

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

the digestive system includes the esophagus, the stomach, and the small and large intestines (to name a few of its organs). Each organ has its own job to do, and, by working together, they keep food moving through the digestive system so that it is properly broken down and absorbed into the blood, providing fuel for all the body's cells. In all, 11 organ systems make up the living body, or the **organism**, which represents the highest level of structural organization, the *organismal level*. The

major organs of each of the 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, goes on 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.

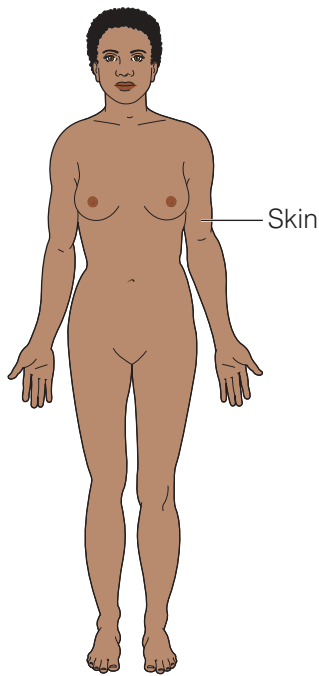
Cardiovascular System

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 through the blood vessels to all body tissues.

Lymphatic System

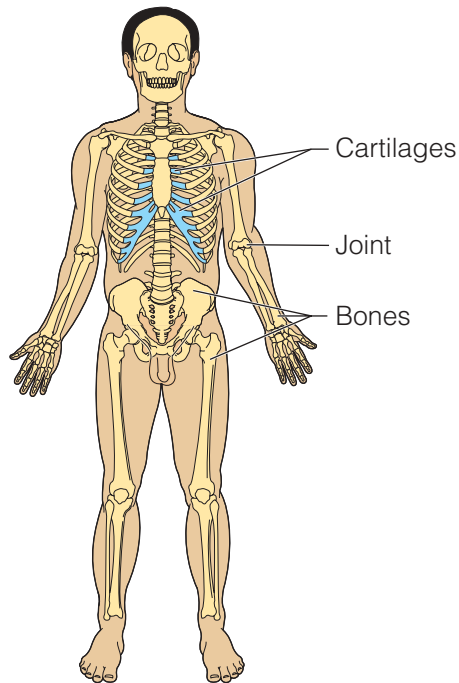
The role of the **lymphatic system** is complementary to that of the cardiovascular system. Its organs include lymphatic vessels, lymph nodes, and other lymphoid organs such as the spleen and tonsils. The lymphatic vessels return fluid leaked from the blood to the blood vessels so that blood can be kept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

FIGURE 1.2 The body's organ systems. The structural components of each organ system are illustrated in the diagrammatic views. The major functions of the organ systems are listed beneath each illustration.



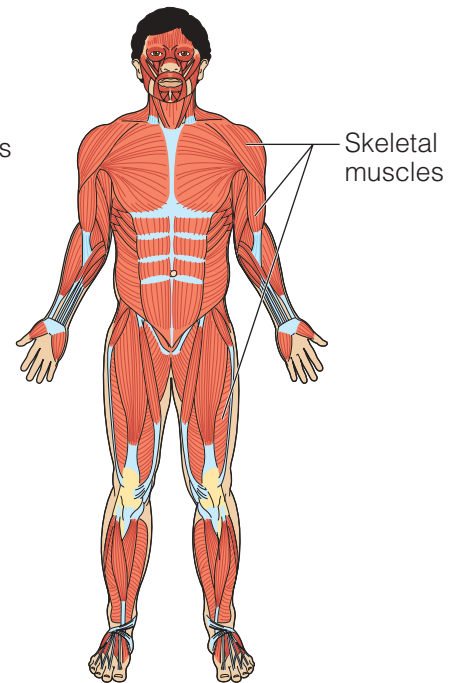
(a) Integumentary system

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.



