

Answers to Check Your Understanding, Multiple Choice, and Matching Questions

Chapter 1

Check Your Understanding 1. Histology is the microscopic study of tissue structure; radiography is the study of internal body structures from X-ray and other imaging techniques. 2. pathology: study of disease; hepatitis: inflammation of the liver; brachial: arm; leukocyte: white cell; pneumonia: condition of air. 3. A tissue is a group of cells of similar structure with a common function. The four types of tissue are epithelial tissue, a covering or lining tissue; connective tissue, which functions in support and protection; muscle tissue, which produces movement; and nervous tissue, which allows for internal communication by electrical impulses. 4. (a) The urinary system eliminates wastes and regulates water and ion balance. (b) The nervous system is a fast-acting control system. (c) The respiratory system supplies blood with oxygen and removes carbon dioxide. 5. The liver lies inferior to the heart and extends laterally in the epigastric and right hypochondriac regions of the abdomen. 6. The outer tube shows evidence of segmentation. 7. The parietal pleura is the outer layer of serous membrane that lines the pleural cavity. 8. In a tissue stained with H&E, the cell nuclei are colored dark blue to purple. 9. Scanning electron microscopy (SEM) produces three-dimensional images of surface features. 10. (a) Ultrasound is best for examining the gallbladder in the ER. (b) Broken bones are best visualized using conventional X-ray imaging. (c) MRI is best for visualizing joint structure. (d) A CT scan is best for imaging internal organs in a trauma situation.

Review Questions 1. c 2. (1) d; (2) b; (3) a 3. (a) superior; (b) deep; (c) proximal; (d) lateral; (e) medial; (f) posterior; (g) lateral; (h) superior; (i) anterior; (j) superficial 4. (1) d; (2) f; (3) c; (4) j; (5) g; (6) i; (7) a; (8) b; (9) e; (10) h 5. b 6. (1) i; (2) l; (3) o; (4) o; (5) o; (6) l; (7) o 7. (1) D; (2) V; (3) D; (4) V; (5) V 8. (a) 2; (b) 3; (c) 1; (d) 4 9. d 10. (1) c; (2) a; (3) b; (4) d 11. c 12. e

Chapter 2

Check Your Understanding 1. The three regions of the cell are the plasma membrane, the cytoplasm, and the nucleus. 2. The plasma membrane is composed of lipids (phospholipids), sugars (glycolipids), and proteins. 3. Water enters and leaves the cell via osmosis. 4. Exocytosis carries large macromolecules out of the cell. 5. Ribosomes and rough ER produce proteins; the Golgi apparatus packages proteins. 6. The mitochondria produce energy for cellular activity. 7. A cell that specialized in phagocytosis would contain numerous lysosomes. 8. The intermediate filaments resist tension. 9. The nucleolus produces ribosomal RNA and assembles the ribosomal subunits. 10. Rough endoplasmic reticulum is

continuous with the nuclear envelope. 11. Extended chromatin is thin strings of chromatin that appear as beads (histones) on a string (DNA) in TEM. Extended chromatin is found in active regions of DNA where transcription is occurring. Condensed chromatin is thick, tightly coiled chromatin that is found in inactive regions of DNA. 12. The cell spends most of its life in interphase. 13. Anaphase = "apart"; the chromosomes move toward opposite poles of the cell during anaphase. Meta = "between, transition"; during metaphase, the chromosomes align in the midline of the cell. Telo = "the end"; in telophase, the nuclei of daughter cells reassemble, cytokinesis continues, cell division ends. 14. Muscle cells have abundant actin and myosin microfilaments. 15. Cells that produce and secrete hormones contain abundant rough ER, mitochondria, and secretory granules. 16. According to the mitochondrial theory of aging, reducing caloric intake can increase life span.

Review Questions 1. a 2. a 3. b 4. a 5. (a) Golgi apparatus (b) rough ER (c) condensed (d) smooth (e) nucleosome (f) microtubules (g) mitochondrion (h) mitochondrion (i) rough ER 6. d 7. b 8. a 9. (a) metaphase (b) prophase (c) telophase (d) prophase (e) anaphase 10. (a) microtubules (b) intermediate filaments (c) microtubules (d) actin microfilaments (e) intermediate filaments (f) microtubules (g) actin microfilaments 11. (1) b; (2) g; (3) c or b; (4) d; (5) e; (6) f; (7) a 12. b

Chapter 3

Check Your Understanding 1. The basic vertebrate body plan is established during the embryonic period. 2. The digestive tract (stomach, intestines) forms from the inner tube, as do the liver, pancreas, and gallbladder. 3. The kidneys are located posterior (or dorsal) to the peritoneal cavity. 4. During gastrulation, cells from the epiblast invaginate (move inward) and form three separate germ layers. This process occurs during the third week of development. 5. The notochord induces the formation of the neural tube. 6. Somites, from the paraxial mesoderm, and intermediate mesoderm cluster into segments along the body axis. 7. Ectoderm forms the outer covering of the embryo. 8. Endoderm forms the inner lining of the inner tube. 9. The sclerotome forms the vertebra and ribs. 10. Splanchnic lateral plate mesoderm forms the connective tissues, muscle tissues, visceral serosa of the respiratory and digestive tubes, and the heart and blood vessels. 11. Lungs are not fully developed until the end of the seventh month in utero. Babies born prior to this time commonly experience respiratory distress.

