



PEARSON NEW INTERNATIONAL EDITION

Human Anatomy

Martini Timmons Tallitsch  
Seventh Edition

# Pearson New International Edition

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Martini Timmons Tallitsch  
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## Glossary of Key Terms

**abdomen:** Region of trunk bounded by the diaphragm and pelvis.

**abdominopelvic cavity:** Portion of the ventral body cavity that contains abdominal and pelvic subdivisions.

**abducens (ab-DŪ-senz):** Cranial nerve VI; innervates the lateral rectus muscle of the eye.

**abduction:** Movement away from the midline.

**abortion:** Premature loss or expulsion of an embryo or fetus.

**abscess:** A localized collection of pus within a damaged tissue.

**absorption:** The active or passive uptake of gases, fluids, or solutes.

**accommodation:** Alteration in the curvature of the lens to focus an image on the retina; decrease in receptor sensitivity or perception following chronic stimulation.

**acetabulum (a-se-TAB-ŭ-lum):** Fossa on lateral aspect of pelvis that accommodates the head of the femur.

**acetylcholine (ACh) (as-e-til-KŌ-lĕn):** Chemical neurotransmitter in the brain and PNS; dominant neurotransmitter in the PNS, released at neuromuscular synapses and synapses of the parasympathetic division.

**acetylcholinesterase (AChE):** Enzyme found in the synaptic cleft, bound to the postsynaptic membrane, and in tissue fluids; breaks down and inactivates ACh molecules.

**achalasia (ak-a-LĀ-zĕ-a):** Condition that develops when the lower esophageal sphincter fails to dilate, and ingested materials cannot enter the stomach.

**Achilles tendon:** Calcaneal tendon.

**acid:** A compound whose dissociation in solution releases a hydrogen ion and an anion; an acid solution has a pH below 7.0 and contains an excess of hydrogen ions.

**acinus/acini (A-si-ni):** Histological term referring to a blind pocket, pouch, or sac.

**acne:** Condition characterized by inflammation of sebaceous glands and follicles; commonly affects adolescents and most often involves the face.

**acoustic:** Pertaining to sound or the sense of hearing.

**acquired immune deficiency syndrome (AIDS):** A disease caused by the human immunodeficiency virus (HIV), characterized by destruction of helper T cells and a resulting severe impairment of the immune response.

**acromegaly:** Condition caused by overproduction of growth hormone in the adult, characterized by thickening of bones and enlargement of cartilages and other soft tissues.

**acromion (a-KRŌ-mĕ-on):** Continuation of the scapular spine that projects superior to the capsule of the shoulder joint.

**acrosomal cap (ak-rŏ-SŌ-mal):** Membranous sac at the tip of a sperm cell that contains hyaluronic acid.

**actin:** Protein component of microfilaments; forms thin filaments in skeletal muscles and produces contractions of all muscles through interaction with thick (myosin) filaments; *see* **sliding filament theory**.

**action potential:** A conducted change in the transmembrane potential of excitable cells, initiated by a change in the membrane permeability to sodium ions; *see* **nerve impulse**.

**active transport:** The ATP-dependent absorption or excretion of solutes across a cell membrane.

**acute:** Sudden in onset, severe in intensity, and brief in duration.

**adaptation:** Alteration of pupillary size in response to changes in light intensity; in CNS, often used as a synonym for accommodation; physiological responses that produce acclimatization.

**Addison's disease:** Condition resulting from hyposecretion of glucocorticoids, characterized by lethargy, weakness, hypotension, and increased skin pigmentation.

**adduction:** Movement toward the axis or midline of the body as viewed in the anatomical position.

**adenine:** A purine, one of the nitrogen bases in the nucleic acids RNA and DNA.

**adenohypophysis (ad-e-nŏ-hi-POF-i-sis):** The anterior lobe of the pituitary gland, also called the *anterior pituitary* or the **pars distalis**.

**adenoid:** The pharyngeal tonsil.

**adenosine triphosphate (ATP):** A high-energy compound consisting of adenosine with three phosphate groups attached; the third is attached by a high-energy bond.

**adhesion:** Fusion of two mesenteric layers following damage or irritation of their opposing surfaces.

**adipocyte (AD-i-pŏ-sit):** A fat cell.

**adipose tissue:** Loose connective tissue dominated by adipocytes.

**adrenocortical hormone:** Any of the steroids produced by the adrenal cortex.

**adrenocorticotropic hormone (ACTH):** Hormone that stimulates the production and secretion of glucocorticoids by the zona fasciculata of the adrenal cortex; released by the anterior pituitary in response to CRE.

**adventitia (ad-ven-TISH-a):** Superficial layer of connective tissue surrounding an internal organ; fibers are continuous with those of surrounding tissues, providing support and stabilization.

**afferent:** Toward a central receiving area.

**afferent arteriole:** An arteriole bringing blood to the glomerulus of the kidney.

**afferent fiber:** Axons carrying sensory information to the CNS.

**agglutination (a-gloo-ti-NĀ-shun):** Aggregation of red blood cells due to interactions between surface agglutinogens and plasma agglutinins.

**aggregated lymphoid nodules:** Lymphoid nodules beneath the epithelium of the small intestine. Also called *Peyer's Patches*.

**agonist:** A muscle responsible for a specific movement.

**agranular:** Without granules; **agranular leukocytes** are monocytes and lymphocytes; the **agranular reticulum** is an intracellular organelle that synthesizes and stores carbohydrates and lipids.

**AIDS:** *See* **acquired immune deficiency syndrome**.

**AIDS-related complex (ARC):** Early symptoms of HIV infection, consisting chiefly of lymphadenopathy, fevers, and chronic nonfatal infections.

**alba, albacans, albuginea (AL-bi-kanz) (al-bŭ-JIN-ĕ-a):** White.

**albinism:** Absence of pigment in hair and skin caused by inability of body to produce melanin.

**albumins (al-BŪ-minz):** The smallest of the plasma proteins; function as transport proteins and important in contributing to plasma oncotic pressure.

**aldosterone:** A mineralocorticoid (steroid) produced by the zona glomerulosa of the adrenal cortex that stimulates sodium and water conservation at the kidneys; secreted in response to the presence of angiotensin II.

**aldosteronism:** Condition caused by the oversecretion of aldosterone, characterized by fluid retention, edema, and hypertension.

**allantois (a-LAN-tŏ-is):** One of the extraembryonic membranes; it provides vascularity to the chorion and is therefore essential to placenta formation; the proximal portion becomes the urinary bladder.

**alpha cells:** Cells in the pancreatic islets that secrete glucagon.

**alpha receptors:** Membrane receptors sensitive to norepinephrine or epinephrine; stimulation usually results in excitation of the target cell.

**alveolar sac:** An air-filled chamber that supplies air to several alveoli.

**alveolus/alveoli (al-VĒ-ŏ-lĭ):** Blind pockets at the end of the respiratory tree, lined by a simple squamous epithelium and surrounded by a capillary network; gas exchange with the blood occurs here.

**Alzheimer's disease:** Disorder resulting from degenerative changes in populations of neurons in the cerebrum, causing dementia characterized by problems with attention, short-term memory, and emotions.

**amacrine cells (AM-a-krin):** Modified neurons in the retina that facilitate or inhibit communication between bipolar and ganglion cells.

**amino acids:** Organic compounds whose chemical structure can be summarized as R—CHNH<sub>2</sub>COOH.

**amnesia:** Temporary or permanent memory loss.

**amniocentesis:** Sampling of amniotic fluid for analytical purposes; used to detect certain forms of genetic abnormalities.

**amnion (AM-nĕ-on):** One of the extraembryonic membranes; surrounds the developing embryo/fetus.

**amniotic fluid (am-nĕ-OT-ik):** Fluid that fills the amniotic cavity; provides cushioning and support for the embryo/fetus.

**amphiarthrosis (am-fĕ-ar-THRŌ-sis):** An articulation that permits a small degree of independent movement.

**amphimixis (am-fi-MIK-sis):** The fusion of male and female pronuclei following fertilization.

**ampulla/ampullae (am-PŪL-la):** A localized dilation in the lumen of a canal or passageway.

**amygdala/amygdaloid nucleus (ah-MIG-da-loid):** A basal nucleus that is a component of the limbic system and acts as an interface between that system, the cerebrum, and sensory systems.

**amylase:** An enzyme that breaks down polysaccharides, produced by the salivary glands and pancreas.

**anabolism (a-NAB-ŏ-lizm):** The synthesis of complex organic compounds from simpler precursors.

**anal canal:** The distal portion of the rectum that contains the anal columns and ends at the anus.

**analgesia:** Relief from pain.

**anal triangle:** The posterior subdivision of the perineum.

**anaphase (AN-uh-fĕz):** Mitotic stage in which the paired chromatids separate and move toward opposite ends of the spindle apparatus.

**anastomosis (a-nas-tŏ-MŌ-sis):** The joining of two tubes, usually referring to a connection between two peripheral vessels without an intervening capillary bed.

**anatomical position:** An anatomical reference position, the body viewed from the anterior surface with the palms facing forward; supine.

**anatomy (a-NAT-ŏ-mĕ):** The study of the structure of the body.

**anaxonic neuron (an-ak-SON-ik):** A CNS neuron that has many processes but no apparent axon.

**androgen (AN-drŏ-jen):** A steroid sex hormone produced primarily by the interstitial cells of the testis, and manufactured in small quantities by the adrenal cortex in either sex.

**anemia (a-NĒ-mĕ-a):** Condition marked by a reduction in the hematocrit and/or hemoglobin content of the blood.

**anencephaly (an-en-SEF-a-lĕ):** Development defect characterized by incomplete development of the cerebral hemispheres and cranium.

**anesthesia:** Total or partial loss of sensation from a region of the body.

**aneurysm (AN-ŭ-rizm):** A weakening and localized dilation in the wall of a blood vessel.

**angiogram (AN-jĕ-ŏ-gram):** An x-ray image of circulatory pathways.

**angiography:** X-ray examination of vessel distribution following the introduction of radiopaque substances into the bloodstream.

**angiotensin I, II:** Angiotensin II is a hormone that causes an elevation in systemic blood pressure, stimulates secretion of aldosterone, promotes thirst, and causes the release of ADH; a converting enzyme in the pulmonary capillaries converts angiotensin I to angiotensin II.

## Glossary of Key Terms

- angiotensinogen:** Blood protein produced by the liver that is converted to angiotensin I by the enzyme renin.
- ankyloglossia (ang-ki-lō-GLOS-ē-a):** Condition characterized by an overly robust and restrictive lingual frenulum.
- annulus (AN-ū-lus):** A cartilage or bone shaped like a ring.
- anorexia nervosa:** An eating disorder marked by a loss of appetite and pronounced weight loss.
- anoxia (an-OK-se-a):** Tissue oxygen deprivation.
- antagonist:** A muscle that opposes the movement of an agonist.
- antebrachium:** The forearm.
- anteflexion (an-tē-FLEK-shun):** Normal position of the uterus, with the superior surface bent forward.
- anterior:** On or near the front or ventral surface of the body.
- antibiotic:** Chemical agent that selectively kills pathogenic microorganisms.
- antibody (AN-ti-bod-ē):** A globular protein produced by plasmocytes that will bind to specific antigens and promote their destruction or removal from the body.
- anticoagulant:** Compound that slows or prevents clot formation by interfering with the clotting system.
- antidiuretic hormone (ADH) (an-ti-di-ū-RET-ik):** Hormone synthesized in the hypothalamus and secreted at the posterior pituitary; causes water retention at the kidneys and an elevation of blood pressure.
- antigen:** A substance capable of inducing the production of antibodies.
- antrum (AN-trum):** A chamber or pocket.
- anuria (a-NŪ-rē-a):** Cessation of urine production.
- anus:** External opening of the anal canal.
- aorta:** Large, elastic artery that carries blood away from the left ventricle and into the systemic circuit.
- aortic reflex:** Baroreceptor reflex triggered by increased aortic pressures; leads to a reduction in cardiac output and a fall in systemic pressure.
- apex (Ā-peks):** A pointed tip, usually referring to a triangular object and positioned opposite a broad base.
- Apgar rating:** A test used to assess the neurological status of a newborn infant.
- aphasia:** Inability to speak.
- apnea (AP-nē-a):** Cessation of breathing.
- apneustic center (ap-NŪ-stik):** Respiratory center whose chronic activation would lead to apnea at full inspiration.
- apocrine secretion:** Mode of secretion where the glandular cell sheds portions of its cytoplasm.
- aponeurosis/aponeuroses (ap-ō-noo-RŌ-sēz):** A broad tendinous sheet that may serve as the origin or insertion of a skeletal muscle.
- appendicitis:** Inflammation of the appendix.
- appendicular:** Pertaining to the upper or lower limbs.
- appendix:** A blind tube connected to the cecum of the large intestine.
- appositional growth:** Enlargement by the addition of cartilage or bony matrix to the outer surface.
- aqueous humor:** Fluid similar to perilymph or CSF that fills the anterior chamber of the eye.
- arachnoid granulations:** Processes of the arachnoid that project into the superior sagittal sinus; sites where CSF enters the venous circulation.
- arachnoid mater (a-RAK-noyd):** The middle meninges that enclose CSF and protect the central nervous system.
- arbor vitae:** Central, branching mass of white matter inside the cerebellum.
- arcuate (AR-kū-āt):** Curving.
- areflexia (a-rē-FLEK-sē-a):** Absence of normal reflex responses to stimulation.
- areola (a-RĒ-ō-la):** Pigmented area that surrounds the nipple of a breast.
- areolar:** Containing minute spaces, as in areolar connective tissue.
- arrector pili (ar-REK-tor PĪ-li):** Smooth muscles whose contractions cause piloerection.
- arrhythmias (a-RITH-mē-az):** Abnormal patterns of cardiac contractions.
- arteriole (ar-TĒ-rē-ōl):** A small arterial branch that delivers blood to a capillary network.
- artery:** A blood vessel that carries blood away from the heart and toward a peripheral capillary.
- arthritis (ar-THRĪ-tis):** Inflammation of a joint.
- arthroscope:** Fiber-optic device intended for visualizing the interior of joints; may also be used for certain forms of joint surgery.
- articular:** Pertaining to a joint.
- articular capsule:** Dense collagen fiber sleeve that surrounds a joint and provides protection and stabilization.
- articular cartilage:** Cartilage pad that covers the surface of a bone inside a joint cavity.
- articulation (ar-tik-ū-LĀ-shun):** A joint; formation of words.
- arytenoid cartilages (ar-i-TĒ-noyd):** A pair of small cartilages in the larynx.
- ascending tract:** A tract carrying information from the spinal cord to the brain.
- ascites (a-SĪ-tēz):** Overproduction and accumulation of peritoneal fluid.
- aseptic:** Free from pathogenic contamination.
- asphyxia:** Unconsciousness due to oxygen deprivation at the CNS.
- aspirate:** To remove or obtain by suction; to inhale.
- association areas:** Cortical areas of the cerebrum responsible for integration of sensory inputs and/or motor commands.
- asthma (AZ-ma):** Reversible constriction of smooth muscles around respiratory passageways, frequently caused by an allergic response.
- astigmatism:** Visual disturbance due to an irregularity in the shape of the cornea.
- astrocyte (AS-trō-sit):** One of the glial cells in the CNS.
- atelectasis (at-e-LEK-ta-sis):** Collapse of a lung or a portion of a lung.
- atherosclerosis (ath-er-ō-skle-RŌ-sis):** Formation of fatty plaques in the walls of arteries, leading to circulatory impairment.
- atresia (a-TRĒ-zē-a):** Closing of a cavity, or its incomplete development; used in the reproductive system to refer to the degeneration of developing ovarian follicles.
- atria:** Thin-walled chambers of the heart that receive venous blood from the pulmonary or systemic circuits.
- atrial natriuretic peptide (nā-tre-ū-RET-ik):** Hormone released by specialized atrial cardiocytes when they are stretched by an abnormally large venous return; promotes fluid loss and reductions in blood pressure and venous return.
- atrioventricular (AV) node (ā-trē-ō-ven-TRIK-ū-lar):** Specialized cardiocytes that relay the contractile stimulus to the bundle of His, the bundle branches, the Purkinje fibers, and the ventricular myocardium; located at the boundary between the atria and ventricles.
- atrioventricular valve:** One of the valves that prevent backflow into the atria during ventricular systole.
- atrophy (AT-rō-fē):** Wasting away of tissues from lack of use or nutritional abnormalities.
- auditory ossicles:** The bones of the middle ear: malleus, incus, and stapes.
- auditory tube:** A passageway that connects the nasopharynx with the middle ear cavity; also called the *Eustachian* or *pharyngotympanic tube*.
- autoimmunity:** Immune system sensitivity to normal cells and tissues, resulting in the production of autoantibodies.
- autolysis:** Destruction of a cell due to the rupture of lysosomal membranes in its cytoplasm.
- autonomic bladder:** Reflex micturition following stimulation of stretch receptors in the bladder wall; seen in patients who have lost motor control of the lower body.
- automaticity:** Spontaneous depolarization to threshold, a characteristic of cardiac pacemaker cells.
- autonomic ganglion:** A collection of visceral motor neurons outside the CNS.
- autonomic nerve:** A peripheral nerve consisting of preganglionic or postganglionic autonomic fibers.
- autonomic nervous system (ANS):** Centers, nuclei, tracts, ganglia, and nerves involved in the unconscious regulation of visceral functions; includes components of the CNS and PNS.
- autopsy:** Detailed examination of a body after death, usually performed by a pathologist.
- autoregulation:** Alterations in activity that maintain homeostasis in direct response to changes in the local environment; does not require neural or endocrine control.
- autosomal (aw-tō-SŌ-mal):** Chromosomes other than the X or Y chromosomes that determine the genetic sex of an individual.
- avascular (ā-VAS-kū-lar):** Without blood vessels.
- avulsion:** An injury involving the violent tearing away of body tissues.
- axilla:** The armpit.
- axolemma:** The cell membrane of an axon, continuous with the cell membrane of the soma and dendrites and distinct from any glial cell coverings.
- axon:** Elongate extension of a neuron that conducts an action potential away from the soma and toward the synaptic terminals.
- axon hillock:** Portion of the neural cell body adjacent to the initial segment.
- axoplasm (AK-sō-plazm):** Cytoplasm within an axon.
- Babinski sign:** Reflexive dorsiflexion of the toes following stroking of the plantar surface of the foot; positive reflex (Babinski sign) is normal up to age 1.5 years; thereafter a positive reflex indicates damage to descending tracts.
- bacteria:** Single-celled microorganisms, some pathogenic, that are common in the environment.
- baroreception:** Ability to detect changes in pressure.
- baroreceptor reflex:** A reflexive change in cardiac activity in response to changes in blood pressure.
- baroreceptors (bar-ō-rē-SEP-terz):** Receptors responsible for baroreception.
- basal nuclei:** Nuclei of the cerebrum that are involved in the regulation of somatic motor activity at the subconscious level.
- base:** A compound whose dissociation releases a hydroxide ion (OH<sup>-</sup>) or removes a hydrogen ion from the solution.
- basement membrane:** A layer of filaments and fibers that attach an epithelium to the underlying connective tissue.
- basilar lamina:** Membrane that supports the organ of Corti and separates the cochlear duct from the scala tympani in the inner ear.
- basophils (BĀ-sō-filz):** Circulating granulocytes (WBCs) similar in size and function to tissue mast cells.
- B cells:** Lymphocytes responsible for the production of antibodies, following their conversion to plasmocytes.
- benign:** Not malignant.
- beta cells:** Cells of the pancreatic islets that secrete insulin in response to elevated blood sugar concentrations.
- beta receptors:** Membrane receptors sensitive to epinephrine; stimulation may result in excitation or inhibition of the target cell.
- bicarbonate ions:** HCO<sub>3</sub><sup>-</sup>; anion components of the bicarbonate buffer system.
- bicuspid (bi-KUS-pid):** A sharp, conical tooth, also called a canine tooth.
- bifurcate:** To branch into two parts.
- bile:** Exocrine secretion of the liver that is stored in the gallbladder and ejected into the duodenum.
- bile salts:** Steroid derivatives in the bile, responsible for the emulsification of ingested lipids.
- bilirubin (bil-ē-ROO-bin):** A reddish pigment, a product of hemoglobin catabolism.

## Glossary of Key Terms

- biopsy:** The removal of a small sample of tissue for pathological analysis.
- bipennate muscle:** A muscle whose fibers are arranged on either side of a common tendon.
- bladder:** A muscular sac that distends as fluid is stored and whose contraction ejects the fluid at an appropriate time; used alone, the term usually refers to the urinary bladder.
- blastocoele (BLAS-tō-sēl):** Fluid-filled cavity within a blastocyst.
- blastocyst (BLAS-tō-sist):** Early stage in the developing embryo, consisting of an outer trophoblast and an inner cell mass.
- blastodisc (BLAS-tō-disk):** Later stage in the development of the inner cell mass; it includes the cells that will form the embryo.
- blastomere (BLAS-tō-mēr):** One of the cells in the morula, a collection of cells produced by the division of the zygote.
- blood-brain barrier:** Isolation of the CNS from the general circulation; primarily the result of astrocyte regulation of capillary permeabilities.
- blood clot:** A network of fibrin fibers and trapped blood cells.
- blood pressure:** A force exerted against the vascular walls by the blood, as the result of the push exerted by cardiac contraction and the elasticity of the vessel walls. It is usually measured along one of the muscular arteries, with systolic pressure measured during ventricular systole, and diastolic pressure during ventricular diastole.
- blood-testis barrier:** Isolation of the seminiferous tubules from the general circulation, due to the activities of the nurse (Sertoli) cells.
- boil:** An abscess of the skin, usually involving a sebaceous gland.
- bolus:** A compact mass; usually refers to compacted ingested material on its way to the stomach.
- bone:** See **osseous tissue**.
- bowel:** The intestinal tract.
- brachial:** Pertaining to the arm.
- brachial plexus:** Network formed by branches of spinal nerves C<sub>5</sub>-T<sub>1</sub>, en route to innervate the upper limb.
- brachium:** The arm.
- bradycardia (brā-dē-KAR-dē-a):** An abnormally slow heart rate.
- brain stem:** The brain minus the cerebrum and cerebellum.
- brevis:** Short.
- Broca's center:** The speech center of the brain, usually found on the neural cortex of the left cerebral hemisphere.
- bronchial tree:** The trachea, bronchi, and bronchioles.
- bronchitis (brong-KĪ-tis):** Inflammation of the bronchial passageways.
- bronchoscope:** A fiber-optic instrument used to examine the bronchial passageways.
- bronchus/bronchi:** One of the branches of the bronchial tree between the trachea and bronchioles.
- buccal (BUK-al):** Pertaining to the cheeks.
- buffer:** A compound that stabilizes the pH of a solution by removing or releasing hydrogen ions.
- bulbar:** Pertaining to the brain stem.
- bulbo-urethral glands (bul-bō-ū-RĒ-thral):** Mucous glands at the base of the penis that secrete into the penile urethra; also called Cowper's glands.
- bundle branches:** Specialized conducting cells in the ventricles that carry the contractile stimulus from the bundle of His to the Purkinje fibers.
- bundle of His (HISS):** Specialized conducting cells in the interventricular septum that carry the contracting stimulus from the AV node to the bundle branches and then to the Purkinje fibers.
- bursa:** A small sac filled with synovial fluid that cushions adjacent structures and reduces friction.
- bursectomy:** The surgical removal of an inflamed bursa.
- bursitis:** Painful inflammation of one or more bursae.
- calcaneal tendon:** Large tendon that inserts on the calcaneus; tension on this tendon produces plantar flexion of the foot; also called the *Achilles tendon*.
- calcaneus (kal-KĀ-nē-us):** The heelbone, the largest of the tarsal bones.
- calcification:** The deposition of calcium salts within a tissue.
- calcitonin (kal-si-TŌ-nin):** Hormone secreted by thyrotropes, or C cells of the thyroid, when calcium ion concentrations are abnormally high; restores homeostasis by increasing the rate of bone deposition and the renal rate of calcium loss, and inhibiting calcium uptake at the digestive tract.
- calculus/calculi (KAL-kū-li):** Concretions of insoluble materials that form within body fluids, especially the gallbladder, kidneys, or urinary bladder.
- callus:** A localized thickening of the epidermis due to chronic mechanical stresses; a thickened area that forms at the site of a bone break as part of the repair process.
- calvaria (kal-VAR-ē-a):** The skullcap, formed of the frontal, parietal, and occipital bones.
- calyx/calyses (KĀL-i-sēz):** A cup-shaped division of the renal pelvis.
- canaliculi (kan-a-LIK-ū-lē):** Microscopic passageways between cells; bile canaliculi carry bile to bile ducts in the liver; in bone, canaliculi permit the diffusion of nutrients and wastes to and from osteocytes.
- cancer:** A malignant tumor that tends to undergo metastasis.
- cannula:** A tube that can be inserted into the body; often placed in blood vessels prior to transfusion or dialysis.
- canthus, medial and lateral (KAN-thus):** The angles formed at either corner of the eye between the upper and lower eyelids.
- capacitation (ka-pas-i-TĀ-shun):** Activation process that must occur before a spermatozoon can successfully fertilize an egg; occurs in the vagina following ejaculation.
- capillaries:** Small blood vessels, interposed between arterioles and venules, whose thin walls permit the diffusion of gases, nutrients, and wastes between the plasma and interstitial fluids.
- capitulum (ka-PIT-ū-lum):** General term for a small, elevated articular process; used to refer to the rounded distal surface of the humerus that articulates with the radial head.
- caput:** The head.
- carbohydrase (kar-bō-HĪ-drāz):** An enzyme that breaks down carbohydrate molecules.
- carbohydrate (kar-bō-HĪ-drāt):** Organic compound containing carbon, hydrogen, and oxygen in a ratio that approximates 1:2:1.
- carbon dioxide:** CO<sub>2</sub>, a compound produced by the decarboxylation reactions of aerobic glycolysis.
- carbonic anhydrase:** An enzyme that catalyzes the reaction H<sub>2</sub>O + CO<sub>2</sub> → H<sub>2</sub>CO<sub>3</sub>; important in carbon dioxide transport, gastric acid secretion, and renal pH regulation.
- carboxypeptidase (kar-bok-sē-PEP-ti-dāz):** A protease that breaks down proteins and releases amino acids.
- carcinogenic (kar-sin-ō-JEN-ik):** Stimulating cancer formation in affected tissues.
- cardia (KAR-dē-a):** The area of the stomach surrounding its connection with the esophagus.
- cardiac:** Pertaining to the heart.
- cardiac cycle:** One complete heartbeat, including atrial and ventricular systole and diastole.
- cardiac glands:** Mucous glands characteristic of the cardia of the stomach.
- cardiac output:** The amount of blood ejected by the left ventricle each minute; normally about 5 liters.
- cardiac tamponade:** Compression of the heart due to fluid accumulation in the pericardial cavity.
- cardiocyte (KAR-dē-ō-sit):** A cardiac muscle cell.
- cardiomyopathy (kar-dē-ō-mi-OP-a-thē):** A progressive disease characterized by damage to the cardiac muscle tissue.
- cardiopulmonary resuscitation:** Method of artificially maintaining respiratory and circulatory function.
- cardiovascular:** Pertaining to the heart, blood, and blood vessels.
- cardiovascular centers:** Poorly localized centers in the reticular formation of the medulla of the brain; includes cardioacceleratory, cardioinhibitory, and vasomotor centers.
- cardium:** The heart.
- carina (ka-RĪ-na):** A ridge on the inner surface of the base of the trachea that runs anteroposteriorly, between the two primary bronchi.
- carotene (KAR-ō-tēn):** A yellow-orange pigment found in carrots and in green and orange leafy vegetables; a compound that the body can convert to vitamin A.
- carotid artery:** The principal artery of the neck, servicing cervical and cranial structures; one branch, the internal carotid, represents a major blood supply for the brain.
- carotid body:** A group of receptors adjacent to the carotid sinus that are sensitive to changes in the carbon dioxide levels, pH, and oxygen concentrations of the arterial blood.
- carotid sinus:** A dilated segment of the internal carotid artery whose walls contain baroreceptors sensitive to changes in blood pressure.
- carotid sinus reflex:** Reflexive changes in blood pressure that maintain homeostatic pressures at the carotid sinus, stabilizing blood flow to the brain.
- carpus/carpal:** The wrist.
- cartilage:** A connective tissue with a gelatinous matrix and an abundance of fibers.
- castration:** Removal of the testes, also called bilateral orchietomy.
- catabolism (ka-TAB-ō-lizm):** The breakdown of complex organic molecules into simpler components, accompanied by the release of energy.
- cataract:** A reduction in lens transparency that causes visual impairment.
- catecholamines (kat-e-KŌL-am-inz):** Epinephrine, norepinephrine, and related compounds.
- catheter (KATH-e-ter):** Surgical instrument; a tube inserted into a body cavity or along a blood vessel or excretory passageway for the collection of body fluids, blood pressure monitoring, or the introduction of medications or radiographic dyes.
- cauda equina (KAW-da ek-WĪ-na):** Spinal nerve roots distal to the tip of the adult spinal cord; they extend caudally inside the vertebral canal en route to lumbar and sacral segments.
- caudal/caudally:** Closest to or toward the tail (coccyx).
- caudate nucleus (KAW-dāt):** One of the basal nuclei, involved with the subconscious control of muscular activity.
- cavernous tissue:** Erectile tissue that can be engorged with blood; found in the penis and clitoris.
- cecum (SĒ-kum):** An expanded pouch at the start of the large intestine.
- cell:** The smallest living unit in the human body.
- cell-mediated immunity:** Resistance to disease through the activities of sensitized T cells that destroy antigen-bearing cells by direct contact or through the release of lymphotoxins; also called cellular immunity.
- cellulitis (sel-ū-LĪ-tis):** Diffuse inflammation, usually involving areas of loose connective tissue, such as the subcutaneous layer.
- cement or cementum (se-MEN-tum):** Bony material covering the root of a tooth, not shielded by a layer of enamel.
- center of ossification:** Site in a connective tissue where bone formation begins.

## Glossary of Key Terms

- central canal:** Longitudinal canal in the center of an osteon that contains blood vessels and nerves, also called the Haversian canal; a passageway along the longitudinal axis of the spinal cord that contains cerebrospinal fluid.
- central nervous system (CNS):** The brain and spinal cord.
- central sulcus:** Groove in the surface of a cerebral hemisphere, between the primary sensory and primary motor areas of the cortex.
- centriole:** A cylindrical intracellular organelle composed of nine groups of microtubules, three in each group; functions in mitosis or meiosis by forming the basis of the spindle apparatus.
- centromere (SEN-trō-mēr):** Localized region where two chromatids remain connected following chromosome replication; site of spindle fiber attachment.
- centrosome:** Region of cytoplasm containing a pair of centrioles oriented at right angles to one another.
- centrum:** The vertebral body.
- cephalic:** Pertaining to the head.
- cerebellum (ser-e-BEL-um):** Posterior portion of the metencephalon, containing the cerebellar hemispheres; includes the arbor vitae, cerebellar nuclei, and cerebellar cortex.
- cerebral cortex:** An extensive area of neural cortex covering the surfaces of the cerebral hemispheres.
- cerebral hemispheres:** Expanded portions of the cerebrum covered in neural cortex.
- cerebral palsy:** Chronic condition resulting from damage to motor areas of the brain during development or at delivery.
- cerebral peduncle:** Mass of nerve fibers on the ventrolateral surface of the mesencephalon; contains ascending tracts that terminate in the thalamus and descending tracts that originate in the cerebral hemispheres.
- cerebrospinal fluid:** Fluid bathing the internal and external surfaces of the CNS; secreted by the choroid plexus.
- cerebrovascular accident (CVA):** A stroke; occlusion of a blood vessel supplying a portion of the brain, resulting in damage to the dependent neurons.
- cerebrum (SER-e-brum or ser-Ē-brum):** The largest portion of the brain, composed of the cerebral hemispheres; includes the cerebral cortex, the basal nuclei, and the internal capsule.
- cerumen:** Waxy secretion of integumentary glands along the external acoustic meatus.
- ceruminous glands (se-ROO-mi-nus):** Integumentary glands that secrete cerumen.
- cervical enlargement:** Relative enlargement of the cervical portion of the spinal cord due to the abundance of CNS neurons involved with motor control of the arms.
- cervix:** The inferior part of the uterus.
- cesarean section:** Surgical delivery of an infant via an incision through the lower abdominal wall and uterus.
- chalazion (kah-LĀ-zē-on):** An inflammation and distension of a Meibomian gland on the eyelid; also called a sty.
- chancre (SHANG-ker):** A skin lesion that develops at the primary site of a syphilis infection.
- charley horse:** Soreness and stiffness in a strained muscle, usually involving the quadriceps group.
- chemoreception:** Detection of alterations in the concentrations of dissolved compounds or gases.
- chemotaxis (kē-mō-TAK-sis):** The attraction of phagocytic cells to the source of abnormal chemicals in tissue fluids.
- chloride shift:** Movement of plasma chloride ions into RBCs in exchange for bicarbonate ions generated by the intracellular dissociation of carbonic acid.
- cholecystitis (kō-lē-sis-TĪ-tis):** Inflammation of the gallbladder.
- cholecystokinin (CCK) (kō-lē-sis-tō-KĪ-nin):** Duodenal hormone that stimulates the contraction of the gallbladder and the secretion of enzymes by the exocrine pancreas; also called *pancreozymin*.
- cholelithiasis (kō-lē-li-THĪ-a-sis):** The formation or presence of gallstones.
- cholesterol:** A steroid component of cell membranes and a substrate for the synthesis of steroid hormones and bile salts.
- choline:** Chemical compound; a breakdown product or precursor of acetylcholine.
- cholinergic synapse (kō-lin-ER-jik):** Synapse where the presynaptic membrane releases ACh on stimulation.
- cholinesterase (kō-li-NES-te-rās):** Enzyme that breaks down and inactivates ACh.
- chondrocyte (KON-drō-sit):** Cartilage cell.
- chondroitin sulfate (kon-DROY-tin):** The predominant proteoglycan in cartilage, responsible for the gelatinous consistency of the matrix.
- chordae tendineae (KOR-dē TEN-di-nē-ē):** Fibrous cords that brace the AV valves in the heart, stabilizing their position and preventing backflow during ventricular systole.
- chorion/chorionic (KOR-ē-on) (kō-rē-ON-ik):** An extraembryonic membrane, consisting of the trophoblast and underlying mesoderm, that forms the placenta.
- choroid:** Middle, vascular layer in the wall of the eye.
- choroid plexus:** The vascular complex in the roof of the third and fourth ventricles of the brain, responsible for CSF production.
- chromatid (KRŌ-ma-tid):** One complete copy of a DNA strand.
- chromatin (KRŌ-ma-tin):** Histological term referring to the grainy material visible in cell nuclei during interphase; the appearance of the DNA content of the nucleus when the chromosomes are uncoiled.
- chromatophilic substance (krō-mā-tō-FIL-ik):** The ribosomes, Golgi, RER, and mitochondria of the nerve cell body, or perikaryon, of a typical nerve cell; also termed *Nissl bodies*.
- chromosomes:** Dense structures, composed of tightly coiled DNA strands and associated histones, that become visible in the nucleus when a cell prepares to undergo mitosis or meiosis; normal human somatic cells contain 46 chromosomes apiece.
- chronic:** Habitual or long-term.
- chylomicrons (ki-lō-MĪ-kronz):** Relatively large droplets that may contain triglycerides, phospholipids, and cholesterol in association with proteins; synthesized and released by intestinal cells and transported to the venous blood via the lymphoid system.
- chyme (KĪM):** A semifluid mixture of ingested food and digestive secretions that is found in the stomach as digestion proceeds.
- chymotrypsin (ki-mō-TRIP-sin):** A protease found in the small intestine.
- chymotrypsinogen:** Inactive proenzyme secreted by the pancreas that is subsequently converted to chymotrypsin.
- ciliary body:** A thickened region of the choroid that encircles the lens of the eye; it includes the ciliary muscle and the ciliary processes that support the suspensory ligaments of the lens.
- cilium/cilia:** A slender organelle that extends above the free surface of an epithelial cell, and usually undergoes cycles of movement; composed of a basal body and microtubules in a  $9 \times 2$  array.
- circulatory system:** The network of lymphatic and blood vessels involved in the circulation and recirculation of extracellular fluid.
- circumduction (sir-kum-DUK-shun):** A movement at a synovial joint where the distal end of the bone describes a circle, but the shaft does not rotate.
- circumvallate papilla (sir-kum-VAL-ăt pa-PIL-la):** One of the large, dome-shaped papillae on the dorsum of the tongue that form the V that separates the body of the tongue from the root.
- cirrhosis (sir-RŌ-sis):** A liver disorder characterized by the degeneration of hepatocytes and their replacement by connective tissue.
- cisterna (sis-TUR-na):** An expanded chamber.
- clavicle (KLAV-i-kul):** The collarbone.
- cleavage (KLĒV-ij):** Mitotic divisions that follow fertilization of the ovum and lead to the formation of a blastocyst.
- cleavage lines:** Stress lines in the skin that follow the orientation of major bundles of collagen fibers in the dermis.
- climacteric:** Age-related cessation of gametogenesis in the male or female due to reduced sex hormone production.
- clitoris (KLI-to-ris):** A small erectile organ of the female that is the developmental equivalent of the male penis.
- clone:** The production of genetically identical cells.
- clonus (KLŌ-nus):** Rapid cycles of muscular contraction and relaxation.
- clot:** A network of fibrin fibers and trapped blood cells; also called a thrombus.
- clotting factors:** Plasma proteins synthesized by the liver that are essential to the clotting response.
- clotting response:** Series of events that result in the formation of a clot.
- coccygeal ligament:** Fibrous extension of the dura mater and filum terminale; provides longitudinal stabilization to the spinal cord.
- coccyx (KOK-siks):** Terminal portion of the vertebral column, consisting of relatively tiny, fused vertebrae.
- cochlea (KOK-lē-a):** Spiral portion of the bony labyrinth of the inner ear that surrounds the organ of hearing.
- cochlear duct (KOK-lē-ar):** Membranous tube within the cochlea that is filled with endolymph and contains the organ of Corti; also called the *scala media*.
- codon (KŌ-don):** A sequence of three nitrogen bases along an mRNA strand that will specify the location of a single amino acid in a peptide chain.
- coelom (SĒ-lom):** The ventral body cavity, lined by a serous membrane and subdivided during development into the pleural, pericardial, and abdominopelvic (peritoneal) cavities.
- coenzymes (kō-EN-zimz):** Complex organic cofactors, usually structurally related to vitamins.
- cofactors:** Ions or molecules that must be attached to the active site before an enzyme can function; examples include mineral ions and several vitamins.
- colectomy (kō-LEK-tō-mē):** Surgical removal of part or all of the colon.
- colitis:** Inflammation of the colon.
- collagen:** Strong, insoluble protein fiber common in connective tissues.
- collagenous tissues: (ko-LĀ-jin-us):** Dense connective tissues in which collagen fibers are the dominant fiber type; includes dense regular and dense irregular connective tissues.
- collateral ganglion (kō-LĀT-er-al):** A sympathetic ganglion situated in front of the spinal column and separate from the sympathetic chain.
- Colles fracture (KOL-lēz):** Fracture of the distal end of the radius and possibly the ulna, with posterior and dorsal displacement of the distal bone fragments.
- colliculus/colliculi (ko-LIK-ū-lus):** A little mound; in the brain, used to refer to one of the cortical thickenings in the roof of the mesencephalon; the superior colliculus is associated with the visual system, and the inferior colliculi with the auditory system.
- colon:** The large intestine.
- colonoscope (kō-LON-ō-skōp):** A fiber-optic device for examining the interior of the colon.
- colostomy (kō-LOS-tō-mē):** The surgical connection of a portion of the colon to the body wall, sometimes performed after a colectomy to permit the discharge of fecal materials.
- colostrum (kō-LOS-trum):** Secretion of the mammary glands at the time of childbirth and for a few days thereafter; contains more protein and less fat than the milk secreted later.
- coma (KŌ-ma):** An unconscious state from which the individual cannot be aroused, even by strong stimuli.
- comedo (kō-MĒ-dō):** An inflamed sebaceous gland.
- comminuted:** Broken or crushed into small pieces.
- commissure:** A crossing over from one side to another.