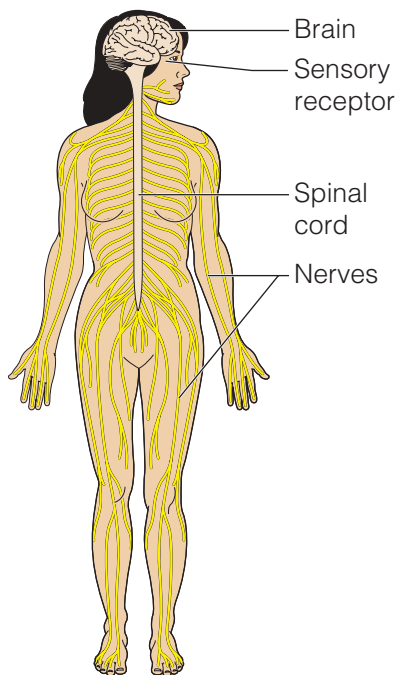
(b) Skeletal system

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



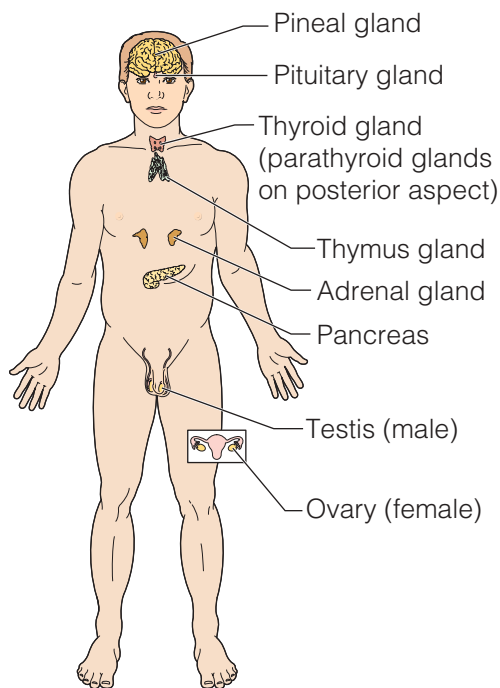
(c) Muscular system

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



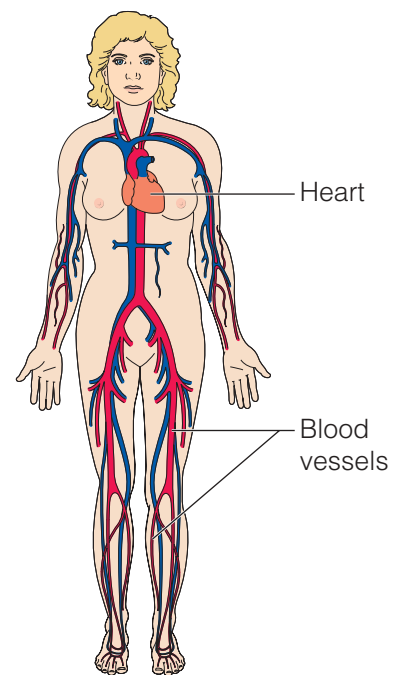
(d) Nervous system

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



(e) Endocrine system

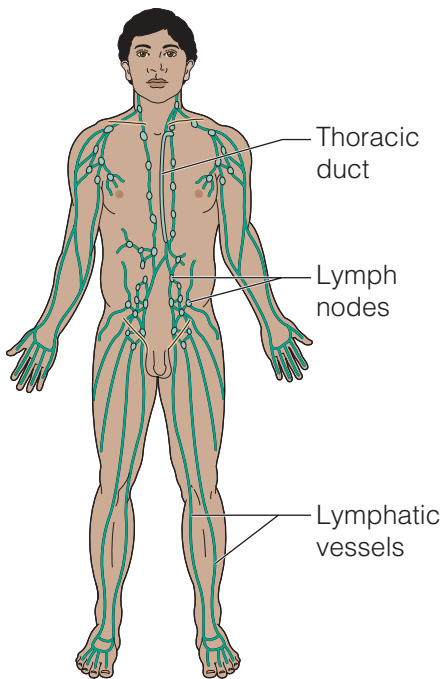
Glands secrete hormones that regulate processes such as growth, reproduction, and nutrient use (metabolism) by body cells.