Review Questions 1. (1) a; (2) b; (3) b; (4) a 2. b 3. b 4. c 5. (1) c; (2) f; (3) i; (4) h; (5) a; (6) d; (7) b; (8) g; (9) e 6. (1) c; (2) g; (3) d; (4) e; (5) f; (6) a; (7) b 7. c 8. d 9. a, d 10. e 11. a 12. a 13. d 14. a 15. c 16. d

Chapter 4

Check Your Understanding 1. The apical layer of the epithelium abuts the white space in each photograph (a–h). 2. Larger-sized cells allow for more room for cellular machinery necessary for producing cellular secretions (ER, ribosomes, Golgi apparatus, mitochondria). Cuboidal epithelium is found in kidney tubules, glands, and the ovary surface. 3. Diffusion is a distant-dependent process; columnar epithelium is too thick for efficient diffusion. Simple squamous epithelium is found in these locations. 4. Goblet cells are unicellular exocrine glands that secrete mucin (mucus). 5. endocrine 6. Simple exocrine glands have unbranched ducts; the ducts of compound glands are branched. 7. Microvilli are short extensions of the plasma membrane with a core of actin microfilaments that extend into the cytoskeleton. They increase the surface area of the plasma membrane. A cilium is a long extension of the plasma membrane composed of a core of microtubules arranged in pairs linked by motor proteins and anchored to a centriole at its base. The bending of a cilium produces movement of the fluid at the epithelial surface. 8. Intermediate filaments extend across the cell and anchor at desmosomes on the opposite side. Linker proteins from the desmosomes link to adjacent cells. 9. Other tissues that contain gap junctions are embryonic tissues, connective tissues, cardiac muscle, and smooth muscle. 10. Epithelial tissues contain lots of cells of similar type closely packed together into sheets with little extracellular matrix. Connective tissues contain fewer cells of various types separated from each other by extensive extracellular material. 11. The matrix of a connective tissue is composed of both ground substance and fibers. The ground substance is commonly a gel-like material that functions to hold fluid. 12. Collagen fibers in connective tissues resist tension; the ground substance resists compression; and the elastic fibers allow for recoil. 13. The fibers of loose connective tissues are separated from each other by ground substance. In dense connective tissue, the fibers are closely packed together. 14. Ligaments and tendons are formed from dense regular connective tissue. The hypodermis is composed of adipose and loose areolar connective tissue. The connective tissue that underlies epithelia is loose areolar connective tissue. Reticular connective tissues contribute to the structure of lymph nodes. 15. Collagen fibers are found in loose areolar, adipose, dense regular, and irregular connective tissues; hyaline cartilage elastic cartilage, and fibrocartilage; and bone. 16. Cells are located in lacunae in both cartilage and bone tissues. 17. In cartilage, compressive forces are resisted by the gel-like ground substance. 18. Most obvious reason that the tissue in Figure 4.10c is not an epithelial tissue is that it does not have an apical and basal region.

19. Neurons function to transmit electrical impulses. 20. Skeletal muscle and cardiac muscle tissues are striated. (Do NOT confuse *striated* with *stratified*. *Stratified*, which means “layered,” is used in reference to epithelium; *striated*, which means “striped,” refers to muscle tissue.) 21. Epithelia and some connective tissues (bone, areolar connective tissue, dense irregular connective tissue, blood) regenerate easily. Cardiac muscle and nervous tissue in brain and spinal cord do not regenerate. 22. Scar tissue is located in the underlying connective tissue. 23. Increased blood flow to an infected tissue and increased fluid leakage from capillaries serving the infected area cause the heat and swelling associated with infection. 24. Epithelia forms from all three embryonic germ layers: ectoderm, mesoderm, and endoderm. 25. Cell division in cancerous cells is uncontrolled, and cells expand beyond their normal tissue boundaries.

