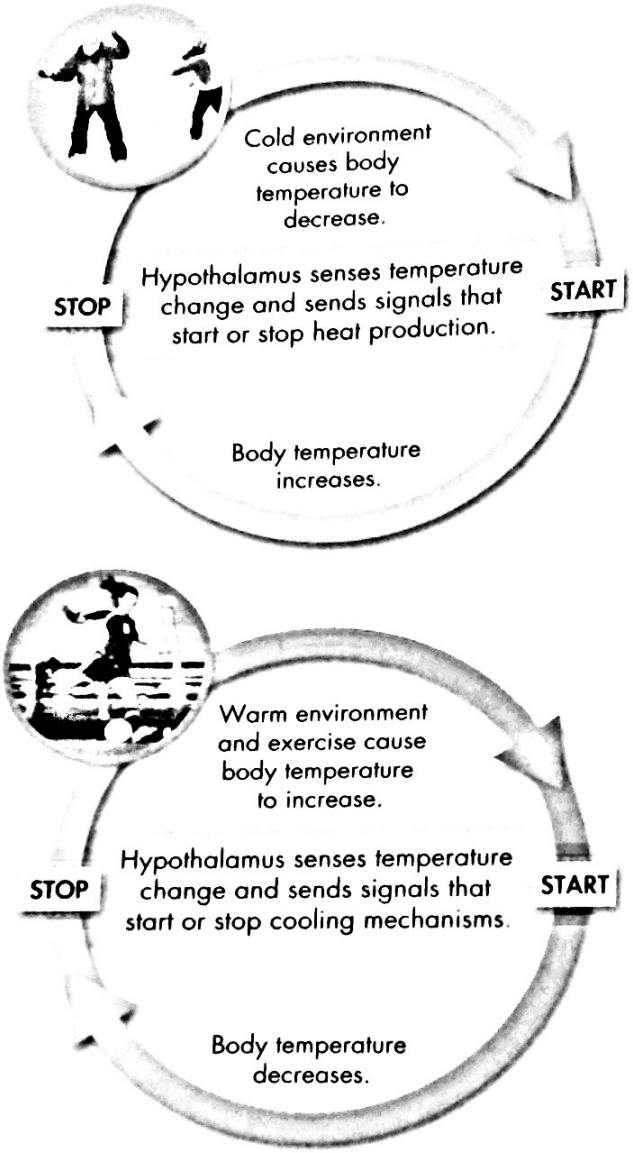


FIGURE 30–4 Body Temperature Control In the human body, temperature is controlled through various feedback inhibition mechanisms. Infer ***Why do you think moving around on a cold day helps to keep you warm?***

► ***A Living Example*** 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. Such mechanisms are very common, not only in the human body, but in all forms of life.

One example is the maintenance of body temperature. The body regulates temperature by a mechanism that is remarkably similar to that of a home heating system. You can follow body temperature regulation in **Figure 30–4.** 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.

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 activity, especially cellular respiration, causes a gradual rise in body temperature, which is detected by nerve cells in the hypothalamus.

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 toward the normal range.

If body temperature rises too far above 37°C, the hypothalamus slows down cellular activities to reduce heat production. This is one of the 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.

QuickLab
OPEN-ENDED INQUIRY

Maintaining Temperature

You will receive a thermometer and three beakers of water at the following temperatures: 25°C, 35°C, and 40°C. Develop a method to keep the temperature of the 35°C water within one degree for a period of fifteen minutes. You may use the contents of the other two beakers.

Analyze and Conclude

1. Compare and Contrast Compare this experiment to what happens in your own body during temperature regulation.

2. Interpret Visuals Make a feedback loop similar to the ones in **Figure 30–4** that shows how feedback inhibition was involved in this activity.

The Liver and Homeostasis The liver is technically part of the digestive system because it produces bile, which aids in the digestion of fats. However, it is also fair to say that the liver is one of the body's most important organs for homeostasis.

For example, when proteins are broken down for energy, ammonia, a toxic byproduct, is produced. The liver quickly converts ammonia to urea, which is much less toxic. The kidneys, as you will read a bit later, then remove urea from the blood. The liver also converts many dangerous substances, including some drugs, into compounds that can be removed from the body safely.

One of the liver's most important roles involves regulating the level of a substance we take almost for granted as something completely harmless—the simple sugar, glucose. Glucose is obtained from the foods we eat, and cells take glucose from the blood to serve as a source of energy for their everyday activities. Naturally, right after a meal, as the body absorbs food molecules, the level of glucose in the blood begins to rise. That's where the liver comes in. By taking glucose out of the blood, it keeps the level of glucose from rising too much. As the body uses glucose for energy, the liver releases stored glucose to keep the level of the sugar from dropping too low.

The liver's role in keeping blood glucose levels within a certain range is critical. Too little glucose, and the cells of the nervous system will slow down to the point that you may lose consciousness and pass out. On the other hand, too much glucose gradually damages cells in the eyes, kidneys, heart, and even the immune system. Abnormally high levels of glucose are associated with a disease called diabetes. In diabetes, changes occur in either the pancreas or body cells that affect the cells' ability to absorb glucose. Diabetes, one of the fastest-growing health problems in the developed world, is the unfortunate result of failure of homeostasis with respect to blood glucose levels.

MYSTERY CLUE

The lab test of Andrew's urine sample showed an abnormal amount of a certain substance. What substance do you think it was?

30.1 Assessment

Review Key Concepts

1. a. Review What are the four types of tissues?

b. Explain Describe the function of three organ systems depicted in **Figure 30–2.**

c. Classify Compare the characteristics of two types of tissues. Identify parts of the body that contain these types of tissues.

2. a. Review What is homeostasis?

b. Explain What are two roles of the liver in maintaining homeostasis?

c. Apply Concepts Do you think that feelings of hunger and fullness are an example of feedback inhibition? Explain.

VISUAL THINKING

3. Draw a Venn diagram to relate the four basic levels of organization in the human body. Provide at least three examples for each level of organization. *Hint:* Your Venn diagram should have a nesting structure. One set of examples could be skin cells, epithelial tissue, skin, and the integumentary system.