## Glossary of Key Terms

- common bile duct:** Duct formed by the union of the cystic duct from the gallbladder and the bile ducts from the liver; terminates at the duodenal ampulla, where it meets the pancreatic duct.
- common pathway:** In the clotting response, the events that begin with the appearance of thromboplastin and end with the formation of a clot.
- compact bone:** Dense bone containing parallel osteons.
- compensation curvatures:** The cervical and lumbar curves that develop to center the body weight over the legs.
- complement:** 11 plasma proteins that interact in a chain reaction following exposure to activated antibodies on the surfaces of certain pathogens, and which promote cell lysis, phagocytosis, and other defense mechanisms.
- compliance:** The ability of certain organs to tolerate changes in volume; a property that reflects the presence of elastic fibers and smooth muscles.
- compound:** A molecule containing two or more elements in combination.
- concentration:** Amount (in grams) or number of atoms, ions, or molecules (in moles) per unit volume.
- conception:** Fertilization.
- concha/conchae (KON-kè):** Three pairs of thin, scroll-like bones that project into the nasal cavities; the superior and medial conchae are part of the ethmoid, and the inferior conchae are separate bones.
- concussion:** A violent blow or shock; loss of consciousness due to a violent blow to the head.
- condyle:** A rounded articular projection on the surface of a bone.
- cone:** Retinal photoreceptor responsible for color vision.
- congenital (kon-JEN-i-tal):** Already present at the birth of an individual.
- congestive heart failure (CHF):** Failure to maintain adequate cardiac output due to circulatory problems or myocardial damage.
- conjunctiva (kon-junk-TĪ-va):** A layer of stratified squamous epithelium that covers the inner surfaces of the lids and the anterior surface of the eye to the edges of the cornea.
- conjunctivitis:** Inflammation of the conjunctiva.
- connective tissue:** One of the four primary tissue types; provides a structural framework for the body that stabilizes the relative positions of the other tissue types; includes connective tissue proper, cartilage, bone, and blood; always has cell products, cells, and ground substance.
- contractility:** The ability to contract, possessed by skeletal, smooth, and cardiac muscle cells.
- contracture:** A permanent contraction of an entire muscle following the atrophy of individual muscle cells.
- contralateral reflex:** A reflex that affects the side of the body opposite the stimulus.
- conus medullaris:** Conical tip of the spinal cord that gives rise to the filum terminale.
- convergence:** In the nervous system, the innervation of a single neuron by the axons from several neurons; this is most common along motor pathways.
- coracoid process (KOR-a-koyd):** A hook-shaped process of the scapula that projects above the anterior surface of the capsule of the shoulder joint.
- Cori cycle:** Metabolic exchange of lactic acid from skeletal muscle for glucose from the liver; performed during the recovery period following muscular exertion.
- cornea (KOR-nè-a):** Transparent portion of the fibrous tunic of the anterior surface of the eye.
- corniculate cartilages (kor-NIK-ù-lăt):** A pair of small laryngeal cartilages.
- cornification:** The production of keratin by a stratified squamous epithelium; also called **keratinization**.
- cornu:** A horn.
- corona radiata (ko-RŌ-na rà-dè-A-ta):** A layer of follicle cells surrounding an oocyte at ovulation.
- coronoid (KOR-ô-noyd):** Hooked or curved.
- corpora quadrigemina (KOR-pô-ra quad-ri-JEM-i-na):** The superior and inferior colliculi of the mesencephalic tectum (roof) in the brain.
- corpus albicans:** The scar tissue that remains after degeneration of the corpus luteum at the end of a uterine cycle.
- corpus callosum:** Bundle of axons linking centers in the left and right cerebral hemispheres.
- corpus cavernosum (KOR-pus ka-ver-NŌ-sum):** Masses of erectile tissue within the body of the penis (male) or clitoris (female).
- corpus/corpora:** Body.
- corpus luteum (LOO-tè-um):** Progesterin-secreting mass of follicle cells that develops in the ovary after ovulation.
- corpus spongiosum (spon-jè-Ō-sum):** Mass of erectile tissue that surrounds the urethra in the penis and expands distally to form the glans.
- cortex:** Outer layer or portion of an organ.
- Corti, organ of:** The spiral organ; a receptor complex in the scala media of the cochlea that includes the inner and outer hair cells, supporting cells and structures, and the tectorial membrane; provides the sensation of hearing.
- corticobulbar tracts (kor-ti-kò-BUL-bar):** Descending tracts that carry information/commands from the cerebral cortex to nuclei and centers in the brain stem.
- corticospinal tracts:** Descending tracts that carry motor commands from the cerebral cortex to the anterior gray horns of the spinal cord.
- corticosteroid:** A steroid hormone produced by the adrenal cortex.
- corticosterone (kor-ti-KOS-te-rôn):** One of the corticosteroids secreted by the zona fasciculata of the suprarenal cortex; a glucocorticoid.
- corticotropin:** See **adrenocorticotrophic hormone (ACTH)**.
- corticotropin-releasing hormone (CRH):** Releasing hormone secreted by the hypothalamus that stimulates secretion of ACTH by the anterior pituitary.
- cortisol (KOR-ti-sol):** One of the corticosteroids secreted by the zona fasciculata of the adrenal cortex; a glucocorticoid.
- costa/costae:** A rib.
- cotransport:** Membrane transport of a nutrient, such as glucose, in company with the movement of an ion, usually sodium; transport requires a carrier protein but does not involve direct ATP expenditure and can occur regardless of the concentration gradient for the nutrient.
- countercurrent multiplication:** Active transport between two limbs of a loop that contains a fluid moving in one direction; responsible for the concentration of the urine in the kidney tubules.
- cranial:** Pertaining to the head.
- cranial nerves:** Peripheral nerves originating at the brain.
- craniosacral division (krá-nè-ô-SA-kral):** See **parasympathetic division**.
- craniostenosis (krá-nè-ô-sten-Ō-sis):** Skull deformity caused by premature closure of the cranial sutures.
- cranium:** The braincase; the skull bones that surround the brain.
- creatine:** A nitrogenous compound synthesized in the body that can bind a high-energy phosphate and serve as an energy reserve.
- creatine phosphate:** A high-energy compound present in muscle cells; during muscular activity the phosphate group is donated to ADP, regenerating ATP.
- creatinine:** A breakdown product of creatine metabolism.
- crenation:** Cellular shrinkage due to an osmotic movement of water out of the cytoplasm.
- cribriform plate:** Portion of the ethmoid of the skull that contains the foramina used by the axons of olfactory receptors en route to the olfactory bulbs of the cerebrum.
- cricoid cartilage (KRĪ-koyd):** Ring-shaped cartilage forming the inferior margin of the larynx.
- crista/cristae:** A ridge-shaped collection of hair cells in the ampulla of a semicircular canal; the crista and cupula form a receptor complex sensitive to movement along the plane of the canal.
- cross-bridge:** Myosin head that projects from the surface of a thick filament, and that can bind to an active site of a thin filament in the presence of calcium ions.
- cruciate ligaments:** A pair of intracapsular ligaments (anterior and posterior) in the knee.
- cryptorchidism (kript-OR-ki-dizm):** The failure of the testes to descend into the inguinal canal during late fetal development.
- cryptorchid testis:** An undescended testis that is in the abdominopelvic cavity rather than the scrotum.
- cuneiform cartilages (kù-NĒ-i-form):** A pair of small cartilages in the larynx.
- cupula (KŪ-pū-la):** A gelatinous mass that sits in the ampulla of a semicircular canal in the inner ear, and whose movement stimulates the hair cells of the crista.
- Cushing's disease:** Condition caused by oversecretion of adrenal steroids.
- cuspid (KUS-pids):** Conical upper teeth with sharp ridges, located in the upper jaw on either side posterior to the second incisor.
- cutaneous membrane:** The epidermis and papillary layer of the dermis.
- cuticle:** Layer of dead, cornified cells surrounding the shaft of a hair; for nails, see **eponychium**.
- cutis:** The skin.
- cyanois:** Bluish coloration of the skin due to the presence of deoxygenated blood in vessels near the body surface.
- cyst:** A fibrous capsule containing fluid or other material.
- cystic duct:** A duct that carries bile between the gallbladder and the common bile duct.
- cystitis:** Inflammation of the urinary bladder.
- cytokinesis (si-tò-ki-NĒ-sis):** The cytoplasmic movement that separates two daughter cells at the completion of mitosis.
- cytology (si-TOL-ò-jè):** The study of cells.
- cytoplasm:** The material between the cell membrane and the nuclear membrane.
- cytoskeleton:** A network of microtubules and microfilaments in the cytoplasm.
- cytosol:** The fluid portion of the cytoplasm.
- cytotoxic:** Poisonous to living cells.
- cytotoxic T cells:** Lymphocytes of the cellular immune response that kill target cells by direct contact or through the secretion of lymphotoxins; also called killer T cells.
- daughter cells:** Genetically identical cells produced by mitosis.
- decebrate:** Lacking a cerebrum.
- decomposition reaction:** A chemical reaction that breaks a molecule into smaller fragments.
- decubitus ulcers:** Ulcers that form where chronic pressure interrupts circulation to a portion of the skin.
- decussate:** To cross over to the opposite side, usually referring to the crossover of the pyramidal tracts on the ventral surface of the medulla oblongata.
- defecation (def-e-KA-shun):** The elimination of fecal wastes.
- deglutition (de-gloo-TISH-un):** Swallowing.
- delta cell:** A pancreatic islet cell that secretes somatostatin.
- dementia:** Loss of mental abilities.
- demyelination:** The loss of the myelin sheath of an axon, usually due to chemical or physical damage to Schwann cells or oligodendrocytes.
- dendrite (DEN-drit):** A sensory process of a neuron.
- denticulate ligaments:** Supporting fibers that extend laterally from the surface of the spinal cord, tying the pia mater to the dura mater and providing lateral support for the spinal cord.
- dentine or dentin (DEN-tin):** Bonelike material that forms the body of a tooth; it differs from bone in lacking osteocytes and osteons.
- deoxyribonucleic acid (DNA) (dè-ok-sè-ri-bò-nù-KLĀ-ik):** DNA strand: a nucleic acid consisting of a chain of nucleotides containing the sugar deoxyribose and the nitrogen bases adenine, guanine, cytosine, and thymine. DNA molecule: two DNA strands wound in a double helix and held together by weak bonds between complementary nitrogen base pairs.
- depolarization:** A change in the transmembrane potential that moves it from a negative value toward 0 millivolts (mV).

## Glossary of Key Terms

- depression:** Inferior (downward) movement of a body part.
- dermatitis:** Inflammation of the skin.
- dermatome:** A sensory region monitored by the dorsal rami of a single spinal segment.
- dermis:** The connective tissue layer beneath the epidermis of the skin.
- desmosomes (DEZ-mō-sōmz):** A cell junction consisting of a thin proteoglycan layer reinforced by a network of intermediate filaments that lock the two cells together.
- detrusor muscle (dē-TROO-sor):** Smooth muscle in the wall of the urinary bladder.
- detumescence (dē-tū-MES-ens):** Loss of a penile erection in the male.
- development:** Growth and the acquisition of increasing structural and functional complexity; includes the period from conception to maturity.
- diabetes insipidus:** Polyuria due to inadequate production of ADH.
- diabetes mellitus (mel-LĪ-tus):** Polyuria and glycosuria, most often due to inadequate production of insulin with resulting elevation of blood glucose levels.
- dialysis:** Diffusion between two solutions of differing solute concentrations across a semipermeable membrane containing pores that permit the passage of some solutes and not others.
- diapedesis (di-a-pe-DE-sis):** Movement of white blood cells through the walls of blood vessels by migration between adjacent endothelial cells.
- diaphragm (DĪ-a-fram):** Any muscular partition; often used to refer to the respiratory muscle that separates the thoracic cavity from the abdominopelvic cavity.
- diaphysis (di-AF-i-sis):** The shaft of a long bone.
- diarrhea (di-a-RE-uh):** Abnormally frequent defecation, associated with the production of unusually fluid feces.
- diarthrosis (di-ar-THRŌ-sis):** A synovial joint.
- diastole (di-AS-tō-lē):** A period of relaxation; may refer to either the atria or the ventricles.
- diastolic pressure:** Pressure measured in the walls of a muscular artery when the left ventricle is in diastole.
- diencephalon (di-en-SEF-a-lon):** A division of the brain that includes the epithalamus, thalamus, and hypothalamus.
- differential count:** The determination of the relative abundance of each type of white blood cell, based on a random sampling of 100 WBCs.
- differentiation:** The gradual appearance of characteristic cellular specializations during development, as the result of gene activation or repression.
- diffusion:** Passive molecular movement from an area of relatively high concentration to an area of relatively low concentration.
- digestion:** The chemical breakdown of ingested materials into simple molecules that can be absorbed by the cells of the digestive tract.
- digestive system:** The digestive tract and associated glands.
- digestive tract:** An internal passageway that begins at the mouth and ends at the anus.
- dilate:** To increase in diameter; to enlarge or expand.
- diploë (DIP-lō-ē):** A layer of spongy bone between the internal and external tables of a flat bone.
- dislocation:** Forceful displacement of an articulating bone to an abnormal position, usually accompanied by damage to tendons, ligaments, the articular capsule, or other structures.
- distal:** Movement away from the point of attachment or origin; for a limb, away from its attachment to the trunk.
- distal convoluted tubule:** Portion of the nephron closest to the collecting tubule and duct; an important site of active secretion.
- diuresis:** Fluid loss at the kidneys; the production of urine.
- divergence:** In neural tissue, the spread of excitation from one neuron to many neurons; an organizational pattern common along sensory pathways of the CNS.
- diverticulitis (di-ver-tik-ū-LĪ-tis):** Inflammation of a diverticulum.
- diverticulosis (di-ver-tik-ū-LŌ-sis):** The formation of diverticula.
- diverticulum:** A sac or pouch in the wall of the colon or other organ.
- dizygotic twins (di-zī-GOT-ik):** Twins that result from the fertilization of two different ova.
- dopamine (DŌ-pah-mēn):** An important neurotransmitter in the CNS.
- dorsal:** Toward the back, posterior.
- dorsal root ganglion:** PNS ganglion containing the cell bodies of sensory neurons.
- dorsiflexion:** Elevation of the superior surface of the foot.
- Down syndrome:** A genetic abnormality resulting from the presence of three copies of chromosome 21; individuals with this condition have characteristic physical and intellectual deficits.
- duct:** A passageway that delivers exocrine secretions to an epithelial surface.
- ductus arteriosus (DUK-tus ar-tē-rē-Ō-sus):** Vascular connection between the pulmonary trunk and the aorta that functions throughout fetal life; normally closes at birth or shortly thereafter, and persists as the ligamentum arteriosum.
- ductus deferens (DUK-tus DEF-e-renz):** A passageway that carries sperm from the epididymis to the ejaculatory duct.
- duodenal ampulla:** Chamber that receives bile from the common bile duct and pancreatic secretions from the pancreatic duct.
- duodenal glands:** See submucosal glands.
- duodenal papilla:** Conical projection from the inner surface of the duodenum that contains the opening of the duodenal ampulla.
- duodenum (doo-o-DE-num):** The proximal 1 ft of the small intestine that contains short villi and submucosal glands.
- dura mater (DOO-ra MĀ-ter):** Outermost component of the meninges that surround the brain and spinal cord.
- dynamic equilibrium:** Maintenance of normal body orientation as sudden changes in position (rotation, acceleration, etc.) occur.
- dyslexia:** Impaired ability to comprehend written words.
- dysmenorrhea:** Painful menstruation.
- dysuria (dis-Ū-rē-a):** Painful urination.
- eccrine glands (EK-rin):** Sweat glands of the skin that produce a watery secretion.
- echocardiography (ek-ō-kar-dē-OG-ra-fē):** Examination of the heart using modified ultrasound techniques.
- ectoderm:** One of the three primary germ layers; covers the surface of the embryo and gives rise to the nervous system, the epidermis and associated glands, and a variety of other structures.
- ectopic (ek-TOP-ik):** Outside of its normal location.
- effector:** A peripheral gland or muscle cell innervated by a motor neuron.
- effluent:** Away from a central receiving area.
- effluent arteriole:** An arteriole carrying blood away from the glomerulus of the kidney.
- effluent fiber:** An axon that carries impulses away from the CNS.
- ejaculation (ē-jak-ū-LĀ-shun):** The ejection of semen from the penis as the result of muscular contractions of the bulbocavernosus and ischiocavernosus muscles.
- ejaculatory duct (ē-JAK-ū-la-tō-rē):** Short ducts that pass within the walls of the prostate and connect the ductus deferens with the prostatic urethra.
- elastase (ē-LAS-tāz):** A pancreatic enzyme that breaks down elastin fibers.
- elastin:** Connective tissue fibers that stretch and rebound, providing elasticity to connective tissues.
- electrocardiogram (ECG, EKG) (ē-lek-trō-KAR-dē-ō-gram):** Graphic record of the electrical activities of the heart, as monitored at specific locations on the body surface.
- electroencephalogram (EEG):** Graphic record of the electrical activities of the brain.
- electrolytes (ē-LEK-trō-lits):** Soluble inorganic compounds whose ions will conduct an electric current in solution.
- electron:** One of the three fundamental particles; a subatomic particle that bears a negative charge and normally orbits around the protons of the nucleus.
- elephantiasis (el-e-fan-TĪ-a-sis):** A lymphedema caused by infection and blockage of lymphatics by mosquito-borne parasites.
- elevation:** Movement in a superior, or upward, direction.
- embolism (EM-bō-lizm):** Obstruction or closure of a vessel by an embolus.
- embolus (EM-bō-lus):** An air bubble, fat globule, or blood clot drifting in the circulation.
- embryo (EM-brē-ō):** Developmental stage beginning at fertilization and ending at the start of the third developmental month.
- embryogenesis (em-brē-ō-JEN-e-sis):** The process of embryo formation.
- embryology (em-brē-OL-o-jē):** The study of embryonic development, focusing on the first two months after fertilization.
- emesis (EM-e-sis):** Vomiting.
- emmetropia:** Normal vision.
- emulsification (ē-mul-si-fi-KĀ-shun):** The physical breakup of fats in the digestive tract, forming smaller droplets accessible to digestive enzymes; normally the result of mixing with bile salts.
- enamel:** Crystalline material similar in mineral composition to bone, but harder and without osteocytes, that covers the exposed surfaces of the teeth.
- encephalitis:** Inflammation of the brain.
- endocarditis:** Inflammation of the endocardium of the heart.
- endocardium (en-dō-KAR-dē-um):** The simple squamous epithelium that lines the heart and is continuous with the endothelium of the great vessels.
- endochondral ossification (en-dō-KON-dral):** The conversion of a cartilaginous model to bone; the characteristic mode of formation for skeletal elements other than the bones of the cranium, the clavicles, and sesamoid bones.
- endocrine gland:** A gland that secretes hormones into the blood.
- endocrine system:** The endocrine glands of the body.
- endocytosis (en-dō-si-TŌ-sis):** The movement of relatively large volumes of extracellular material into the cytoplasm via the formation of a membranous vesicle at the cell surface; includes pinocytosis and phagocytosis.
- endoderm:** One of the three primary germ layers; the layer on the undersurface of the embryonic disc that gives rise to the epithelia and glands of the digestive system, the respiratory system, and portions of the urinary system.
- endogenous:** Produced within the body.
- endolymph (EN-dō-limf):** Fluid contents of the membranous labyrinth (the sacculus, utricle, semicircular ducts, and cochlear duct) of the inner ear.
- endometrial glands:** Secretory glands of the endometrium.
- endometrium (en-dō-MĒ-trē-um):** The mucous membrane lining the uterus.
- endomysium (en-dō-MĪS-ē-um):** A delicate network of connective tissue fibers that surrounds individual muscle cells.
- endoneurium:** A delicate network of connective tissue fibers that surrounds individual nerve fibers.
- endoplasmic reticulum (en-dō-PLAZ-mik re-TIK-ū-lum):** A network of membranous channels in the cytoplasm of a cell that function in intracellular transport, synthesis, storage, packaging, and secretion.
- endorphins (en-DOR-finz):** Neuromodulators produced in the CNS that inhibit activity along pain pathways.
- endosteum:** An incomplete cellular lining found on the inner (medullary) surfaces of bones.
- endothelium (en-dō-THĒ-lē-um):** The simple squamous epithelium that lines blood and lymphatic vessels.

## Glossary of Key Terms

- enkephalins (en-KEF-a-linz):** Neuromodulators produced in the CNS that inhibit activity along pain pathways.
- enteritis (en-ter-I-tis):** Inflammation of the intestinal tract.
- enterocrinin:** A hormone secreted by the duodenal lining when exposed to acid chyme; stimulates the secretion of the duodenal glands.
- enteroendocrine cells (en-ter-ō-EN-dō-krin):** Endocrine cells scattered among the epithelial cells lining the digestive tract.
- enterogastric reflex:** Reflexive inhibition of gastric secretion initiated by the arrival of acid chyme in the small intestine.
- enterohepatic circulation:** Excretion of bile salts by the liver, followed by absorption of bile salts by intestinal cells for return to the liver via the hepatic portal vein.
- enterokinase:** An enzyme in the lumen of the small intestine that activates the proenzymes secreted by the pancreas.
- enzyme:** A protein that catalyzes a specific biochemical reaction.
- eosinophils (ē-ō-SIN-ō-filz):** A granulocyte (WBC) with a lobed nucleus and red-staining granules; participates in the immune response and is especially important during allergic reactions.
- ependyma (ep-EN-di-mah):** Layer of cells lining the ventricles and central canal of the CNS.
- epiblast (EP-i-blast):** The layer of the inner cell mass facing the amniotic cavity prior to gastrulation.
- epicardium:** Serous membrane covering the outer surface of the heart; also called the *visceral pericardium*.
- epidermis:** The epithelium covering the surface of the skin.
- epididymis (ep-i-DID-i-mus):** Coiled duct that connects the rete testis to the ductus deferens; site of functional maturation of spermatozoa.
- epidural block:** Anesthesia caused by the elimination of sensory inputs from dorsal nerve roots following the introduction of drugs into appropriate regions of the epidural space.
- epidural space:** Space between the spinal dura mater and the walls of the vertebral foramen; contains blood vessels and adipose tissue; a frequent site of injection for regional anesthesia.
- epiglottis (ep-i-GLOT-is):** Blade-shaped flap of tissue, reinforced by cartilage, that is attached to the dorsal and superior surface of the thyroid cartilage; it folds over the entrance to the larynx during swallowing.
- epimysium (ep-i-MIS-ē-um):** A dense investment of collagen fibers that surrounds a skeletal muscle, and is continuous with the tendons/aponeuroses of the muscle and with the perimysium.
- epineurium:** A dense investment of collagen fibers that surrounds a peripheral nerve.
- epiphyseal cartilage (e-pi-FI-sē-al):** Cartilaginous region between the epiphysis and diaphysis of a growing bone.
- epiphysis (e-PIF-i-sis):** The end of a long bone.
- epistaxis (ep-i-STAK-sis):** Nosebleed.
- epithelium (e-pi-THĒ-lē-um):** One of the four primary tissue types; a layer of cells that forms a superficial covering or an internal lining of a body cavity or vessel.
- eponychium (ep-ō-NIK-ē-um):** A narrow zone of stratum corneum that extends across the surface of a nail at its exposed base; also called the **cuticle**.
- equational division:** The second meiotic division.
- equilibrium (ē-kwi-LIB-rē-um):** A dynamic state where two opposing forces or processes are in balance.
- erection:** Stiffening of the penis prior to copulation due to the engorgement of the erectile tissues of the corpora cavernosa and the corpus spongiosum.
- erythema (er-i-THĒ-ma):** Redness and inflammation at the surface of the skin.
- erythrocyte (e-RITH-rō-sit):** A red blood cell; an anucleate blood cell containing large quantities of hemoglobin.
- erythrocytosis (e-rith-rō-si-TŌ-sis):** An abnormally large number of erythrocytes in the circulating blood.
- erythropoiesis (e-rith-rō-poy-Ē-sis):** Red blood cell formation.
- erythropoietin (e-rith-rō-POY-e-tin):** Hormone released by tissues, especially the kidneys, exposed to low oxygen concentrations; stimulates hematopoiesis in bone marrow.
- Escherichia coli:*** Normal bacterial resident of the large intestine.
- esophagus:** A muscular tube that connects the pharynx to the stomach.
- estradiol (es-tra-DĪ-ol):** The primary estrogen secreted by ovarian follicles.
- estrogens (ES-trō-jenz):** The dominant sex hormones in females; notably estradiol.
- eupnea (ūp-NĒ-a):** Normal quiet breathing.
- eversion (ē-VER-shun):** A turning outward.
- excitable membranes:** Membranes that conduct action potentials, a characteristic of muscle and nerve cells.
- excretion:** Elimination from the body.
- exocrine gland:** A gland that secretes onto the body surface or into a passageway connected to the exterior.
- exocytosis (eks-ō-si-TŌ-sis):** The ejection of cytoplasmic materials by fusion of a membranous vesicle with the cell membrane.
- expiration:** Exhalation; breathing out.
- expiratory reserve:** The amount of additional air that can be voluntarily moved out of the respiratory tract after a normal tidal expiration.
- extension:** An increase in the angle between two articulating bones; the opposite of flexion.
- extensor retinaculum (ret-i-NAK-ū-lum):** A thickening of the fascia of the forearm at the wrist or the leg at the ankle, forming a band of dense connective tissue that holds extensor muscle tendons in place.
- external acoustic meatus:** Passageway in the temporal bone that leads to the tympanic membrane.
- external ear:** The auricle, external acoustic meatus, and tympanic membrane.
- external nares:** The nostrils; the external openings into the nasal cavity.
- exteroceptors:** Sensory receptors in the skin, mucous membranes, and special sense organs that provide information about the external environment and our position within it.
- extracellular fluid:** All body fluid other than that contained within cells; includes plasma and interstitial fluid.
- extraembryonic membranes:** The yolk sac, amnion, chorion, and allantois.
- extrafusal fibers:** Contractile muscle fibers, as opposed to the sensory intrafusal fibers (muscle spindles).
- extrinsic pathway:** Clotting pathway that begins with damage to blood vessels or surrounding tissues and ends with the formation of tissue thromboplastin.
- fabella:** A sesamoid bone often found in the tendon of the lateral head of the gastrocnemius muscle.
- facilitated diffusion:** Passive movement of a substance across a cell membrane via a protein carrier.
- facilitation:** Depolarization of a neuron cell membrane toward threshold, or making the cell more sensitive to depolarizing stimuli.
- falciform ligament (FAL-si-form):** A sheet of mesentery that contains the ligamentum teres, the fibrous remains of the umbilical vein of the fetus.
- falx (falks):** Sickle-shaped.
- falx cerebri (falks ser-Ē-brē):** Curving sheet of dura mater that extends between the two cerebral hemispheres; encloses the superior sagittal sinus.
- fascia (FASH-a):** Connective tissue fibers, primarily collagenous, that form sheets or bands beneath the skin to attach, stabilize, enclose, and separate muscles and other internal organs.
- fasciculus (fa-SIK-ū-lus):** A small bundle, usually referring to a collection of nerve axons or muscle fibers.
- fatty acids:** Hydrocarbon chains ending in a carboxyl group.
- fauces (FAW-sēz):** The passage from the mouth to the pharynx, bounded by the palatal arches, the soft palate, and the uvula.
- feces:** Waste products eliminated by the digestive tract at the anus; contain indigestible residue, bacteria, mucus, and epithelial cells.
- fenestra:** An opening.
- fenestrated (FEN-es-trāt-ed):** Having multiple openings; used when referring to very permeable capillaries whose endothelial cells are penetrated by pores of varying sizes.
- fertilization:** Fusion of egg and sperm to form a zygote.
- fetus:** Developmental stage lasting from the start of the third developmental month to delivery.
- fibrillation (fi-bri-LĀ-shun):** Uncoordinated contractions of individual muscle cells that impair or prevent normal function.
- fibrin (FĪ-brin):** Insoluble protein fibers that form the basic framework of a blood clot.
- fibrinogen (fi-BRIN-ō-jen):** Plasma proteins that can be converted by the action of enzymes into insoluble strands of fibrin that form the basis for a blood clot.
- fibrinolysis (fi-brin-OL-i-sis):** The breakdown of the fibrin strands of a blood clot by a proteolytic enzyme.
- fibroblasts (FĪ-brō-blasts):** Cells of connective tissue proper that are responsible for the production of extracellular fibers and the secretion of the organic compounds of the extracellular matrix.
- fibrocytes (FĪ-brō-sits):** Cells of connective tissue proper that are responsible for the maintenance of the extracellular fibers and ground substance of the extracellular matrix.
- fibrous cartilage:** Cartilage containing an abundance of collagen fibers; found around the edges of joints, in the intervertebral discs, the menisci of the knee, etc. Also termed *fibrocartilage*.
- fibrous tunic:** The outermost layer of the eye, composed of the sclera and cornea.
- fibula (FIB-ū-la):** The lateral, relatively small bone of the lower leg.
- filariasis (fil-a-RĪ-a-sis):** Condition resulting from infection by mosquito-borne parasites; may cause elephantiasis.
- filiform papillae:** Slender conical projections from the dorsal surface of the anterior two-thirds of the tongue.
- filtrate:** Fluid produced by filtration at a glomerulus in the kidney.
- filtration:** Movement of a fluid across a membrane whose pores restrict the passage of solutes on the basis of size.
- filum terminale:** A fibrous extension of the spinal cord that extends from the conus medullaris to the coccygeal ligament.
- fimbriae (FIM-brē-ē):** A fringe; used to describe the fingerlike processes that surround the entrance to the uterine tube.
- fissure:** An elongated groove or opening.
- fistula:** An abnormal passageway between two organs or from an internal organ or space to the body surface.
- flaccid:** Limp, soft, flabby; a muscle without muscle tone.
- flagellum/flagella (fla-JEL-ah):** An organelle structurally similar to a cilium, but used to propel a cell through a fluid.
- flatus:** Intestinal gas.
- flexion (FLEK-shun):** A movement at a joint that reduces the angle between two articulating bones; the opposite of extension.
- flexor:** A muscle that produces flexion.
- flexor reflex:** A reflex contraction of the flexor muscles of a limb in response to an unpleasant stimulus.
- flexure:** A bending.
- fluoroscope:** An instrument that permits the examination of the body with x-rays in real time, rather than via fixed images on photographic plates.
- folia (FO-lē-a):** Leaflike folds; used in reference to the slender folds in the surface of the cerebellar cortex.
- follicle (FOL-i-kl):** A small secretory sac or gland.

