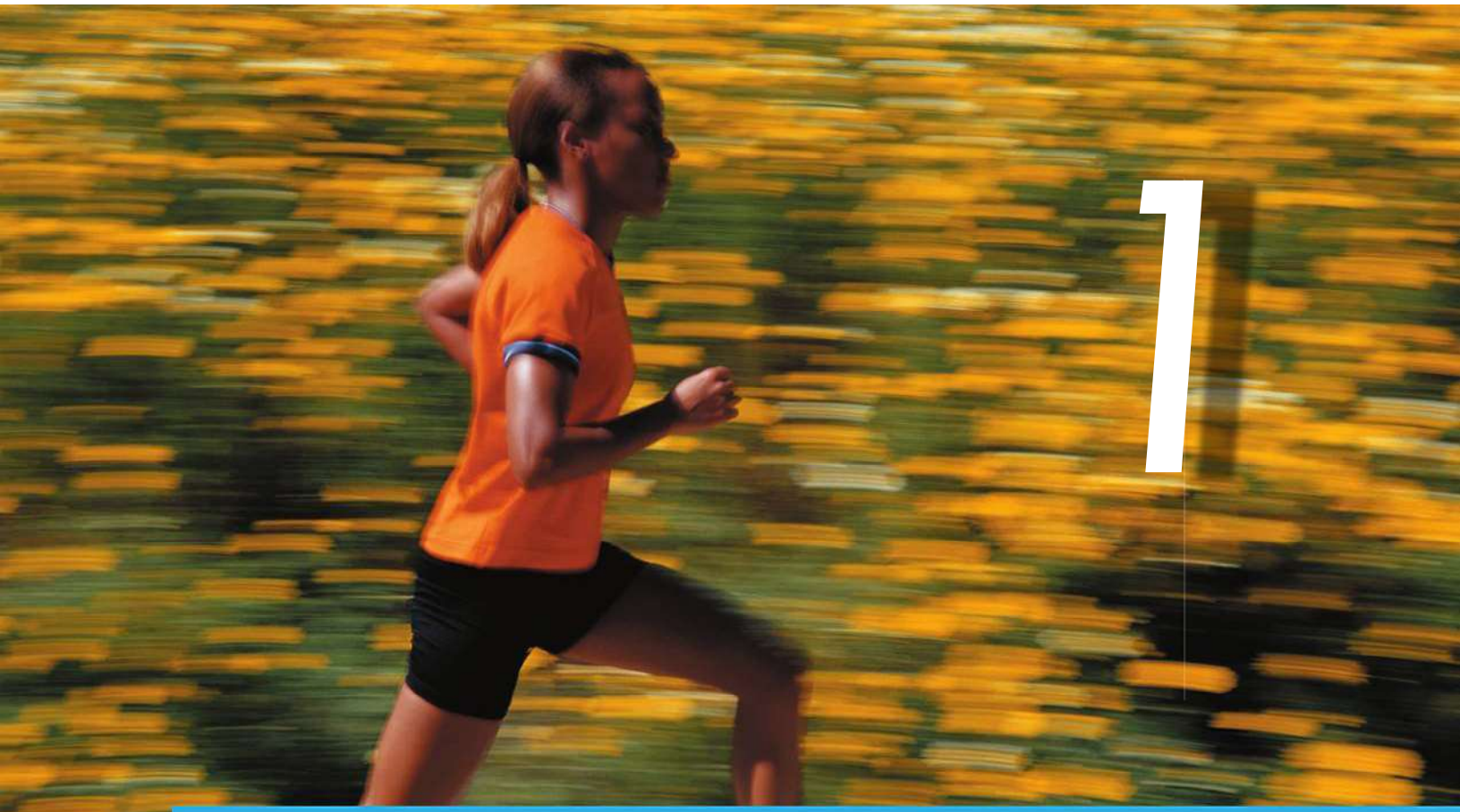


1 The Human Body: An Orientation

FUNCTION PREVIEW

- Anatomy and physiology are complementary sciences that allow one to study, classify, and understand body structures and functions.

