20A-2 Objectives

- Summarize the difference between anatomy and physiology
- Identify the major areas and cavities of the human body
- Demonstrate proper use of anatomical terms of direction
- List and describe the four basic human tissues

20A-2 Human Tissues, Organs, and Systems

Anatomy* is the study of the shape and structure of an organism and of its parts. **Physiology*** is the study of the function of living organisms and their parts. Both are important since one cannot be fully understood without the other.

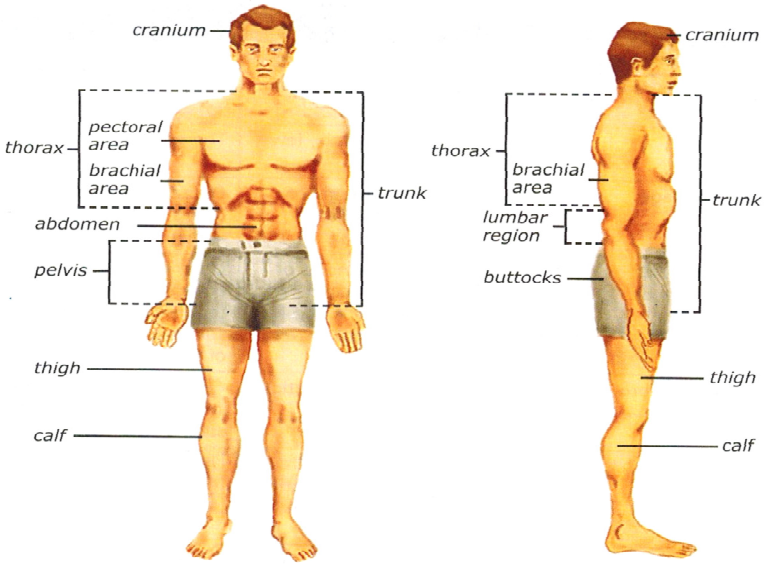
anatomy: ana- (Gk. ANA, up) + -tomy (TOMOS, a cutting)

physiology: phys-, physi-, or physio- (Gk. PHYSIS, nature) + -logy (the study of)

Anatomical Terms

Human anatomy can be an exacting science. There is a name and description for every structure no matter how tiny or insignificant it may appear. For most high-school students, such detailed knowledge is not necessary; however, knowledge of the proper names of major areas of the body is useful. Figure 20A.5 includes some terms that help in understanding the information and descriptions presented in this and the remaining chapters of the text.

To be precise, anatomists use terms of direction and locality based on the **anatomical** (AN uh TAHM ih kul) **position**. When a person stands erect, arms at his sides, with toes, palms, and face forward, he is in the anatomical position. Anatomical descriptions of the body should be given as if it were in this position. Properly speaking, the left side of a person's heart (or other body part) is that part of his heart on his left side when he is in the anatomical position, not the left side of the heart as someone else is viewing it.



20A.5
Anatomical terms

Relative Directions on a Human Body in Anatomical Position

- *Anterior (ventral):* toward the front (stomach side)
- *Posterior (dorsal):* toward the back
- *Superior:* upward; toward the head
- *Inferior:* downward; toward the feet
- *Superficial:* on or near the surface
- *Deep:* toward the inside
- *Proximal:* a location closer to the trunk of the body, or another specified reference point
- *Distal:* away from the trunk; the opposite of proximal
- *Lateral:* toward the side from an imaginary line that divides the body into halves
- *Medial:* closer to the midline in relation to another part
- *Transverse:* a line that divides the body into a superior and an inferior portion
- *Sagittal:* a line that divides the body into right and left portions

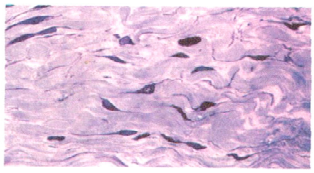
Human Tissues

After the development of the light microscope, the primary study of the human body shifted from gross anatomy (the study of the parts of the body that are visible to the naked eye) to **histology*** (hih STAHL uh jee), the microscopic study of tissues. A tissue is a group of similar cells that work together to perform a similar function (see Chap. 3). Now, with advanced techniques, the study of individual cells and even organelles has become prominent.

Most tissues are *vascular*: that is, blood vessels run through them. Tissues that lack blood vessels are called *avascular*. Avascular tissue is usually very thin since food and wastes must enter and exit by diffusion from nearby blood vessels. Knowledge of cells and other materials that make up human tissues is important to the understanding of how the tissues function. Histologists classify human tissues into four main groups according to their structure and function.

Connective Tissue

Connective tissues, including bones, blood, lymph, tendons, fat, and cartilage, are the most abundant and diverse of the four tissue types in the human body. They support, connect, and protect other structures in the body. The connective tissue cells are usually not adjacent to each other but have varying amounts of an intercellular substance between them called a **matrix**. The matrix can be fluid, semisolid, or solid. Bone cells are embedded in a solid, crystalline matrix. The cellular components of blood and lymph are suspended in a fluid matrix that carries them throughout the body. Tendons, ligaments, and cartilage are in a semisolid, fibrous matrix. The fibers may be elastic or inelastic, depending on the function of the particular type of connective tissue.