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- follicle-stimulating hormone (FSH):** A hormone secreted by the anterior pituitary; stimulates oogenesis (female) and spermatogenesis (male).
- folliculitis (fo-lik-ū-LĪ-tis):** Inflammation of a follicle, such as a hair follicle of the skin.
- fontanel (fon-tah-NEL):** A relatively soft, flexible, fibrous region between two flat bones in the developing skull.
- foramen:** An opening or passage through a bone.
- forearm:** Distal portion of the upper limb between the elbow and wrist.
- forebrain:** The cerebrum.
- fornix (FOR-niks):** An arch, or the space bounded by an arch; in the brain, an arching tract that connects the hippocampus with the mammillary bodies; in the eye, a slender pocket found where the epithelium of the ocular conjunctiva folds back upon itself as the palpebral conjunctiva.
- fossa:** A shallow depression or furrow in the surface of a bone.
- fourth ventricle:** An elongate ventricle of the metencephalon (pons and cerebellum) and the myelencephalon (medulla) of the brain; the roof contains a region of choroid plexus.
- fovea (FŌ-vē-a):** Portion of the retina providing the sharpest vision, with the highest concentration of cones; also called the **macula lutea**.
- fracture:** A break or crack in a bone.
- frenulum (FREN-ū-lum):** A bridle; *see* **lingual frenulum**.
- frontal plane:** A sectional plane that divides the body into anterior and posterior portions.
- fructose:** A hexose (simple sugar containing six carbons) found in foods and in semen.
- fundus (FUN-dus):** The base of an organ.
- fungiform papillae:** Mushroom-shaped papillae on the dorsal and dorsolateral surfaces of the tongue.
- furuncle (FÜR-ung-kl):** A boil, resulting from the invasion and inflammation of a hair follicle or sebaceous gland.
- gallbladder:** Pear-shaped reservoir for the bile secreted by the liver.
- gametes (GAM-êts):** Reproductive cells (sperm or eggs) that contain one-half of the normal chromosome complement.
- gametogenesis (ga-mē-tō-JEN-e-sis):** The formation of gametes.
- gamma aminobutyric acid (GABA) (GAM-ma a-ME-nō-bū-TIR-ik):** A neurotransmitter of the CNS whose effects are usually inhibitory.
- gamma motor neurons:** Motor neurons that adjust the sensitivities of muscle spindles (intrafusal fibers).
- ganglion/ganglia:** A collection of nerve cell bodies outside the CNS.
- gap junctions:** Connections between cells that permit electrical coupling.
- gaster (GAS-ter):** The stomach; the body or belly of a skeletal muscle.
- gastrectomy (gas-TREK-tō-mē):** Partial or total surgical removal of the stomach.
- gastric:** Pertaining to the stomach.
- gastric glands:** Tubular glands of the stomach whose cells produce acid, enzymes, intrinsic factor, and hormones.
- gastrin (GAS-trin):** Hormone produced by enteroendocrine cells of the stomach, when exposed to mechanical stimuli or vagal stimulation, and the duodenum, when exposed to chyme containing undigested proteins.
- gastritis (gas-TRĪ-tis):** Inflammation of the stomach.
- gastroenteric reflex (gas-trō-en-TER-ik):** An increase in peristalsis along the small intestine triggered by the arrival of food in the stomach.
- gastroileal reflex (gas-trō-IL-ē-al):** Peristaltic movements that shift materials from the ileum to the colon, triggered by the arrival of food in the stomach.
- gastrointestinal (GI) tract:** An internal passageway that begins at the mouth, ends at the anus, and is lined by a mucous membrane; also known as the digestive tract.
- gastroscope:** A fiber-optic instrument that permits visual inspection of the stomach lining.
- gastrulation (gas-troo-LĀ-shun):** The movement of cells of the inner cell mass that creates the three primary germ layers of the embryo.
- gene:** A portion of a DNA strand that functions as a hereditary unit and is found at a particular locus on a specific chromosome.
- genetic engineering:** Research and experiments involving the manipulation of the genetic makeup of an organism.
- genetics:** The study of mechanisms of heredity.
- geniculate (je-NĪK-ū-lāt):** Like a little knee; the medial geniculate nuclei and the lateral geniculate nuclei are thalamic nuclei in the walls of the thalamus of the brain.
- genitalia (jen-i-TĀ-lē-a):** Reproductive organs.
- genotype (JĒN-ō-tip):** The genetic complement of a particular individual.
- germinal centers:** Pale regions in the interior of lymphoid tissues or nodules, where mitoses are under way.
- gestation (jes-TĀ-shun):** The period of intrauterine development.
- gingivae (JIN-ji-vē):** The gums.
- gingivitis:** Inflammation of the gums.
- gland:** Cells that produce exocrine or endocrine secretions, derived from epithelia.
- glans penis:** Expanded tip of the penis that surrounds the urethra meatus; continuous with the corpus spongiosum.
- glaucoma:** Eye disorder characterized by rising intraocular pressures due to inadequate drainage of aqueous humor at the canal of Schlemm.
- glenoid cavity:** A rounded depression that forms the articular surface of the scapula at the shoulder joint.
- glial cells (GLĒ-al):** Supporting cells in the neural tissue of the CNS and PNS.
- globular proteins:** Proteins whose tertiary structure makes them rounded and compact.
- globulins (GLOB-ū-linz):** Globular plasma proteins with a variety of important functions.
- glomerular capsule:** Expanded initial portion of the nephron that surrounds the glomerulus.
- glomerulonephritis (glō-mer-ū-lō-nef-RĪ-tis):** Inflammation of the glomeruli of the kidneys.
- glomerulus (glō-MER-ū-lus):** A ball or knot; in the kidneys, a knot of capillaries that projects into the enlarged, proximal end of a nephron; the site where filtration occurs, the first step in the production of urine.
- glossopharyngeal nerve (glos-ō-fah-RIN-jē-al):** Cranial nerve IX.
- glottis (GLOT-is):** The passage from the pharynx to the larynx.
- glucagon (GLOO-ka-gon):** Hormone secreted by the alpha cells of the pancreatic islets; elevates blood glucose concentrations.
- glucocorticoids (gloo-kō-KOR-ti-kōyds):** Hormones secreted by the zona fasciculata of the adrenal cortex to modify glucose metabolism; cortisol and corticosterone are important examples.
- glucose (GLOO-kōs):** A six-carbon sugar, C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>; the preferred energy source for most cells and the only energy source for neurons under normal conditions.
- glucose-dependent insulinotropic hormone (GIP):** A duodenal hormone released when the arriving chyme contains large quantities of carbohydrates; triggers the secretion of insulin and a slowdown in gastric activity.
- glycerides:** Lipids composed of glycerol bound to 1–3 fatty acids.
- glycogen (GLĪ-kō-jen):** A polysaccharide that represents an important energy reserve; a polymer consisting of a long chain of glucose molecules.
- glycolipids (gli-cō-LIP-idz):** Compounds created by the combination of carbohydrate and lipid components.
- glycoprotein (gli-kō-PRŌ-tĕn):** A compound containing a relatively small carbohydrate group attached to a large protein.
- glycosuria (gli-cō-SŪ-rē-a):** The presence of glucose in the urine.
- goblet cell:** A goblet-shaped, mucus-producing, unicellular gland found in certain epithelia of the digestive tract.
- goiter:** Enlargement of the thyroid gland.
- Golgi apparatus (GŌL-jē):** Cellular organelle consisting of a series of membranous plates that give rise to lysosomes and secretory vesicles.
- Golgi tendon organ:** *See* **tendon organ**.
- gomphosis (gom-FŌ-sis):** A fibrous synarthrosis that binds a tooth to the bone of the jaw; *see* **periodontal ligament**.
- gonadotropic hormones:** FSH and LH, hormones that stimulate gamete development and sex hormone secretion.
- gonadotropin-releasing hormone (GnRH) (gō-nad-ō-TRŌ-pin):** Hypothalamic releasing hormone that causes the secretion of FSH and LH by the anterior pituitary gland.
- gonadotropins (gō-nad-ō-TRŌ-pinz):** Hormones that stimulate the gonads (testes or ovaries).
- gonads (GŌ-nadz):** Organs that produce gametes and hormones.
- gout:** Clinical condition resulting from elevated uric acid concentrations in the blood and peripheral tissues.
- granulocytes (GRAN-ū-lō-sits):** White blood cells containing granules visible with the light microscope; includes eosinophils, basophils, and neutrophils; also called granular leukocytes.
- gray matter:** Areas in the central nervous system dominated by nerve cell bodies, glial cells, and unmyelinated axons.
- gray ramus:** A bundle of postganglionic sympathetic nerve fibers that go to a spinal nerve for distribution to effectors in the body wall, skin, and extremities.
- greater omentum:** A large fold of the dorsal mesentery of the stomach that hangs in front of the intestines.
- greater vestibular glands:** Mucous glands in the vaginal walls that secrete into the vestibule; the equivalent of the bulbo-urethral glands of the male.
- greenstick fracture:** A fracture most often affecting the long bones of young children.
- groin:** The inguinal region.
- gross anatomy:** The study of the structural features of the human body without the aid of a microscope.
- growth hormone (GH):** Anterior pituitary hormone that stimulates tissue growth and anabolism when nutrients are abundant, and restricts tissue glucose dependence when nutrients are in short supply.
- gustation (gus-TĀ-shun):** Taste.
- gynecologists (gi-ne-KOL-ō-jists):** Physicians specializing in the pathology of the female reproductive system.
- gyrus (JĪ-rus):** A prominent fold or ridge of neural cortex on the surfaces of the cerebral hemispheres.
- hair:** A keratinous strand produced by epithelial cells of the hair follicle.
- hair cells:** Sensory cells of the inner ear.
- hair follicle:** An accessory structure of the integument; a tube lined by a stratified squamous epithelium that begins at the surface of the skin and ends at the hair papilla.
- hair root:** A thickened, conical structure consisting of a connective tissue papilla and the overlying matrix; a layer of epithelial cells that produces the hair shaft.
- hallux:** The great toe.
- haploid (HAP-loid):** Possessing one-half of the normal number of chromosomes; a characteristic of gametes.
- hard palate:** The bony roof of the oral cavity, formed by the maxillary and palatine bones.
- haustra (HAWS-tra):** Saclike pouches along the length of the large intestine that result from tension in the taeniae coli.
- Haversian system:** *See* **osteon**.
- heart block:** A cardiac arrhythmia due to conduction delays that affect communication between the atria and ventricles.

## Glossary of Key Terms

- Heimlich maneuver (HIM-lik):** A technique for removing an airway blockage by external compression of the abdomen and forceful elevation of the diaphragm.
- helper T cells:** Lymphocytes (T cells) whose secretions and other activities coordinate the cellular and humoral immune responses.
- hematocrit (hē-MA-tō-krit):** Percentage of the volume of whole blood contributed by cells; also called the packed cell volume (PCV) or the volume of packed red cells (VPRC).
- hematologists (hē-ma-TOL-ō-jists):** Specialists in disorders of the blood and blood-forming tissues.
- hematoma:** A tumor or swelling filled with blood.
- hematuria (hē-ma-TŪ-rē-a):** The presence of abnormal numbers of red blood cells in the urine.
- heme (hēm):** A porphyrin ring containing a central iron atom that can reversibly bind oxygen molecules; a component of the hemoglobin molecule.
- hemiplegia:** Paralysis affecting one side of the body (arm, trunk, and leg).
- hemodialysis (hē-mō-dī-AL-i-sis):** Dialysis of the blood.
- hemoglobin (HE-mō-glō-bin):** Protein composed of four globular subunits, each bound to a single molecule of heme; the protein found in red blood cells that gives them the ability to transport oxygen in the blood.
- hemolysis:** Breakdown (lysis) of red blood cells.
- hemophilia (hē-mō-FĒL-ē-a):** A congenital condition resulting from the inadequate synthesis of one of the clotting factors.
- hemopoiesis (hē-mō-poy-Ē-sis):** Blood cell formation and differentiation.
- hemorrhage:** Blood loss.
- hemorrhoids (HEM-ō-roidz):** Swollen, varicose veins that protrude from the walls of the rectum and/or anal canal.
- hemostasis:** The cessation of bleeding.
- hemothorax:** The entry of blood into one of the pleural cavities.
- heparin (HEP-a-rin):** An anticoagulant released by activated basophils and mast cells.
- hepatic duct:** Duct carrying bile away from the liver lobes and toward the union with the cystic duct.
- hepatic portal vein:** Vessel that carries blood between the intestinal capillaries and the sinusoids of the liver.
- hepatitis (hep-a-TĪ-tis):** Inflammation of the liver, resulting from exposure to toxic chemicals, drugs, or viruses.
- hepatocyte (he-PAT-ō-sit):** A liver cell.
- hernia:** The protrusion of a loop or portion of a visceral organ through the abdominopelvic wall or into the thoracic cavity.
- herniated disc:** Rupture of the connective tissue sheath of the nucleus pulposus of an intervertebral disc.
- heterotopic:** Ectopic; outside of its normal location.
- heterozygous (het-er-ō-ZI-gus):** Possessing two different alleles at corresponding loci on a chromosome pair; the individual's phenotype may be determined by one or both of the alleles.
- hexose:** A six-carbon simple sugar.
- hiatus (hī-Ā-tus):** A gap, cleft, or opening.
- hilum (HĪ-lum) or hilus (HĪ-lus):** A localized region where blood vessels, lymphatics, nerves, and/or other anatomical structures are attached to an organ.
- hippocampus:** A portion of the limbic system that is concerned with the organization and storage of memories.
- hirsutism (HER-sut-izm):** Excessive hair growth in women that follows the distribution pattern typical of adult males; sometimes caused by the overproduction of androgens.
- histamine (HIS-ta-mēn):** Chemical released by stimulated mast cells or basophils to initiate or enhance an inflammatory response.
- histology (his-TOL-ō-jē):** The study of tissues.
- histones:** Proteins associated with the DNA of the nucleus, and around which the DNA strands are wound.
- holocrine secretion (HÖL-ō-krin):** Form of exocrine secretion where the secretory cell becomes swollen with vesicles and then ruptures.
- homeostasis (hō-mē-ō-STA-sis):** The maintenance of a relatively constant internal environment.
- homologous chromosomes (hō-MOL-ō-gus):** The members of a chromosome pair, each containing the same gene loci.
- homozygous (hō-mō-ZĪ-gus):** Having the same gene for a particular character on two homologous chromosomes.
- hormone:** A compound secreted by one cell that travels through the circulatory system to affect the activities of cells in another portion of the body.
- human chorionic gonadotropin (HCG):** Placental hormone that maintains the corpus luteum for the first three months of pregnancy.
- human immunodeficiency virus (HIV):** The infectious agent that causes **acquired immune deficiency syndrome (AIDS)**.
- human leukocyte antigen (HLA):** Antigens on cell surfaces important to foreign antigen recognition and that play a role in the coordination and activation of the immune response.
- human placental lactogen (HPL):** Placental hormone that stimulates the functional development of the mammary glands.
- humoral immunity:** Immunity resulting from the presence of circulating antibodies produced by plasmocytes.
- hyaline cartilage (HĪ-a-lin):** The most common type of cartilage; the matrix contains collagen fibers. Examples include the connections between the ribs and sternum, the tracheal and bronchial cartilages, and synovial cartilages.
- hyaluronic acid or hyaluronan:** A proteoglycan in the matrix of many connective tissues that gives the matrix a viscous consistency; also functions as intercellular cement.
- hyaluronidase (hī-a-lŭr-ON-a-dāz):** An enzyme that breaks down hyaluronic acid; produced by some bacteria and found in the acrosomal cap of a sperm cell.
- hydrocephalus:** Condition resulting from excessive production or inadequate drainage of cerebrospinal fluid.
- hydrostatic pressure:** Fluid pressure.
- hymen:** A membrane that forms during development, covering the entrance to the vagina.
- hypercapnia (hī-per-KAP-nē-a):** High plasma carbon dioxide concentrations, often the result of hypoventilation or inadequate tissue perfusion.
- hyperglycemia:** Elevated plasma glucose concentrations.
- hyperopia:** The farsighted condition, characterized by an inability to focus on objects close by.
- hyperplasia:** Abnormal enlargement of an organ due to an increase in the number of cells.
- hyperpnea (hī-perp-NĒ-a):** Abnormal increases in the rate and depth of respiration.
- hyperreflexia:** Abnormally exaggerated reflex responses to stimulation.
- hypersecretion:** Overactivity of glands that produce exocrine or endocrine secretions.
- hypertension:** Abnormally high blood pressure.
- hyperthermia:** Excessively high body temperature.
- hyperthyroidism:** Excessive production of thyroid hormones.
- hypertonic:** When comparing two solutions, used to refer to the solution with the higher osmolarity.
- hypertrophy (hī-PER-trō-fē):** Increase in the size of tissue without cell division.
- hyperventilation (hī-per-ven-ti-LĀ-shun):** A rate of respiration sufficient to reduce the plasma  $P_{CO_2}$  to levels below normal.
- hypoblast (HĪ-pō-blast):** The undersurface of the inner cell mass that faces the blastocoele of the early embryo.
- hypocapnia:** Abnormally low plasma  $P_{CO_2}$  usually the result of hyperventilation.
- hypodermic needle:** A needle inserted through the skin to introduce drugs into the subcutaneous layer.
- hypodermis:** The subcutaneous layer, a region of loose connective tissue also called the **superficial fascia**.
- hyposthesia:** Abnormally decreased sensitivity to stimuli.
- hypoglossal nerve:** N XII, the cranial nerve responsible for the control of the muscles that move the tongue.
- hyponychium (hī-pō-NĪK-Ē-um):** A thickening in the epidermis beneath the free edge of a nail.
- hypophyseal portal system (hī-pō-FIZ-ē-al):** Network of vessels that carry blood from capillaries in the hypothalamus to capillaries in the anterior lobe of the pituitary gland (hypophysis).
- hypophysis (hī-POF-i-sis):** The anterior lobe of the pituitary gland, which can be further subdivided into the pars distalis and the pars intermedia.
- hyporeflexia:** Abnormally depressed reflex responses to stimuli.
- hyposecretion:** Abnormally low rates of exocrine or endocrine secretion.
- hypothalamus:** The floor of the diencephalon; region of the brain containing centers involved with the unconscious regulation of visceral functions, emotions, drives, and the coordination of neural and endocrine functions.
- hypotonic:** When comparing two solutions, used to refer to the one with the lower osmolarity.
- hypoventilation:** A respiratory rate insufficient to keep plasma  $P_{CO_2}$  within normal levels.
- hypovolemic (hī-pō-vō-LE-mik):** An abnormally low blood volume.
- hypoxia (hī-POKS-ē-a):** Low tissue oxygen concentrations.
- ileocecal valve (ī-ē-ō-SĒ-kal):** A fold of mucous membrane that guards the connection between the ileum and the cecum.
- ileostomy (ī-ē-OS-tō-mē):** Surgical creation of an opening into the ileum; the opening created when the ileum is surgically attached to the abdominal wall.
- ileum (īL-ē-um):** The last 8 ft of the small intestine.
- ilium (īL-ē-um):** The largest of the three bones whose fusion creates a coxa.
- immunity:** Resistance to injuries and diseases caused by foreign compounds, toxins, and pathogens.
- immunization:** Developing immunity by the deliberate exposure to antigens under conditions that prevent the development of illness but stimulate the production of memory B cells.
- immunoglobulin (ī-mū-nō-GLOB-ū-lin):** A circulating antibody.
- implantation (im-plan-TĀ-shun):** The erosion of a blastocyst into the uterine wall.
- impotence:** Inability to obtain or maintain an erection in the male.
- incisors (in-SĪ-zerz):** Two pairs of flattened, blade-like teeth located at the front of the dental arches in both the upper and lower jaws.
- inclusions:** Aggregations of insoluble pigments, nutrients, or other materials in the cytoplasm.
- incontinence (in-KON-ti-nens):** Inability to voluntarily control micturition (or defecation).
- incus (IN-kus):** The central auditory ossicle, situated between the malleus and the stapes in the middle ear cavity.
- infarct:** An area of dead cells resulting from an interruption of circulation.
- infection:** Invasion and colonization of body tissues by pathogenic organisms.
- inferior:** A directional reference meaning below.
- inferior vena cava:** The vein that carries blood from the parts of the body below the heart to the right auricle.
- infertility:** Inability to conceive.
- inflammation:** A nonspecific defense mechanism that operates at the tissue level, characterized by swelling, redness, warmth, pain, and some loss of function.
- inflation reflex:** A reflex mediated by the vagus nerve that prevents overexpansion of the lungs.

## Glossary of Key Terms

- infundibulum (in-fun-DIB-ū-lum):** A tapering, funnel-shaped structure; in the nervous system, refers to the connection between the pituitary gland and the hypothalamus; the infundibulum of the uterine tube is the entrance bounded by fimbriae that receives the ova at ovulation.
- ingestion:** The introduction of materials into the digestive tract via the mouth.
- inguinal canal:** A passage through the abdominal wall that marks the path of testicular descent, and that contains the testicular arteries, veins, and ductus deferens.
- inguinal region:** The area near the junction of the trunk and the thighs that contains the external genitalia.
- inhibin (in-HIB-in):** A hormone produced by the sustentacular cells that inhibits the pituitary secretion of FSH.
- initial segment:** The proximal portion of the axon, adjacent to the axon hillock, where an action potential first appears.
- injection:** Forcing of fluid into a body part or organ.
- inner cell mass:** Cells of the blastocyst that will form the body of the embryo.
- inner ear:** See **internal ear**.
- innervation:** The distribution of sensory and motor nerves to a specific region or organ.
- insertion:** Point of attachment of a muscle that is more movable.
- insoluble:** Incapable of dissolving in solution.
- insomnia:** Sleep disorder characterized by an inability to fall asleep.
- inspiration:** Inhalation; the movement of air into the respiratory system.
- inspiratory reserve:** The maximum amount of air that can be drawn into the lungs over and above the normal tidal volume.
- insula (IN-sū-la):** A region of the temporal lobe that is visible only after opening the lateral sulcus.
- insulin (IN-su-lin):** Hormone secreted by the beta cells of the pancreatic islets; causes a reduction in plasma glucose concentrations.
- integument (in-TEG-ū-ment):** The skin and associated organs (hair, glands, receptors, etc.).
- intercalated discs (in-TER-ka-lā-ted):** Regions where adjacent cardiocytes interlock and where gap junctions permit electrical coupling between the cells.
- intercellular cement:** Proteoglycans, containing the polysaccharide hyaluronic acid, found between adjacent epithelial cells.
- intercellular fluid:** See **interstitial fluid**.
- interdigitate:** To interlock.
- interferons (in-ter-FER-ons):** Peptides released by virally infected cells, especially lymphocytes, that make other cells more resistant to viral infection and slow viral replication.
- interleukins (in-ter-LOO-kins):** Peptides released by activated monocytes and lymphocytes that assist in the coordination of the cellular and humoral immune responses.
- internal capsule:** Term given to the appearance of the white matter of the cerebral hemispheres on gross dissection of the brain.
- internal ear:** The membranous labyrinth that contains the organs of hearing and equilibrium.
- internal nares:** The entrance to the nasopharynx from the nasal cavity.
- internal respiration:** Diffusion of gases between the blood and interstitial fluid.
- interneuron:** Neurons inside the CNS that are interposed between sensory and motor neurons.
- internode:** See **myelin sheath gap**. Area between adjacent glial cells where the myelin covering of an axon is incomplete. Also termed a *node of Ranvier*.
- interoceptors:** Sensory receptors monitoring the functions and status of internal organs and systems.
- interosseous membrane:** Fibrous connective tissue membrane between the shafts of the tibia and fibula or the radius and ulna; an example of a fibrous amphiarthrosis.
- interphase:** Stage in the life of a cell during which the chromosomes are uncoiled and all normal cellular functions except mitosis are under way.
- intersegmental reflex:** A reflex that involves several segments of the spinal cord.
- interstitial cell-stimulating hormone:** An alternative name for LH in the male; stimulates androgen production by the interstitial cells of the testes.
- interstitial fluid (in-ter-STISH-al):** Fluid in the tissues that fills the spaces between cells.
- interstitial growth:** Form of cartilage growth through the growth, mitosis, and secretion of chondrocytes inside the matrix.
- interventricular foramen:** The opening that permits fluid movement between the lateral and third ventricles.
- intervertebral disc:** Fibrous cartilage pad between the centra of successive vertebrae that acts as a shock absorber.
- intestinal crypt:** A tubular epithelial pocket lined by secretory cells and opening into the lumen of the digestive tract; also called an intestinal gland.
- intestine:** Tubular organ of the digestive tract.
- intracellular fluid:** The cytosol.
- intrafusal fibers:** Muscle spindle fibers.
- intramembranous ossification (in-tra-MEM-bra-nus):** The formation of bone within a connective tissue without the prior development of a cartilaginous model.
- intramuscular injection:** Injection of medication into the bulk of a skeletal muscle.
- intraocular pressure:** The hydrostatic pressure exerted by the aqueous humor of the eye.
- intrapleural pressure:** The pressure measured in a pleural cavity; also called the intrathoracic pressure.
- intrapulmonary pressure (in-tra-PUL-mō-ner-ē):** The pressure measured in an alveolus; also called the intralveolar pressure.
- intrauterine:** Within the uterus; used to refer to the period of prenatal development.
- intrinsic factor:** Glycoprotein secreted by the parietal cells of the stomach that facilitates the intestinal absorption of vitamin B<sub>12</sub>.
- inversion:** A turning inward.
- in vitro:** Outside of the body, in an artificial environment.
- in vivo:** In the living body.
- involuntary:** Not under conscious control.
- ion:** An atom or molecule bearing a positive or negative charge due to the acceptance or donation of an electron.
- ipsilateral:** A reflex response affecting the same side as the stimulus; referring to the same side of the body.
- iris:** A contractile structure made up of smooth muscle that forms the colored portion of the eye.
- ischemia (is-KĒ-mē-a):** Inadequate blood supply to a region of the body.
- ischium (IS-kē-um):** One of the three bones whose fusion creates the coxa.
- islets of Langerhans:** See **pancreatic islets**.
- isometric contraction:** A muscular contraction characterized by rising tension production but no change in length.
- isotonic:** A solution having an osmolarity that does not result in water movement across cell membranes; of the same contractive strength.
- isotonic contraction:** A muscular contraction during which tension climbs and then remains stable as the muscle shortens.
- isthmus (IS-mus):** A narrow band of tissue connecting two larger masses.
- jaundice (JAWN-dis):** Condition characterized by yellowing of connective tissues due to elevated tissue bilirubin levels; usually associated with damage to the liver or biliary system.
- jejunum (je-JOO-num):** The middle portion of the small intestine.
- joint:** An area where adjacent bones interact; an articulation.
- juxtaglomerular cells:** Modified smooth muscle cells in the walls of the afferent and efferent arterioles adjacent to the glomerulus and the macula densa.
- juxtaglomerular complex or juxtaglomerular apparatus:** The macula densa, mesangial, and juxtaglomerular cells; a complex responsible for the release of renin and erythropoietin.
- juxtamedullary nephrons:** The 15 percent of nephrons whose nephron loops, or loops of Henle, extend into the medulla; these nephrons are responsible for creating the osmotic gradient within the medulla.
- karyotyping (KAR-ē-ō-ti-ping):** The determination of the chromosomal characteristics of an individual or cell.
- keratin (KER-a-tin):** Tough, fibrous protein component of nails, hair, calluses, and the general integumentary surface.
- keratinization (KER-a-tin-i-zā-shun):** The production of keratin by epithelial cells.
- keratinized (KER-a-tin-izd):** Containing large quantities of keratin.
- keratohyalin (ker-a-tō-HĪ-a-lin):** A protein within maturing keratinocytes.
- ketone bodies:** Keto acids produced during the catabolism of lipids and ketogenic amino acids; specifically acetone, acetoacetate, and beta-hydroxybutyrate.
- kidney:** A component of the urinary system; an organ functioning in the regulation of plasma composition, including the excretion of wastes and the maintenance of normal fluid and electrolyte balance.
- killer T cells:** See **cytotoxic T cells**.
- Kupffer cells (KOOP-fer):** Stellate cells of the liver; phagocytic cells of the liver sinusoids.
- kyphosis (ki-FŌ-sis):** Exaggerated thoracic curvature.
- labia (LĀ-bē-a):** Lips; labia majora and minora are components of the female external genitalia.
- labrum:** A lip or rim.
- labyrinth:** A maze of passageways; usually refers to the structures of the inner ear.
- lacrimal gland (LAK-ri-mal):** Tear gland on the dorsolateral surface of the eye.
- lactase:** An enzyme that breaks down a disaccharide (lactose) in milk.
- lactation (lak-TĀ-shun):** The production of milk by the mammary glands.
- lacteal (LAK-tē-al):** A terminal lymphatic within an intestinal villus.
- lactic acid:** Compound produced from pyruvic acid during glycolysis.
- lactiferous duct (lak-TIF-e-rus):** Duct draining one lobe of the mammary gland.
- lactiferous sinus:** An expanded portion of a lactiferous duct adjacent to the nipple of a breast.
- lacuna (la-KOO-na):** A small pit or cavity.
- lambdoid suture (LAM-doyd):** Synarthrotic articulation between the parietal and occipital bones of the cranium.
- lamellae (la-MEL-lē):** Concentric layers of bone within an osteon.
- lamellated corpuscle:** Receptor sensitive to vibration; also called a *pacinian corpuscle*.
- lamina (LA-mi-na):** A thin sheet or layer.
- lamina propria (PRO-prē-a):** A layer of loose connective tissue situated immediately beneath the epithelium of a mucous membrane.
- laminectomy:** Removal of the spinous processes of a vertebra to gain access to and treat a herniated disc.
- Langerhans cells (LAN-ger-hanz):** Cells in the epithelium of the skin and digestive tract that participate in the immune response by presenting antigens to T cells.
- laparoscope (LAP-a-rō-skōp):** Fiber-optic instrument used to visualize the contents of the abdominopelvic cavity.

## Glossary of Key Terms

- large intestine:** The terminal portions of the intestinal tract, consisting of the colon, the rectum, and the anal canal.
- laryngopharynx (la-RING-go-far-inks):** Division of the pharynx inferior to the epiglottis and superior to the esophagus.
- larynx (LAR-inks):** A complex cartilaginous structure that surrounds and protects the glottis and vocal cords; the superior margin is bound to the hyoid bone and the inferior margin is bound to the trachea.
- lateral:** Pertaining to the side.
- lateral apertures:** Openings in the roof of the fourth ventricle that permit the circulation of CSF into the subarachnoid space.
- lateral ventricle:** Fluid-filled chamber within one of the cerebral hemispheres.
- laxatives:** Compounds that promote defecation via increased peristalsis or an increase in the water content and volume of the feces.
- lens:** The transparent body lying behind the iris and pupil and in front of the vitreous humor.
- lesion:** A localized abnormality in tissue organization.
- lesser omentum:** A small pocket in the mesentery that connects the lesser curvature of the stomach to the liver.
- leukemia (loo-KĒ-mē-ah):** A malignant disease of the blood-forming tissues.
- leukocyte (LOO-kō-sit):** A white blood cell.
- leukocytosis (loo-kō-si-TŌ-sis):** Abnormally high numbers of circulating white blood cells.
- leukopenia (loo-kō-PĒ-nē-a):** Abnormally low numbers of circulating white blood cells.
- leukopoiesis (loo-kō-poy-Ē-sis):** White blood cell formation.
- ligament (LIG-a-ment):** Dense band of connective tissue fibers that attach one bone to another.
- ligamentum arteriosum:** The fibrous strand found in the adult that represents the remains of the ductus arteriosus of the fetus.
- ligamentum nuchae (NOO-kā):** An elastic ligament that extends between the vertebra prominens and the external occipital crest.
- ligamentum teres:** The fibrous strand in the falciform ligament that represents the remains of the umbilical vein of the fetus.
- ligate:** To tie off.
- limbic system (LIM-bik):** Group of nuclei and centers in the cerebrum and diencephalon that are involved with emotional states, memories, and behavioral drives.
- limbus (LIM-bus):** The edge of the cornea, marked by the transition from the corneal epithelium to the ocular conjunctiva.
- liminal stimulus:** A stimulus sufficient to depolarize the transmembrane potential of an excitable membrane to threshold, and produce an action potential.
- linea alba:** Tendinous band that runs along the midline of the rectus abdominis.
- lingual:** Pertaining to the tongue.
- lingual frenulum:** An epithelial fold that attaches the inferior surface of the tongue to the floor of the mouth.
- lipase (LĪ-pāz):** A pancreatic enzyme that breaks down triglycerides.
- lipemia (lip-Ē-mē-a):** Elevated concentration of lipids in the circulation.
- lipid:** An organic compound containing carbons, hydrogens, and oxygens in a ratio that does not approximate 1:2:1; includes fats, oils, and waxes.
- lipogenesis (lī-pō-JEN-e-sis):** Synthesis of lipids from nonlipid precursors.
- lipolysis:** The catabolism of lipids as a source of energy.
- lipoprotein (lī-pō-PRŌ-tēn):** A compound containing a relatively small lipid bound to a protein.
- liver:** An organ of the digestive system with varied and vital functions that include the production of plasma proteins, the excretion of bile, the storage of energy reserves, the detoxification of poisons, and the interconversion of nutrients.
- lobule (LOB-ūl):** A small lobe or subdivision of a lobe; the basic organizational unit of the liver at the histological level.
- loose connective tissue:** A loosely organized, easily distorted connective tissue containing several different fiber types, a varied population of cells, and a viscous ground substance.
- lordosis (lor-DŌ-sis):** An exaggeration of the lumbar curvature.
- lumbar:** Pertaining to the lower back.
- lumen:** The central space within a duct or other internal passageway.
- lungs:** Paired organs of respiration, situated in the left and right pleural cavities.
- lutinizing hormone (LH) (LOO-tē-in-i-zing):** Anterior pituitary hormone that in the female assists FSH in follicle stimulation, triggers ovulation, and promotes the maintenance and secretion of the endometrial glands; in the male, stimulates spermatogenesis; also known as **interstitial cell-stimulating hormone**.
- luxation (luks-Ā-shun):** Dislocation of a joint.
- lymph:** Fluid contents of lymphatic vessels, similar in composition to interstitial fluid.
- lymphadenopathy (lim-fad-e-NOP-a-thē):** Pathological enlargement of the lymph nodes.
- lymphatics:** Vessels of the lymphoid system.
- lymphedema (lim-fe-DE-ma):** Swelling of peripheral tissues due to excessive lymph production or inadequate drainage.
- lymph nodes:** Lymphoid organs that monitor the composition of lymph.
- lymphocyte (LIM-fō-sit):** A cell of the lymphoid system that participates in the immune response.
- lymphokines:** Chemicals secreted by activated lymphocytes.
- lymphopoiesis:** The production of lymphocytes.
- lymphotoxin (lim-fō-TOK-sin):** A secretion of lymphocytes that kills the target cells.
- lysis (LĪ-sis):** The destruction of a cell through the rupture of its cell membrane.
- lysosome (LĪ-sō-sōm):** Intracellular vesicle containing digestive enzymes.
- lysozyme:** An enzyme present in some exocrine secretions that has antibiotic properties.
- macrophage:** A phagocytic cell of the monocyte-macrophage system.
- macula (MAK-ū-la):** A receptor complex in the sacculus or utricle that responds to linear acceleration or gravity.
- macula densa (MAK-ū-la DEN-sa):** A group of specialized secretory cells in a portion of the distal convoluted tubule adjacent to the glomerulus and the juxtaglomerular cells; a component of the juxtaglomerular apparatus.
- macula lutea (LOO-tē-a):** The fovea.
- malignant cancer:** A form of cancer characterized by rapid cellular growth and the spread of cancer cells throughout the body.
- malleus (MAL-ē-us):** The first auditory ossicle, bound to the tympanic membrane and the incus.
- mamillary bodies (MAM-i-lar-ē):** Nuclei in the hypothalamus concerned with feeding reflexes and behaviors; a component of the limbic system.
- mammary glands:** Milk-producing glands of the female breast.
- manubrium:** The broad, roughly triangular, superior element of the sternum.
- manus:** The hand.
- marrow:** A tissue that fills the internal cavities in a bone; may be dominated by hemopoietic cells (red marrow) or adipose tissue (yellow marrow).
- mass peristalsis:** Powerful peristaltic contraction that moves fecal materials along the colon and into the rectum.
- mass reflex:** Hyperreflexia in an area innervated by spinal cord segments distal to an area of injury.
- mast cell:** A connective tissue cell that when stimulated releases histamine, serotonin, and heparin, initiating the inflammatory response.
- mastectomy:** Surgical removal of part or all of a mammary gland.
- mastication (mas-ti-KĀ-shun):** Chewing.
- mastoid sinus:** Air-filled spaces in the mastoid process of the temporal bone.
- matrix:** The ground substance of a connective tissue.
- maxillary sinus (MAK-si-ler-ē):** One of the paranasal sinuses; an air-filled chamber lined by a respiratory epithelium that is located in a maxilla and opens into the nasal cavity.
- meatus (mē-Ā-tus):** An opening or entrance into a passageway.
- mechanoreception:** Detection of mechanical stimuli, such as touch, pressure, or vibration.
- medial:** Toward the midline of the body.
- mediastinum (mē-dē-as-TĪ-num):** A septum between two parts of an organ or a cavity such as the central tissue mass that divides the thoracic cavity into two pleural cavities; includes the aorta and other great vessels, the esophagus, trachea, thymus, the pericardial cavity and heart, and a host of nerves, small vessels, and lymphatics.
- medulla:** Inner layer or core of an organ.
- medulla oblongata:** The most caudal of the five brain regions, also known as the **myelencephalon**.
- medullary cavity:** The space within a bone that contains the marrow.
- medullary rhythmicity center:** Center in the medulla oblongata that sets the background pace of respiration; includes inspiratory and expiratory centers.
- megakaryocytes (meg-a-KAR-ē-ō-sits):** Bone marrow cells responsible for the formation of platelets.
- meiosis (mī-Ō-sis):** Cell division that produces gametes with half of the normal somatic chromosome complement.
- melanin (MEL-a-nin):** Yellow-brown pigment produced by the melanocytes of the skin.
- melanocyte (me-LAN-ō-sit):** Specialized cell found in the deeper layers of the stratified squamous epithelium of the skin, responsible for the production of melanin.
- melanocyte-stimulating hormone (MSH):** Hormone of the pars intermedia of the anterior pituitary that stimulates melanin production.
- melanomas (mel-a-NŌ-maz):** Dangerous malignant skin cancers that involve melanocytes.
- melatonin (mel-a-TŌ-nin):** Hormone secreted by the pineal gland; inhibits secretion of MSH and gonadotropins.
- membrane:** Any sheet or partition; a layer consisting of an epithelium and the underlying connective tissue.
- membrane flow:** The movement of sections of membrane surface to and from the cell surface and components of the endoplasmic reticulum, the Golgi apparatus, and vesicles.
- membranous labyrinth:** Endolymph-filled tubes of the inner ear that enclose the receptors of the inner ear.
- menarche (me-NAR-kē):** The beginning of menstrual function.
- meninges (men-IN-jēz):** Three membranes that surround the surfaces of the CNS; the dura mater, the pia mater, and the arachnoid mater.
- meningitis:** Inflammation of the spinal or cranial meninges.
- meniscectomy:** Removal of a meniscus.
- meniscus (men-IS-kus):** A fibrous cartilage pad between opposing surfaces in a joint.
- menopause (MEN-ō-pawz):** The cessation of uterine cycles as a consequence of the aging process and exhaustion of viable follicles.
- menses (MEN-sez):** The first menstrual period that normally occurs at puberty.
- menstrual (MEN-stroo-al) cycle:** See **uterine cycle**.
- menstruation (men-stroo-Ā-shun):** The sloughing of blood and endometrial tissue at menses.