An Overview of Anatomy and Physiology

- ✓ Define *anatomy* and *physiology*.
- ✓ Explain how anatomy and physiology are related.

Most of us are naturally curious about our bodies; we want to know what makes us tick. We see this curiosity even in infants, who can keep themselves happy for a long time staring at their own hands or pulling their mother's nose. Older children wonder where food goes when they swallow it, and some believe that they will grow a watermelon in their belly if they swallow the seeds. They scream loudly when approached by medical personnel (fearing shots that sting), but they like to play doctor. Adults become upset when their hearts pound, when they have uncontrollable hot flashes, or when they cannot keep their weight down.

Anatomy and physiology, subdivisions of biology, explore many of these topics as they describe how our bodies are put together and how they work.

Anatomy

Anatomy (ah-nat′o-me) is the study of the structure and shape of the body and its parts and their

relationships to one another. Whenever we look at our own body or study large body structures such as the heart or bones, we are observing *gross anatomy;* that is, we are studying large, easily observable structures. Indeed, the term *anatomy,* derived from the Greek words meaning to cut (*tomy*) apart (*ana*), is related most closely to gross anatomical studies because in such studies preserved animals or their organs are dissected (cut up) to be examined. *Microscopic anatomy,* in contrast, is the study of body structures that are too small to be seen with the naked eye. The cells and tissues of the body can only be seen through a microscope.

Physiology

Physiology (fiz″e-ol′o-je) is the study of how the body and its parts work or function (*physio* = nature; *ology* = the study of). Like anatomy, physiology has many subdivisions. For example, *neurophysiology* explains the workings of the nervous system, and *cardiac physiology* studies the function of the heart, which acts as a muscular pump to keep blood flowing throughout the body.

Relationship between Anatomy and Physiology

Anatomy and physiology are always related. The parts of your body form a well-organized unit, and each of those parts has a job to do to make the body operate as a whole. Structure determines what functions can take place. For example, the lungs are not muscular chambers like the heart and cannot pump blood through the body, but because the walls of their air sacs are very thin, they *can* exchange gases and provide oxygen to the body. We stress the intimate relationship between anatomy and physiology throughout this book to make your learning meaningful.

DID YOU GET IT?

1. Why would you have a hard time learning and understanding physiology if you did not also understand anatomy?
2. Kidney function, bone growth, and beating of the heart are all topics of anatomy. True or false?

For answers, see Appendix D.

Levels of Structural Organization

- ✓ Name the six levels of structural organization that make up the human body, and explain how they are related.
- ✓ Name the organ systems of the body, and briefly state the major functions of each system.
- ✓ Identify and classify by organ system all organs discussed.

From Atoms to Organisms

The human body exhibits many levels of structural complexity (**Figure 1.1**). The simplest level of the structural ladder is the *chemical level,* which we will study in Chapter 2. At this level, **atoms,** tiny building blocks of matter, combine to form *molecules* such as water, sugar, and proteins. Molecules, in turn, associate in specific ways to form microscopic **cells,** the smallest units of all living things. We will examine the *cellular level* in Chapter 3. All cells have some common functions, but individual cells vary widely in size and shape, reflecting their particular functions in the body.

The simplest living creatures are composed of single cells, but in complex organisms such as trees or human beings, the structural ladder continues on to the *tissue level.* **Tissues** consist of groups of similar cells that have a common function. As we will discuss in Chapter 3, each of the four basic tissue types (epithelial, connective, muscular, and neural) plays a definite but different role in the body.

An **organ** is a structure composed of two or more tissue types that performs a specific function for the body. At the *organ level* of organization, extremely complex functions become possible. For example, the small intestine, which digests and absorbs food, is composed of all four tissue types. An **organ system** is a group of organs that work together to accomplish a common purpose. For example, the heart and blood vessels of the cardiovascular system circulate blood continuously to carry nutrients and oxygen to all body cells.