Review Questions 1. (1) a; (2) c; (3) d; (4) b; (5) b 2. c and e 3. (1) b; (2) f; (3) a; (4) d; (5) g 4. b 5. a 6. (a) cilia; (b) microvilli; (c) desmosome; (d) tight junction; (e) basement membrane 7. (1) e; (2) a; (3) b; (4) c; (5) d 8. (1) a; (2) a,b,c; (3) a; (4) c; (5) a 9. d 10. c 11. b 12. b 13. (a) mesoderm; (b) mesoderm; (c) ectoderm

Chapter 5

Check Your Understanding 1. The word root *epi* means “over” or “above”; *hypo* means “below”; and *derm* means “skin.” 2. The five main functions of skin are protection, body temperature regulation, excretion, production of vitamin D, and sensory reception. 3. The stratum basale, stratum spinosum, and stratum granulosum are the epidermal layers containing living cells. 4. Cells in the epidermis function in protection, production of vitamin D, and sensory reception. 5. Thick skin contains an additional layer, the stratum lucidum, and has a much thicker stratum corneum. 6. Dermal blood vessels dilate to release heat when the body is warm, and they constrict to prevent the loss of heat when the body is cold. 7. (a) The papillary layer of the dermis is composed of loose areolar connective tissue. (b) The reticular layer is dense irregular connective tissue. (c) The hypodermis contains both loose areolar and adipose connective tissue. 8. Fibroblasts in the dermis produce the collagen and elastic fibers of the dermis. These fibers give the skin strength, resilience, and recoil properties; the macrophages, mast cells, and white blood cells function to fight infections. 9. The large variation in skin color in humans is due to variation in the type and amount of melanin in the epidermal layer. 10. A dark-skinned individual in northern latitudes would have concerns about vitamin D production. Because there is less sunlight, particularly in the winter months, dark skin produces less vitamin D than light skin. 11. The keratin in hair and nails is a hard keratin: it is tougher and more durable, and its cells do not flake off. 12. Hair and the hair follicle form from the epidermal layer. 13. The cells of the medulla are deepest layer of hair cells, the next layer of cells is the cortex, and the outermost layer is the cuticle. 14. Chemotherapy stops the cell division of the cells in the hair matrix, causing hair to fall out, but it does not destroy the hair follicles. A severe burn, however, destroys hair follicles; thus, hair cannot regrow. 15. Apocrine sweat glands do not cause acne. Acne is caused by sebaceous glands, which also become active at adolescence. 16. Eccrine sweat glands, like most glands, are formed from cuboidal epithelium. In some portions of the micrograph, this epithelium appears stratified because of the section. 17. Eccrine glands function in temperature regulation (sweat causes evaporative cooling)

and excretion (sweat contains metabolic wastes, salts, and water). 18. Second-degree burns cause blisters. 19. The life-threatening concerns associated with third-degree burns are fluid loss and the resulting circulatory shock, followed by risk of infection. Fluid loss is treated with intravenous fluids to maintain blood volume. To prevent infection, the damaged area is covered with either skin grafts or artificial skin, and intravenous antibiotics are given. 20. Basal cell carcinoma is the most common type of skin cancer. Melanomas are the skin cancers that can be fatal. 21. Appendages of the skin develop from ectoderm. The hypodermis develops from mesoderm. 22. UV radiation degrades the collagen fibers and other components of the dermis.

Review Questions 1. c 2. (1) e; (2) b or d; (3) a; (4) c; (5) d 3. d 4. d 5. b 6. a 7. c 8. b 9. d 10. d 11. (1) b; (2) a; (3) a; (4) b; (5) d 12. a 13. (1) e; (2) d; (3) f; (4) b,g; (5) a; (6) g; (7) c 14. c 15. (1) d; (2) a; (3) e; (4) c; (5) d; (6) d; (7) d