## Glossary of Key Terms

- merocrine (MER-ō-krin):** A method of secretion where the cell ejects materials through exocytosis.
- mesencephalic aqueduct:** Passageway that connects the third ventricle (diencephalon) with the fourth ventricle (metencephalon).
- mesencephalon (mez-en-SEF-a-lon):** The midbrain.
- mesenchyme (MEZ-en-kim):** Embryonic/fetal connective tissue.
- mesentery (MES-en-ter-ē):** A double layer of serous membrane that supports and stabilizes the position of an organ in the abdominopelvic cavity and provides a route for the associated blood vessels, nerves, and lymphatics.
- mesoderm:** The middle germ layer that lies between the ectoderm and endoderm of the embryo.
- mesothelium (mez-ō-THĒ-lē-um):** A simple squamous epithelium that lines one of the divisions of the ventral body cavity.
- messenger RNA (mRNA):** RNA formed at transcription to direct protein synthesis in the cytoplasm.
- metabolism (me-TAB-ō-lizm):** The sum of all of the biochemical processes under way within the human body at a given moment; includes anabolism and catabolism.
- metabolites (me-TAB-ō-lits):** Compounds produced in the body as the result of metabolic reactions.
- metacarpals (met-a-KAR-pals):** The five bones of the palm of the hand.
- metalloproteins (me-tal-ō-PRŌ-tēnz):** Plasma proteins that transport metal ions.
- metaphase (MET-a-fāz):** A stage of mitosis wherein the chromosomes line up along the equatorial plane of the cell.
- metaphysis (me-TAF-i-sis):** The region of a long bone between the epiphysis and diaphysis, corresponding to the location of the epiphyseal cartilage of the developing bone.
- metarteriole (met-ar-TĒ-rē-ōl):** A vessel that connects an arteriole to a venule and that provides blood to a capillary plexus. Also termed a *precapillary arteriole*.
- metastasis (me-TAS-ta-sis):** The spread of a disease from one organ to another.
- metatarsal:** One of the five bones of the foot that articulate with the tarsals (proximally) and the phalanges (distally).
- metencephalon (met-en-SEF-a-lon):** The pons and cerebellum of the brain.
- micelle (mi-SEL):** A spherical aggregation of bile salts, monoglycerides, and fatty acids in the lumen of the intestinal tract.
- microcephaly (mī-krō-SEF-a-lē):** An abnormally small cranium, due to premature closure of one or more fontanels.
- microfilaments:** Fine protein filaments visible with the electron microscope; components of the cytoskeleton.
- microglia (mī-KRŌ-glē-a):** Phagocytic glial cells in the CNS, derived from the monocytes of the blood.
- microphages:** Neutrophils and eosinophils.
- microtubules:** Microscopic tubules that are part of the cytoskeleton and are found in cilia, flagella, the centrioles, and spindle fibers.
- microvilli:** Small, fingerlike extensions of the exposed cell membrane of an epithelial cell.
- micturition (mik-tū-RI-shun):** Urination.
- midbrain:** The mesencephalon.
- middle ear:** Space between the external and internal ear that contains auditory ossicles.
- midsagittal plane:** A plane passing through the midline of the body that divides it into left and right halves.
- mineralocorticoids:** Corticosteroids produced by the zona glomerulosa of the adrenal cortex; steroids such as aldosterone that affect mineral metabolism.
- miscarriage:** Spontaneous abortion.
- mitochondrion (mī-tō-KON-drē-on):** An intracellular organelle responsible for generating most of the ATP required for cellular operations.
- mitosis (mī-TŌ-sis):** The division of a single cell that produces two identical daughter cells; the primary mechanism of tissue growth.
- mitral valve (MĪ-tral):** The left AV, or bicuspid, valve of the heart.
- mixed gland:** A gland that contains exocrine and endocrine cells, or an exocrine gland that produces serous and mucous secretions.
- mixed nerve:** A peripheral nerve that contains sensory and motor fibers.
- modiolus (mō-DĪ-ō-lus):** The bony central hub of the cochlea.
- mole:** A quantity of an element or compound having a mass in grams equal to its atomic or molecular weight.
- molecular weight:** The sum of the atomic weights of the atoms in a molecule.
- molecule:** A compound containing two or more atoms that are held together by chemical bonds.
- monocytes (MON-ō-sits):** Phagocytic agranulocytes (white blood cells) in the circulating blood.
- monoglyceride (mon-ō-GLĪ-se-rid):** A lipid consisting of a single fatty acid bound to a molecule of glycerol.
- monokines:** Secretions released by activated cells of the monocyte-macrophage system to coordinate various aspects of the immune response.
- monosaccharide (mon-ō-SAK-ah-rid):** A simple sugar, such as glucose or ribose.
- monosynaptic reflex:** A reflex where the sensory afferent synapses directly on the motor efferent.
- monozygotic twins:** Twins produced through the splitting of a single fertilized egg (zygote).
- morula (MOR-ū-la):** A mulberry-shaped collection of cells produced through the mitotic divisions of a zygote.
- motor unit:** All of the muscle cells controlled by a single motor neuron.
- mucins (MŪ-sins):** Proteoglycans responsible for the lubricating properties of mucus.
- mucosa (mū-KŌ-sa):** A mucous membrane; the epithelium plus the lamina propria.
- mucous:** An adjective referring to the presence or production of mucus.
- mucous cell:** A mucus-producing, unicellular gland found in certain epithelia of the respiratory system.
- mucous membrane:** See **mucosa**.
- mucus:** Lubricating secretion produced by unicellular and multicellular glands along the digestive, respiratory, urinary, and reproductive tracts.
- multipennate muscle:** A muscle whose internal fibers are organized around several different tendons.
- multipolar neuron:** A neuron with many dendrites and a single axon, the typical form of a motor neuron.
- multiunit smooth muscle:** Smooth muscle tissue whose muscle cells are innervated in motor units.
- muric acid:** Hydrochloric acid (HCl).
- muscarinic receptors (mus-kar-IN-ik):** Membrane receptors sensitive to acetylcholine (ACh) and to muscarine, a toxin produced by certain mushrooms; found at all parasympathetic neuroeffector junctions and at a few sympathetic neuroeffector junctions.
- muscle:** A contractile organ composed of muscle tissue, blood vessels, nerves, connective tissues, and lymphatics.
- muscle tissue:** A tissue characterized by the presence of cells capable of contraction; includes skeletal, cardiac, and smooth muscle tissue.
- muscularis externa (mus-kū-LAR-is):** Concentric layers of smooth muscle responsible for peristalsis.
- muscularis mucosae:** Layer of smooth muscle beneath the lamina propria responsible for moving the mucosal surface.
- mutagens (MŪ-ta-jenz):** Chemical agents that induce mutations and may be carcinogenic.
- myalgia (mī-AL-jē-a):** Muscle pain.
- myasthenia gravis (mī-as-THĒ-nē-a GRA-vis):** Muscular weakness due to a reduction in the number of ACh receptor sites on the sarcolemmal surface; suspected to be an autoimmune disorder.
- myelencephalon (mī-el-en-SEF-a-lon):** The medulla oblongata.
- myelin (MĪ-e-lin):** Insulating sheath around an axon consisting of multiple layers of glial cell membrane; significantly increases conduction rate along the axon.
- myelination:** The formation of myelin.
- myelin sheath gap:** Area between adjacent glial cells where the myelin covering an axon is incomplete. Also termed a *node of Ranvier* or *internode*.
- myenteric plexus (mī-en-TER-ik):** Parasympathetic motor neurons and sympathetic postganglionic fibers located between the circular and longitudinal layers of the muscularis externa.
- myocardial infarction (mī-ō-KAR-dē-al):** Heart attack; damage to the heart muscle due to an interruption of regional coronary circulation.
- myocarditis:** Inflammation of the myocardium.
- myocardium:** The cardiac muscle tissue of the heart.
- myofibrils:** Organized collections of myofilaments in skeletal and cardiac muscle cells.
- myofilaments:** Fine protein filaments, composed of the proteins actin (thin filaments) and myosin (thick filaments).
- myoglobin (MĪ-ō-glō-bin):** An oxygen-binding pigment especially common in slow skeletal and cardiac muscle fibers.
- myogram:** A recording of the tension produced by muscle fibers on stimulation.
- myometrium (mī-ō-MĒ-trē-um):** The thick layer of smooth muscle in the wall of the uterus.
- myopia:** Nearsightedness; an inability to accommodate for distant vision.
- myosepta:** Connective tissue partitions that separate adjacent skeletal muscles.
- myosin:** Protein component of the thick myofilaments.
- myositis (mī-ō-SĪ-tis):** Inflammation of muscle tissue.
- nail:** Keratinous structure produced by epithelial cells of the nail root.
- narcolepsy:** A sleep disorder characterized by falling asleep at inappropriate moments.
- nares, external (NA-rēz):** The entrance from the exterior to the nasal cavity.
- nares, internal:** The entrance from the nasal cavity to the nasopharynx.
- nasal cavity:** A chamber in the skull bounded by the internal and external nares.
- nasolacrimal duct:** Passageway that transports tears from the nasolacrimal sac to the nasal cavity.
- nasolacrimal sac:** Chamber that receives tears from the nasolacrimal ducts.
- nasopharynx (nā-zō-FAR-inks):** Region posterior to the internal nares, superior to the soft palate, and ending at the oropharynx.
- necrosis (nek-RŌ-sis):** Death of cells or tissues from disease or injury.
- negative feedback:** Corrective mechanism that opposes or negates a variation from normal limits.
- neonate:** A newborn infant, or baby.
- neoplasm:** A tumor, or mass of abnormal tissue.
- nephritis (nef-RĪ-tis):** Inflammation of the kidney.
- nephrolithiasis (nef-rō-li-THĪ-a-sis):** Condition resulting from the formation of kidney stones.
- nephron (NEF-ron):** Basic functional unit of the kidney.
- nephron loop:** The segment of the nephron between the proximal and distal convoluted tubules. Also termed the *loop of Henle*.

## Glossary of Key Terms

- nerve impulse:** An action potential in a nerve cell membrane.
- neural cortex:** An area where gray matter is found at the surface of the CNS.
- neurilemma (noo-ri-LEM-ma):** The outer surface of a glial cell that encircles an axon.
- neuroeffector junction:** A synapse between a motor neuron and a peripheral effector, such as a muscle cell or gland cell.
- neurofibrils:** Microfibrils in the cytoplasm of a neuron.
- neurofilaments:** Microfilaments in the cytoplasm of a neuron.
- neuroglandular junction:** A specific type of neuroeffector junction.
- neuroglia (noo-ROG-lē-a):** Nonneural cells of the CNS and PNS that support and protect the neurons.
- neurohypophysis (noo-rō-hi-POF-i-sis):** The posterior lobe of the pituitary gland or *pars nervosa*.
- neuromuscular synapse:** A specific type of neuroeffector junction. Also termed a *neuromuscular junction*.
- neuron (NOO-ron):** A nerve cell.
- neurotransmitter:** Chemical compound released by one neuron to affect the transmembrane potential of another.
- neurotubules:** Microtubules in the cytoplasm of a neuron.
- neurulation:** The embryological process responsible for the formation of the CNS.
- neutropenia:** An abnormally low number of neutrophils in the circulating blood.
- neutrophil (NOO-trō-fil):** A phagocytic microphage (granulocyte, WBC) that is very numerous and usually the first of the mobile phagocytic cells to arrive at an area of injury or infection.
- nicotinic receptors (nik-ō-TIN-ik):** ACh receptors found on the surfaces of sympathetic and parasympathetic ganglion cells, that will also respond to the compound nicotine.
- nipple:** An elevated epithelial projection on the surface of the breast, containing the openings of the lactiferous sinuses.
- nitrogenous wastes:** Organic waste products of metabolism that contain nitrogen, such as urea, uric acid, and creatinine.
- NK cells (natural killer cells):** Lymphocytes responsible for immune surveillance, the detection and destruction of cancer cells.
- nociception (nō-si-SEP-shun):** Pain perception.
- nodose ganglion (NŌ-dōs):** A sensory ganglion of cranial nerve X.
- nonvesicular synapse:** A synapse found between neurons of the CNS and PNS. Also termed an *electrical synapse*.
- noradrenaline:** Catecholamine secreted by the adrenal medulla, released at most sympathetic neuroeffector junctions, and at certain synapses inside the CNS; also called *norepinephrine*.
- norepinephrine (nor-ep-i-NEF-rin):** A catecholamine neurotransmitter in the PNS and CNS, and a hormone secreted by the adrenal medulla; also called *noradrenaline*.
- normovolemic (nor-mō-vō-LĒ-mik):** Having a normal blood volume.
- nucleic acid (noo-KLĒ-ik):** A polymer of nucleotides containing a pentose sugar, a phosphate group, and one of four nitrogenous bases that regulate the synthesis of proteins and make up the genetic material in cells.
- nucleolus (noo-KLĒ-ō-lus):** Dense region in the nucleus that represents the site of RNA synthesis.
- nucleoplasm:** Fluid content of the nucleus.
- nucleoproteins:** Proteins of the nucleus that are generally associated with the DNA.
- nucleus:** Cellular organelle that contains DNA, RNA, and proteins; a mass of gray matter in the CNS.
- nucleus pulposus (pul-PŌ-sus):** The gelatinous core of an intervertebral disc.
- nurse cell:** Cells attached to the basal lamina of the seminiferous tubule capsule. During spermeogenesis developing spermatids are embedded within the cytoplasm of these cells. Also termed *Sertoli cells*.
- nutrient:** An organic compound that can be broken down in the body to produce energy.
- nystagmus:** Involuntary, continual movement of the eyes as if to adjust to constant motion.
- obesity:** Body weight 10–20 percent above standard values, as the result of body fat accumulation.
- occlusal surface (o-KLOO-zal):** The opposing surfaces of the teeth that come into contact when processing food.
- ocular:** Pertaining to the eye.
- oculomotor nerve (ok-ū-lō-MŌ-ter):** Cranial nerve III that controls the extra-ocular muscles other than the superior oblique and the lateral rectus.
- olecranon:** The proximal end of the ulna that forms the prominent point of the elbow.
- olfaction:** The sense of smell.
- olfactory bulb (ol-FAK-tor-ē):** Two olfactory nerves that lie beneath the frontal lobe of the cerebrum.
- olfactory tract:** Tract over which nerve impulses from the retina are transmitted between the optic chiasma and the thalamus.
- oligodendrocytes (ol-i-gō-DEN-drō-sits):** CNS glial cells responsible for maintaining cellular organization in the gray matter and providing a myelin sheath in areas of white matter.
- oncogene (ON-kō-jēn):** A gene that can turn a normal cell into a cancer cell.
- oncologists (on-KOL-ō-jists):** Physicians specializing in the study and treatment of tumors.
- oocyte (Ō-ō-sit):** A cell whose meiotic divisions will produce a single ovum and three polar bodies.
- oogenesis (ō-ō-JEN-e-sis):** Ovum production.
- oogonia (ō-ō-GŌ-nē-a):** Stem cells in the ovaries whose divisions give rise to oocytes.
- oophorectomy (ō-of-ō-REK-tō-mē):** Surgical removal of the ovaries.
- oophoritis (ō-of-ō-RĪ-tis):** Inflammation of the ovaries.
- ooplasm:** The cytoplasm of the ovum.
- opsin:** A protein, one structural component of the visual pigment rhodopsin.
- opsonization:** An effect of coating an object with antibodies; the attraction and enhancement of phagocytosis.
- optic chiasma (OP-tik ki-AZ-ma):** Crossing point of the optic nerves.
- optic nerve:** Nerve that carries signals from the eye to the optic chiasma.
- ora serrata (Ō-ra ser-RA-ta):** The anterior edge of the neural retina.
- orbit:** Bony cavity of the skull that contains the eyeball.
- orchietomy (or-kē-EK-tō-mē):** Surgical removal of one or both testes.
- orchitis:** Inflammation of the testes.
- organelle (or-gan-EL):** An intracellular structure that performs a specific function or group of functions.
- organic compound:** A compound containing carbon, hydrogen, and usually oxygen.
- organogenesis:** The formation of organs during embryological and fetal development.
- organ of Corti:** See **Corti**, **organ of**.
- organs:** Combinations of tissues that perform complex functions.
- origin:** Point of attachment of a muscle that is less movable.
- oropharynx (or-ō-FAR-inks):** The middle portion of the pharynx, bounded superiorly by the nasopharynx, anteriorly by the oral cavity, and inferiorly by the laryngopharynx.
- os coxa/coxae:** The bones of the hip.
- osmolarity (oz-mō-LAR-i-tē):** The total concentration of dissolved materials in a solution, regardless of their specific identities, expressed in terms of moles.
- osmoreceptor:** A receptor sensitive to changes in the osmolarity of the plasma.
- osmosis (oz-MŌ-sis):** The movement of water across a semipermeable membrane toward a solution containing a relatively high solute concentration.
- osmotic pressure:** The force of osmotic water movement; the pressure that must be applied to prevent osmotic movement across a membrane.
- osseous tissue:** A strong connective tissue containing specialized cells and a mineralized matrix of crystalline calcium phosphate and calcium carbonate.
- ossicles:** Small bones.
- ossification:** The formation of bone.
- osteoblasts (OS-tē-ō-blāsts):** Cells that produce bone within connective tissue (intramembranous ossification) or cartilage (endochondral ossification); may differentiate into osteocytes.
- osteoclast (OS-tē-ō-klast):** A cell that dissolves the fibers and matrix of bone.
- osteocyte (OS-tē-ō-sit):** A bone cell responsible for the maintenance and turnover of the mineral content of the surrounding bone.
- osteogenesis (os-tē-ō-JEN-e-sis):** Bone production.
- osteogenic layer (os-tē-ō-JEN-ik):** The inner cellular layer of the periosteum that participates in bone growth and repair.
- osteoid (OS-tē-ō-oid):** The organic components of the bone matrix, produced by osteoblasts and osteocytes.
- osteolysis (os-tē-ō-OL-i-sis):** The breakdown of the mineral matrix of bone.
- osteon (OS-tē-ō-n):** The basic histological unit of compact bone, consisting of osteocytes organized around a central canal and separated by concentric lamellae.
- osteopenia (os-tē-ō-PE-nē-a):** The condition of inadequate bone production in the adult, leading to a loss in bone mass and strength.
- osteoporosis (os-tē-ō-pō-RŌ-sis):** A reduction in bone mass and strength sufficient to compromise normal bone function.
- osteoprogenitor cells:** Stem cells that give rise to osteoblasts.
- otic:** Pertaining to the ear.
- otitis media:** Inflammation of the middle ear cavity.
- oval window:** Opening in the bony labyrinth where the stapes attaches to the membranous wall of the scala vestibuli.
- ovarian cycle (ō-VAR-ē-an):** Monthly cycle of gamete development in the ovaries, associated with cyclical changes in the production of sex hormones (estrogens and progestins).
- ovary:** Female reproductive gland.
- ovulation (ov-ū-LĀ-shun):** The release of a secondary oocyte, surrounded by cells of the corona radiata, following the rupture of the wall of a tertiary follicle.
- ovum/ova (Ō-vum):** A gamete produced by the reproductive system of a female; an egg.
- oxytocin (ok-sē-TŌ-sin):** Hormone produced by hypothalamic cells and secreted into capillaries at the posterior pituitary; stimulates smooth muscle contractions of the uterus or mammary glands in the female, but has no known function in males.
- pacemaker cells:** Cells of the SA node that set the pace of cardiac contraction.
- palate:** Horizontal partition separating the oral cavity from the nasal cavity and nasopharynx; can be divided into an anterior bony (hard) palate and a posterior fleshy (soft) palate.
- palatine:** Pertaining to the palate.
- palpate:** To examine by touch.
- palpebrae (pal-PĒ-brē):** Eyelids.
- pancreas:** Digestive organ containing exocrine and endocrine tissues; exocrine portion secretes pancreatic juice; endocrine portion secretes hormones, including insulin and glucagon.
- pancreatic duct:** A tubular duct that carries pancreatic juice from the pancreas to the duodenum.
- pancreatic islets:** Aggregations of endocrine cells in the pancreas.

## Glossary of Key Terms

- pancreatic juice:** A mixture of buffers and digestive enzymes that is discharged into the duodenum under the stimulation of the enzymes secretin and cholecystokinin.
- pancreatitis (pan-kre-ä-TĪ-tis):** Inflammation of the pancreas.
- Papanicolaou (Pap) test:** Test for the detection of malignancies of the female reproductive tract, especially the cervix and uterus.
- papilla (pa-PIL-la):** A small, conical projection.
- paralysis:** Loss of voluntary motor control over a portion of the body.
- paranasal sinuses:** Bony chambers lined by respiratory epithelium that open into the nasal cavity; include the frontal, ethmoidal, sphenoid, and maxillary sinuses.
- paraplegia:** Paralysis of the upper limbs.
- parasagittal:** A section or plane that parallels the midsagittal plane but does not pass along the midline.
- parasympathetic division:** One of the two divisions of the autonomic nervous system; also known as the craniosacral division; generally responsible for activities that conserve energy and lower the metabolic rate.
- parathyroid glands:** Four small glands embedded in the posterior surface of the thyroid; responsible for parathyroid hormone secretion.
- parathyroid hormone:** Hormone secreted by the parathyroid gland when plasma calcium levels fall below the normal range; causes increased osteoclast activity, increased intestinal calcium uptake, and decreased calcium ion loss at the kidneys.
- parenchyma (pa-RENG-kĭ-ma):** The cells of a tissue or organ that are responsible for fulfilling its functional role.
- paresthesia:** Sensory abnormality that produces a tingling sensation.
- parietal:** Referring to the body wall or outer layer.
- parietal cell:** Cells of the gastric glands that secrete HCl and intrinsic factor.
- Parkinson's disease:** Progressive motor disorder due to degeneration of the cerebral nuclei.
- parotid glands (pa-ROT-id):** Large salivary glands that secrete a saliva containing high concentrations of salivary (alpha) amylase.
- pars distalis (dis-TAL-is):** The large, anterior portion of the adenohypophysis, or anterior lobe of the pituitary gland.
- pars intermedia (in-ter-MĒ-dĕ-a):** The portion of the anterior lobe of the pituitary gland immediately adjacent to the posterior pituitary and the infundibulum.
- pars nervosa or neurohypophysis (noor-ö-hi-POF-i-sis):** The posterior pituitary gland.
- parturition (par-tü-RISH-un):** Childbirth, delivery.
- patella (pa-TEL-a):** The sesamoid bone of the kneecap.
- pathogenic:** Disease-causing.
- pathologist (pa-THOL-ö-jĭst):** A physician specializing in the identification of diseases based on characteristic structural and functional changes in tissues and organs.
- pedicel (PED-i-sel):** A slender process of a podocyte that forms part of the filtration apparatus of the kidney glomerulus.
- pedicles (PED-i-klz):** Thick bony struts that connect the vertebral body with the articular and spinous processes.
- pelvic cavity:** Inferior subdivision of the abdominopelvic (peritoneal) cavity; encloses the urinary bladder, the sigmoid colon and rectum, and male or female reproductive organs.
- pelvis:** A bony complex created by the articulations between the coxae, the sacrum, and the coccyx.
- penis (PĒ-nis):** Component of the male external genitalia; a copulatory organ that surrounds the urethra and serves to introduce semen into the female vagina.
- pepsin:** Proteolytic enzyme secreted by the chief cells of the gastric glands in the stomach.
- pepsinogen (pep-SIN-ö-jen):** The inactive proenzyme that is secreted by chief cells of the gastric pits; after secretion it is converted to the proteolytic enzyme pepsin.
- peptidases:** Enzymes that split peptide bonds and release amino acids.
- perforating canal:** A passageway in compact bone that runs at right angles to the axes of the osteons, between the periosteum and endosteum.
- perfusion:** The blood flow through a tissue.
- pericardial cavity (per-i-KAR-dĕ-al):** The space between the parietal pericardium and the epicardium (visceral pericardium) that covers the outer surface of the heart.
- pericarditis:** Inflammation of the pericardium.
- pericardium (per-i-KAR-dĕ-um):** The fibrous sac that surrounds the heart, and whose inner, serous lining is continuous with the epicardium.
- perichondrium (per-i-KON-drĕ-um):** Layer that surrounds a cartilage, consisting of an outer fibrous and an inner cellular region.
- perikaryon (per-i-KAR-ĕ-on):** The cytoplasm that surrounds the nucleus in the soma of a nerve cell. Also termed the *nerve cell body*.
- perilymph (PER-i-limf):** A fluid similar in composition to cerebrospinal fluid; found in the spaces between the bony labyrinth and the membranous labyrinth of the inner ear.
- perimysium (per-i-MĪS-ĕ-um):** Connective tissue partition that separates adjacent fasciculi in a skeletal muscle.
- perineum (per-i-NĒ-um):** The pelvic floor and associated structures.
- perineurium:** Connective tissue partition that separates adjacent bundles of nerve fibers in a peripheral nerve.
- periodontal ligament (per-ĕ-ö-DON-tal):** Collagen fibers that bind the cement, or cementum, of a tooth to the periosteum of the surrounding alveolus.
- periosteum (per-ĕ-OS-tĕ-um):** Layer that surrounds a bone, consisting of an outer fibrous and inner cellular region.
- peripheral nervous system (PNS):** All neural tissue outside the CNS.
- peristalsis (per-i-STAL-sis):** A wave of smooth muscle contractions that propels materials along the axis of a tube such as the digestive tract, the ureters, or the ductus deferens.
- peritoneal cavity:** See **abdominopelvic cavity**.
- peritoneum (per-i-tö-NĒ-um):** The serous membrane that lines the peritoneal (abdominopelvic) cavity.
- peritonitis (per-i-tö-NĪ-tis):** Inflammation of the peritoneum.
- peritubular capillaries:** A network of capillaries that surrounds the proximal and distal convoluted tubules of the kidneys.
- permeability:** Ease with which dissolved materials can cross a membrane; if freely permeable, any molecule can cross the membrane; if impermeable, nothing can cross; most biological membranes are selectively permeable.
- peroxisome:** A membranous vesicle containing enzymes that break down hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>).
- pes:** The foot.
- petrosal ganglion:** Sensory ganglion of the glossopharyngeal nerve (N IX).
- petrous:** Stony; usually used to refer to the thickened portion of the temporal bone that encloses the inner ear.
- Peyer's patches (PĪ-erz):** See **aggregated lymphoid nodules**.
- pH:** The negative exponent of the hydrogen ion concentration, in moles per liter.
- phagocyte:** A cell that performs phagocytosis.
- phagocytosis (FA-gö-si-TÖ-sis):** The engulfing of extracellular materials or pathogens; movement of extracellular materials into the cytoplasm by enclosure in a membranous vesicle.
- phalanx/phalanges (fa-LAN-jĕz):** Digits; the bones of the fingers and toes.
- pharmacology:** The study of drugs, their physiological effects, and their clinical uses.
- pharynx (FAR-inks):** The throat; a muscular passageway shared by the digestive and respiratory tracts.
- phasic response:** A pattern of response to stimulation by sensory neurons that are normally inactive; stimulation causes a burst of neural activity that ends when the stimulus either stops or stops changing in intensity.
- phenotype (FĒN-ö-tip):** Physical characteristics that are genetically determined.
- phonation (fö-NÄ-shun):** Sound production at the larynx.
- phosphate group:** PO<sub>4</sub><sup>3-</sup>.
- phospholipid (fos-fo-LIP-id):** An important membrane lipid whose structure includes hydrophilic and hydrophobic regions.
- phosphorylation (fos-for-i-LÄ-shun):** The addition of a phosphate group to a molecule.
- photoreception:** Sensitivity to light.
- physiology (fiz-ĕ-OL-ö-jĕ):** The study of function; considers the ways living organisms perform vital activities.
- pia mater:** The delicate inner meningeal layer that is in direct contact with the neural tissue of the CNS.
- pigment:** A compound with a characteristic color.
- piloerection:** "Goosebumps" effect produced by the contraction of the arrector pili muscles of the skin.
- pineal gland:** Neural tissue in the posterior portion of the roof of the diencephalon, responsible for the secretion of melatonin.
- pinealocytes (PĪN-ĕ-a-lö-sits):** Secretory cells of the pineal gland.
- pinna:** The expanded, projecting portion of the external ear that surrounds the external auditory meatus.
- pinocytosis (PIN-ö-si-TÖ-sis):** The introduction of fluids into the cytoplasm by enclosing them in membranous vesicles at the cell surface.
- pituitary gland:** The "master gland," situated in the sella turcica of the sphenoid bone and connected to the hypothalamus by the infundibulum; includes the posterior lobe (pars nervosa) and the anterior lobe (pars intermedia and pars distalis).
- placenta (pla-SENT-a):** A complex structure in the uterine wall that permits diffusion between the fetal and maternal circulatory systems; also called the afterbirth.
- placentation (pla-sen-TÄ-shun):** Formation of a functional placenta following implantation of a blastocyst in the endometrium.
- plantar:** Referring to the sole of the foot.
- plasma (PLAZ-mah):** The fluid ground substance of whole blood; what remains after the cells have been removed from a sample of whole blood.
- plasmalemma (plaz-ma-LEM-a):** Cell membrane.
- plasmocyte:** Activated B cells that secrete antibodies. Also termed a *plasma cell*.
- platelets (PLÄT-lets):** Small packets of cytoplasm that contain enzymes important in the clotting response; manufactured in the bone marrow by cells called **megakaryocytes**.
- pleura (PLOO-rah):** The serous membrane lining the pleural cavities.
- pleural cavities:** Subdivisions of the thoracic cavity that contain the lungs.
- pleuritis (pleor-I-tis):** Inflammation of the pleura.
- plexus (PLEK-sus):** A complex interwoven network of peripheral nerves or blood vessels.
- plica (PLĪ-ka):** A permanent transverse fold in the wall of the small intestine.
- pluripotential stem cells:** Stem cells that ultimately give rise to all blood cells. Also termed *hemocytoblasts*.
- pneumotaxic center (nü-mö-TAKS-ik):** A center in the reticular formation of the pons that regulates the activities of the apneustic and respiratory rhythmicity centers to adjust the pace of respiration.
- pneumothorax (nü-mö-THÖR-aks):** The introduction of air into the pleural cavity.
- podocyte (POD-ö-sit):** A cell whose processes surround the glomerular capillaries and assist in the filtration process.
- polar body:** A nonfunctional packet of cytoplasm containing chromosomes eliminated from an oocyte during meiosis.