20A.6
PMG of connective tissue

Epithelial Tissue

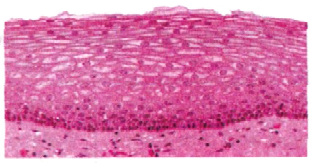
Epithelial (EP uh THEE lee ul) **tissue** consists of layers of cells that cover or line the external surfaces as well as internal surfaces such as the various organs and the blood vessels. The epithelial cell layers vary in thickness from a

histology: histo- (Gk. HISTOS, web; *hence*, cells with weblike structure) + -logy (the study of)

Table 20A-1 Human Tissues

Type and name	Description	Location	Function
Connective tissues	Contains matrix; usually vascular	Scattered throughout the entire body	Connects; supports; stores
Bone	Solidified matrix; few cells	The skeleton	Supports rigidly; protects; stores minerals
Cartilage	Semisolid matrix of fibers; avascular	Outer ear; end of the nose; ends of the bones; between the vertebrae; between ends of ribs and sternum; in trachea	Supports firmly but flexibly; cushions; reduces friction in some joints
Dense fibrous connective tissue	Matrix of bundles of fibers that may be arranged all in the same direction or as a membrane	Ligaments; tendons; membrane around bone (continuous with ligaments and/or tendons); the covering of the brain and spinal cord (dura mater); in the dermis of the skin	Joins bone to bone or muscle to bone, permitting flexibility with strength; provides protection; supports
Loose fibrous connective tissue	Fibers (mainly elastic) in a soft matrix	Capsules around organs; beneath facial skin; around the cells of various tissues such as muscle	Holds structures flexibly in place
Adipose (fat)	Predominantly cells with large lipid-storing vacuoles; some fibers; vascular	Under skin; padding in various areas	Cushions; insulates; supports; stores fats
Blood	Cells in fluid matrix	In blood vessels	Transports substances; protects
Lymph	Mostly fluid with few cells	In vessels of lymphatic system	Bathes cells in fluid to supply substances and remove wastes; protects
Hemopoietic (blood-forming)	Cells supported by a delicate network of fibers	Marrow spaces of bones; lymph nodes; spleen; tonsils; thymus gland	Forms blood cells; filters bacteria; forms antibodies
Epithelial tissues	Avascular; may be a single layer or multiple layers of cells that are tightly bound together	The skin; covering internal organs; lining body cavities, blood vessels, heart, mouth, nose, throat, esophagus, stomach, intestines, urinary tract, and reproductive tract; found in many glands that secrete substances	Covers and lines to protect; secretes; absorbs; filters
Muscle tissues	Vascular	Throughout entire body	Moves and supports
Skeletal	Long (up to 3.8 cm), multinucleate, striated cells	Attached to bones, other muscles, and structures	Moves bones, eyes, tongue, and other structures
Smooth	Short uninucleate, nonstriated cells	In walls of tubular organs such as blood vessels, intestines, and stomach; in eye; attached to hair follicles	Moves substances through tubular organs; changes size of pupil; focuses lens of eye; causes gooseflesh
Cardiac	Branching fibers; short, uninucleate, striated cells	The walls of the heart	Pumps blood
Nerve tissues	Cells with long (sometimes several feet long) projections; often protected by other cells; avascular; most with no further mitosis once maturity is reached	The brain; spinal cord; nerves; in eye; in ear; taste buds; touch receptors	Has irritability; conducts nerve impulses, thoughts, and emotions

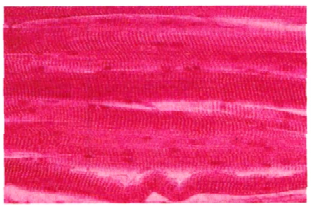
single layer lining capillaries to multiple layers of cells forming the skin. The epithelial cells of the skin are bound tightly together, forming a protective barrier; those lining the capillaries allow some substances to pass between them. Some epithelial cells have specialized functions and structures. For example, the respiratory tract is lined with both ciliated and mucus-secreting epithelial cells that trap and remove foreign substances.



20A.7
PMG of epithelial tissue

Muscle Tissue

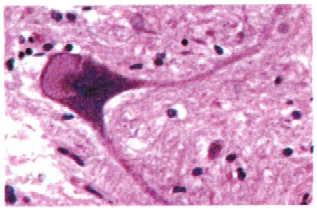
Muscle tissue is composed of cells that can contract. By contracting, the muscles either move the body or move substances through the body. The human body contains three types of muscle tissue—skeletal, smooth, and cardiac. The skeletal muscles move the body—arms, legs, and face. The smooth muscle performs many functions that are not controlled voluntarily, such as moving food through the digestive system. The third type, cardiac muscle, is found only in the heart and pumps blood throughout the body.