Chapter 6

Check Your Understanding 1. The matrix of the three types of cartilage differs in the amount and type of fibers found in each. Hyaline cartilage has small collagen fibrils; elastic cartilage has both collagen and elastic fibers; and fibrocartilage contains thick bundles of collagen. 2. Hyaline cartilage is most abundant. It is located in articular cartilages, respiratory passageways, costal cartilages of ribs, the embryonic skeleton, and the cartilages of the nose. 3. Chondroblasts in the perichondrium produce new cartilage by appositional growth. 4. Collagen fibers contribute to the strength and flexibility of bone, and the mineralized ground substance makes bone hard. 5. Calcium and phosphate are stored in bone. These minerals are released by the action of osteoclasts. 6. Osteoblasts secrete new bone matrix. Osteocytes are surrounded by bony matrix and function to keep the matrix healthy. 7. Periosteum covers the external surfaces of bone (except for the articular areas); endosteum covers the internal surfaces of bone (including the central and perforating canals). Both membranes contain osteoblasts and osteoclasts. 8. In a flat bone, compact bone is located on the external surfaces, and spongy bone is located internally. 9. A condyle is a joint surface. A tubercle is an attachment site for muscle or ligament. A foramen is a hole in the bone that acts as a passageway for vessels or nerves. 10. The central canal is in the middle of an osteon; the perforating canals connect osteons; canaliculi are small connections between lacunae that link adjacent osteocytes. 11. Oxygen and nutrients diffuse through the spaces in the matrix, the canaliculi and lacunae of the inner lamellae, to reach the cells in the outermost lamella. 12. A trabecula is a “beam” of bone composed of several lamellae and associated osteocytes. The bone tissue in a trabecula is not aligned in concentric rings around a central canal, as it is in an osteon. 13. Most bones of the skull, except for parts of the base of the skull and the clavicle, are membrane bones. 14. In a 6-month-old fetus, only the diaphysis of the long bone is ossified. 15. The thickness of the epiphyseal plate does not change during childhood. As the long bone grows, bone is added to the diaphyseal end of the epiphyseal plate. 16. Exercise stimulates bone deposition. Mechanical stress on the bone stimulates osteoblasts to produce additional bone matrix. 17. Remodeling of the bony callus following a fracture makes the repaired area resemble the original unbroken bone. 18. Comminuted and compression fractures are common in older individuals. 19. Osteomalacia and rickets result from inadequate mineralization of bone. 20. Activity of

osteoclasts should be targeted to slow bone loss. 21. Development of osteoporosis is best prevented during the bone-building years of adolescence and early adulthood. 22. Bones begin to ossify by week 8 of embryonic development. Bone mass starts to decline around age 40. 23. Estrogens aid in maintaining bone density. Estrogen decline in postmenopausal women increases their risk of bone loss.

Review Questions 1. e 2. a 3. e 4. (1) a; (2) b; (3) a; (4) c; (5) a 5. (1) T; (2) F; (3) T; (4) F; (5) F; (6) T; (7) T 6. b 7. c 8. (1) a; (2) b; (3) c; (4) a; (5) b; (6) a 9. d 10. c 11. (a) 3; (b) 2; (c) 4; (d) 1; (e) 5; (f) 6 12. b 13. c 14. b 15. b 16. a 17. a 18. (1) b,d; (2) a,d; (3) b; (4) c; (5) a,c

Chapter 7

Check Your Understanding 1. The frontal, ethmoid, and sphenoid bones form the anterior cranial fossa. 2. The crista galli is on the ethmoid bone; the mastoid process is on the temporal bone; the nuchal line is on the occipital bone; the sella turcica is on the sphenoid bone; the supraorbital foramen is on the frontal bone; the zygomatic process is on the temporal bone. 3. The four bones that articulate with the left parietal bone are the right parietal bone via the sagittal suture; the frontal bone via the coronal suture; the left temporal bone via the squamous suture; and the occipital bone via the lambdoid suture. 4. The bones that articulate with the maxilla are the zygomatic, vomer, palatine, nasal, lacrimal, ethmoid, and inferior nasal concha. 5. The hard palate is formed from the horizontal plates of the palatine bones and palatine processes of the maxillae. 6. The alveolar margins are the superior margin of the mandible and the inferior margin of the maxilla that contain the teeth in the alveoli (sockets). 7. Nasal conchae are formed from the ethmoid bone (superior and middle) and the inferior nasal concha. These conchae create turbulence in the incoming air and function to warm, moisten, and filter the air. 8. Cranial bones contributing to the orbit are the frontal, sphenoid, and ethmoid bones; the facial bones that contribute to the orbit are the lacrimal, maxillary, zygomatic, and palatine bones. 9. Ethmoidal air cells and maxillary sinuses are located in the lateral walls of the nasal cavity. All sinuses are lined with a mucous membrane. 10. The nucleus pulposus, the inner core of the intervertebral disc, expands under compression. The outer rings of fibrocartilage, the annulus fibrosus, function to resist twisting forces. 11. The cervical curvature develops at 3 months, as the infant begins to hold up his head; the lumbar curvature develops around 1 year, when the baby begins to walk. 12. The annulus fibrosus is thinnest posteriorly, but the posterior longitudinal ligaments prevent direct posterior herniation; thus, most herniations occur in the posterolateral direction. 13. The superior articular process of a vertebra articulates with the inferior articular process of the vertebra just superior. 14. All cervical vertebrae have a transverse foramen. This is the most distinctive feature. Other possible answers are listed in Table 7.2. 15. Thoracic vertebra T₁₂ has costal facets on its vertebral body; lumbar vertebra L₁ does not. 16. The fused spinous processes of the sacral vertebrae form the median sacral crest. 17. The sternal angle is the junction between the manubrium and the body of the sternum. Rib 2 articulates here. 18. The head of the rib articulates with the superior and inferior costal facets of the thoracic vertebra. The tubercle of the rib articulates with the transverse costal facet. 19. The frontal bone and mandible form as two individual bones that fuse during childhood. 20. Age-related degenerative bone loss can cause kyphosis.