## Glossary of Key Terms

- pollex (POL-eks):** The thumb.
- polycythemia (po-lē-si-THĪ-mē-a):** An unusually high hematocrit due to the presence of excess numbers of formed elements, especially RBCs.
- polymorph:** Polymorphonuclear leukocyte; a neutrophil.
- polypeptide:** A chain of amino acids strung together by peptide bonds; those containing more than 100 peptides are called proteins.
- polysaccharide (pol-ē-SAK-ah-rid):** A complex sugar, such as glycogen or a starch.
- polysynaptic reflex:** A reflex with interneurons interposed between the sensory fiber and the motor neuron(s).
- polyuria (pol-ē-Ū-rē-a):** Excessive urine production.
- pons:** The portion of the metencephalon anterior to the cerebellum.
- popliteal (pop-LIT-ē-al):** Pertaining to the back of the knee.
- porphyrins (POR-fi-rinz):** Ring-shaped molecules that form the basis for important respiratory and metabolic pigments, including heme and the cytochromes.
- porta hepatis:** A region of mesentery between the duodenum and liver that contains the hepatic artery, the hepatic portal vein, and the common bile duct.
- positive feedback:** Mechanism that increases a deviation from normal limits following an initial stimulus.
- postcentral gyrus:** The primary sensory cortex, where touch, vibration, pain, temperature, and taste sensations arrive and are consciously perceived.
- posterior:** Toward the back; dorsal.
- postganglionic neuron:** An autonomic neuron in a peripheral ganglion, whose activities control peripheral effectors.
- postovulatory phase:** The secretory phase of the menstrual cycle.
- precentral gyrus:** The primary motor cortex on a cerebral hemisphere, located rostral to the central sulcus.
- prefrontal cortex:** Rostral portion of each cerebral hemisphere thought to be involved with higher intellectual functions, predictions, calculations, and so forth.
- preganglionic neuron:** Visceral motor neuron inside the CNS whose output controls one or more ganglionic motor neurons in the PNS.
- premolars:** Bicuspid; teeth with flattened occlusal surfaces located anterior to the molar teeth.
- premotor cortex:** Motor association area between the precentral gyrus and the prefrontal area.
- preoptic nucleus:** Hypothalamic nucleus that coordinates thermoregulatory activities.
- preovulatory phase:** A portion of the menstrual cycle; period of estrogen-induced repair of the functional zone of the endometrium through the growth and proliferation of epithelial cells in the glands not lost during menses.
- prepuce (PRĒ-pus):** Loose fold of skin that surrounds the glans penis (males) or the clitoris (females).
- preputial glands (prĒ-PŪ-shal):** Glands on the inner surface of the prepuce that produce a viscous, odorless secretion called **smegma**.
- presbyopia:** Farsightedness; an inability to accommodate for near vision.
- prevertebral ganglion:** See **collateral ganglion**.
- prime mover:** A muscle that performs a specific action.
- proenzyme:** An inactive enzyme secreted by an epithelial cell.
- progesterone (prō-JES-ter-ōn):** The most important progestin secreted by the corpus luteum following ovulation.
- progestins (prō-JES-tinz):** Steroid hormones structurally related to cholesterol.
- prognosis:** A prediction concerning the possibility or time course of recovery from a specific disease.
- projection fibers:** Axons carrying information from the thalamus to the cerebral cortex.
- prolactin (prō-LAK-tin):** Hormone that stimulates functional development of the mammary gland in females; secreted by the anterior lobe of the pituitary gland.
- prolapse:** The abnormal descent or protrusion of a portion of an organ, such as the vagina or anorectal canal.
- proliferative phase:** See **preovulatory phase**.
- pronation (prō-NĀ-shun):** Rotation of the forearm that makes the palm face posteriorly.
- pronucleus:** Enlarged egg or sperm nucleus that forms after fertilization but before amphimixis.
- properdin:** Complement factor that prolongs and enhances non-antibody-dependent complement binding to bacterial cell walls.
- prophase (PRŌ-fāz):** The initial phase of mitosis, characterized by the appearance of chromosomes, breakdown of the nuclear membrane, and formation of the spindle apparatus.
- proprioception (prō-prē-ō-SEP-shun):** Awareness of the positions of bones, joints, and muscles.
- prostaglandin (pros-tah-GLAN-din):** Lipoid secreted by one cell that alters the metabolic activities or sensitivities of adjacent cells; sometimes called *local hormones*.
- prostate gland (PROS-tāt):** Accessory gland of the male reproductive tract, contributing roughly one-third of the volume of semen.
- prostatectomy (pros-ta-TEK-tō-mē):** Surgical removal of the prostate.
- prostatitis (pros-ta-TĪ-tis):** Inflammation of the prostate.
- prosthesis:** An artificial substitute for a body part.
- protease:** See **proteinase**.
- protein:** A large polypeptide with a complex structure.
- proteinase:** An enzyme that breaks down proteins into peptides and amino acids.
- proteinuria (prō-tēn-ŪR-ē-a):** Abnormal amounts of protein in the urine.
- proteoglycan (prō-tē-ō-GLĪ-kan):** Compound containing a large polysaccharide complex attached to a relatively small protein; examples include hyaluronic acid and chondroitin sulfate.
- prothrombin:** Circulating proenzyme of the common pathway of the clotting system; converted to thrombin by the enzyme thromboplastin.
- proton:** A fundamental particle bearing a positive charge.
- protraction:** Movement anteriorly in the horizontal plane.
- proximal:** Toward the attached base of an organ or structure.
- proximal convoluted tubule:** The portion of the nephron between Bowman's capsule and the nephron loop; the major site of active reabsorption from the filtrate.
- pruritis (proo-RĪ-tus):** Itching.
- pseudopodia (soo-dō-PŌ-dē-a):** Temporary cytoplasmic extensions typical of mobile or phagocytic cells.
- pseudostratified epithelium:** An epithelium containing several layers of nuclei, but whose cells are all in contact with the underlying basement membrane.
- psoriasis (sō-RĪ-a-sis):** Skin condition characterized by excessive keratin production and the formation of dry, scaly patches on the body surface.
- psychosomatic condition:** An abnormal physiological state with a psychological origin.
- puberty:** Period of rapid growth, sexual maturation, and the appearance of secondary sexual characteristics; usually occurs at ages 10–15.
- pubic symphysis:** Fibrocartilaginous amphiarthrosis between the pubic bones of the coxae.
- pubis (PŪ-bis):** The anterior, inferior component of the coxa.
- pubendum (pŪ-DEN-dum):** The external genitalia.
- pulmonary circuit:** Blood vessels between the pulmonary semilunar valve of the right ventricle and the entrance to the left atrium; the blood circulation through the lungs.
- pulmonary ventilation:** Movement of air in and out of the lungs.
- pulp cavity:** Internal chamber in a tooth, containing blood vessels, lymphatics, nerves, and the cells that maintain the dentin.
- pulpitis (pul-PĪ-tis):** Inflammation of the tissues of the pulp cavity.
- pupil:** The opening in the center of the iris through which light enters the eye.
- purine:** An N compound with a ring-shaped structure; examples include adenine and guanine, two nitrogen bases common in nucleic acids.
- Purkinje cell (pur-KIN-jē):** Large, branching neuron of the cerebellar cortex.
- Purkinje fibers:** Specialized conducting cardiocytes in the ventricles.
- pus:** An accumulation of debris, fluid, dead and dying cells, and necrotic tissue.
- putamen (pŪ-TĀ-men):** Thalamic nucleus involved in the integration of sensory information prior to projection to the cerebral hemispheres.
- P wave:** Deflection of the ECG corresponding to atrial depolarization.
- pyelogram (PĪ-el-ō-gram):** A radiographic image of the kidneys and ureters.
- pyelonephritis (pĪ-e-lō-nef-RĪ-tis):** Inflammation of the kidneys.
- pyloric sphincter (pĪ-LOR-ic):** Sphincter of smooth muscle that regulates the passage of chyme from the stomach to the duodenum.
- pylorus (pĪ-LŌR-us):** Gastric region between the body of the stomach and the duodenum; includes the pyloric sphincter.
- pyrexia (pĪ-REK-sē-a):** A fever.
- pyrimidine:** An N compound with a ring-shaped structure; examples include cytosine, thymine, and uracil, nitrogen bases common in nucleic acids.
- pyruvic acid (pĪ-RŪ-vik):** Three-carbon compound produced by glycolysis.
- quadrilegia:** Paralysis of the upper and lower limbs.
- radiodensity:** Relative resistance to the passage of x-rays.
- radiographic techniques:** Methods of visualizing internal structures using various forms of radiational energy.
- radiopaque:** Having a relatively high radiodensity.
- rami communicantes:** Axon bundles that link the spinal nerves with the ganglia of the sympathetic chain.
- ramus:** A branch.
- raphe (RĀ-fē):** A seam.
- receptor field:** The area monitored by a single sensory receptor.
- recessive gene:** An allele that will affect the phenotype only when the individual is homozygous for that trait.
- rectal columns:** Longitudinal folds in the walls of the anorectal canal.
- rectouterine pouch (rek-tō-Ū-te-rin):** Peritoneal pocket between the anterior surface of the rectum and the posterior surface of the uterus.
- rectum (REK-tum):** The last 15 cm (6 in.) of the digestive tract.
- rectus:** Straight.
- red blood cell:** See **erythrocyte**.
- reduction:** The gain of hydrogen atoms or electrons, or the loss of an oxygen molecule.
- reductional division:** The first meiotic division, which reduces the chromosome number from 46 to 23.
- reflex:** A rapid, automatic response to a stimulus.
- reflex arc:** The receptor, sensory neuron, motor neuron, and effector involved in a particular reflex; interneurons may or may not be present, depending on the reflex considered.
- refraction:** The bending of light rays as they pass from one medium to another.
- refractory period:** Period between the initiation of an action potential and the restoration of the normal resting potential; over this period the membrane will not respond normally to stimulation.
- relaxation phase:** The period following a contraction when the tension in the muscle fiber returns to resting levels.
- relaxin:** Hormone that loosens the pubic symphysis; a hormone secreted by the placenta.

## Glossary of Key Terms

**renal:** Pertaining to the kidneys.

**renal corpuscle:** The initial portion of the nephron, consisting of an expanded chamber that encloses the glomerulus.

**renin:** Enzyme released by the juxtaglomerular cells when renal blood pressure or  $P_{O_2}$  declines; converts angiotensinogen to angiotensin I.

**rennin:** Gastric enzyme that breaks down milk proteins.

**replication:** Duplication.

**repolarization:** Movement of the transmembrane potential away from positive millivolt (mV) values and toward the resting potential.

**residual volume:** Amount of air remaining in the lungs after maximum forced expiration.

**respiration:** Exchange of gases between living cells and the environment; includes pulmonary ventilation, external respiration, internal respiration, and cellular respiration.

**respiratory minute volume:** The amount of air moved in and out of the respiratory system each minute.

**resting potential:** The transmembrane potential of a normal cell under homeostatic conditions.

**rete (RĒ-tē):** An interwoven network of blood vessels or passageways.

**reticular activating center:** Mesencephalic portion of the reticular formation responsible for arousal and the maintenance of consciousness.

**reticular formation:** Diffuse network of gray matter that extends the entire length of the brain stem.

**reticulocytes (re-TIK-ū-lō-sits):** The last stage in the maturation of red blood cells; normally the youngest red blood cells present in the blood.

**reticulospinal tracts:** Descending tracts that carry involuntary motor commands issued by neurons of the reticular formation.

**retina:** The innermost layer of the eye, lining the vitreous chamber; also known as the neural tunic.

**retinene (RET-i-nēn):** Visual pigment derived from vitamin A.

**retraction:** Movement posteriorly in the horizontal plane.

**retroflexion (re-trō-FLEK-shun):** A posterior tilting of the uterus that has no clinical significance.

**retrograde flow (RET-rō-grad):** Transport of materials from the terminal arborization to the soma of a neuron.

**retroperitoneal (re-trō-per-i-tō-NĒ-al):** Situated behind or outside of the peritoneal cavity.

**reverberation:** Positive feedback along a chain of neurons, so that they remain active once stimulated.

**rheumatism (ROO-muh-tizm):** A condition characterized by pain in muscles, tendons, bones, or joints.

**Rh factor:** Agglutinin that may be present (Rh-positive) or absent (Rh-negative) from the surfaces of red blood cells.

**rhizotomy:** Surgical transection of a dorsal root, usually performed to relieve pain.

**rhodopsin (rō-DOP-sin):** The visual pigment found in the membrane discs of the distal segments of rods.

**rhythmicity center:** Medullary center responsible for the basic pace of respiration; includes inspiratory and expiratory centers.

**ribonucleic acid (RNA) (rī-bō-nū-KLĀ-ik):** A nucleic acid consisting of a chain of nucleotides that contain the sugar ribose and the nitrogen bases adenine, guanine, cytosine, and uracil.

**ribosome:** An organelle containing rRNA and proteins that is essential to mRNA translation and protein synthesis.

**right lymphatic duct:** Lymphatic vessel delivering lymph from the right side of the head, neck, and chest to the venous system via the right subclavian vein.

**rigor mortis:** Extended muscular contraction and rigidity that occurs after death, as the result of calcium ion release from the SR and the exhaustion of cytoplasmic ATP reserves.

**rod:** Photoreceptor responsible for vision under dimly lit conditions.

**rostral:** Toward the nose; used when referring to relative position inside the skull.

**rough endoplasmic reticulum (RER):** A membranous organelle that is a site of protein synthesis and storage.

**rouleau/rouleaux (roo-LŌ):** A stack of red blood cells.

**round window:** An opening in the bony labyrinth of the inner ear that exposes the membranous wall of the scala tympani to the air of the middle ear cavity.

**rubrospinal tracts:** Descending tracts that carry involuntary motor commands issued by the red nucleus of the mesencephalon.

**Ruffini corpuscles (ru-FĒ-nē):** Receptors sensitive to tension and stretch in the dermis of the skin.

**rugae (ROO-gē):** Mucosal folds in the lining of the empty stomach that disappear as gastric distension occurs.

**sacculle (SAK-ūl):** A portion of the vestibular apparatus of the inner ear, responsible for static equilibrium.

**sagittal plane:** Sectional plane that divides the body into left and right portions.

**salivatory nucleus (SAL-i-va-tōr-ē):** Medullary nucleus that controls the secretory activities of the salivary glands.

**saltatory conduction:** Relatively rapid conduction of a nerve impulse between successive nodes of a myelinated axon.

**sarcolemma:** The cell membrane of a muscle cell.

**sarcoma (sar-KŌ-ma):** A tumor of connective tissues.

**sarcomere:** The smallest contractile unit of a striated muscle cell.

**sarcoplasm:** The cytoplasm of a muscle cell.

**scala media:** The central, endolymph-filled chamber of the inner ear; see **cochlear duct**.

**scala tympani:** The perilymph-filled chamber of the inner ear below the basilar membrane; pressure changes here distort the round window.

**scala vestibuli:** The perilymph-filled chamber of the inner ear above the vestibular membrane; pressure changes here result from distortions of the oval window.

**scapula (SKAP-ū-la):** The shoulder blade.

**scar tissue:** Thick, collagenous tissue that forms at an injury site.

**Schlemm, canal of:** Passageway that delivers aqueous humor from the anterior chamber of the eye to the venous circulation.

**Schwann cells:** Glial cells responsible for the neurilemma that surrounds axons in the PNS.

**sciatica (sī-AT-i-ka):** Pain resulting from compression of the roots of the sciatic nerve.

**sciatic nerve (sī-AT-ik):** Nerve innervating the posteromedial portions of the thigh and lower leg.

**sclera (SKLER-a):** The fibrous, outer layer of the eye forming the white area of the anterior surface; a portion of the fibrous tunic of the eye.

**sclerosis:** A hardening and thickening that often occurs secondary to tissue inflammation.

**scoliosis (skō-lē-Ō-sis):** An abnormal, exaggerated lateral curvature of the spine.

**scrotum (SKRŌ-tum):** Loose-fitting, fleshy pouch that encloses the testes of the male.

**sebaceous glands (se-BĀ-shus):** Glands that secrete sebum, usually associated with hair follicles.

**sebum (SĒ-bum):** A waxy secretion that coats the surfaces of hairs.

**secondary sex characteristics:** Physical characteristics that appear at puberty in response to sex hormones, but are not involved in the production of gametes.

**secretin (sē-KRĒ-tin):** Duodenal hormone that stimulates pancreatic buffer secretion and inhibits gastric activity.

**semen (SĒ-men):** Fluid ejaculate containing spermatozoa and the secretions of accessory glands of the male reproductive tract.

**semicircular ducts:** Tubular components of the vestibular apparatus responsible for dynamic equilibrium.

**semilunar valve:** A three-cusped valve guarding the exit from one of the cardiac ventricles; includes the pulmonary and aortic valves.

**seminal glands (SEM-i-nal):** Glands of the male reproductive tract that produce roughly 60 percent of the volume of semen. Also known as **seminal vesicles**.

**seminiferous tubules (sem-in-IF-er-us):** Coiled tubules where sperm production occurs in the testis.

**senescence:** Aging.

**septae (SEP-tē):** Partitions that subdivide an organ.

**serosa:** See **serous membrane**.

**serotonin (ser-ō-TŌ-nin):** A neurotransmitter in the CNS; a compound that enhances inflammation, released by activated mast cells and basophils.

**serous cell:** A cell that produces a watery secretion containing high concentrations of enzymes.

**serous membrane:** A squamous epithelium and the underlying loose connective tissue; the lining of the pericardial, pleural, and peritoneal cavities.

**serum:** Blood plasma from which clotting agents have been removed.

**sesamoid bone:** A bone that forms in a tendon.

**sigmoid colon (SIG-moid):** The S-shaped 8-inch portion of the colon between the descending colon and the rectum.

**sign:** A clinical term for objective evidence of the presence of a disease.

**simple epithelium:** An epithelium containing a single layer of cells above the basement membrane.

**sinus:** A chamber or hollow in a tissue; a large, dilated vein.

**sinusitis:** Inflammation of a nasal sinus.

**sinusoid (SĪ-nus-oid):** An extensive network of vessels found in the liver, adrenal cortex, spleen, and pancreas; similar in histological structure to capillaries.

**skeletal muscle:** A contractile organ of the muscular system.

**skeletal muscle tissue:** Contractile tissue dominated by skeletal muscle fibers; characterized as striated, voluntary muscle.

**sliding filament theory:** The concept that a sarcomere shortens as the thick and thin filaments slide past one another.

**small intestine:** The duodenum, jejunum, and ileum; the digestive tract between the stomach and large intestine.

**smegma (SMEG-ma):** Secretion of the preputial glands of the penis or clitoris.

**smooth endoplasmic reticulum:** Membranous organelle where lipid and carbohydrate synthesis and storage occur.

**smooth muscle tissue:** Muscle tissue found in the walls of many visceral organs; characterized as nonstriated, involuntary muscle.

**soft palate:** Fleshy posterior extension of the hard palate, separating the nasopharynx from the oral cavity.

**sole:** The inferior surface of the foot.

**solute:** Material dissolved in a solution.

**solution:** A fluid containing dissolved materials.

**solvent:** The fluid component of a solution.

**soma (SŌ-ma):** Body.

**somatic (sō-MAT-ik):** Pertaining to the body.

**somatic nervous system:** System of nerve fibers that run from the central nervous system to the muscles of the skeleton.

**somatomedins:** Compounds stimulating tissue growth, released by the liver following GH secretion.

**somatostatin:** GH-IH, a hypothalamic regulatory hormone that inhibits GH secretion by the anterior pituitary.

**somatotropin:** Growth hormone produced by the anterior pituitary in response to GH-RH.

**sperm:** See **spermatozoon/spermatozoa**.

**spermatic cords:** Spermatic vessels, nerves, lymphatics, and the ductus deferens, extending between the testes and the proximal end of the inguinal canal.

**spermatids (SPER-ma-tidz):** The product of meiosis in the male, cells that differentiate into spermatozoa.

**spermatocyte (sper-MAT-ō-sit):** Cells of the seminiferous tubules that are engaged in meiosis.

**spermatogenesis (sper-ma-tō-JEN-e-sis):** Sperm production.

**spermatogonia (sper-ma-tō-GŌ-nē-a):** Stem cells whose mitotic divisions give rise to other stem cells and spermatocytes.

## Glossary of Key Terms

- spermatozoon/spermatozoa (sper-ma-tō-ZŌ-on):** A sperm cell, the male gamete.
- spermicide:** Compound toxic to sperm cells, sometimes used as a contraceptive method.
- spermiogenesis:** The process of spermatid differentiation that leads to the formation of physically mature spermatozoa.
- sphincter (SFINK-ter):** Muscular ring that contracts to close the entrance or exit of an internal passageway.
- spina bifida (SPĪ-na BI-fi-da):** A developmental abnormality in which the vertebral laminae fail to unite at the midline; the entire vertebral column and skull may be affected in severe cases.
- spinal meninges (men-IN-jēz):** Specialized membranes that line the vertebral canal and provide protection, stabilization, nutrition, and shock absorption to the spinal cord.
- spinal nerve:** One of 31 pairs of nerves that originate on the spinal cord from anterior and posterior roots.
- spindle apparatus:** A muscle spindle (intrafusal fiber) and its sensory and motor innervation.
- spinocerebellar tracts:** Ascending tracts carrying sensory information to the cerebellum.
- spinothalamic tracts:** Ascending tracts carrying poorly localized touch, pressure, pain, vibration, and temperature sensations to the thalamus.
- spinous process:** Prominent posterior projection of a vertebra, formed by the fusion of two laminae.
- splanchnic nerves:** Preganglionic (myelinated) sympathetic nerves that end in one of the collateral ganglia.
- spleen:** Lymphoid organ important for red blood cell phagocytosis, immune response, and lymphocyte production.
- splenectomy (splĒ-NEK-tō-mē):** Surgical removal of the spleen.
- spongy bone:** Trabecular bone, composed of a network of bony struts. Also termed *cancellous* (KAN-se-lus) *bone*.
- sprain:** Forceful distortion of an articulation that produces damage to the capsule, ligaments, or tendons but not dislocation.
- sputum (SPŪ-tum):** Viscous mucus ejected from the mouth after transport to the pharynx by the mucus escalator of the respiratory tract.
- squama:** A broad, flat surface.
- squamous (SKWĀ-mus):** Flattened.
- squamous epithelium:** An epithelium whose superficial cells are flattened and platelike.
- stapedius (sta-PĒ-dē-us):** A muscle of the middle ear whose contraction tenses the auditory ossicles and reduces the forces transmitted to the oval window.
- stapes (STĀ-pēz):** The auditory ossicle attached to the tympanic membrane.
- statoconia (otoliths) (sta-tō-KŌ-nē-a):** Aggregations of calcium carbonate crystals in a gelatinous membrane that sits above one of the maculae of the vestibular apparatus.
- stenosis (ste-NŌ-sis):** A constriction or narrowing of a passageway.
- stereocilia:** Elongate microvilli characteristic of the epithelium of the epididymis and portions of the ductus deferens.
- steroid:** A ring-shaped lipid structurally related to cholesterol.
- stimulus:** An environmental alteration that produces a change in cellular activities; often used to refer to events that alter the transmembrane potentials of excitable cells.
- stratified:** Containing several layers.
- stratum (STRĀ-tum):** Layer.
- stratum basale (BASA-le):** The deepest epidermal layer.
- stratum corneum (KŌR-nē-um):** Layers of flattened, dead, keratinized cells covering the epidermis of the skin.
- stretch receptors:** Sensory receptors that respond to stretching of the surrounding tissues.
- stroma:** The connective tissue framework of an organ, as distinguished from the functional cells (parenchyma) of that organ.
- subarachnoid space:** Meningeal space containing CSF; the area between the arachnoid mater and the pia mater.
- subclavian (sub-KLĀ-vē-an):** Pertaining to the region under the clavicle.
- subcutaneous layer:** The layer of loose connective tissue below the dermis; also called the **hypodermis** or **superficial fascia**.
- sublingual salivary glands (sub-LING-gwal):** Mucus-secreting salivary glands situated under the tongue.
- subluxation (sub-luks-A-shun):** A partial dislocation of a joint.
- submandibular salivary glands:** Salivary glands nestled in depressions on the medial surfaces of the mandible; salivary glands that produce a mixture of mucins and enzymes (salivary amylase).
- submucosa (sub-mū-KŌ-sa):** Region between the muscularis mucosae and the muscularis externa.
- submucosal glands:** Mucous glands in the submucosa of the duodenum.
- subserous fascia:** Loose connective tissue layer beneath the serous membrane lining the ventral body cavity.
- substantia nigra:** A nucleus in the midbrain that is responsible for negative feedback control of the basal nuclei.
- substrate:** A participant (product or reactant) in an enzyme-catalyzed reaction.
- sulcus (SUL-kus):** A groove or furrow.
- summation:** Temporal or spatial addition of stimuli.
- superficial fascia:** See **subcutaneous layer**.
- superior:** Directional reference meaning above.
- superior vena cava:** The vein that carries blood from the parts of the body above the heart to the right atrium.
- supination (su-pi-NĀ-shun):** Rotation of the forearm so that the palm faces anteriorly.
- supine (soo-PĪN):** Lying face up, with palms facing anteriorly.
- suppressor T cells:** Lymphocytes that inhibit B cell activation and plasmocyte secretion of antibodies.
- suprarenal cortex:** Superficial portion of adrenal gland that produces steroid hormones; also called the *adrenal cortex*.
- suprarenal gland:** Small endocrine gland secreting steroids and catecholamines, located superior to each kidney; also called the *adrenal gland*.
- suprarenal medulla:** Core of the adrenal gland (also called the *adrenal medulla*); a modified sympathetic ganglion that secretes catecholamines into the blood following sympathetic activation.
- surfactant (sur-FAK-tant):** Lipid secretion that coats alveolar surfaces and prevents their collapse.
- sustentacular cells (sus-ten-TAK-ū-lar):** Supporting cells of the seminiferous tubules of the testis, responsible for the differentiation of spermatids, the maintenance of the blood–testis barrier, and the secretion of inhibin.
- sutural bones:** Irregular bones that form in fibrous tissue between the flat bones of the developing cranium; also called **Wormian bones**.
- suture:** Fibrous joint between flat bones of the skull.
- sympathectomy (sim-path-EK-tō-mē):** Transection of the sympathetic innervation to a region.
- sympathetic division:** Division of the autonomic nervous system responsible for “fight or flight” reactions; concerned primarily with the elevation of metabolic rate and increased alertness.
- symphysis:** A fibrous amphiarthrosis, such as those between adjacent vertebrae or between the pubic bones of the coxae.
- symptom:** Clinical term for an abnormality of function due to the presence of disease.
- synapse (SIN-aps):** Site of communication between a nerve cell and some other cell; if the other cell is not a neuron, the term *neuroeffector junction* is often used.
- synarthrosis (sin-ar-THRŌ-sis):** A joint that does not permit relative movement between the articulating elements.
- synchondrosis (sin-kon-DRŌ-sis):** A cartilaginous synarthrosis, such as the articulation between the epiphysis and diaphysis of a growing bone.
- syncope:** A sudden, transient loss of consciousness; a faint.
- syncytial trophoblast (sin-SISH-al):** Multinucleate cytoplasmic layer that covers the blastocyst; the layer responsible for uterine erosion and implantation.
- syncytium:** A multinucleate mass of cytoplasm, produced by the fusion of cells or repeated mitoses without cytokinesis.
- syndesmosis (sin-dez-MŌ-sis):** A fibrous amphiarthrosis.
- syndrome:** A discrete set of symptoms that occur together.
- syneresis (si-NER-e-sis):** Clot retraction.
- synergist (SIN-er-jist):** A muscle that assists a prime mover in performing its primary action.
- synostosis (sin-os-TŌ-sis):** A synarthrosis formed through the fusion of the articulating elements.
- synovial cavity (sin-Ō-vē-al):** Fluid-filled chamber in a diarthrotic joint.
- synovial fluid:** Substance secreted by synovial membranes that lubricates joints.
- synovial membrane:** An incomplete layer of fibroblasts confronting the synovial cavity, plus the underlying loose connective tissue.
- synthesis (SIN-the-sis):** Manufacture; anabolism.
- system:** An interacting group of organs that performs one or more specific functions.
- systemic circuit:** Vessels between the aortic semilunar valve and the entrance to the right atrium; the circulatory system other than vessels of the pulmonary circuit.
- systole (SIS-tō-le):** The period of cardiac contraction.
- systolic pressure:** Peak arterial pressure measured during ventricular systole.
- tachycardia (tak-ē-KAR-dē-a):** An abnormally rapid heart rate.
- tactile:** Pertaining to the sense of touch.
- tactile corpuscles:** Touch receptors located within dermal papillae adjacent to the basement membrane of the epidermis; also called *Meissner’s corpuscles*.
- tactile discs:** Sensory nerve endings that contact special receptors called Merkel cells, located within the deeper layers of the epidermis; also called *Merkel’s discs*.
- taeniae coli (TE-nē-a KŌ-li):** Three longitudinal bands of smooth muscle in the muscularis externa of the colon.
- tarsus:** The ankle.
- T cells:** Lymphocytes responsible for cellular immunity, and for the coordination and regulation of the immune response; include regulatory T cells (helpers and suppressors) and cytotoxic (killer) T cells.
- tears:** Fluid secretions of the lacrimal glands that bathe the anterior surfaces of the eyes.
- tectorial membrane (tek-TŌR-ē-al):** Gelatinous membrane suspended over the hair cells of the organ of Corti.
- tectospinal tracts:** Descending extrapyramidal tracts carrying involuntary motor commands issued by the colliculi.
- tectum:** The roof of the mesencephalon of the brain.
- telencephalon (tel-en-SEF-a-lon):** The forebrain or cerebrum, including the cerebral hemispheres, the internal capsule, and the cerebral nuclei.
- telophase (TEL-ŏ-fāz):** The final stage of mitosis, characterized by the disappearance of the spindle apparatus, the reappearance of the nuclear membrane and the disappearance of the chromosomes, and the completion of cytokinesis.
- temporal:** Pertaining to time (temporal summation) or pertaining to the temples (temporal bone).
- tendinitis:** Painful inflammation of a tendon.
- tendon:** A collagenous band that connects a skeletal muscle to an element of the skeleton.
- tendon organ:** Receptor sensitive to tension in a tendon.
- tentorium cerebelli (ten-TŌR-ē-um ser-e-BEL-ē):** Dural partition that separates the cerebral hemispheres from the cerebellum.

## Glossary of Key Terms

- teratogen (TER-a-tō-jen):** Stimulus that causes developmental defects.
- teres:** Long and round.
- terminal:** Toward the end.
- terminal arborizations:** Terminal axonal branches that end in terminal boutons; also termed *telodendria*.
- terminal bouton:** A structure found where one neuron synapses with another. Also termed a *synaptic knob*.
- tertiary follicle:** A mature ovarian follicle containing a large, fluid-filled chamber.
- testes (TES-tēz):** The male gonads, sites of gamete production and hormone secretion.
- testosterone (tes-TOS-ter-ōn):** The principal androgen produced by the interstitial cells of the testes.
- tetanic contraction:** Sustained skeletal muscle contraction due to repeated stimulation at a frequency that prevents muscle relaxation.
- tetanus:** A tetanic contraction; also used to refer to a disease state resulting from the stimulation of muscle cells by bacterial toxins.
- tetrad (TET-rad):** Paired, duplicated chromosomes visible at the start of meiosis I.
- tetraiodothyronine (tet-ra-i-ō-dō-THĪ-rō-nēn):** T<sub>4</sub>, or thyroxine, a thyroid hormone.
- thalamus:** The walls of the diencephalon.
- thalassemia (thal-ah-SĒ-mē-uh):** A hereditary disorder affecting hemoglobin synthesis and producing anemia.
- theory:** A hypothesis that makes valid predictions, as demonstrated by evidence that is testable, unbiased, and repeatable.
- therapy:** Treatment of disease.
- thermogenesis (ther-mō-JEN-e-sis):** Heat production.
- thermography:** Diagnostic procedure involving the production of an infrared image.
- thermoreception:** Sensitivity to temperature changes.
- thermoregulation:** Homeostatic maintenance of body temperature.
- thick filament:** A myosin filament in a skeletal or cardiac muscle cell.
- thin filament:** An actin filament in a skeletal or cardiac muscle cell.
- thoracoabdominal pump (thō-ra-kō-ab-DOM-i-nal):** Changes in the intrapleural pressures during the respiratory cycle that assist the venous return to the heart.
- thoracolumbar division (thor-a-kō-LUM-bar):** The sympathetic division of the ANS.
- thorax:** The chest.
- threshold:** The transmembrane potential at which an action potential begins.
- thrombin (THROM-bin):** Enzyme that converts fibrinogen to fibrin.
- thrombocytes (THROM-bō-sits):** See **platelets**.
- thrombocytopenia (throm-bō-si-tō-PĒ-nē-a):** Abnormally low platelet count in the circulating blood.
- thromboembolism (throm-bō-EM-bō-lizm):** Occlusion of a blood vessel by a drifting blood clot.
- thromboplastin:** Enzyme that converts prothrombin to thrombin; enzyme formed by the intrinsic or extrinsic clotting pathways.
- thrombus:** A blood clot.
- thymic corpuscles:** Aggregations of epithelial cells in the thymus whose functions are unknown. Also termed *Hassall's corpuscles*.
- thymine:** A pyrimidine found in DNA.
- thymosin (thi-MŌ-sin):** Thymic hormone essential to the development and differentiation of T cells.
- thymus:** Lymphoid organ, site of T cell formation.
- thyroglobulin (thi-rō-GLOB-ū-lin):** Circulating transport globulin that binds thyroid hormones.
- thyroid gland:** Endocrine gland whose lobes sit lateral to the thyroid cartilage of the larynx.
- thyroid hormones:** Thyroxine (T<sub>4</sub>) and triiodothyronine (T<sub>3</sub>), hormones of the thyroid gland; hormones that stimulate tissue metabolism, energy utilization, and growth.
- thyroid-stimulating hormone (TSH):** Anterior pituitary hormone that triggers the secretion of thyroid hormones by the thyroid gland.
- thyroxine (TX) (thi-ROKS-ēn):** A thyroid hormone (T<sub>4</sub>).
- tibia (TIB-ē-a):** The large, medial bone of the leg.
- tidal volume:** The volume of air moved in and out of the lungs during a normal quiet respiratory cycle.
- tissue:** A collection of specialized cells and cell products that perform a specific function.
- tonsil:** A lymphoid nodule beneath the epithelium of the pharynx; includes the palatine, pharyngeal, and lingual tonsils.
- topical:** Applied to the body surface.
- trabecula (tra-BEK-ū-la):** A connective tissue partition that subdivides an organ.
- trabeculae carneae (tra-BEK-ū-lē CAR-nē-ē):** Muscular ridges projecting from the walls of the ventricles of the heart.
- trachea (TRĀ-kē-a):** The windpipe, an airway extending from the larynx to the primary bronchi.
- tracheal ring:** C-shaped supporting cartilage of the trachea.
- tracheostomy (trā-kē-OS-tō-mē):** Surgical opening of the anterior tracheal wall to permit airflow.
- trachoma:** An infectious disease of the conjunctiva and cornea.
- tract:** A bundle of axons inside the CNS.
- tractotomy:** The surgical transection of a tract, sometimes used to relieve pain.
- transcription:** The encoding of genetic instructions on a strand of mRNA.
- transdermal medication:** Administration of medication by absorption through the skin.
- transection:** To sever or cut in the transverse plane.
- transfusion:** Transfer of blood from a donor directly into the bloodstream of another person.
- transient ischemic attack:** A temporary loss of consciousness due to the occlusion of a small blood vessel in the brain.
- translation:** The process of peptide formation using the instructions carried by an mRNA strand.
- transmembrane potential:** The potential difference, in millivolts, measured across the cell membrane; a potential difference that results from the uneven distribution of positive and negative ions across a cell membrane.
- transudate (TRANS-ū-dāt):** Fluid that diffuses across a serous membrane and lubricates opposing surfaces.
- trappe (TREP-ē):** "Staircase" increase in tension production following repeated stimulation of a muscle, even though the muscle is allowed to complete each relaxation phase.
- triad (liver):** The combination of branches of the hepatic duct, the hepatic portal vein, and the hepatic artery, found at each corner of a liver lobule.
- triad (muscle cell):** The combination of a T tubule and two cisternae of the sarcoplasmic reticulum.
- tricuspid valve (tri-KUS-pid):** The right atrioventricular valve that prevents backflow of blood into the right atrium during ventricular systole.
- trigeminal nerve (tri-JEM-i-nal):** Cranial nerve V, responsible for providing sensory information from the lower portions of the face, including the upper and lower jaws, and delivering motor commands to the muscles of mastication.
- triglyceride (tri-GLIS-e-rid):** A lipid composed of a molecule of glycerol attached to three fatty acids.
- trigone (TRĪ-gōn):** Triangular region of the bladder bounded by the exits of the ureters and the entrance to the urethra.
- triiodothyronine:** T<sub>3</sub>, one of the thyroid hormones.
- trisomy:** The abnormal possession of three copies of a chromosome; trisomy 21 is responsible for Down syndrome.
- trochanters (trō-KAN-terz):** Large processes near the head of the femur.
- trochlea (TRŌK-lē-ā):** A pulley.
- trochlear nerve (TRŌK-lē-ar):** Cranial nerve IV, controlling the superior oblique muscle of the eye.
- trophoblast (TRŌ-fō-blast):** Superficial layer of the blastocyst that will be involved with implantation, hormone production, and placenta formation.
- troponin/tropomyosin (TRŌ-pō-nin) (trō-pō-MĪ-ō-sin):** Proteins on the thin filaments that mask the active sites in the absence of free calcium ions.
- trunk:** The thoracic and abdominopelvic regions.
- trypsin (TRIP-sin):** One of the pancreatic proteases.
- trypsinogen:** The inactive proenzyme secreted by the pancreas and converted to trypsin in the duodenum.
- T tubules:** Transverse, tubular extensions of the sarcolemma that extend deep into the sarcoplasm to contact cisternae of the sarcoplasmic reticulum.
- tuberculum (too-BER-kū-lum):** A small, localized elevation on a bony surface.
- tuberosity:** A large, roughened elevation on a bony surface.
- tubulin:** Protein subunit of microtubules.
- tumor:** A tissue mass formed by the abnormal growth and replication of cells.
- tunica (TU-ni-ka):** A layer or covering; in blood vessels: t. externa, the outermost layer of connective tissue fibers that stabilizes the position of the vessel; t. intima, the innermost layer, consisting of the endothelium plus an underlying elastic membrane; t. media, a middle layer containing collagen, elastin, and smooth muscle fibers in varying proportions.
- turbinates:** See **concha/conchae**.
- T wave:** Deflection of the ECG corresponding to ventricular repolarization.
- twitch:** A single contraction/relaxation cycle in a skeletal muscle.
- tympanic membrane (tim-PAN-ik):** Membrane that separates the external acoustic meatus from the middle ear; membrane whose vibrations are transferred to the auditory ossicles and ultimately to the oval window; the "eardrum."
- ulcer:** An area of epithelial sloughing associated with damage to the underlying connective tissues and vasculature.
- ultrasound:** Diagnostic visualization procedure that uses high-frequency sound waves.
- umbilical cord (um-BIL-i-ka):** Connecting stalk between the fetus and the placenta; contains the allantois, the umbilical arteries, and the umbilical vein.
- umbilicus:** The navel.
- unicellular gland:** Goblet cell; mucous cell.
- unipennate muscle:** A muscle whose fibers are all arranged on one side of the tendon.
- unipolar neuron:** A sensory neuron whose soma lies in a dorsal root ganglion or a sensory ganglion of a cranial nerve.
- unmyelinated axon:** Axon whose neurilemma does not contain myelin, and where continuous conduction occurs.
- urachus (Ū-ra-kus):** The middle umbilical ligament.
- uracil:** One of the pyrimidines characteristic of RNA.
- uremia (ū-RĒ-mē-a):** Abnormal condition caused by impaired kidney function, characterized by the retention of wastes and the disruption of many other organ systems.
- ureters (ū-RĒ-terz):** Muscular tubes, lined by transitional epithelium, that carry urine from the renal pelvis to the urinary bladder.
- urethra (ū-RĒTH-ra):** A muscular tube that carries urine from the urinary bladder to the exterior.
- urethritis:** Inflammation of the urethra.
- urinalysis:** Analysis of the physical and chemical characteristics of urine.
- urinary bladder:** Muscular, distensible sac that stores urine prior to micturition.
- urination:** The voiding of urine; micturition.
- uterine (menstrual) cycle:** Cyclical changes in the uterine lining that occur in reproductive-age women. Each uterine cycle, which occurs in response to circulating hormones (see **ovarian cycle**), lasts 21–35 days.