20A.8
PMG of muscle tissue

Nervous Tissue

Nervous tissue contains cells that receive and transmit electrochemical impulses from muscles, glands, and other nerve cells. It includes the brain, spinal cord, and nerves throughout the body. Nervous tissue coordinates muscular movements, interprets sensations received from the environment, and controls thought processes and emotions.



20A.9
PMG of nervous tissue

Human Organs and Systems

The tissues of the body are organized into organs. The heart, for example, is an organ made up of several different representatives of the four basic tissue groups. All these tissues work together to accomplish the functions of the heart.

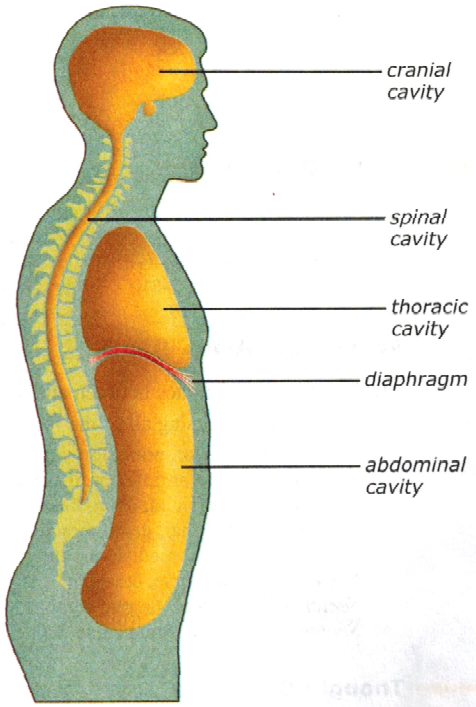
Organs with related functions are grouped together into systems. This grouping is artificial and is designed for man's convenience. For example, most would agree that the muscular system includes all muscles. But what about the muscles that churn food? They are in the stomach—an organ in the digestive system. Stomach muscles are not considered as part of the muscular system. There are many other examples of systems that seem to overlap.

The body was not designed to be studied easily; it was designed to carry on life. The systems approach—studying the body one organ system at a time—is probably the clearest method and is used in this text. Table 20A-2 lists the eleven systems in the order in which this book discusses them.

Human Body Cavities

The body is divided into four main cavities, or spaces, that contain the major internal organs. The cavities protect and cushion the organs from possible injury from activities such as jumping and running and from trauma. The **cranial cavity** houses the brain, and the **spinal cavity** surrounds the spinal cord.

The trunk has two large cavities, separated by a large muscle called the diaphragm. The superior cavity is called the **thoracic cavity** and contains the heart, respiratory organs, and esophagus. The **abdominal cavity** is the inferior cavity and contains the digestive, reproductive, and excretory organs.



20A.10
Major body cavities

Table 20A-2 Human Organ Systems

Group	Organ system	Major functions	Major components
Covering	Integumentary	Protect tissues; provide covering	Skin, hair, nails
Support and movement	Skeletal	Support; attachment for muscles; protect internal organs	Bones, cartilage, joints
	Muscular	Bodily movement; maintain posture; move substances through body	Muscles (skeletal, smooth, cardiac)
Incoming substances	Respiratory	Movement of air in and out of body; gas exchange between blood and air	Nose, throat, trachea, bronchi, lungs
	Digestive	Take in, break down, and absorb food; eliminate waste	Mouth, teeth, tongue, esophagus, stomach, intestines, pancreas, liver, gallbladder
Internal transport	Circulatory	Circulate blood throughout body; transport substances throughout body	Heart, arteries, veins, capillaries
	Lymphatic	Protect against disease	Spleen, lymph glands, lymphatic vessels, tonsils
Excretion	Excretory	Eliminate wastes; maintain water balance	Kidneys, ureters, urinary bladder, urethra
Control	Nervous	Coordinate and control all movement; receive and transmit information; process sensory information	Brain, spinal cord, peripheral nerves, eyes, ears, taste receptors, olfactory and auditory organs
	Endocrine	Regulate body functions	Glands that secrete hormones: pituitary, thyroid, adrenal, pancreas
Reproduction	Reproductive	Produce offspring	Ovaries, fallopian tubes, uterus, testes, prostate gland

Human Tissues, Organs, and Systems Questions

1. What is the difference between anatomy and physiology?
2. Choose the correct answer:
    a. The brachial area is (proximal/distal) to the elbow.
    b. The cervical area is (superior/inferior) to the lumbar area.
    c. A line drawn from the left lateral area of the abdomen to the right lateral area of the abdomen would be a (medial/transverse) line.
    d. A line drawn from the nose to the navel would be a (medial/transverse) line.
    e. The abdomen is on the (posterior/anterior) side of the body.
    f. The thumb is (lateral/medial) to the longest finger.
    g. The calf muscle is (proximal/distal) to the foot.
    h. A (sagittal/transverse) line divides the body in to right and left portions.
3. There are four basic types of tissue in the human body: connective, epithelial, muscle, and nervous. Tell the function of each type of tissue and give an example of where it is found in the body.
4. List the eleven human organ systems.
5. List the four main body cavities. What organs are in each cavity?
6. Why are your organs located in body cavities?