In all, 11 organ systems make up the living human being, or the **organism,** which represents the highest level of structural organization, the *organismal level.* The organismal level is the sum total of all structural levels working together to keep us alive. The major organs of each of the

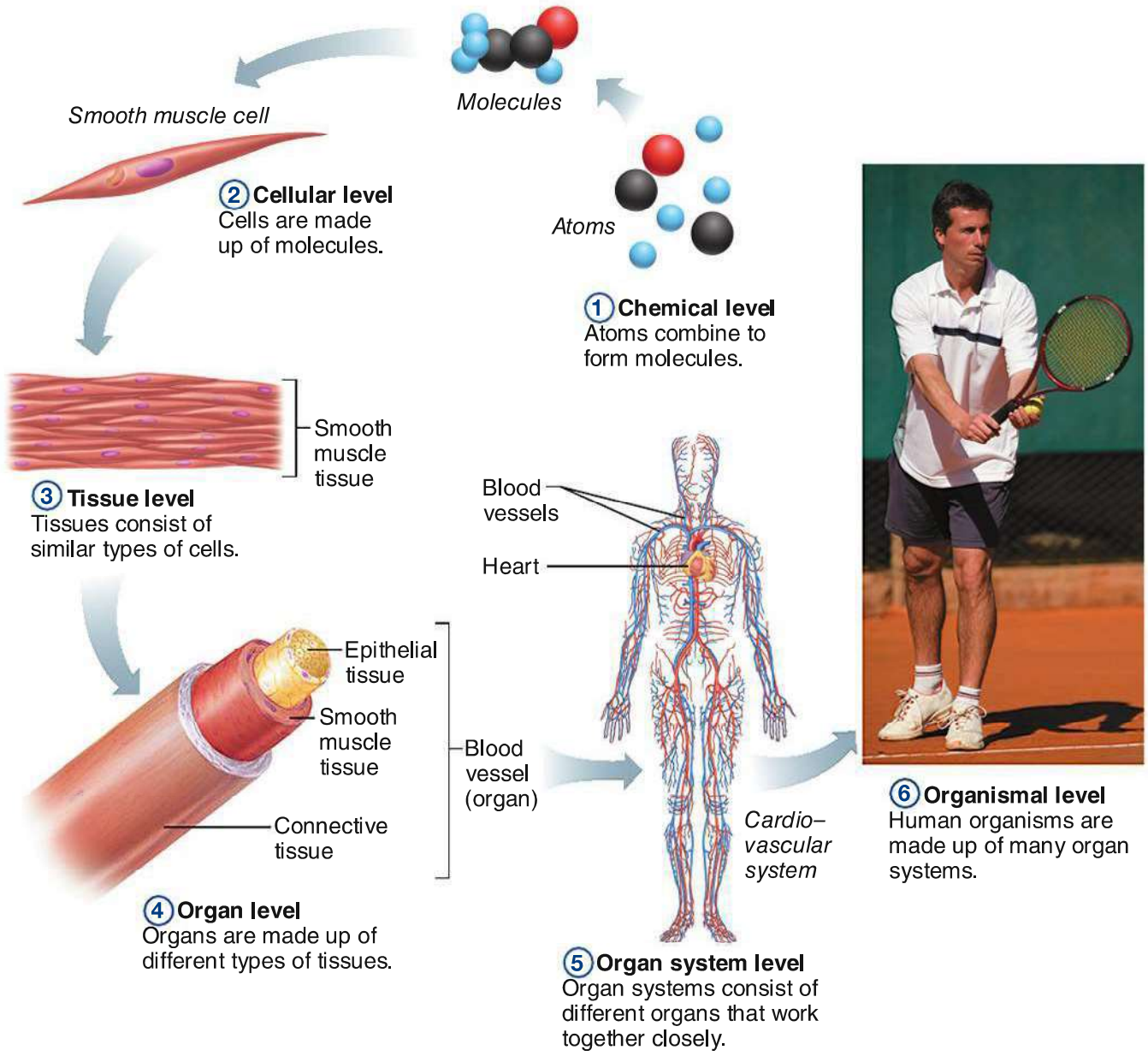


Figure 1.1 Levels of structural organization. In this diagram, components of the cardiovascular system are used to illustrate the levels of structural organization in a human being.

systems are shown in **Figure 1.2**. Refer to the figure as you read through the following descriptions of the organ systems.