(f) Cardiovascular system

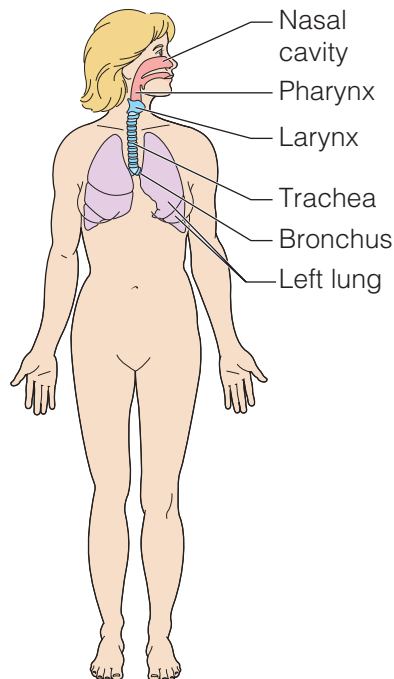
Blood vessels transport blood, which carries oxygen, carbon dioxide, nutrients, wastes, etc.; the heart pumps blood.

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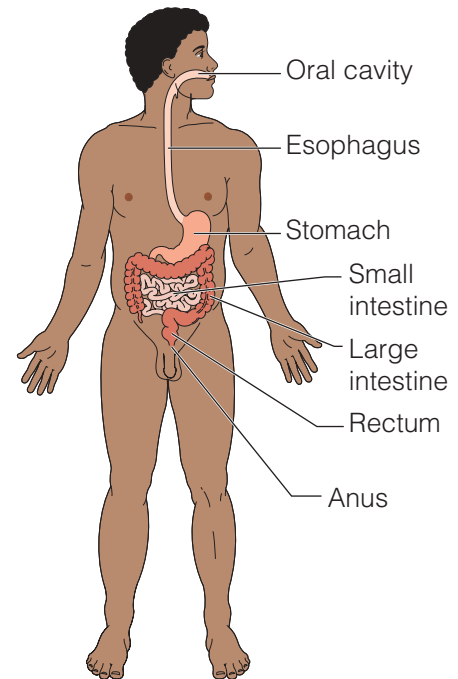
(g) Lymphatic system

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.