Review Questions 1. (1) b,g; (2) h; (3) d; (4) d,f; (5) e; (6) c; (7) a,b,d,h; (8) i 2. c 3. c 4. a 5. a 6. (1) a; (2) c; (3) f; (4) b; (5) d; (6) e; (7) c; (8) d; (9) f; (10) e 7. (1) e; (2) d; (3) b; (4) a; (5) c

Chapter 8

Check Your Understanding 1. The acromion of the scapula articulates with the clavicle. 2. The only bony attachment between the pectoral girdle and the axial skeleton is the clavicle joining with the sternum and rib 1. 3. The three fossae of the scapula are the supraspinous fossa, “above” the scapula spine; the infraspinous fossa, “below” the scapula spine; and the subscapular fossa, “beneath” the scapula on its anterior surface. 4. The radius is on the lateral side of the forearm. 5. The capitulum is on the humerus, and it articulates with the head of the radius. The trochlear notch is on the ulna, and it articulates with the trochlea of the humerus. The head of the ulna is on the ulna, and it articulates with the ulna notch of the radius. The radial notch is on the ulna, and it articulates with the head of the radius. 6. The anatomical neck of the humerus is just inferior to the head; it is the area where the diaphysis joins with the proximal epiphysis. The surgical neck, the most frequently fractured region of the humerus, is inferior to the greater and lesser tubercles. 7. The metacarpals are located in the palm of the hand. 8. The pubis is the most anterior bone of the pelvic girdle. 9. When you sit, the ischial tuberosities carry your weight. 10. When your hands are on your hips, your hands are resting on the iliac crests. 11. The pubic arch is greater in females than in males; the greater sciatic notch is wider and more shallow in females than in males; and the sacrum is wider, shorter, and more curved in females. 12. The acetabulum of the hip bone articulates with the head of the femur. 13. The bony bumps on either side of your ankle are formed by the medial malleolus of the tibia and the lateral malleolus of the fibula. 14. The lateral malleolus is on the fibula; the linea aspera is on the femur; the lesser trochanter is on the femur; the fibular notch is on the tibia; the talar shelf is on the calcaneus; and the tibial tuberosity is on the tibia. 15. The anterior portion of the talus is the keystone of the medial longitudinal arch. The arches distribute weight anteriorly to the heads of the metatarsals (the “ball of the foot”) and posteriorly to the calcaneus (heel). 16. The skeleton in males becomes more robust at puberty. In females, the pelvis broadens. 17. The three bones of the hip fuse together during childhood at the acetabulum. Splinting holds the femoral head in place so the acetabulum and surrounding ligaments can form normally.

Review Questions 1. (1) g; (2) f; (3) b; (4) a; (5) b; (6) c; (7) d; (8) e 2. (1) b; (2) c; (3) e; (4) a; (5) h; (6) e (7) f 3. e 4. b 5. d 6. a 7. c,d, (f) 8. c 9. b 10. c

Chapter 9

Check Your Understanding 1. A synarthrosis is an immovable joint. This is a functional joint classification. A syndesmosis is a fibrous joint where the adjoining bones are connected exclusively by ligaments. A synchondrosis is a cartilaginous joint where hyaline cartilage unites adjoining bones. Both syndesmosis and synchondrosis are considered structural classifications. 2. A symphysis joint contains both hyaline cartilage, which covers the articular joint surfaces, and fibrocartilage, which unites adjoining bones. 3. The six basic features of synovial joints are (1) articular cartilage, (2) a joint cavity, (3) an articular capsule, (4) synovial fluid, (5) reinforcing ligaments, and (6) nerves and vessels. 4. An articular disc is composed of fibrocartilage,