Organ System Overview

Integumentary System

The **integumentary** (in-teg″u-men′tar-e) **system** is the external covering of the body, or the skin. It waterproofs the body and cushions and protects the deeper tissues from injury. It also excretes salts and urea in perspiration and helps regulate body temperature. Temperature, pressure, and pain receptors located in the skin alert us to what is happening at the body surface.

Skeletal System

The **skeletal system** consists of bones, cartilages, ligaments, and joints. It supports the body and provides a framework that the skeletal muscles use to cause movement. It also has a protective

function (for example, the skull encloses and protects the brain). *Hematopoiesis* (hem″ah-to-poi-e′sis), or formation of blood cells, takes place within the cavities of the skeleton. The hard substance of bones acts as a storehouse for minerals.

Muscular System

The muscles of the body have only one function—to *contract,* or shorten. When this happens, movement occurs. Hence, muscles can be viewed as the "machines" of the body. The mobility of the body as a whole reflects the activity of *skeletal muscles,* the large, fleshy muscles attached to bones. When these contract, you are able to stand erect, walk, leap, grasp, throw a ball, or smile. The skeletal muscles form the **muscular system.** These muscles are distinct from the muscles of the heart and of other hollow organs, which move fluids (blood, urine) or other substances (such as food) along definite pathways within the body.

Nervous System

The **nervous system** is the body's fast-acting control system. It consists of the brain, spinal cord, nerves, and sensory receptors. The body must be able to respond to irritants or stimuli coming from outside the body (such as light, sound, or changes in temperature) and from inside the body (such as decreases in oxygen or stretching of tissue). The sensory receptors detect these changes and send messages (via electrical signals called *nerve impulses*) to the central nervous system (brain and spinal cord) so that it is constantly informed about what is going on. The central nervous system then assesses this information and responds by activating the appropriate body effectors (muscles or glands).

Endocrine System

Like the nervous system, the **endocrine** (en′do-krin) **system** controls body activities, but it acts much more slowly. The endocrine glands produce chemical molecules called *hormones* and release them into the blood to travel to relatively distant target organs.

The endocrine glands include the pituitary, thyroid, parathyroids, adrenals, thymus, pancreas, pineal, ovaries (in the female), and testes (in the male). The endocrine glands are not connected anatomically in the same way that parts of the other organ systems are. What they have in common is that they all secrete hormones, which regulate other structures. The body functions controlled by hormones are many and varied, involving every cell in the body. Growth, reproduction, and food use by cells are all controlled (at least in part) by hormones.

Cardiovascular System

The primary organs of the **cardiovascular system** are the heart and blood vessels. Using blood as the transporting fluid, the cardiovascular system carries oxygen, nutrients, hormones, and other substances to and from the tissue cells where exchanges are made. White blood cells and chemicals in the blood help to protect the body from such foreign invaders as bacteria, toxins, and tumor cells. The heart acts as the blood pump, propelling blood out of its chambers into the blood vessels to be transported to all body tissues.

Lymphatic System

The role of the **lymphatic system** complements that of the cardiovascular system. Its organs include lymphatic vessels, lymph nodes, and other lymphoid organs such as the spleen and tonsils. The lymphatic vessels return fluid leaked from the blood back to the blood vessels so that blood can be kept continuously circulating through the body. The lymph nodes and other lymphoid organs help to cleanse the blood and house cells involved in immunity.