## Glossary of Key Terms

- uterus (Ū-ter-us):** Muscular organ of the female reproductive tract where implantation, placenta formation, and fetal development occur.
- utricle (Ū-tre-kl):** The largest chamber of the vestibular apparatus; contains a macula important for static equilibrium.
- uvea:** The vascular tunic of the eye.
- uvula (Ū-vū-la):** A dangling, fleshy extension of the soft palate.
- vagina (va-JĪ-na):** A muscular tube extending between the uterus and the vestibule.
- vagus nerve:** N X, the cranial nerve responsible for most (75 percent) of the parasympathetic preganglionic output from the CNS.
- varicose veins (VAR-i-kōs):** Distended superficial veins.
- vasa vasorum:** Blood vessels that supply the walls of large arteries and veins.
- vascular:** Pertaining to blood vessels.
- vascularity:** The blood vessels in a tissue.
- vascular spasm:** Contraction of the wall of a blood vessel at an injury site, a process that may slow the rate of blood loss.
- vasoconstriction:** A reduction in the diameter of arterioles due to contraction of smooth muscles in the media of a blood vessel; an event that elevates peripheral resistance, and that may occur in response to local factors, through the action of hormones, or from stimulation of the vasomotor center.
- vasodilation (vaz-ō-dī-LĀ-shun):** An increase in the diameter of arterioles due to the relaxation of smooth muscles in the media of a blood vessel; an event that reduces peripheral resistance, and that may occur in response to local factors, through the action of hormones, or following decreased stimulation of the vasomotor center.
- vasomotion:** Alterations in the pattern of blood flow through a capillary bed in response to changes in the local environment.
- vasomotor center:** Medullary center whose stimulation produces vasoconstriction and an elevation in peripheral resistance.
- vein:** Blood vessel carrying blood from a capillary bed toward the heart.
- venae cavae (VĒ-nē CĀ-vē):** The major veins delivering systemic blood to the right atrium.
- ventilation:** Air movement in and out of the lungs.
- ventilatory rate:** The respiratory rate.
- ventral:** Pertaining to the anterior surface.
- ventricle (VEN-tri-kl):** One of the large, muscular pumping chambers of the heart that discharges blood into the pulmonary or systemic circuits.
- venules (VEN-ūlz):** Thin-walled veins that receive blood from capillaries.
- vermis (VER-mis):** Midsagittal band of neural cortex on the surface of the cerebellum.
- vertebral canal:** Passageway that encloses the spinal cord, a tunnel bounded by the neural arches of adjacent vertebrae.
- vertebral column:** The cervical, thoracic, and lumbar vertebrae, the sacrum, and the coccyx.
- vertebrochondral ribs:** Ribs 8–10, false ribs connected to the sternum by shared cartilaginous bars.
- vertebrosternal ribs:** Ribs 1–7, true ribs connected to the sternum by individual cartilaginous bars.
- vertigo:** Dizziness.
- vesicle:** A membranous sac in the cytoplasm of a cell.
- vesicular synapse:** The most abundant neuronal synapse. Also termed a *chemical synapse*.
- vestibular folds:** Mucosal folds in the laryngeal walls that do not play a role in sound production; the false vocal cords.
- vestibular membrane:** The membrane that separates the scala media from the scala vestibuli of the inner ear.
- vestibular nucleus:** Processing center for sensations arriving from the vestibular apparatus; located near the border between the pons and medulla oblongata.
- vestibule (VES-ti-būl):** A chamber; in the inner ear, the term refers to the utricle, saccule, and semicircular ducts; also refers to (1) a region of the female external genitalia, (2) the space within the fleshy portion of the nose between the nostrils and the external nares, and (3) the space between the ventricular folds and the vocal folds of the larynx.
- vestibulospinal tracts:** Descending tracts of the extrapyramidal system, carrying involuntary motor commands issued by the vestibular nucleus to stabilize the position of the head.
- villus:** A slender projection of the mucous membrane of the small intestine.
- virus:** A pathogenic microorganism.
- viscera:** Organs in the ventral body cavity.
- visceral:** Pertaining to viscera or their outer coverings.
- visceral smooth muscle tissue:** Smooth muscle tissue forming sheets or layers in the walls of visceral organs; the cells may not be innervated, and the layers often show automaticity (rhythmic contractions).
- viscosity:** The resistance to flow exhibited by a fluid, due to molecular interactions within the fluid.
- viscous:** Thick, syrupy.
- vital capacity:** The maximum amount of air that can be moved in or out of the respiratory system; the sum of the inspiratory reserve, the expiratory reserve, and the tidal volume.
- vitamin:** An essential organic nutrient that functions as a coenzyme in vital enzymatic reactions.
- vitreous humor:** Gelatinous mass in the vitreous chamber of the eye.
- vocal folds:** Folds in the laryngeal wall containing elastic ligaments whose tension can be voluntarily adjusted; the true vocal cords, responsible for phonation.
- voluntary:** Controlled by conscious thought processes.
- ulva (VUL-va):** The female pudendum (external genitalia).
- Wallerian degeneration:** Disintegration of an axon and its myelin sheath distal to an injury site.
- white blood cells:** Leukocytes; the granulocytes and agranulocytes of the blood.
- white matter:** Regions inside the CNS that are dominated by myelinated axons.
- white ramus:** A nerve bundle containing the myelinated preganglionic axons of sympathetic motor neurons en route to the sympathetic chain or a collateral ganglion.
- Wormian bones:** See **sutural bones**.
- xiphoid process (ZĪ-foyd):** Slender, inferior extension of the sternum.
- Y chromosome:** The sex chromosome whose presence indicates that the individual is a genetic male.
- yolk sac:** One of the three extraembryonic membranes, composed of an inner layer of endoderm and an outer layer of mesoderm.
- Zeis, glands of (zis):** Enlarged sebaceous glands on the free edges of the eyelids.
- zona fasciculata (ZŌ-na fa-sik-ū-LĀ-ta):** Region of the adrenal cortex responsible for glucocorticoid secretion.
- zona glomerulosa (glō-mer-ū-LŌ-sa):** Region of the adrenal cortex responsible for mineralocorticoid secretion.
- zona pellucida (pel-LOO-si-da):** Region between a developing oocyte and the surrounding follicular cells of the ovary.
- zona reticularis (re-tik-ū-LAR-is):** Region of the adrenal cortex responsible for androgen secretion.
- zygote (ZĪ-gōt):** The fertilized ovum prior to the start of cleavage.



# Foundations

## *An Introduction to Anatomy*

Introduction

Microscopic Anatomy

Gross Anatomy

Other Perspectives on Anatomy

Levels of Organization

An Introduction to Organ Systems

The Language of Anatomy

### Student Learning Outcomes

After completing this chapter, you should be able to do the following:

- 1  Describe the reasons for studying anatomy and the relationships between structure and function.
- 2  Define the limits of microscopic anatomy and briefly describe cytology and histology.
- 3  Summarize various ways to approach gross anatomy.
- 4  Define and contrast the various specialties of anatomy.
- 5  Identify the major levels of organization in living organisms.
- 6  Summarize the basic life functions of an organism.
- 7  Identify the organ systems of the human body and contrast their major functions.
- 8  Utilizing anatomical terminology, describe body sections, body regions, relative positions, and the anatomical position.
- 9  Identify the major body cavities and describe their functions.

David Marchal/iStockphoto

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WE ARE ALL anatomists in our daily lives, if not in the classroom. For example, we rely on our memories of specific anatomical features to identify our friends and family, and we watch for subtle changes in body movement or position that give clues to what others are thinking or feeling. To be precise, anatomy is the study of external and internal structures and the physical relationships between body parts. But in practical terms, anatomy is the careful observation of the human body. Anatomical information provides clues about probable functions. Physiology is the study of function, and physiological mechanisms can be explained only in terms of the underlying anatomy. *All specific physiological functions are performed by specific anatomical structures.* For instance, filtering, warming, and humidifying inspired air are functions of the nasal cavity. The shapes of the bones projecting into the nasal cavity cause turbulence in the inhaled air, making it swirl against the moist lining. This contact warms and humidifies the air, and any suspended particles stick to the moist surfaces. In this way, the air is conditioned and filtered before it reaches the lungs.

The link between structure and function is always present, but not always understood. For example, the superficial anatomy of the heart was clearly described in the 15th century, but almost 200 years passed before the pumping action of the heart was demonstrated. On the other hand, many important cell functions were recognized decades before the electron microscope revealed the anatomical basis for those functions.

This course will discuss the anatomical structures and functions that make human life possible. The goals are to help you develop a three-dimensional understanding of anatomical relationships as well as prepare you for more advanced courses in anatomy, physiology, and related subjects, and to help you make informed decisions about your personal health.

## Microscopic Anatomy [Figure 1]

**Microscopic anatomy** considers structures that cannot be seen without magnification. The boundaries of microscopic anatomy, or *fine anatomy*, are established by the limits of the equipment used (**Figure 1**). A simple hand lens shows details that barely escape the naked eye, while an electron microscope demonstrates structural details that are less than one-millionth as large. As we proceed through the text, we will be considering details at all levels, from macroscopic to microscopic.

Microscopic anatomy can be subdivided into specialties that consider features within a characteristic range of sizes. **Cytology** (sī-TOL-ō-jē) analyzes the internal structure of **cells**, the smallest units of life. Living cells are composed of complex chemicals in various combinations, and our lives depend on the chemical processes occurring in the trillions of cells that form our body.

**Histology** (his-TOL-ō-jē) takes a broader perspective and examines **tissues**, groups of specialized cells and cell products that work together to perform specific functions. The cells in the human body can be assigned to four basic tissue types.

Tissues in combination form **organs** such as the heart, kidney, liver, and brain. Organs are anatomical units that have multiple functions. Many tissues and most organs are examined easily without a microscope, and at this point we cross the boundary from microscopic anatomy into gross anatomy.

## Gross Anatomy

**Gross anatomy**, or **macroscopic anatomy**, considers relatively large structures and features visible to the unaided eye. There are many ways to approach gross anatomy:

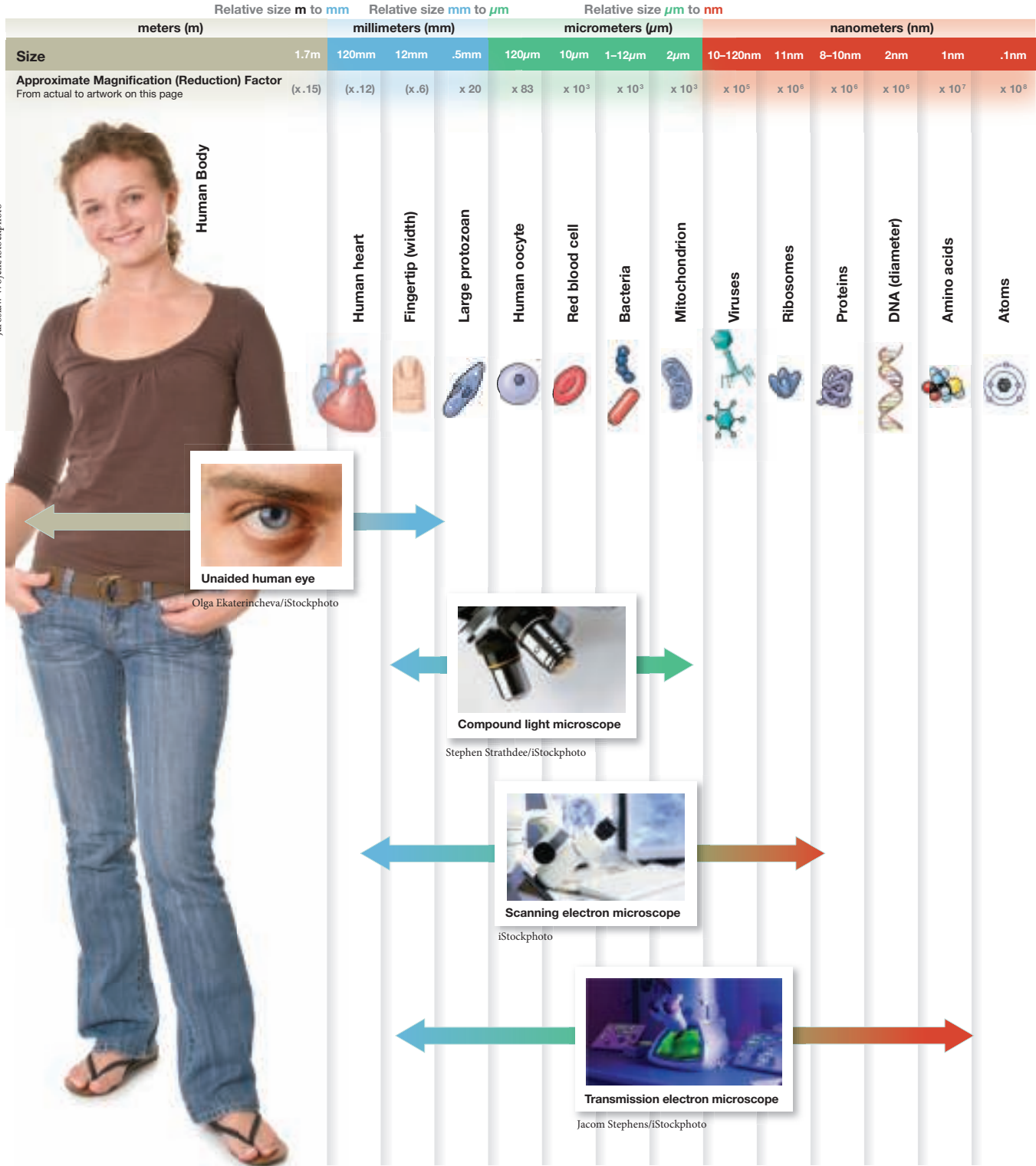
- *Surface anatomy* refers to the study of general form, or *morphology*, and superficial anatomical markings.
- *Regional anatomy* considers all of the superficial and internal features in a specific area of the body, such as the head, neck, or trunk. Advanced courses in anatomy often stress a regional approach because it emphasizes the spatial relationships among structures.
- *Systemic anatomy* considers the structure of major *organ systems*, such as the skeletal or muscular systems. Organ systems are groups of organs that function together to produce coordinated effects. For example, the heart, blood, and blood vessels form the *cardiovascular system*, which distributes oxygen and nutrients throughout the body. There are 11 organ systems in the human body, and they will be introduced later in the chapter. Introductory texts in anatomy use a systemic approach because it provides a framework for organizing information about important structural and functional patterns.

## Other Perspectives on Anatomy [Figure 2]

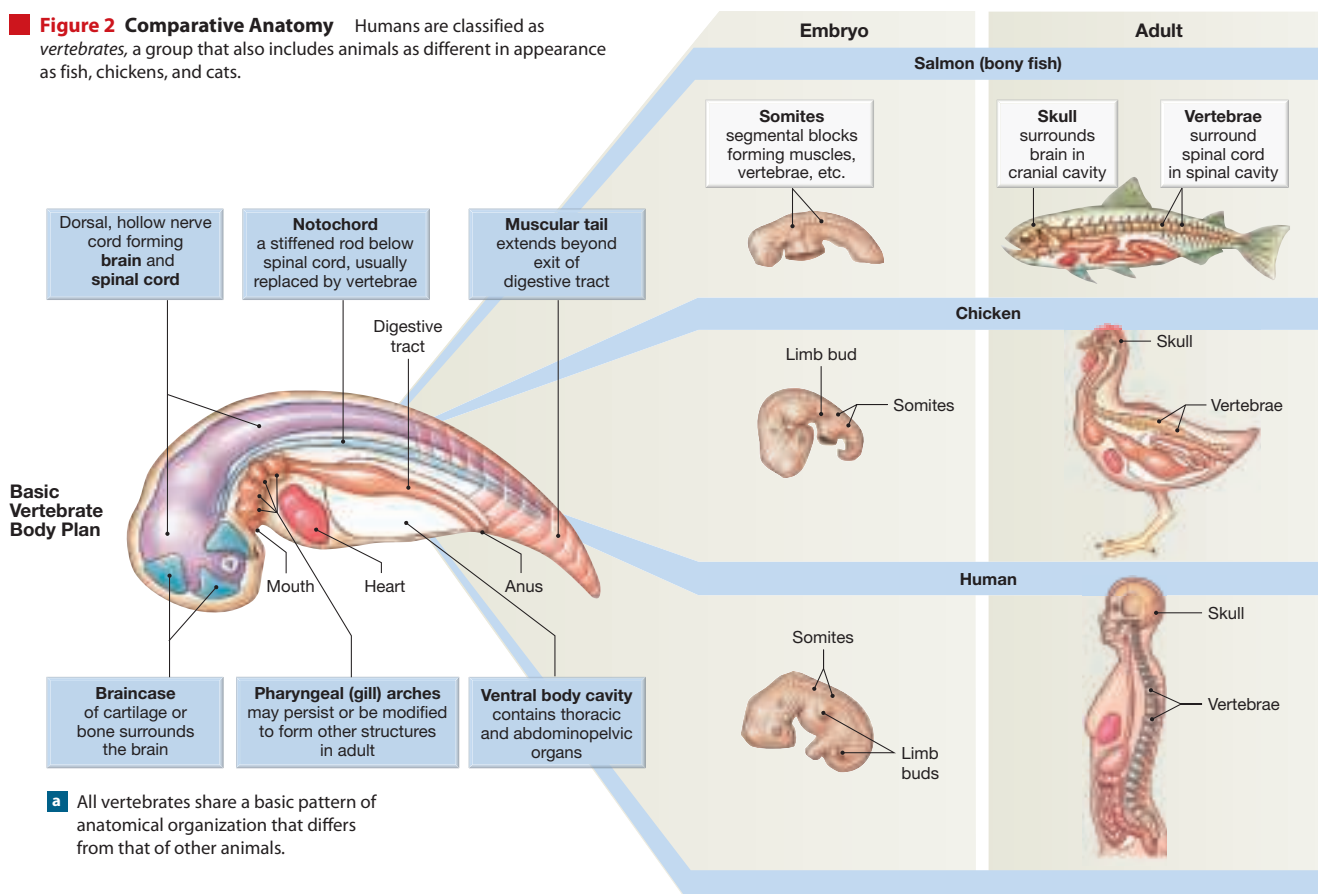
Other anatomical specialties will be encountered in this text.

- *Developmental anatomy* examines the changes in form that occur during the period between conception and physical maturity. Because it considers anatomical structures over such a broad range of sizes (from a single cell to an adult human), developmental anatomy involves the study of both microscopic and gross anatomy. Developmental anatomy is important in medicine because many structural abnormalities can result from errors that occur during development. The most extensive structural changes occur during the first two months of development. **Embryology** (em-brē-OL-ō-jē) is the study of these early developmental processes.
- *Comparative anatomy* considers the anatomical organization of different types of animals. Observed similarities may reflect evolutionary relationships. Humans, lizards, and sharks are all called *vertebrates* because they share a combination of anatomical features that is not found in any other group of animals. All vertebrates have a spinal column composed of individual elements called *vertebrae* (**Figure 2a**). Comparative anatomy uses techniques of gross, microscopic, and developmental anatomy. Information on developmental anatomy has demonstrated that related animals typically go through very similar developmental stages (**Figure 2b,c**).  
Several other gross anatomical specialties are important in medical diagnosis.
- *Clinical anatomy* focuses on anatomical features that may undergo recognizable pathological changes during illness.
- *Surgical anatomy* studies anatomical landmarks important for surgical procedures.

**Figure 1 The Study of Anatomy at Different Scales** The amount of detail recognized depends on the method of study and the degree of magnification.



**Figure 2 Comparative Anatomy** Humans are classified as *vertebrates*, a group that also includes animals as different in appearance as fish, chickens, and cats.



**a** All vertebrates share a basic pattern of anatomical organization that differs from that of other animals.

**b** The similarities between vertebrates are most apparent when comparing embryos at comparable stages of development.

**c** The similarities are less obvious when comparing adult vertebrates.

**CLINICAL NOTE**

### Disease, Pathology, and Diagnosis

**THE FORMAL NAME FOR THE STUDY OF DISEASE** is **pathology**. Different diseases typically produce similar signs, the physical manifestation of a disease, and symptoms, the patient's perception of a change in normal body function. For example, a person whose lips are paler than normal and who complains of a lack of energy and breathlessness might have (1) respiratory problems that prevent normal oxygen transfer to the blood (as in *emphysema*); (2) cardiovascular problems that interfere with normal blood circulation to all parts of the body (heart failure); or (3) an inability to transport adequate amounts of oxygen in the blood, due to blood loss or problems with blood forma-

tion. In such cases, doctors must ask questions and collect information to determine the source of the problem. The patient's history and physical exam may be enough for a diagnosis in many cases, but laboratory testing and imaging studies such as x-rays are often needed.

A **diagnosis** is a decision about the nature of an illness. The diagnostic procedure is often a process of elimination, in which several potential causes are evaluated and the most likely one is selected. This brings us to a key concept: *All diagnostic procedures presuppose an understanding of the normal structure and function of the human body.*





- *Radiographic anatomy* involves the study of anatomical structures as they are visualized by x-rays, ultrasound scans, or other specialized procedures performed on an intact body.
- *Cross-sectional anatomy* has emerged as a new subspecialty of gross anatomy as new advances in radiographic anatomy, such as CT (computerized tomography) and spiral scans, have emerged.

**Concept Check 1**

See the blue ANSWERS tab at the end of the chapter.

- 1  A histologist investigates structures at what level of organization?
- 2  Which level(s) of organization does a gross anatomist investigate?
- 3  How does the study of regional anatomy differ from the study of systemic anatomy?

**Levels of Organization [Figures 3 • 4]**

Our study of the human body will begin with an overview of cellular anatomy and then proceed to the anatomy, both gross and microscopic, of each organ system. When considering events from the microscopic to macroscopic scales, we are examining several interdependent *levels of organization*.

We begin at the *chemical* or *molecular level of organization*. The human body consists of more than a dozen different elements, but four of them (hydrogen, oxygen, carbon, and nitrogen) account for more than 99 percent of the total number of atoms (Figure 3a). At the chemical level, atoms interact to form three-dimensional compounds with distinctive properties. The major classes of compounds in the human body are indicated in Figure 3b.

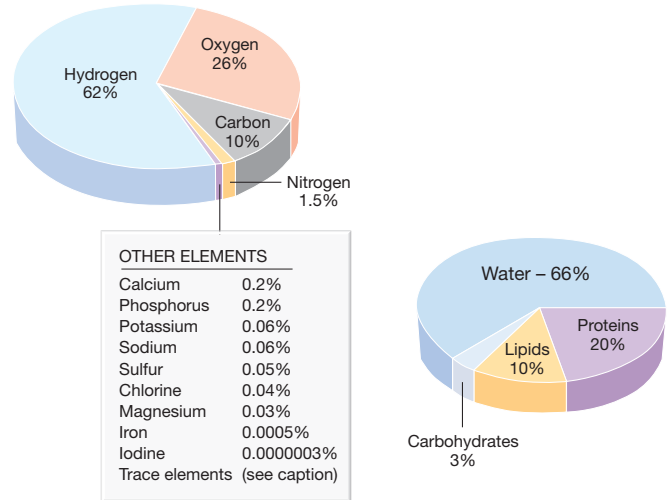
Figure 4 presents an example of the relationships between the chemical level and higher levels of organization. The *cellular level of organization* includes *cells*, the smallest living units in the body. Cells contain internal structures called *organelles*. Cells and their organelles are made up of complex chemicals. In Figure 4, chemical interactions produce complex proteins within a *muscle cell* in the heart. Muscle cells are unusual because they can contract powerfully, shortening along their longitudinal axis.

Heart muscle cells are connected to form a distinctive *muscle tissue*, an example of the *tissue level of organization*. Layers of muscle tissue form the bulk of the wall of the heart, a hollow, three-dimensional organ. We are now at the *organ level of organization*.

Normal functioning of the heart depends on interrelated events at the chemical, cellular, tissue, and organ levels of organization. Coordinated contractions in the adjacent muscle cells of cardiac muscle tissue produce a heartbeat. When that beat occurs, the internal anatomy of the organ enables it to function as a pump. Each time it contracts, the heart pushes blood into the *circulatory system*, a network of blood vessels. Together the heart, blood, and circulatory system form an *organ system*, the *cardiovascular system (CVS)*.

Each level of organization is totally dependent on the others. For example, damage at the cellular, tissue, or organ level may affect the entire system. Thus,

**Figure 3 Composition of the Body at the Chemical Level of Organization** The percent composition of elements and major molecules.



**a Elemental composition of the body.** Trace elements include silicon, fluorine, copper, manganese, zinc, selenium, cobalt, molybdenum, cadmium, chromium, tin, aluminum, and boron.

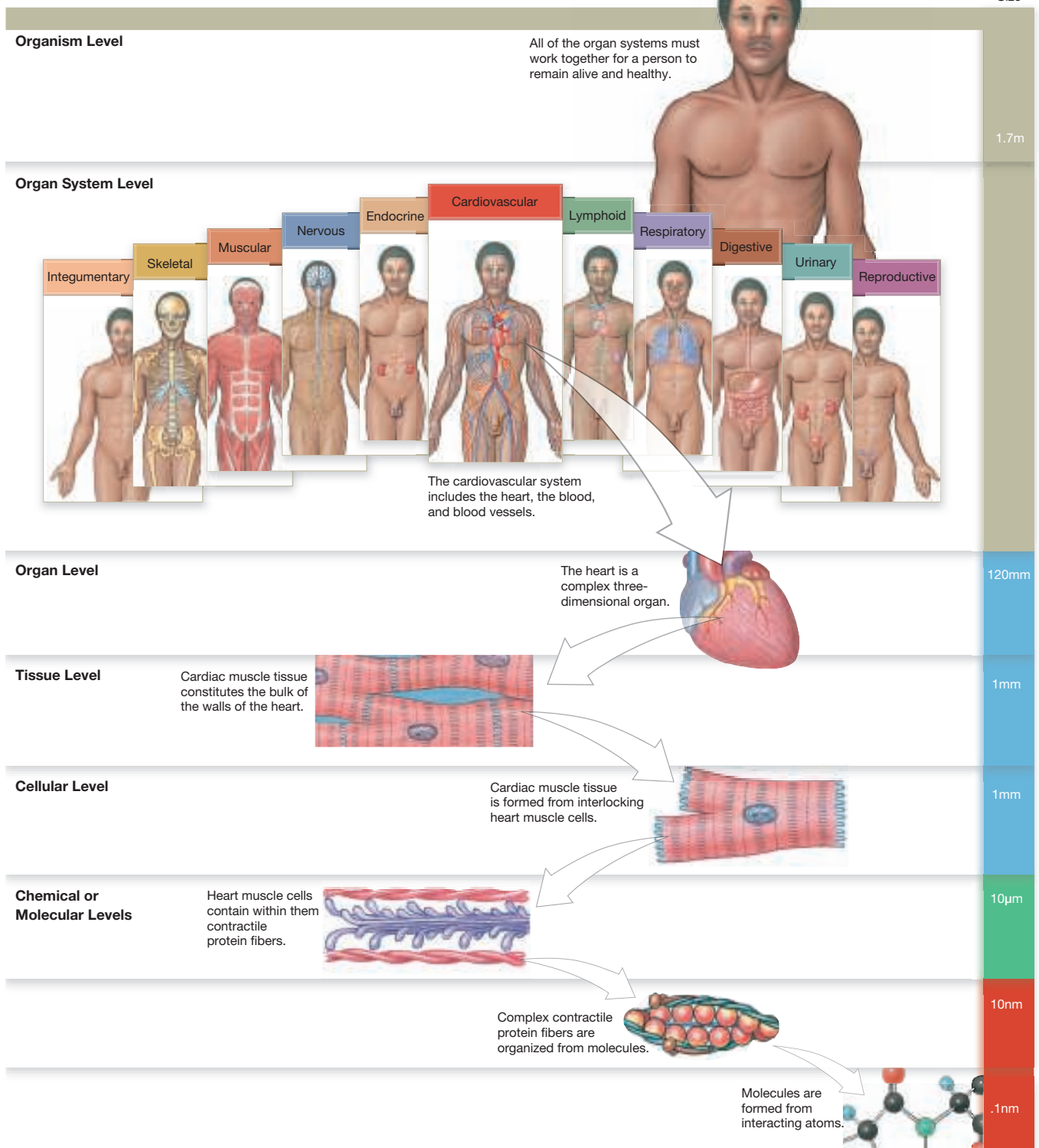
**b Molecular composition of the body**

a chemical change in heart muscle cells may cause abnormal contractions or even stop the heartbeat. Physical damage to the muscle tissue, as in a chest wound, can make the heart ineffective even when most of the heart muscle cells are intact and uninjured. An inherited abnormality in heart structure can make it an ineffective pump, although the muscle cells and muscle tissue are perfectly normal.

Finally, it should be noted that something that affects the system will ultimately affect all of its components. For example, the heart may not be able to pump blood effectively after a massive blood loss due to damage of a major blood vessel somewhere in the body. If the heart cannot pump and blood cannot flow, oxygen and nutrients cannot be distributed. In a very short time, the tissue begins to break down as heart muscle cells die from oxygen and nutrient starvation.

Of course, the changes that occur when the heart is not pumping effectively will not be restricted to the cardiovascular system; all of the cells, tissues, and organs in the body will be damaged. This observation brings us to another, higher level of organization, that of the *organism*; in this case a human being. This level reflects the interactions among organ systems. All are vital; every system must be working properly and in harmony with every other system, or survival will be impossible. When those systems are functioning normally, the characteristics of the internal environment will be relatively stable at all levels. This vital state of affairs is called **homeostasis** (hō-mē-ō-STĀ-sis; *homeo*, unchanging + *stasis*, standing).

**Figure 4 Levels of Organization** Interacting atoms form molecules that organize themselves into complex contractile protein fibers within heart muscle cells. These cells interlock, forming cardiac muscle tissue that constitutes the bulk of the walls of the heart, a three-dimensional organ. The heart is one component of the cardiovascular system, which also includes the blood and blood vessels. All of the organ systems must work together for the person to remain alive and healthy.





CLINICAL NOTE



### The Diagnosis of Disease












**HOMEOSTASIS** is the maintenance of a relatively constant internal environment suitable for the survival of body cells and tissues. A failure to maintain homeostatic conditions constitutes **disease**. The disease process may initially affect a specific tissue, an organ, or an organ system, but it will ultimately lead to changes in the function or structure of cells throughout the body. Some diseases can be overcome by the body's defenses. Others require intervention and assistance. For example, when trauma has occurred and there is severe bleeding or damage to internal organs, surgical intervention may be necessary to restore homeostasis and prevent fatal complications.

## An Introduction to Organ Systems [Figures 5 • 6]

**Figure 5** provides an overview of the 11 organ systems in the human body. **Figure 6** introduces the major organs in each system. All living organisms share vital properties and processes:

- **Responsiveness:** Organisms respond to changes in their immediate environment; this property is also called *irritability*. You move your hand away from a hot stove; your dog barks at approaching strangers; fish are scared by loud noises; and amoebas glide toward potential prey. Organisms also make longer-lasting changes as they adjust to their environments. For example, as winter approaches, an animal may grow a heavier coat or migrate to a warmer climate. The capacity to make such adjustments is termed *adaptability*.
- **Growth and Differentiation:** Over a lifetime, organisms grow larger, increasing in size through an increase in the size or number of their cells. In multicellular organisms, the individual cells become specialized to perform particular functions. This specialization is called **differentiation**. Growth and differentiation in cells and organisms often produce changes in form and function. For example, the anatomical proportions and physiological capabilities of an adult human are quite different from those of an infant.
- **Reproduction:** Organisms reproduce, creating subsequent generations of their own kind, whether unicellular or multicellular.
- **Movement:** Organisms are capable of producing movement, which may be internal (transporting food, blood, or other materials inside the body) or external (moving through the environment).
- **Metabolism and Excretion:** Organisms rely on complex chemical reactions to provide energy for responsiveness, growth, reproduction, and movement. They must also synthesize complex chemicals, such as proteins. The term **metabolism** refers to all the chemical operations under

**Figure 5 An Introduction to Organ Systems** An overview of the 11 organ systems and their major functions.

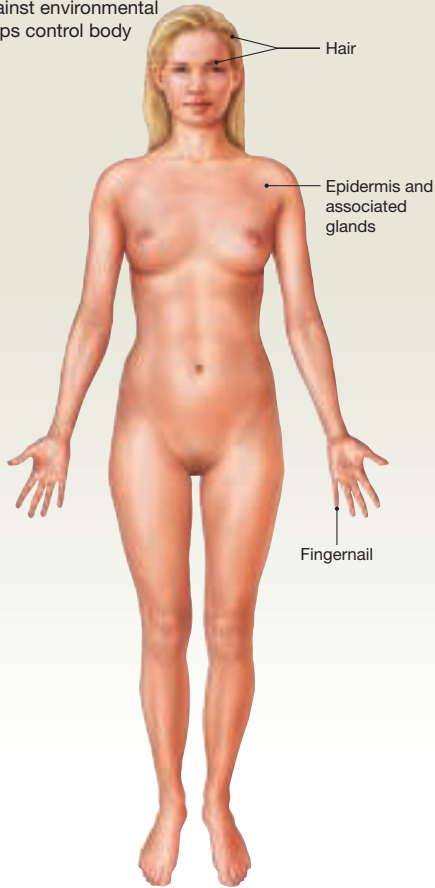
ORGAN SYSTEM	MAJOR FUNCTIONS
 <b>Integumentary system</b>	Protection from environmental hazards; temperature control
 <b>Skeletal system</b>	Support, protection of soft tissues; mineral storage; blood formation
 <b>Muscular system</b>	Locomotion, support, heat production
 <b>Nervous system</b>	Directing immediate responses to stimuli, usually by coordinating the activities of other organ systems
 <b>Endocrine system</b>	Directing long-term changes in the activities of other organ systems
 <b>Cardiovascular system</b>	Internal transport of cells and dissolved materials, including nutrients, wastes, and gases
 <b>Lymphoid system</b>	Defense against infection and disease
 <b>Respiratory system</b>	Delivery of air to sites where gas exchange can occur between the air and circulating blood
 <b>Digestive system</b>	Processing of food and absorption of organic nutrients, minerals, vitamins, and water
 <b>Urinary system</b>	Elimination of excess water, salts, and waste products; control of pH
 <b>Reproductive system</b>	Production of sex cells and hormones

way in the body: *Catabolism* is the breakdown of complex molecules into simple ones, and *anabolism* is the synthesis of complex molecules from simple ones. Normal metabolic operations require the **absorption** of materials from the environment. To generate energy efficiently, most cells require various nutrients, as well as oxygen, an atmospheric gas. The term **respiration** refers to the absorption, transport, and use of oxygen by cells. Metabolic operations often generate unneeded or potentially harmful waste products that must be removed through the process of **excretion**.