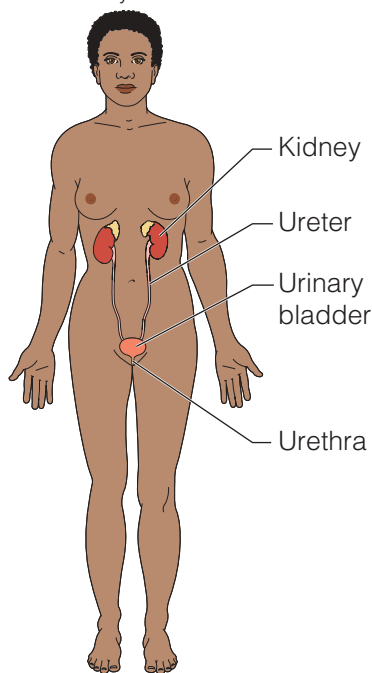
(h) Respiratory system

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



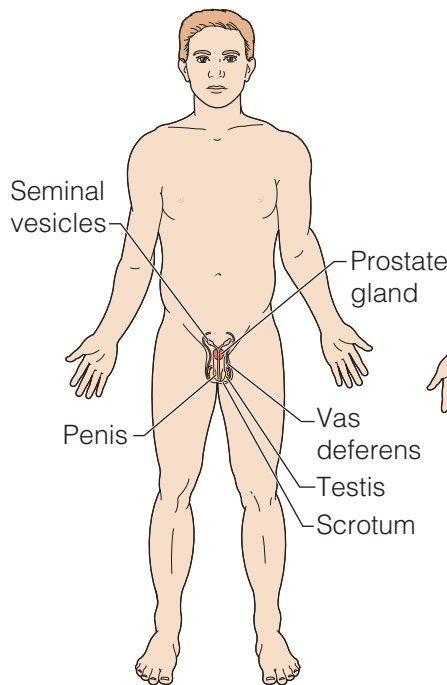
(i) Digestive system

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



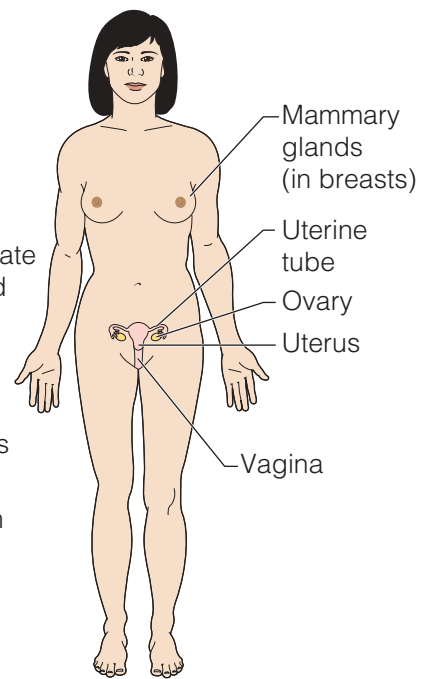
(j) Urinary system

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



(k) Male 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.



(l) Female reproductive system

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. It is through the thin walls of these air sacs that gas exchanges are made to and from the blood.

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. 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 leaves the body through the anus as feces. The breakdown activities that begin in the mouth are completed in the small intestine. From that point on, the major function of the digestive system is to reclaim water. The liver is considered to be a digestive organ because the bile it produces helps to break down fats. The pancreas, which delivers digestive enzymes to the small intestine, also is functionally a digestive organ.

Urinary System

The body produces wastes as by-products of its normal functions, and these wastes must be disposed of. One type of waste contains nitrogen (examples are urea and uric acid), which results from the breakdown of proteins and nucleic acids by the body cells. The **urinary system** removes the nitrogen-containing wastes from the blood and flushes them from the body in urine. This system, often called the *excretory system*, is composed of the kidneys, ureters, bladder, and urethra. Other important functions of this system include maintaining the body's water and salt (electrolyte) balance and regulating the acid-base balance of the blood.

Reproductive System

The **reproductive system** exists primarily to produce offspring. Sperm are produced by the testes of the male. Other male reproductive system

structures are the scrotum, penis, accessory glands, and the duct system, which carries sperm to the outside of the body. The ovary of the female produces the eggs, or ova; the female duct system consists of the uterine tubes, uterus, and vagina. The uterus provides the site for the development of the fetus (immature infant) once fertilization has occurred.

Maintaining Life

Necessary Life Functions

Now that we have introduced the structural levels composing the human body, the question that naturally follows is: What does this highly organized human body do? Like all complex animals, human beings maintain their boundaries, move, respond to environmental changes, take in and digest nutrients, carry out metabolism, dispose of wastes, reproduce themselves, and grow. We will discuss each of these necessary life functions briefly here and in more detail in later chapters.

Organ systems do not work in isolation; instead, they work together to promote the well-being of the entire body. Because this theme will be emphasized throughout this book, it is worthwhile to identify the most important organ systems contributing to each of the necessary life functions (Figure 1.3). Also, as you read through this material, you may want to refer back to the more detailed descriptions of the organ systems provided on pp. 3 through 7 and in Figure 1.2.

Maintaining Boundaries

Every living organism must be able to maintain its boundaries so that its “inside” remains distinct from its “outside.” Every cell of the human body is surrounded by an external membrane that contains its contents and allows needed substances in while generally preventing the entry of potentially damaging or unnecessary substances. The body as a whole is also enclosed by the integumentary system, or skin. The integumentary system protects internal organs from drying out (which would be fatal), from bacteria, and from the damaging effects of heat, sunlight, and an unbelievable number of chemical substances in the external environment.