Respiratory System

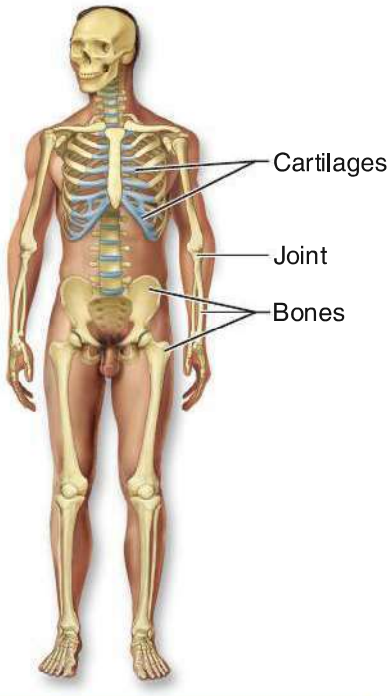
The job of the **respiratory system** is to keep the body constantly supplied with oxygen and to remove carbon dioxide. The respiratory system consists of the nasal passages, pharynx, larynx, trachea, bronchi, and lungs. Within the lungs are tiny air sacs. Gases are transported to and from the blood through the thin walls of these air sacs.

Digestive System

The **digestive system** is basically a tube running through the body from mouth to anus. The organs of the digestive system include the oral cavity (mouth), esophagus, stomach, small and large intestines, and rectum plus a number of accessory organs (liver, salivary glands, pancreas, and others). Their role is to break down food and deliver the products to the blood for dispersal to the body cells. The undigested food that remains in the tract

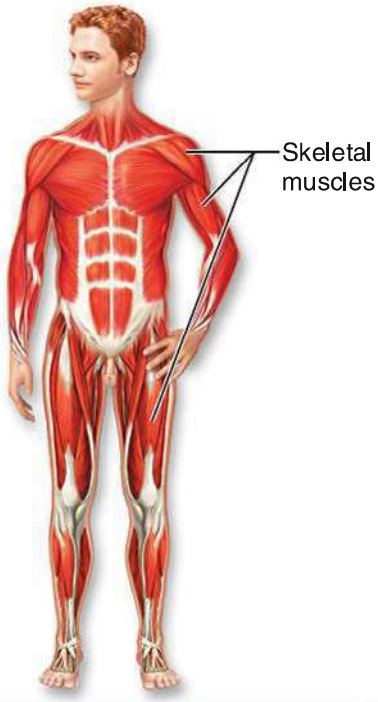
(a) Integumentary System

Forms the external body covering; protects deeper tissue from injury; synthesizes vitamin D; location of cutaneous (pain, pressure, etc.) receptors and sweat and oil glands.



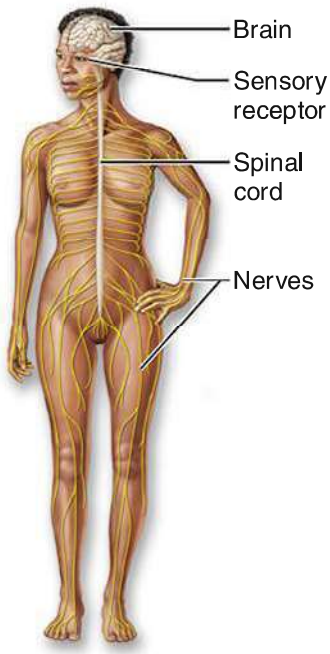
(b) Skeletal System

Protects and supports body organs; provides a framework the muscles use to cause movement; blood cells are formed within bones; stores minerals.



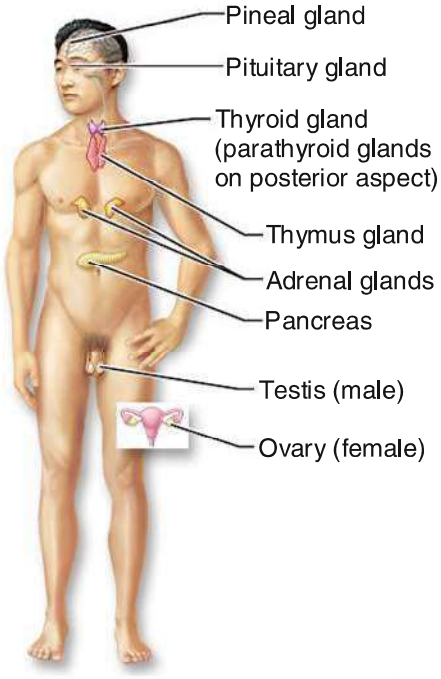
(c) Muscular System

Allows manipulation of the environment, locomotion, and facial expression; maintains posture; produces heat.