and it is located within the joint cavity. Articular cartilage is composed of hyaline cartilage and covers the adjoining surfaces of all synovial joints. 5. Synovial fluid nourishes the cells of the articular cartilage and lubricates the joint surfaces. 6. (a) The movements that occur at the elbow are flexion and extension. (b) The hip allows flexion/extension, abduction/adduction, medial and lateral rotation, and circumduction. (c) Dorsiflexion and plantar flexion occur at the ankle. (d) Rotation occurs at the atlantoaxial joint. (e) The metacarpophalangeal joint can produce flexion/extension, abduction/adduction, and circumduction. 7. (a) The elbow is a uniaxial hinge joint. (b) The hip is a multiaxial ball-and-socket joint. (c) The ankle is a uniaxial hinge joint. (d) The atlantoaxial joint is a uniaxial pivot joint. (e) The metacarpophalangeal joint is a biaxial condyloid joint. 8. Pronation is medial rotation of the forearm such that the palm faces posteriorly; supination is lateral rotation of the forearm such that the palm faces anteriorly. This movement occurs at the proximal and distal radioulnar joints. 9. The articular disc in the sternoclavicular and the temporomandibular joints divide each joint cavity and enable multiple complex movements of each joint. 10. The knee also contains an articular disc. 11. The elbow is the most stable, and the shoulder is the least stable. 12. The muscle tendons that cross the shoulder contribute most to its stability. 13. The ulna forms part of the elbow. The radius forms part of the wrist joint. 14. The intracapsular ligament of the hip is the ligament of the head of the femur. The intracapsular ligaments of the knee are the anterior and posterior cruciate ligaments. 15. Forceful inversion of the ankle can sprain the lateral ligament. 16. The medial and lateral menisci of the knee aid in joint stability, as do the extensive capsular, extracapsular, and intracapsular ligaments. 17. (a) Gouty arthritis is caused by crystallization of uric acid in the synovial membranes. (b) Osteoarthritis is the erosion of the articular cartilage. (c) Rheumatoid arthritis is an autoimmune response causing inflammation of the synovial membrane. 18. A sprain or subluxation stretches the joint capsule and surrounding ligaments and makes the joint more susceptible to repeat injury. 19. Synovial joints form by week 8 of fetal development.

Review Questions 1. (1) a,b; (2) a; (3) a; (4) a; (5) b; (6) c; (7) c; (8) a,b; (9) c 2. e 3. c 4. e 5. a 6. (1) a,c; (2) b,d; (3) c; (4) c; (5) b,d 7. (1) g; (2) e; (3) a; (4) a,b,g; (5) d; (6) g; (7) h; (8) e,c; (9) g 8. (1) c; (2) e; (3) b; (4) d; (5) d; (6) d; (7) c; (8) a; (9) a; (10) a

Chapter 10

Check Your Understanding 1. All muscle tissue contains the myofilaments actin and myosin, which generate contractile forces; the plasma membrane is called a sarcolemma; and the cytoplasm is called sarcoplasm. The functional characteristics of muscle tissue are (1) contractility, (2) excitability, (3) extensibility, and (4) elasticity. 2. Cardiac muscle and skeletal muscle are striated. Cardiac muscle and smooth muscle are called visceral muscle, because they occur in the visceral organs and are not voluntarily controlled. 3. Perimysium is the fibrous connective tissue that surrounds a fascicle. 4. The origin of a muscle is the attachment site of the muscle that does not move when the muscle contracts. The insertion is the attachment site on the bone that does move when the muscle contracts. In the limbs, conventionally, the origin is the more proximal attachment, and the insertion is located distally. 5. Smallest to largest: myofilament, sarcomere, myofibril, muscle fiber. Myofilaments are composed of the contractile proteins actin and myosin. In striated muscle, the myofilaments are arranged into sarco-

meres, the smallest contractile unit in striated muscle. A myofibril is an organelle within a muscle cell made up of repeating sarcomeres. A muscle fiber is a muscle cell. 6. The thick (myosin) myofilaments are limited to the A band. 7. The terminal cistern stores Ca^{2+} . The T tubules carry the stimulus to contract from the surface sarcolemma to the deeper regions of the muscle fiber, initiating the release of Ca^{2+} from the terminal cistern. 8. The myosin heads must attach to the overlapping thin filament to generate a contractile force. If there is no overlap, the myosin heads have nothing to attach to. 9. The length of the I band shortens during muscle contraction.

10. The neuromuscular junction is the connection between a single axon terminal and a muscle fiber. A motor unit is a single motor neuron and all of the muscle fibers it innervates. 11. Usain Bolt has a predominance of fast glycolytic muscle fibers in his lower limbs. 12. Muscle tissue from an individual with this Duchenne muscular dystrophy has muscle fibers of irregular size, and in many regions the muscle fibers are replaced with fat and connective tissue. 13. Skeletal muscle fibers form from the fusion of multiple embryonic cells; thus, they are multinucleated. 14. Weight-training exercise increases the size of muscle fibers and thus helps maintain muscle strength in older individuals.