**Figure 6** The Organ Systems of the Body

### The Integumentary System

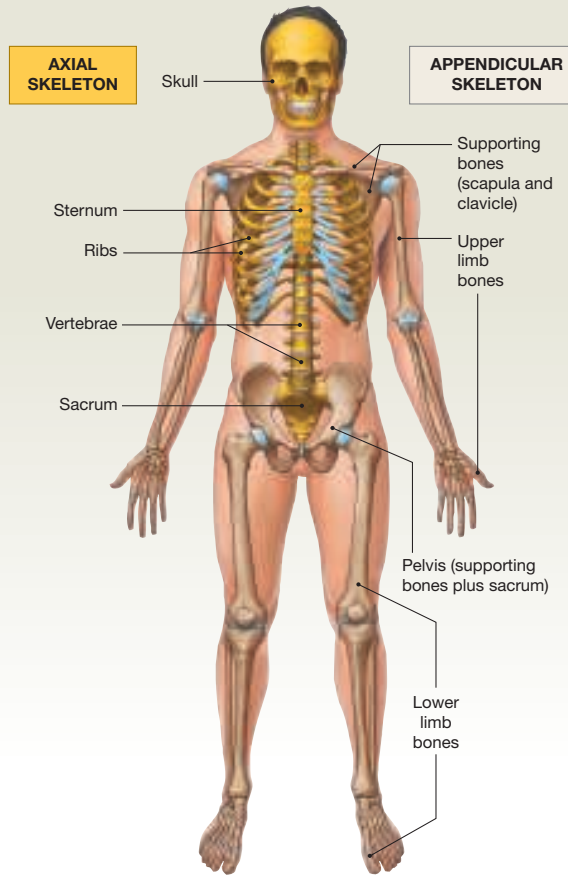
Protects against environmental hazards; helps control body temperature



Organ/Component	Primary Functions
<b>Cutaneous Membrane</b> Epidermis Dermis	Covers surface; protects deeper tissues Nourishes epidermis; provides strength; contains glands
<b>Hair Follicles</b> Hairs Sebaceous glands	Produce hair; innervation provides sensation Provide protection for head Secrete lipid coating that lubricates hair shaft and epidermis
<b>Sweat Glands</b>	Produce perspiration for evaporative cooling
<b>Nails</b>	Protect and stiffen distal tips of digits
<b>Sensory Receptors</b>	Provide sensations of touch, pressure, temperature, pain
<b>Subcutaneous Layer</b>	Stores lipids; attaches skin to deeper structures

### The Skeletal System

Provides support; protects tissues; stores minerals; forms blood cells

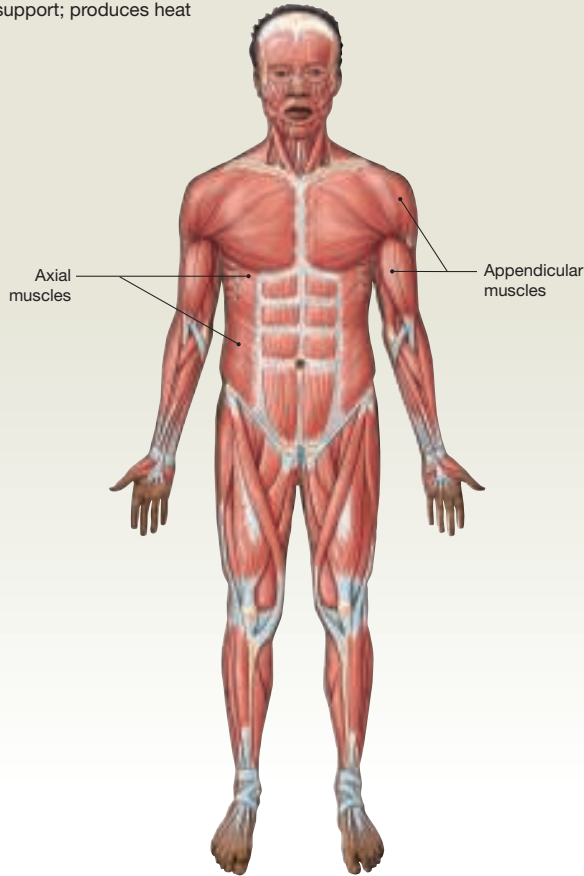


Organ/Component	Primary Functions
<b>Bones, Cartilages, and Joints</b> Axial skeleton (skull, vertebrae, sacrum, coccyx, sternum, ribs, supporting cartilages and ligaments) Appendicular skeleton (limbs and supporting bones and ligaments)	Support, protect soft tissues, bones store minerals Protects brain, spinal cord, sense organs, and soft tissues of thoracic cavity; supports the body weight over lower limbs Provides internal support and positioning of the limbs; supports and moves axial skeleton
<b>Bone Marrow</b>	Primary site of blood cell production (red marrow); storage of energy reserves in fat cells (yellow marrow)



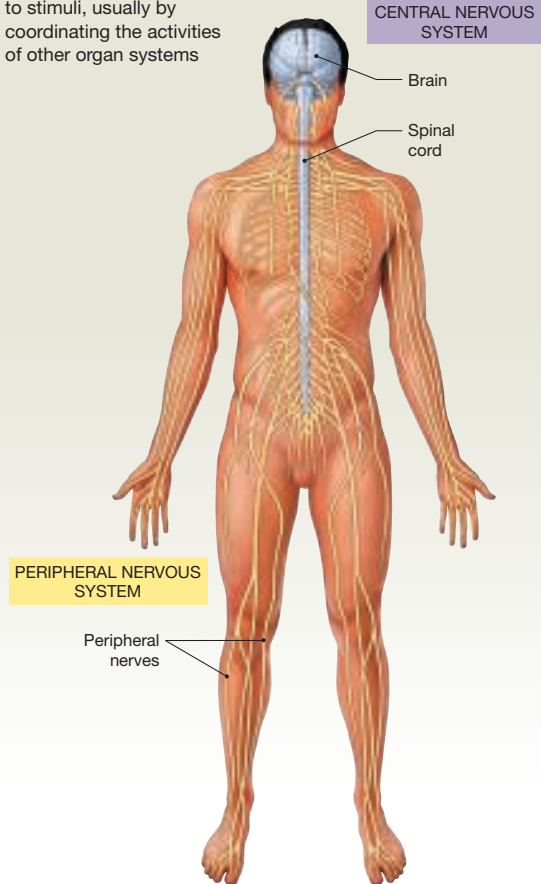
### The Muscular System

Allows for locomotion; provides support; produces heat



### The Nervous System

Directs immediate responses to stimuli, usually by coordinating the activities of other organ systems

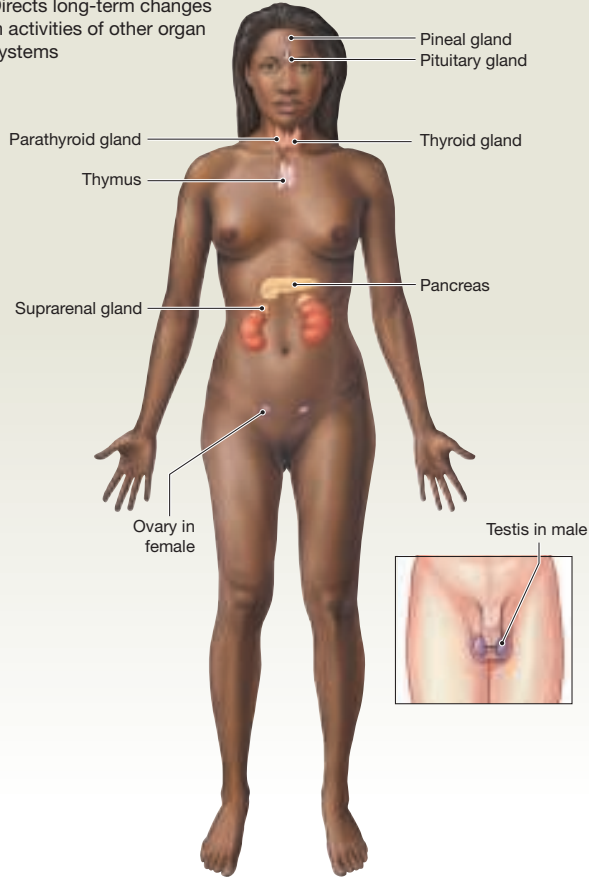


Organ/Component	Primary Functions
<b>Skeletal Muscles (700)</b>  Axial muscles Appendicular muscles	Provide skeletal movement; control entrances to digestive and respiratory tracts and exits to digestive and urinary tracts; produce heat; support skeleton; protect soft tissues  Support and position axial skeleton Support, move, and brace limbs
<b>Tendons, Aponeuroses</b>	Harness forces of contraction to perform specific tasks

Organ/Component	Primary Functions
<b>Central Nervous System (CNS)</b>  Brain  Spinal cord  Special senses	Acts as control center for nervous system; processes information; provides short-term control over activities of other systems  Performs complex integrative functions; controls both voluntary and autonomic activities  Relays information to and from brain; performs less-complex integrative activities  Provide sensory input to the brain relating to sight, hearing, smell, taste, and equilibrium
<b>Peripheral Nervous System (PNS)</b>	Links CNS with other systems and with sense organs

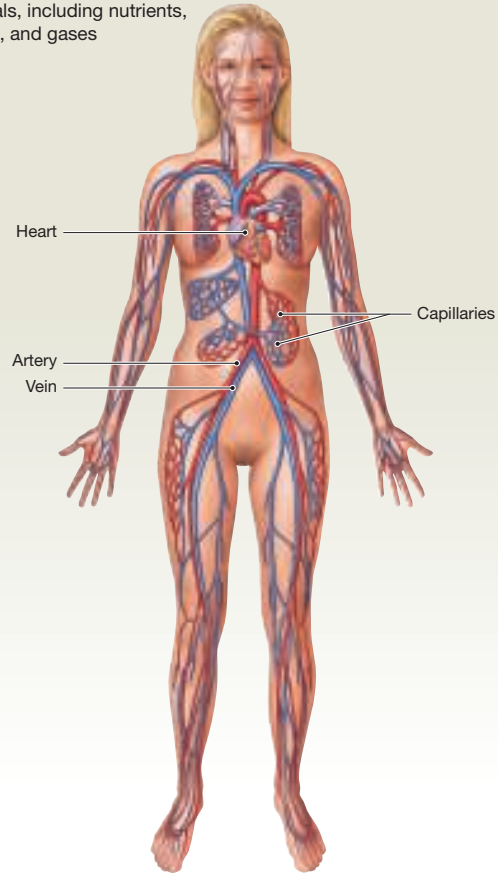
### The Endocrine System

Directs long-term changes in activities of other organ systems



### The Cardiovascular System

Transports cells and dissolved materials, including nutrients, wastes, and gases



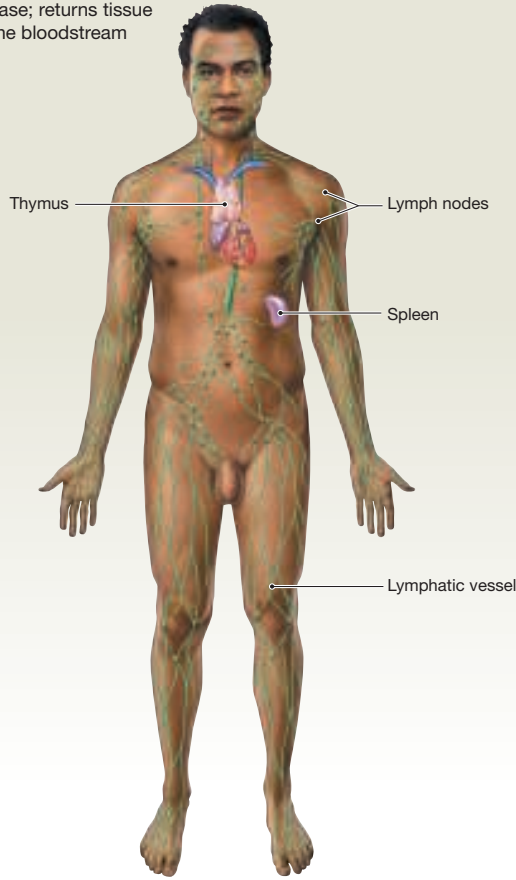
Organ/Component	Primary Functions
<b>Pineal Gland</b>	May control timing of reproduction and set day-night rhythms
<b>Pituitary Gland</b>	Controls other endocrine glands; regulates growth and fluid balance
<b>Thyroid Gland</b>	Controls tissue metabolic rate; regulates calcium levels
<b>Parathyroid Glands</b>	Regulate calcium levels (with thyroid)
<b>Thymus</b>	Controls maturation of lymphocytes
<b>Suprarenal Glands</b>	Adjust water balance, tissue metabolism, cardiovascular and respiratory activity
<b>Kidneys</b>	Control red blood cell production and elevate blood pressure
<b>Pancreas</b>	Regulates blood glucose levels
<b>Gonads</b>	
Testes	Support male sexual characteristics and reproductive functions
Ovaries	Support female sexual characteristics and reproductive functions

Organ/Component	Primary Functions
<b>Heart</b>	Propels blood; maintains blood pressure
<b>Blood Vessels</b>	
Arteries	Distribute blood around the body
Capillaries	Carry blood from the heart to capillaries
Veins	Permit diffusion between blood and interstitial fluids
	Return blood from capillaries to the heart
<b>Blood</b>	Transports oxygen, carbon dioxide, and blood cells; delivers nutrients and hormones; removes waste products; assists in temperature regulation and defense against disease



### The Lymphoid System

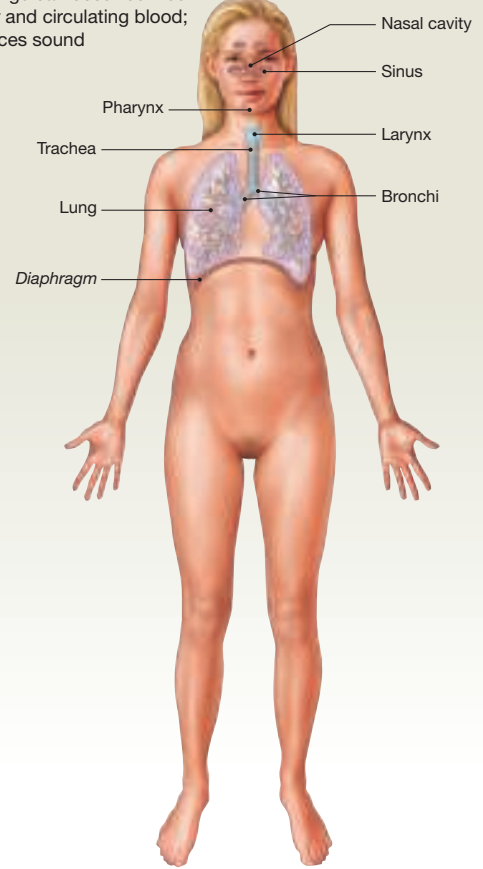
Defends against infection and disease; returns tissue fluid to the bloodstream



Organ/Component	Primary Functions
<b>Lymphatic Vessels</b>	Carry lymph (water and proteins) and lymphocytes from peripheral tissues to veins of the cardiovascular system
<b>Lymph Nodes</b>	Monitor the composition of lymph; engulf pathogens; stimulate immune response
<b>Spleen</b>	Monitors circulating blood; engulfs pathogens and recycles red blood cells; stimulates immune response
<b>Thymus</b>	Controls development and maintenance of one class of lymphocytes (T cells)

### The Respiratory System

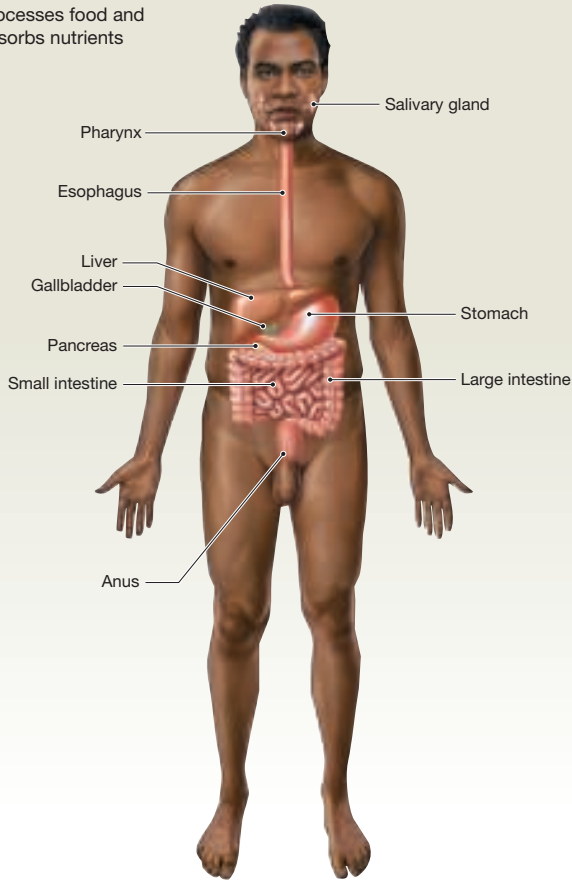
Delivers air to sites where gas exchange can occur between the air and circulating blood; produces sound



Organ/Component	Primary Functions
<b>Nasal Cavities and Paranasal Sinuses</b>	Filter, warm, humidify air; detect smells
<b>Pharynx</b>	Conducts air to larynx; a chamber shared with the digestive tract
<b>Larynx</b>	Protects opening to trachea and contains vocal cords
<b>Trachea</b>	Filters air, traps particles in mucus; cartilages keep airway open
<b>Bronchi</b>	Same functions as trachea; diameter decreases as branching occurs
<b>Lungs</b>	Responsible for air movement during movement of ribs and diaphragm; include airways and alveoli
Alveoli	Blind pockets at the end of the smallest branches of the bronchioles; sites of gas exchange between air and blood

### The Digestive System

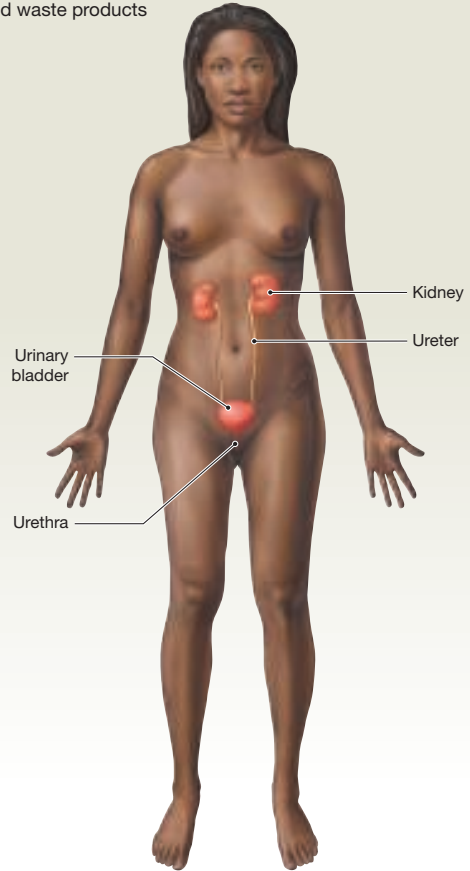
Processes food and absorbs nutrients



Organ/Component	Primary Functions
<b>Mouth</b>	Receptacle for food; works with associated structures (teeth, tongue) to break up food and pass food and liquids to pharynx
<b>Salivary Glands</b>	Provide buffers and lubrication; produce enzymes that begin digestion
<b>Pharynx</b>	Conducts solid food and liquids to esophagus; chamber shared with respiratory tract
<b>Esophagus</b>	Delivers food to stomach
<b>Stomach</b>	Secretes acids and enzymes
<b>Small Intestine</b>	Secretes digestive enzymes, buffers, and hormones; absorbs nutrients
<b>Liver</b>	Secretes bile; regulates nutrient composition of blood
<b>Gallbladder</b>	Stores and concentrates bile for release into small intestine
<b>Pancreas</b>	Secretes digestive enzymes and buffers; contains endocrine cells
<b>Large Intestine</b>	Removes water from fecal material; stores wastes

### The Urinary System

Eliminates excess water, salts, and waste products

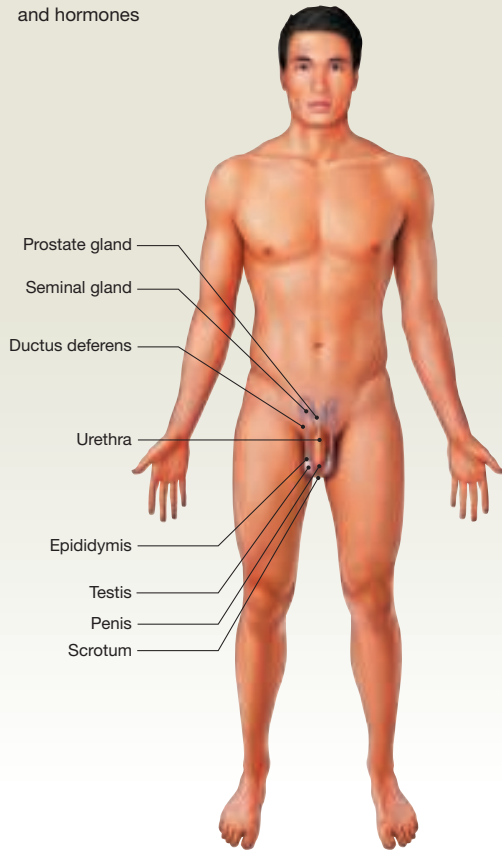


Organ/Component	Primary Functions
<b>Kidneys</b>	Form and concentrate urine; regulate blood pH and ion concentrations; perform endocrine functions
<b>Ureters</b>	Conduct urine from kidneys to urinary bladder
<b>Urinary Bladder</b>	Stores urine for eventual elimination
<b>Urethra</b>	Conducts urine to exterior



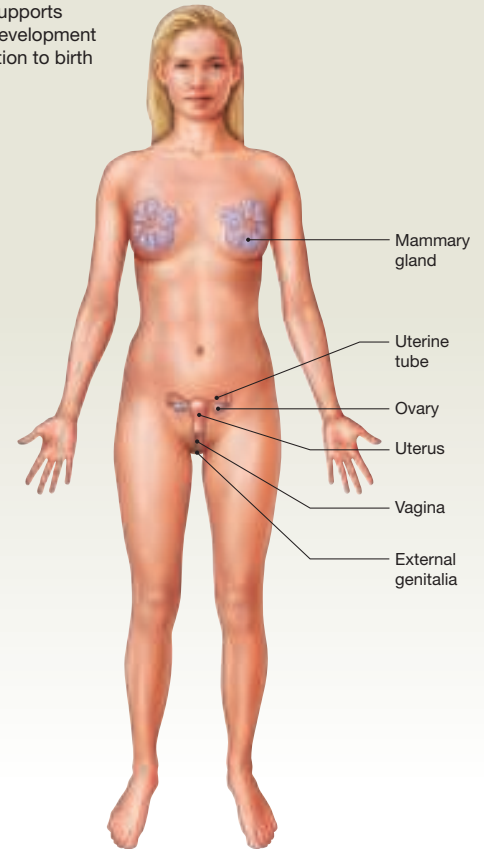
### The Male Reproductive System

Produces sex cells and hormones



### The Female Reproductive System

Produces sex cells and hormones; supports embryonic development from fertilization to birth



Organ/Component	Primary Functions
<b>Testes</b>	Produce sperm and hormones
<b>Accessory Organs</b> Epididymis Ductus deferens (sperm duct) Seminal glands Prostate gland Urethra	Acts as site of sperm maturation Conducts sperm from the epididymis and merges with the duct of the seminal gland Secrete fluid that makes up much of the volume of semen Secrete fluid and enzymes Conducts semen to exterior
<b>External Genitalia</b> Penis  Scrotum	Contains erectile tissue; deposits sperm in vagina of female; produces pleasurable sensations during sexual activities  Surrounds the testes and controls their temperature

Organ/Component	Primary Functions
<b>Ovaries</b>	Produce oocytes and hormones
<b>Uterine Tubes</b>	Deliver oocyte or embryo to uterus; normal site of fertilization
<b>Uterus</b>	Site of embryonic development and exchange between maternal and fetal bloodstreams
<b>Vagina</b>	Site of sperm deposition; acts as a birth canal during delivery; provides passageway for fluids during menstruation
<b>External Genitalia</b> Clitoris  Labia	Contains erectile tissue; provides pleasurable sensations during sexual activities  Contain glands that lubricate entrance to vagina
<b>Mammary Glands</b>	Produce milk that nourishes newborn infant

For very small organisms, absorption, respiration, and excretion involve the movement of materials across exposed surfaces. But creatures larger than a few millimeters seldom absorb nutrients directly from their environment. For example, human beings cannot absorb steaks, apples, or ice cream directly—they must first alter the foods' chemical structure. That processing, called **digestion**, occurs in specialized areas where complex foods are broken down into simpler components that can be absorbed easily. Respiration and excretion are also more complicated for large organisms, and we have specialized organs responsible for gas exchange (the lungs) and waste excretion (the kidneys). Finally, because absorption, respiration, and excretion are performed in different portions of the body, there must be an internal transportation system, or **cardiovascular system**.

### Concept Check 2

See the blue ANSWERS tab at the end of the chapter.

- 1  What system includes the following structures: sweat glands, nails, and hair follicles?
- 2  What system has structures with the following functions: production of hormones and ova, site of embryonic development?
- 3  What is differentiation?

## The Language of Anatomy [Figure 7]

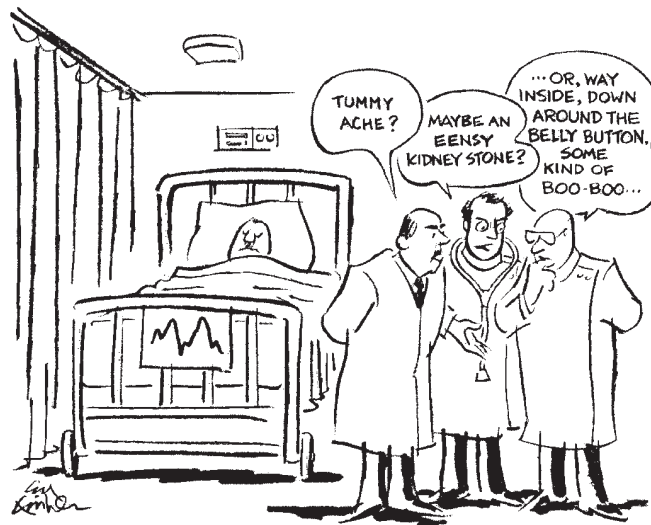
If you discovered a new continent, how would you begin collecting information so that you could report your findings? You would have to construct a detailed map of the territory. The completed map would contain (1) prominent landmarks, such as mountains, valleys, or volcanoes; (2) the distance between them; and (3) the direction you traveled to get from one place to another. The distances might be recorded in miles, and the directions recorded as compass bearings (north, south, northeast, southwest, and so on). With such a map, anyone could go directly to a specific location on that continent.

Early anatomists faced similar communication problems. Stating that a bump is “on the back” does not give very precise information about its location. So anatomists created maps of the human body. The landmarks are prominent anatomical structures, and distances are measured in centimeters or inches. In effect, anatomy uses a special language that must be learned at the start. It will take some time and effort but is absolutely essential if you want to avoid a situation like that shown in Figure 7.

New anatomical terms continue to appear as technology advances, but many of the older words and phrases remain in use. As a result, the vocabulary of this science represents a form of historical record. Latin and Greek words and phrases form the basis for an impressive number of anatomical terms. For example, many of the Latin names assigned to specific structures 2000 years ago are still in use today.

A familiarity with Latin roots and patterns makes anatomical terms more understandable, and the notes included on word derivation are intended to assist you in that regard. In English, when you want to indicate more than one of something, you usually add an *s* to the name—*girl/girls* or *doll/dolls*. Latin words change their endings. Those ending in *-us* convert to *-i*, and other conversions involve changing from *-um* to *-a*, and from *-a* to *-ae*.

■ **Figure 7 The Importance of Precise Vocabulary** Would you want to be this patient? [©The New Yorker Collection 1990 Ed Fisher from cartoonbank.com All Rights Reserved.]



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Latin and Greek terms are not the only foreign terms imported into the anatomical vocabulary over the centuries. Many anatomical structures and clinical conditions were initially named after either the discoverer or, in the case of diseases, the most famous victim. The major problem with this practice is that it is difficult for someone to remember a connection between the structure or disorder and the name. Over the last 100 years most of these commemorative names, or *eponyms*, have been replaced by more precise terms.

## Superficial Anatomy

A familiarity with major anatomical landmarks and directional references will make more understandable, since none of the organ systems except the integument can be seen from the body surface. You must create your own mental maps and extract information from the anatomical illustrations that accompany this discussion.

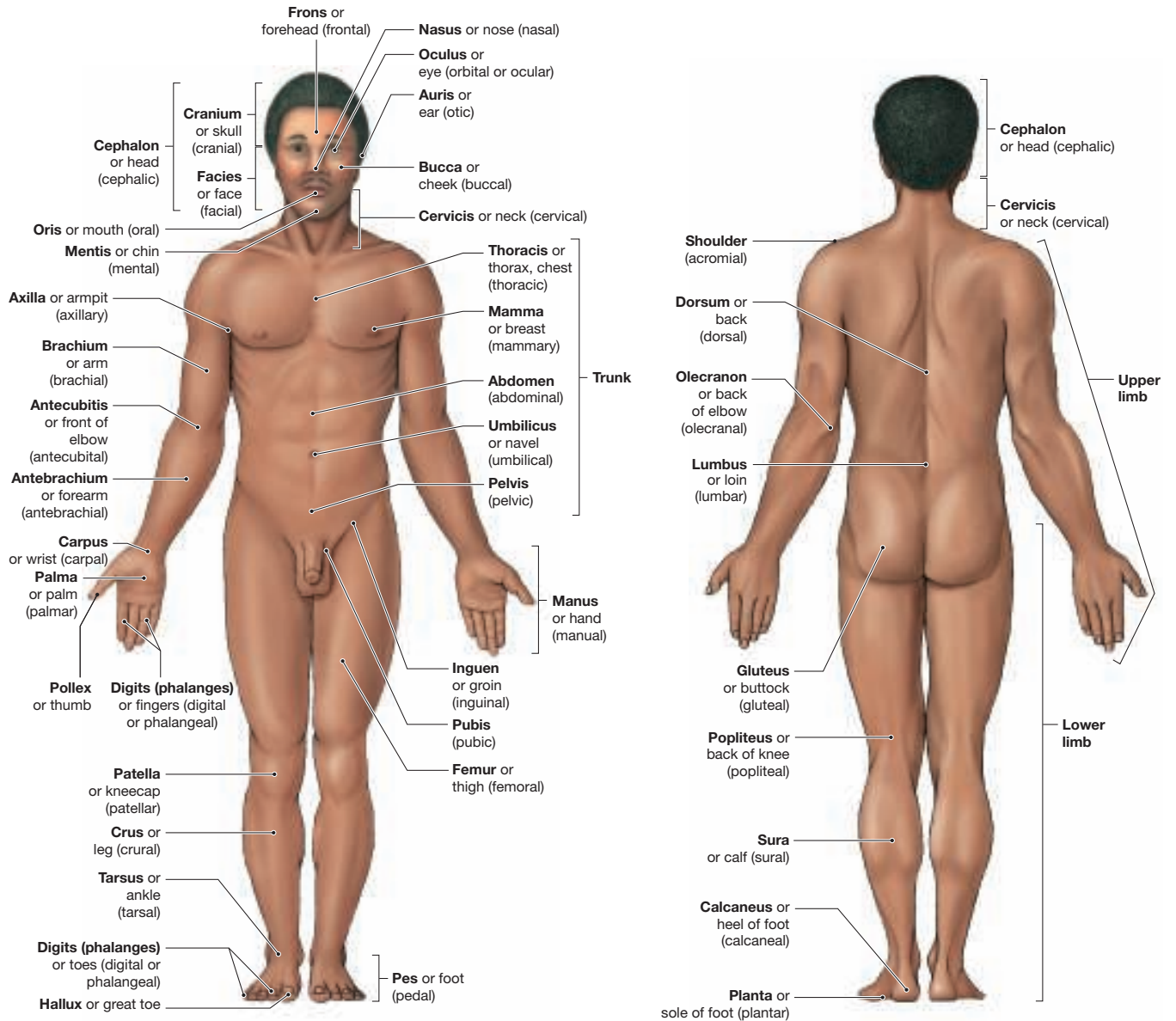
## Anatomical Landmarks [Figure 8]

Important anatomical landmarks are presented in Figure 8. You should become familiar with the adjectival form as well as the anatomical term. Understanding the terms and their origins will help you to remember the location of a particular structure, as well as its name. For example, the term **brachium** refers to the arm, discuss the *brachialis muscle* and branches of the *brachial artery*.

Standard anatomical illustrations show the human form in the **anatomical position**. In the anatomical position, the person stands with the legs together and the feet flat on the floor. The hands are at the sides, and the palms face forward. The individual shown in Figure 8 is in the anatomical position as seen from the front (Figure 8a) and back (Figure 8b). The anatomical position is



**Figure 8 Anatomical Landmarks** The anatomical terms are shown in boldface type, the common names are in plain type, and the anatomical adjectives are in parentheses.



**a** Anterior view in the anatomical position.

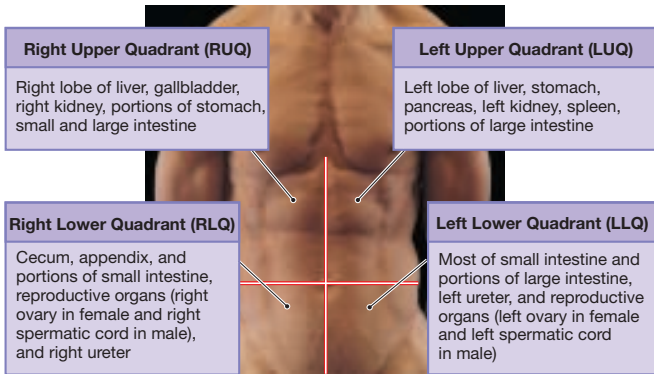
**b** Posterior view in the anatomical position.

the standard by which the language of anatomy, regardless of level, from basic to clinical, is communicated. Therefore, unless otherwise noted, all of the descriptions given refer to the body in the anatomical position. A person lying down in the anatomical position is said to be **supine** (soo-PĪN) when lying face up and **prone** when lying face down.