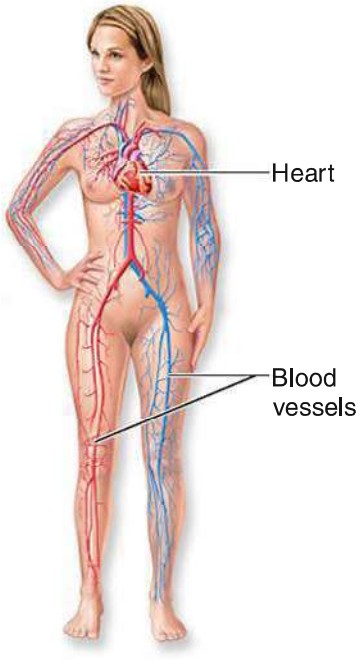
(d) Nervous System

Fast-acting control system of the body; responds to internal and external changes by activating appropriate muscles and glands.



(e) Endocrine System

Glands secrete hormones that regulate processes such as growth, reproduction, and nutrient use by body cells.

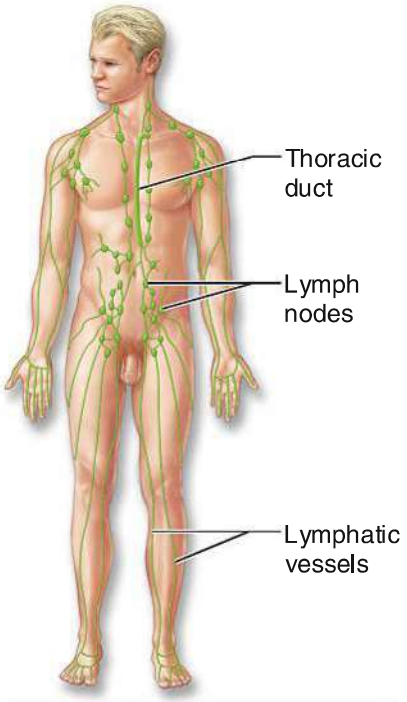


(f) Cardiovascular System

Blood vessels transport blood, which carries oxygen, carbon dioxide, nutrients, wastes, etc.; the heart pumps blood.

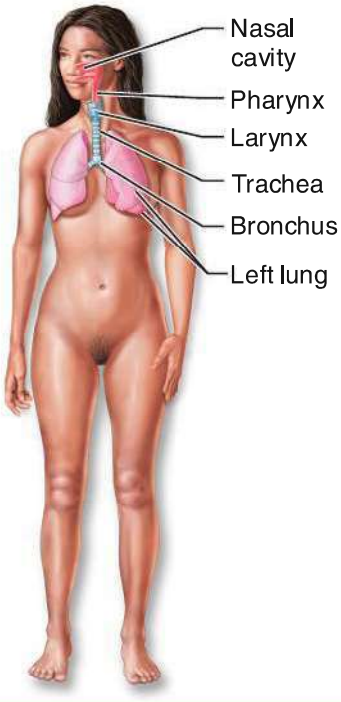
Figure 1.2 **The body's organ systems.**

(Continues on page 6)



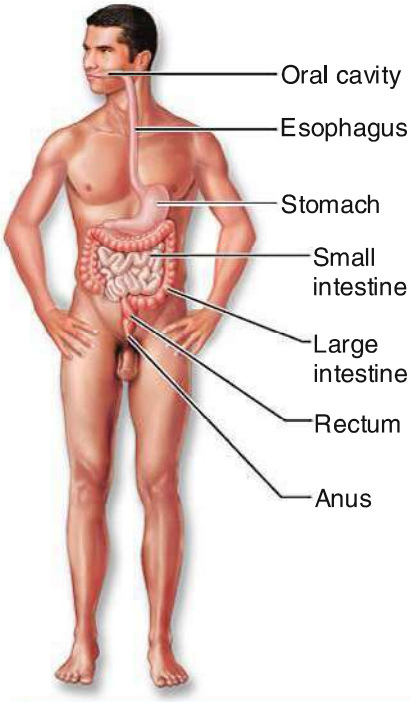
(g) Lymphatic System

Picks up fluid leaked from blood vessels and returns it to blood; disposes of debris in the lymphatic stream; houses white blood cells involved in immunity.