Review Questions 1. c 2. b 3. (1) thin; (2) thick; (3) thick; (4) thin; (5) thick; (6) thin 4. (1) yes; (2) no; (3) yes; (4) no 5. (1) d; (2) a; (3) b; (4) e; (5) c 6. c 7. c 8. a 9. (1) b; (2) a; (3) c; (4) c; (5) b; (6) a; (7) a,c (8) c; (9) c; (10) a,b,c

Chapter 11

Check Your Understanding 1. The fascicles are arranged in parallel in Figure 11.2a. 2. The power of a muscle depends on the total number of muscle fibers. Pennate muscles pack more muscle fibers into a unit area than parallel muscles; thus, they are able to generate greater force. 3. Second class levers always operate at a mechanical advantage. First class levers operate at a mechanical advantage when the length of the effort arm is longer than the length of the load arm. 4. The fulcrum of a skeletal/muscular lever system is the joint. 5. Levers that operate at a mechanical disadvantage allow for greater speed and larger distance of movement for a given muscular effort. 6. (a) The muscles that move the thigh are limb muscles. (b) The abdominal muscles are axial muscles. (c) The chewing muscles are pharyngeal arch muscles. 7. Muscles that develop on the dorsal side of the limb are extensor muscles. 8. The biceps brachii and brachialis function as synergists. 9. A thigh abductor crosses the hip on the lateral side of the joint. The antagonist muscle produces adduction. 10. Muscles that cross on the posterior side of a joint generally produce extension. 11. The biceps brachii and brachialis are located in the anterior compartment of the arm. Their antagonist muscle group, the triceps brachii, are located in the posterior compartment of the arm. 12. Muscles in the posterior compartment of the thigh extend the thigh and flex the knee. The quadriceps femoris group functions as an antagonist to these muscles. 13. The gastrocnemius and soleus act in synergy as prime movers for plantar flexion. 14. (a) *Latissimus dorsi* means “wide back,” an excellent description of this superficial back muscle. (b) *Sternocleidomastoid* indicates that the origin of this muscle is at the sternum and clavicle and that its insertion is on the mastoid process of the temporal bone. (c) *Serratus anterior* refers to the saw-like appearance of this muscle, much like a serrated knife, and its location on the anterior/lateral thoracic wall. (d) The adductor magnus is the large adductor muscle of the thigh. 15. The diaphragm is the most important

muscle for inspiration. The intercostal muscles, pectoralis minor, the scalenes, and sternocleidomastoid aid in forceful inspiration. The abdominal muscles aid in forceful expiration. **16.** The six movements of the shoulder joint are flexion, extension, abduction, adduction, medial rotation, and lateral rotation. The muscles involved in these movements are described in Table 11.11, p. 000. **17.** The prime mover of dorsiflexion is the tibialis anterior. Dorsiflexion of the foot keeps the toes from dragging during the recovery phase of walking. **18.** The lesser gluteals shift the trunk from side to side during walking to keep the body upright and to keep the center of gravity over the limb that is on the ground. Without their action, the trunk would fall over toward the unsupported side when the limb is in the swing phase of gait. **19.** The linea alba runs down the anterior abdominal wall from the xiphoid process to the symphysis pubis. The external and internal oblique and the transversus abdominis muscles insert into the linea alba. **20.** The triangle of auscultation is bounded by the trapezius medially, the latissimus dorsi inferiorly, and the medial border of the scapula laterally. The area is used to listen for lung sounds. **21.** Intramuscular injections can be given in the deltoid, about 5 cm inferior to the rounded superior part of the shoulder; the gluteus medius, 5 cm superior from the midpoint between the posterior superior iliac spine and the greater trochanter; or midway down the vastus lateralis on the lateral thigh. **22.** (a) The supracristal line is in the lumbar region. (b) The linea semilunaris is in the abdomen. (c) The cubital fossa is on the anterior side of the elbow. (d) The median bicipital furrow is on the medial side of the arm. **23.** The boundaries of the posterior triangle of the neck are the sternocleidomastoid muscle anteriorly, the trapezius posteriorly, and the clavicle inferiorly. The carotid pulse is located in the anterior triangle just anterior to the sternocleidomastoid and superior to the level of the larynx. **24.** In most individuals, the tendons of palmaris longus and flexor carpi radialis are apparent in the distal forearm when the person makes a fist.

Review Questions 1. d 2. c 3. (1) c; (2) b; (3) e; (4) a; (5) d 4. e 5. c 6. d 7. c 8. b 9. b 10. a 11. d 12. b 13. b