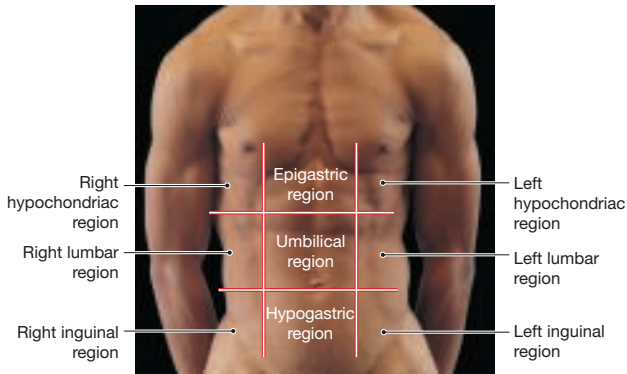
### Anatomical Regions [Figures 8 • 9 • Table 1]

Major regions of the body are indicated in Table 1. These and additional regions and anatomical landmarks are noted in **Figure 8**. Anatomists and clinicians often use specialized regional terms to indicate a specific area of the

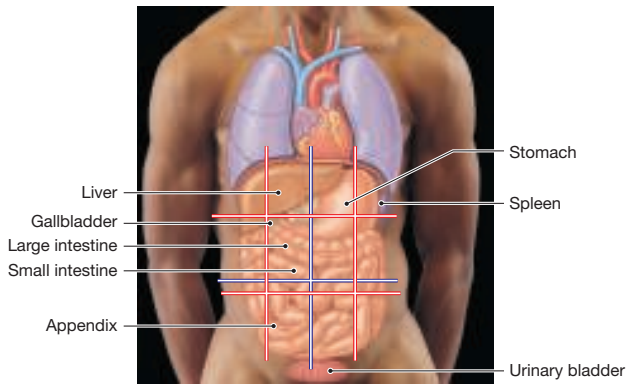
**Figure 9 Abdominopelvic Quadrants and Regions** The abdominopelvic surface is separated into sections to identify anatomical landmarks more clearly and to define the location of contained organs more precisely.



**a** Abdominopelvic quadrants divide the area into four sections. These terms, or their abbreviations, are most often used in clinical discussions.



**b** More precise anatomical descriptions are provided by reference to the appropriate abdominopelvic region.



**c** Quadrants or regions are useful because there is a known relationship between superficial anatomical landmarks and underlying organs.

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Anatomical Name	Anatomical Region	Area Indicated
<b>Cephalon</b>	Cephalic	Area of head
<b>Cervicis</b>	Cervical	Area of neck
<b>Thoracis</b>	Thoracic	The chest
<b>Brachium</b>	Brachial	The segment of the upper limb closest to the trunk; the arm
<b>Antebrachium</b>	Antebrachial	The forearm
<b>Carpus</b>	Carpal	The wrist
<b>Manus</b>	Manual	The hand
<b>Abdomen</b>	Abdominal	The abdomen
<b>Pelvis</b>	Pelvic	The pelvis (in general)
<b>Pubis</b>	Pubic	The anterior pelvis
<b>Inguen</b>	Inguinal	The groin (crease between thigh and trunk)
<b>Lumbus</b>	Lumbar	The lower back
<b>Gluteus</b>	Gluteal	The buttock
<b>Femur</b>	Femoral	The thigh
<b>Patella</b>	Patellar	The kneecap
<b>Crus</b>	Crural	The leg, from knee to ankle
<b>Sura</b>	Sural	The calf
<b>Tarsus</b>	Tarsal	The ankle
<b>Pes</b>	Pedal	The foot
<b>Planta</b>	Plantar	Sole region of foot

\* See Figures 8 and 9.

abdominal or pelvic regions. There are two different methods in use. One refers to the **abdominopelvic quadrants**. The abdominopelvic surface is divided into four segments using a pair of imaginary lines (one horizontal and one vertical) that intersect at the *umbilicus* (navel). This simple method, shown in **Figure 9a**, provides useful references for the description of aches, pains, and injuries. The location can assist the doctor in deciding the possible cause; for example, tenderness in the right lower quadrant (RLQ) is a symptom of appendicitis, whereas tenderness in the right upper quadrant (RUQ) may indicate gallbladder or liver problems.

Regional distinctions are used to describe the location and orientation of internal organs more precisely. There are nine **abdominopelvic regions**, shown in **Figure 9b**. **Figure 9c** shows the relationship between quadrants, regions, and internal organs.

### Anatomical Directions [Figure 10 • Table 2]

**Figure 10** and Table 2 show the principal directional terms and examples of their use. There are many different terms, and some can be used interchangeably. As you learn these directional terms, it is important to remember that all anatomical directions utilize the anatomical position as the standard point of reference. For example, *anterior* refers to the front of the



**Figure 10 Directional References** Important directional references used in this text are indicated by arrows; definitions and descriptions are included in Table 2.

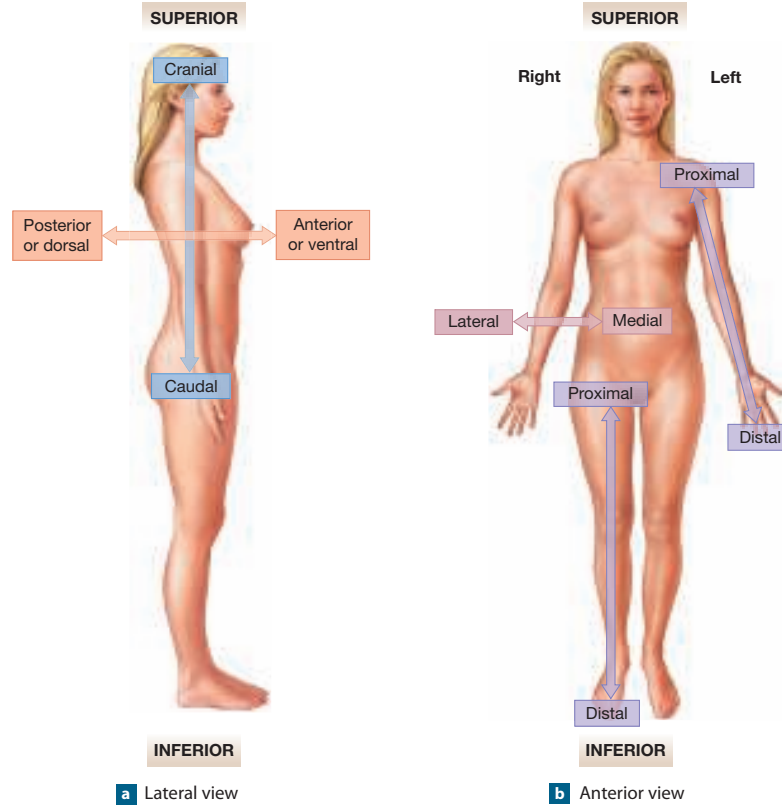


Table 2 Regional and Directional Terms (see Figure 10)		
Term	Region or Reference	Example
<b>Anterior</b>	The front; before	The navel is on the <i>anterior</i> surface of the trunk.
<b>Ventral</b>	The belly side (equivalent to anterior when referring to human body)	The navel is on the <i>ventral</i> surface.
<b>Posterior</b>	The back; behind	The scapula (shoulder blade) is located <i>posterior</i> to the rib cage.
<b>Dorsal</b>	The back (equivalent to posterior when referring to human body)	The scapula (shoulder blade) is located on the <i>dorsal</i> side of the body.
<b>Cranial</b>	Toward the head	The <i>cranial</i> , or <i>cephalic</i> , border of the pelvis is <i>superior</i> to the thigh.
<b>Cephalic</b>	Same as cranial	
<b>Superior</b>	Above; at a higher level (in human body, toward the head)	
<b>Caudal</b>	Toward the tail (coccyx in humans)	The hips are <i>caudal</i> to the waist.
<b>Inferior</b>	Below; at a lower level; toward the feet	The knees are <i>inferior</i> to the hips.
<b>Medial</b>	Toward the midline (the longitudinal axis of the body)	The <i>medial</i> surfaces of the thighs may be in contact.
<b>Lateral</b>	Away from the midline (the longitudinal axis of the body)	The femur articulates with the <i>lateral</i> surface of the pelvis.
<b>Proximal</b>	Toward an attached base	The thigh is <i>proximal</i> to the foot.
<b>Distal</b>	Away from an attached base	The fingers are <i>distal</i> to the wrist.
<b>Superficial</b>	At, near, or relatively close to the body surface	The skin is <i>superficial</i> to underlying structures.
<b>Deep</b>	Toward the interior of the body; farther from the surface	The bone of the thigh is <i>deep</i> to the surrounding skeletal muscles.

body; in humans, this term is equivalent to *ventral*, which actually refers to the belly side. Although your instructor may have additional terminology, the terms that appear frequently have been emphasized in Table 2. When following anatomical descriptions, you will find it useful to remember that the terms *left* and *right* always refer to the left and right sides of the subject, not the observer. You should also note that although some reference terms are equivalent—*posterior* and *dorsal*, or *anterior* and *ventral*—anatomical descriptions use them in opposing pairs. For example, a discussion will give directions with reference either to posterior versus anterior, or dorsal versus ventral. Finally, you should be aware that some of the reference terms listed in Table 2 are either not used or have different meanings in veterinary anatomy.

## Sectional Anatomy

A presentation in sectional view is sometimes the only way to illustrate the relationships between the parts of a three-dimensional object. An understanding of sectional views has become increasingly important since the development of electronic imaging techniques that enable us to see inside the living body without resorting to surgery.

### Planes and Sections [Figures 11 • 12 • Table 3]

Any slice through a three-dimensional object can be described with reference to three **sectional planes**, indicated in Table 3 and **Figure 11**. The **transverse**

**Figure 11 Planes of Section** The three primary planes of section are indicated here. Table 3 defines and describes these terms.

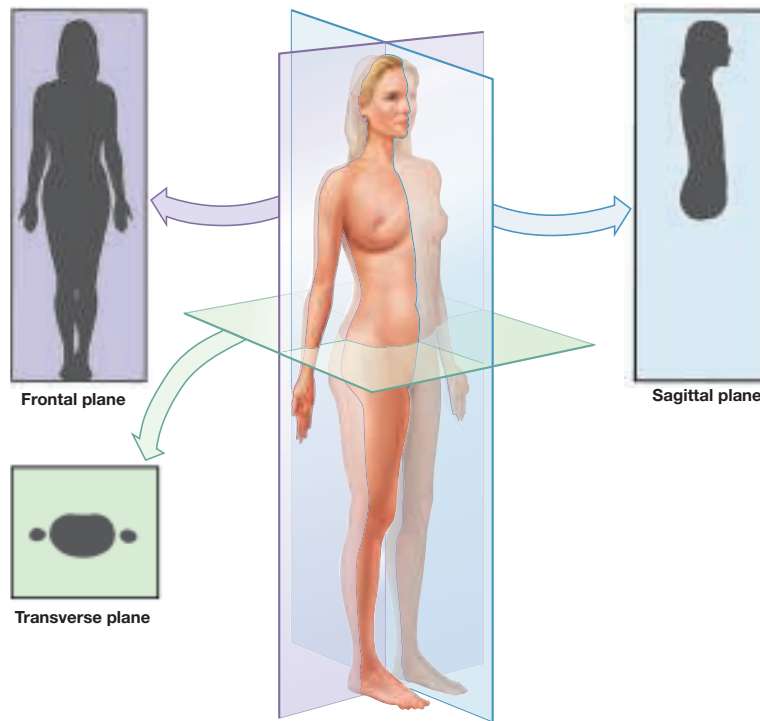
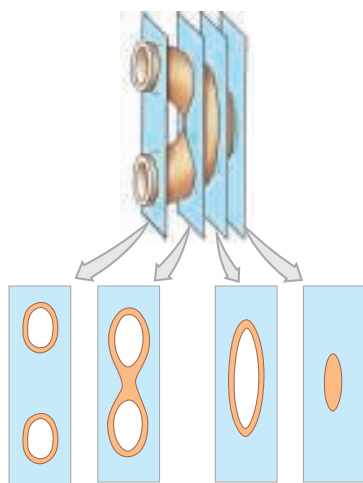


Table 3 Terms That Indicate Planes of Section (see Figure 11)			
Orientation of Plane	Adjective	Directional Term	Description
<b>Perpendicular to long axis</b>	Transverse or horizontal or cross-sectional	Transversely or horizontally	A <i>transverse</i> , or <i>horizontal</i> , <i>section</i> separates superior and inferior portions of the body; sections typically pass through head and trunk regions.
<b>Parallel to long axis</b>	Sagittal	Sagittally	A <i>sagittal section</i> separates right and left portions. You examine a sagittal section, but you section sagittally.
	Midsagittal	Frontally or coronally	In a <i>midsagittal section</i> , the plane passes through the midline, dividing the body in half and separating right and left sides.
	Parasagittal		A <i>parasagittal section</i> misses the midline, separating right and left portions of unequal size.
	Frontal or coronal		A <i>frontal</i> , or <i>coronal</i> , <i>section</i> separates anterior and posterior portions of the body; coronal usually refers to sections passing through the skull.



**Figure 12 Sectional Planes and Visualization** Here we are serially sectioning a bent tube, like a piece of elbow macaroni. Notice how the sectional views change as one approaches the curve; the effects of sectioning must be kept in mind when looking at slides under the microscope. They also affect the appearance of internal organs when seen in a sectional view, through a CT or MRI scan. For example, although it is a simple tube, the small intestine can look like a pair of tubes, a dumbbell, an oval, or a solid, depending on where the section was taken.



**plane** lies at right angles to the longitudinal axis of the part of the body being studied. A division along this plane is called a **transverse section**, or *cross section*. The **frontal plane**, or *coronal plane*, and the **sagittal plane** parallel the longitudinal axis of the body. The frontal plane extends from side to side, dividing the body into **anterior** and **posterior** sections. The sagittal plane extends from anterior to posterior, dividing the body into *left* and *right* sections. A section that passes along the midline and divides the body into left and right halves is a **midsagittal section**, or a *median sagittal section*; a section parallel to the midsagittal line is a **parasagittal section**.

Sometimes it is helpful to compare the information provided by sections made along different planes. Each sectional plane provides a different perspective on the structure of the body; when combined with observations on the external anatomy, they create a reasonably complete picture (see the Clinical Note below). You could develop a more accurate and complete picture by choosing

one sectional plane and making a series of sections at small intervals. This process, called **serial reconstruction**, permits the analysis of relatively complex structures. **Figure 12** shows the serial reconstruction of a simple bent tube, such as a piece of elbow macaroni. The procedure could be used to visualize the path of a small blood vessel or to follow a loop of the intestine. Serial reconstruction is an important method for studying histological structure and for analyzing the images produced by sophisticated clinical procedures.

### Concept Check 3

See the blue Answers tab at the end of the chapter.

- 1  What type of section would separate the two eyes?
- 2  You fall and break your antebrachium. What part of the body is affected?
- 3  What is the anatomical name for each of the following areas: groin, buttock, hand?

### Body Cavities [Figures 13 • 14]

Viewed in sections, the human body is not a solid object, and many vital organs are suspended in internal chambers called **body cavities**. These cavities protect delicate organs from accidental shocks and cushion them from the thumps and bumps that occur during walking, jumping, and running. The **ventral body cavity**, or *coelom* (SĒ-lom; *koila*, cavity), contains organs of the respiratory, cardiovascular, digestive, urinary, and reproductive systems. Because they project partly or completely into the ventral body cavity, there can be significant changes in the size and shape of these organs without distorting surrounding tissues or disrupting the activities of adjacent organs.

As development proceeds, internal organs grow and change their relative positions. These changes lead to the subdivision of the ventral body cavity. Relationships among the various subdivisions of the ventral body cavity are diagrammed in **Figures 13a** and **14**. The **diaphragm** (DĪ-a-gram), a dome-shaped muscular sheet, separates the ventral body cavity into a superior *thoracic cavity*, enclosed by the chest wall, and an inferior *abdominopelvic cavity*, enclosed by the abdominal wall and pelvis.

Many of the organs within these cavities change size and shape as they perform their functions. For example, the stomach swells at each meal, and the heart contracts and expands with each beat. These organs project into moist internal

#### CLINICAL NOTE

### The Visible Human Project

**THE GOAL OF THE VISIBLE HUMAN PROJECT**, funded by the U.S. National Library of Medicine, has been to create an accurate computerized human body that can be studied and manipulated in ways that would be impossible using a real body. The data set in its current form consists of the digital images of cross sections painstakingly prepared (by Dr. Victor Spitzer and colleagues at the University of Colorado Health Sciences Center) at 1 mm intervals for the visible male and

0.33 mm intervals for the visible female. Even the relatively “low-resolution” data sets are enormous—the male sections total 14 GB and the female sections total 40 GB. These images can be viewed on the Web at [http://www.nlm.nih.gov/research/visible/visible\\_human.html](http://www.nlm.nih.gov/research/visible/visible_human.html). These data have subsequently been used to generate a variety of enhanced images and for interactive educational projects, such as the Digital Cadaver.



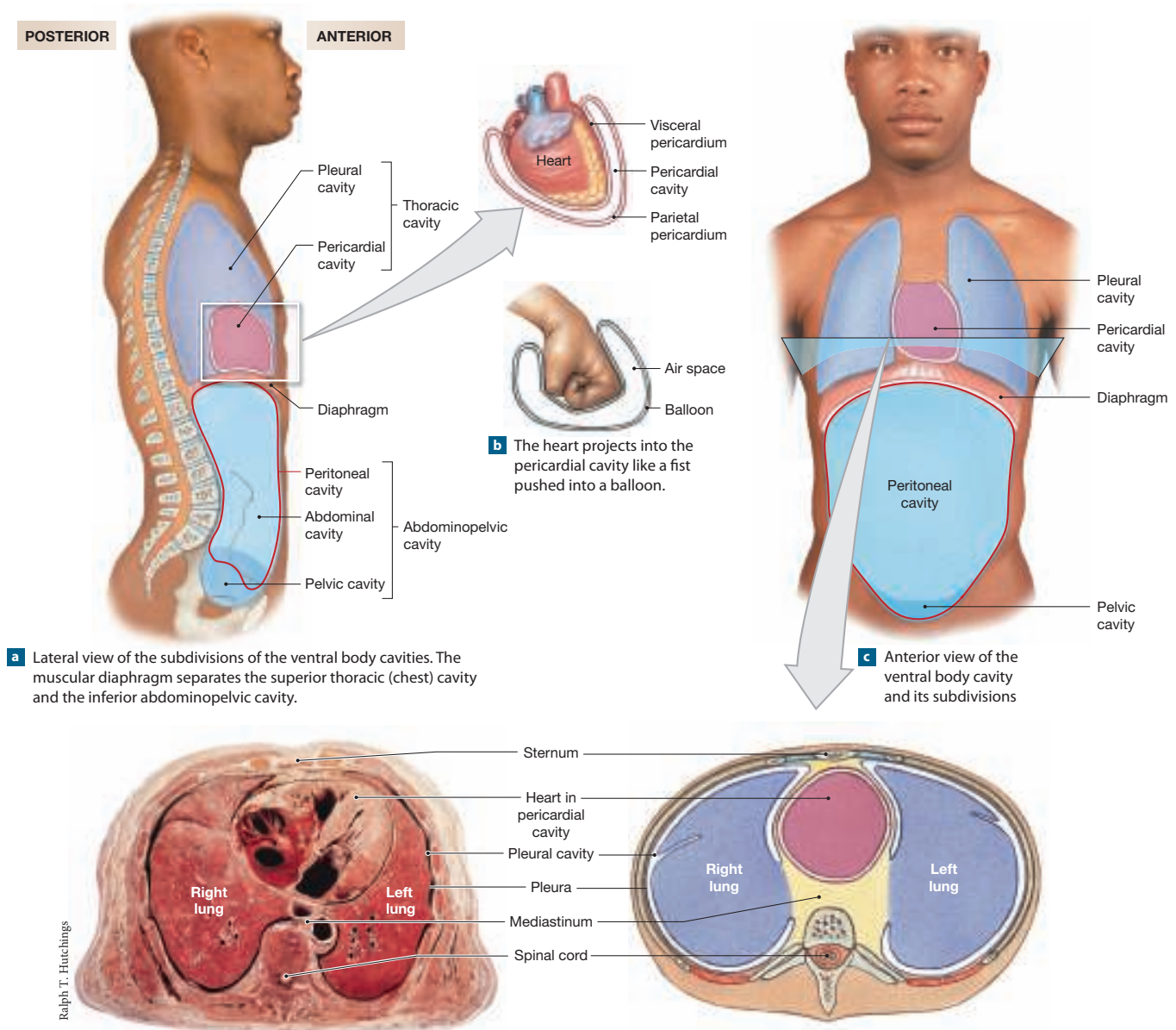
chambers that permit expansion and limited movement, but prevent friction. There are three such chambers in the thoracic cavity and one in the abdominopelvic cavity. The internal organs that project into these cavities are called **viscera** (VIS-er-a).

**The Thoracic Cavity** The lungs and heart, associated organs of the respiratory, cardiovascular, and lymphoid systems, as well as the thymus and inferior portions of the esophagus, are contained within the **thoracic cavity**. The bound-

aries of the thoracic cavity are established by the muscles and bones of the chest wall and the diaphragm, a muscular sheet that separates the thoracic cavity from the abdominopelvic cavity (see **Figure 13a,c**). The thoracic cavity is subdivided into the left and right **pleural cavities** separated by the **mediastinum** (mê-dê-as-TĪ-num or mê-dê-AS-ti-num) (**Figure 13a,c,d**).

Each **pleural cavity** contains a lung. The cavity is lined by a shiny, slippery **serous membrane**, which reduces friction as the lung expands and recoils during respiration. The serous membrane lining a pleural cavity is

**Figure 13 Body Cavities**



**a** Lateral view of the subdivisions of the ventral body cavities. The muscular diaphragm separates the superior thoracic (chest) cavity and the inferior abdominopelvic cavity.

**b** The heart projects into the pericardial cavity like a fist pushed into a balloon.

**c** Anterior view of the ventral body cavity and its subdivisions

**d** Sectional view of the thoracic cavity. Unless otherwise noted, all sectional views are presented in inferior view.

Ralph T. Hutchings



called a *pleura* (PLOOR-ah). The *visceral pleura* covers the outer surfaces of a lung, and the *parietal pleura* covers the opposing mediastinal surface and the inner body wall.

The mediastinum consists of a mass of connective tissue that surrounds, stabilizes, and supports the esophagus, trachea, and thymus, and the major blood vessels that originate or end at the heart. It also contains the **pericardial cavity**, a small chamber that surrounds the heart (Figure 13d). The relationship between the heart and the pericardial cavity resembles that of a fist pushing into a balloon (Figure 13b). The wrist corresponds to the base (attached portion) of the heart, and the balloon corresponds to the serous membrane that lines the pericardial cavity. The serous membrane covering the heart is called the **pericardium** (*peri-*, around + *kardia*, heart). The layer covering the heart is the *visceral pericardium*, and the opposing surface is the *parietal pericardium*. During each beat, the heart changes in size and shape. The pericardial cavity permits these changes, and the slippery pericardial lining prevents friction between the heart and adjacent structures in the mediastinum.

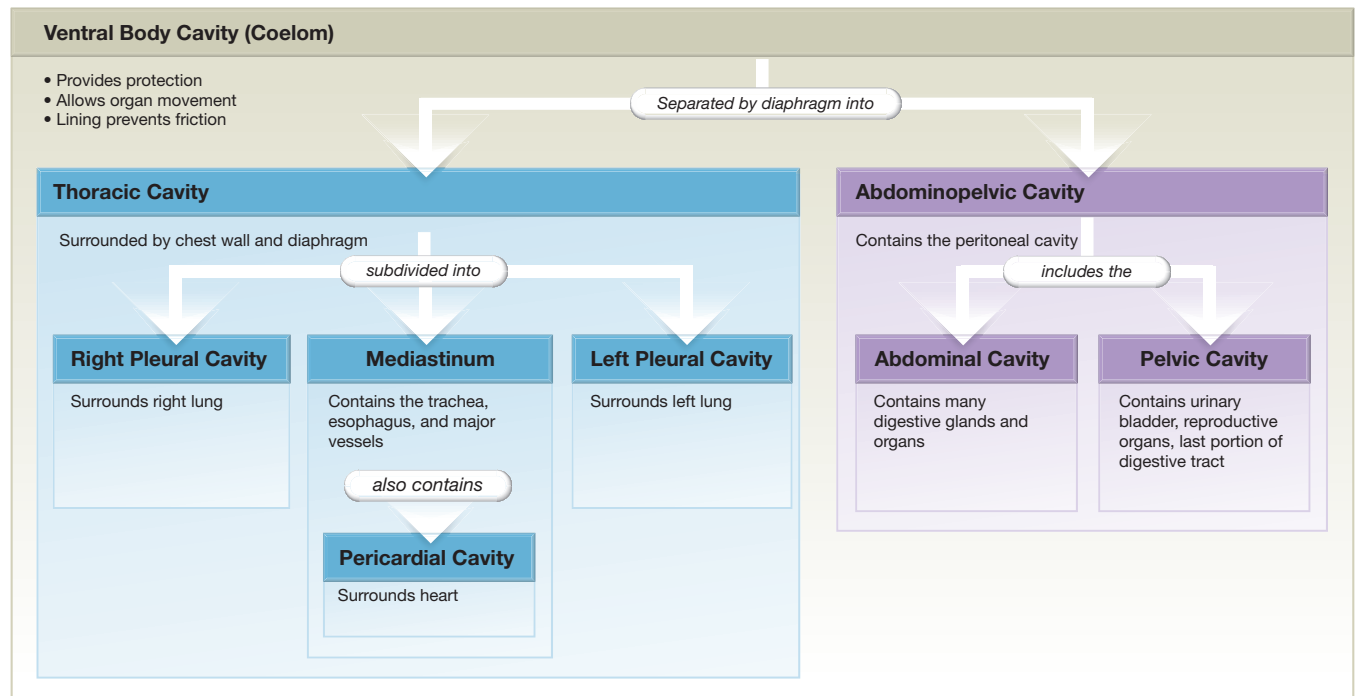
**The Abdominopelvic Cavity** Figures 13a and 14 demonstrate that the **abdominopelvic cavity** can be divided into a superior *abdominal cavity* and an inferior *pelvic cavity*. The abdominopelvic cavity contains the **peritoneal** (*per-i-tō-NĒ-al*) **cavity**, an intern-al chamber lined by a serous membrane known as the **peritoneum** (*per-i-tō-NĒ-um*). The *parietal peritoneum* lines the body wall. A narrow, fluid-filled space separates the parietal peritoneum from the *visceral peritoneum* that covers the enclosed organs. Organs such as the stomach, small intestine, and portions of the large intestine are suspended within the peritoneal cavity by double sheets of peritoneum, called **mesenteries**

(MES-en-ter-ēs). Mesenteries provide support and stability while permitting limited movement.

- The **abdominal cavity** extends from the inferior surface of the diaphragm to an imaginary plane extending from the inferior surface of the lowest spinal vertebra to the anterior and superior margins of the pelvic girdle. The abdominal cavity contains the liver, stomach, spleen, kidneys, pancreas, and small intestine, and most of the large intestine. (The positions of many of these organs can be seen in Figure 9c). These organs project partially or completely into the peritoneal cavity, much as the heart and lungs project into the pericardial and pleural cavities, respectively.
- The inferior portion of the abdominopelvic cavity is the **pelvic cavity**. The pelvic cavity, enclosed by the bones of the pelvis, contains the last segments of the large intestine, the urinary bladder, and various reproductive organs. For example, the pelvic cavity of a female contains the ovaries, uterine tubes, and uterus; in a male, it contains the prostate gland and seminal glands. The inferior portion of the peritoneal cavity extends into the pelvic cavity. The superior portion of the urinary bladder in both sexes, and the uterine tubes, the ovaries, and the superior portion of the uterus in females are covered by the peritoneum.

This chapter provided an overview of the locations and functions of the major components of each organ system, and it introduced anatomical vocabulary. Modern methods of visualizing anatomical structures in living individuals are summarized in the Clinical Note on the next page. A true understanding of anatomy involves integrating the information provided by sectional

**Figure 14 The Ventral Body Cavity** Relationships, contents, and some selected functions of the subdivisions of the ventral body cavity.



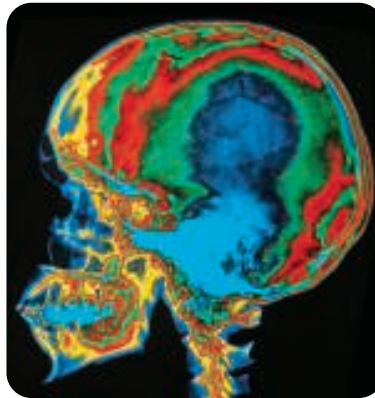
CLINICAL NOTE

Clinical Anatomy and Technology

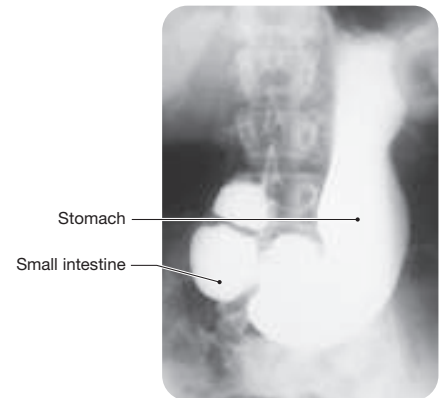


Science Source/Photo Researchers

X-ray



Color-enhanced x-ray



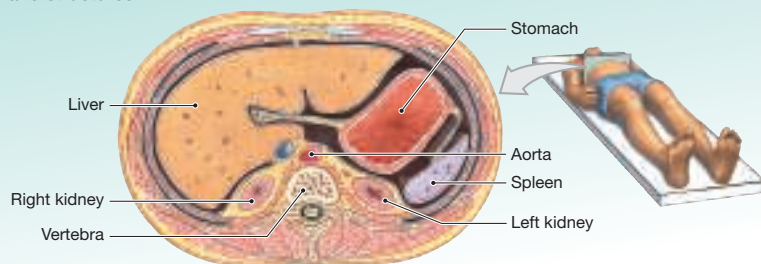
Barium-contrast x-ray

Radiological procedures

include various noninvasive techniques that use radioisotopes, radiation, and magnetic fields to produce images of internal structures. Physicians who specialize in the performance and analysis of these diagnostic images are called radiologists. Radiological procedures can provide detailed information about internal systems and structures.

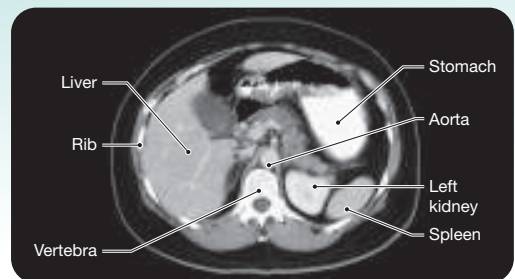
**X-rays** are a form of high-energy radiation that can penetrate living tissues. In the most familiar procedure, a beam of x-rays travels through the body and strikes a photographic plate. Not all of the projected x-rays arrive at the film; some are absorbed or deflected as they pass through the body. The resistance to x-ray penetration is called radiodensity. In the human body, the order of increasing radiodensity is as follows: air, fat, liver, blood, muscle, bone. The result is an image with radiodense tissues, such as bone, appearing white, while less dense tissues are seen in shades of gray to black.

A **barium-contrast x-ray** of the upper digestive tract. Barium is very radiodense, and the contours of the gastric and intestinal lining can be seen outlined against the white of the barium solution.



The relative position and orientation of the scans shown to the right.

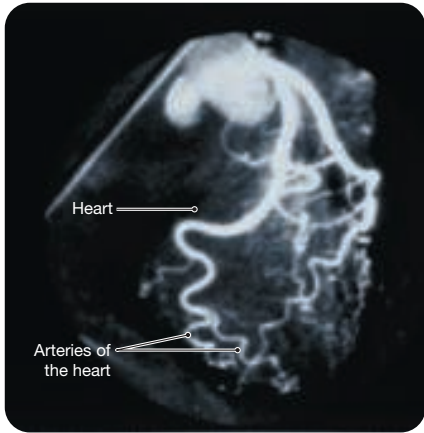
Note that when anatomical diagrams or scans present cross-sectional views, the sections are presented as though the observer were standing at the feet of a person in the supine position and looking toward the head of the subject.



Dr. Kathleen Welch

CT scan of the abdomen

**CT scans**, formerly called CAT (computerized axial tomography), use a single x-ray source rotating around the body. The x-ray beam strikes a sensor monitored by a computer. The source completes one revolution around the body every few seconds; it then moves a short distance and repeats the process. By comparing the information obtained at each point in the rotation, the computer reconstructs the three-dimensional structure of the body. The result is usually displayed as a sectional view in black and white, but it can be colorized.



Alexander Tsiras/Photo Researchers

Digital subtraction angiography

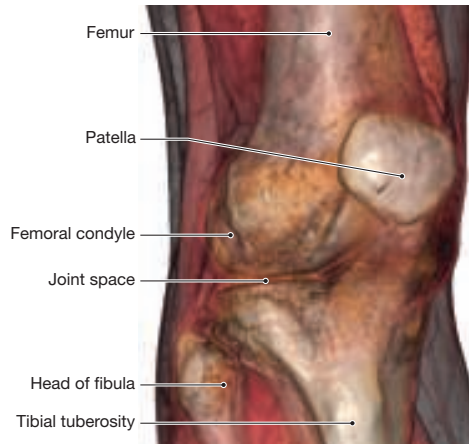


Image rendered with High Definition Volume Rendering © Software, provided by Fovia, Inc.

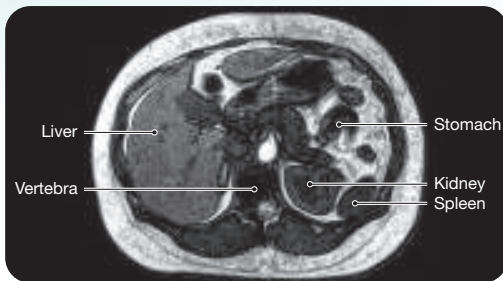
Spiral scan [Image rendered with High Definition Volume Rendering® software provided by Fovia, Inc.]



Nikolay Suslov/Stockphoto

**Digital subtraction angiography (DSA)** is used to monitor blood flow through specific organs, such as the brain, heart, lungs, and kidneys. X-rays are taken before and after radiopaque dye is administered, and a computer “subtracts” details common to both images. The result is a high-contrast image showing the distribution of the dye.

A **spiral CT scan** (also termed a helical CT scan) is a new form of three-dimensional clinical imaging technology that is becoming increasingly important in clinical settings. With a spiral CT scan the patient is placed on a platform that advances at a steady pace through the scanner while the imaging source, usually x-rays, rotates continuously around the patient. Because the x-ray detector gathers data quickly and continuously, a higher quality image is generated, and the patient is exposed to less radiation as compared to a standard CT scanner, which collects data more slowly and only one slice of the body at a time.



Dr. Kathleen Welch

MRI scan of the abdomen

An **MRI (magnetic resonance imaging)** scan surrounds part or all of the body with a magnetic field about 3000 times as strong as that of Earth. This field affects protons within atomic nuclei throughout the body, which line up along the magnetic lines of force like compass needles in Earth’s magnetic field. When struck by a radio wave of the proper frequency, a proton will absorb energy. When the pulse ends, that energy is released, and the energy source of the radiation is detected by the MRI computers.



CNSI/Photo Researchers

Ultrasound scan of the abdomen

In **ultrasound** procedures, a small transmitter contacting the skin broadcasts a brief, narrow burst of high-frequency sound and then picks up the echoes. The sound waves are reflected by internal structures, and a picture, or echogram, can be assembled from the pattern of echoes. These images lack the clarity of other procedures, but no adverse effects have been attributed to the sound waves, and fetal development can be monitored without a significant risk of birth defects.