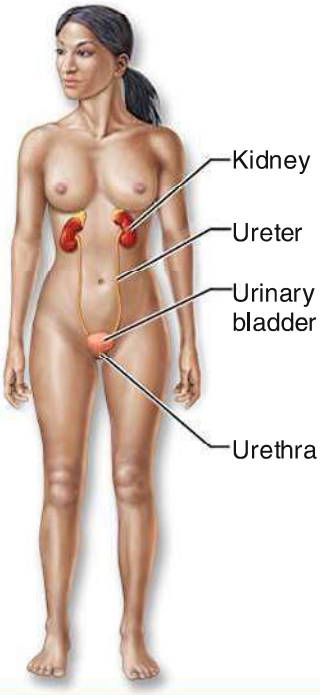
(h) Respiratory System

Keeps blood constantly supplied with oxygen and removes carbon dioxide; the gaseous exchanges occur through the walls of the air sacs of the lungs.



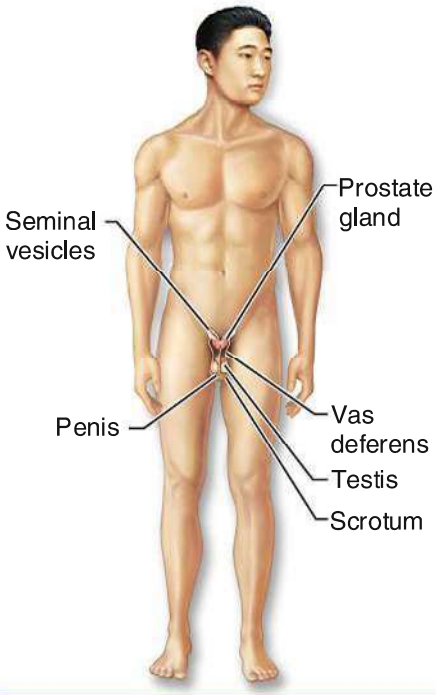
(i) Digestive System

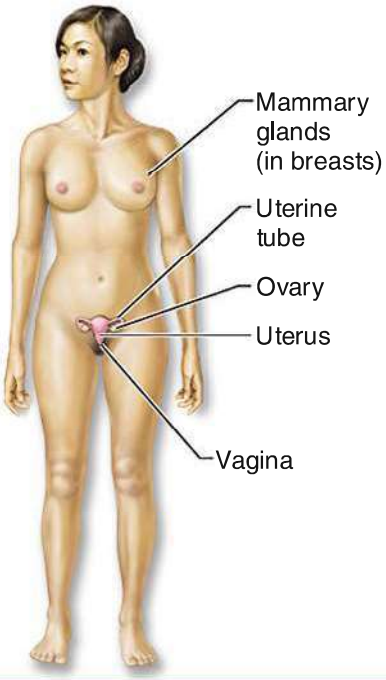
Breaks food down into absorbable units that enter the blood for distribution to body cells; indigestible foodstuffs are eliminated as feces.



(j) Urinary System

Eliminates nitrogen-containing wastes from the body; regulates water, electrolyte, and acid-base balance of the blood.





(k) Male Reproductive System (l) Female Reproductive System

Overall function of the reproductive system is production of offspring. Testes produce sperm and male sex hormone; ducts and glands aid in delivery of viable sperm to the female reproductive tract. Ovaries produce eggs and female sex hormones; remaining structures serve as sites for fertilization and development of the fetus. Mammary glands of female breast produce milk to nourish the newborn.

Figure 1.2 *(continued)* **The body's organ systems.**