Chapter 12

Check Your Understanding 1. Afferent signals carry sensory information toward the CNS. 2. The visceral motor (autonomic) division of the peripheral nervous system regulates contraction of cardiac muscle. 3. (a) Pain from a pulled muscle is somatic sensory. (b) Nausea is visceral sensory. (c) Taste is a special visceral sensory sensation. 4. The neuronal cell processes that receive stimuli are the dendrites. 5. When an electrical impulse in the presynaptic neuron reaches the axon terminal, it stimulates the release of chemical neurotransmitters from this neuron. These neurotransmitters diffuse across the synaptic cleft, bind to receptor sites on the postsynaptic neuron (usually on the dendrite or cell body), and stimulate an electrical response in the postsynaptic neuron. In this way, the electrical signal is passed, via a chemical messenger, from one neuron to another. 6. Most sensory neurons are unipolar (pseudounipolar) neurons. 7. Multipolar neurons are the most abundant type of neuron. Motor neurons of the PNS are multipolar neurons. 8. Oligodendrocytes produce myelin in the CNS, and Schwann cells produce myelin in the PNS. 9. Astrocytes are common in regions where synapse occurs because they regulate ionic and neurotransmitter levels in neural tissue. 10. Schwann cells do cover unmyelinated axons in the PNS; however, these axons are not wrapped by concentric layers of the Schwann cell. Numerous unmyelinated

axons are embedded in a single Schwann cell (see Figure 12.7). 11. The perineurium wraps a bundle of nerve fibers (axons) into a fascicle. 12. Synapses in the CNS always occur in the gray matter. 13. The white matter of the CNS appears white because the majority of the nerve fibers in these regions are myelinated. 14. The integration center occurs in the gray matter of the CNS at the synapse between the sensory neuron and motor neuron. 15. The sensory impulse must be carried to the brain for processing the conscious sensation of pain. This processing takes more time than is required for processing the simple withdrawal reflex. 16. A converging circuit contains multiple presynaptic neurons synapsing on a single postsynaptic neuron. 17. After a peripheral injury, axons in the PNS can regrow within regeneration tubes formed by surviving Schwann cells. In the CNS, neuroglia do not guide regrowing axons and, in fact, secrete inhibitory chemicals that block neuronal regrowth. 18. Myelin insulates nerve signals and increases the speed of impulse conduction. Loss of myelin in the CNS, as occurs with MS, interferes with the conduction of nerve signals. All of the symptoms described for MS indicate disruption of neural processing (balance disorders, muscle weakness, vision disturbance). 19. The neuroblasts of the basal plate form motor neurons. 20. Sensory neurons develop from neural crest tissue, which is located outside the developing neural tube.

Review Questions 1. b 2. (1) d; (2) b; (3) f; (4) c; (5) a; (6) a 3. b 4. (1) SS; (2) VS; (3) VM; (4) SM; (5) VS; (6) SS; (7) SM 5. b 6. b 7. a 8. c 9. d 10. (1) c; (2) b; (3) a 11. b 12. c 13. d 14. 2, 1, 3

Chapter 13

Check Your Understanding 1. Lumbar spinal nerves L₃–L₅ and sacral spinal nerves S₁–S₅ pass through the vertebral foramen of lumbar vertebra L₅. 2. White matter provides the two-way conduction pathway between the brain and spinal cord. 3. Somatic motor neurons to the muscles of the upper limb are located in the ventral horn of the lower cervical segments. Paralysis of these muscles would result from damage to this region of the spinal cord. 4. Cerebrospinal fluid is located in the subarachnoid space, which is located deep to the arachnoid mater and superficial to the pia mater. 5. The telencephalon forms the cerebrum, and the mesencephalon forms the midbrain. 6. Brain nuclei are clusters of neuronal cell bodies that form portions of the gray matter of the CNS. 7. The third ventricle is connected to the fourth ventricle through the cerebral aqueduct, located in the midbrain. 8. (a) The pyramids of the medulla are white fiber tracts connecting the cerebrum with the spinal cord. (b) The vestibular and cochlear nuclei are involved with innervation of the head. They receive sensory impulses from the cranial nerves that innervate the inner ear. (c) The cerebral peduncles are white fiber tracts in the midbrain connecting the cerebrum with the brain stem. (d) The periaqueductal gray matter is involved with the autonomic behaviors associated with the fight-or-flight response and mediates the response to visceral pain. Two cranial nerve nuclei are also located here. (e) The trigeminal nuclei are involved with sensory innervation of the face and motor innervation of the chewing muscles. 9. The pyramids (a) and the vestibular and cochlear nuclei (b) are located in the medulla oblongata. The cerebral peduncles (c) and the periaqueductal gray matter (d) are in the midbrain. The trigeminal nuclei (e) are in the pons. 10. The corpora quadrigemina are four brain nuclei located at the roof of the midbrain involved with auditory (inferior colliculi) and visual (superior colliculi) reflexes. 11. The vermis connects the two cerebellar hemispheres. 12. The flocculonodular lobe receives sensory information

from the vestibular nuclei about equilibrium. 13. The superior cerebellar peduncles connect the midbrain to the cerebellum; the middle cerebellar peduncles connect to the pons; and the inferior cerebellar peduncles extend from the medulla to the cerebellum. 14. Axonal fibers from the thalamic nuclei extend to the cerebral cortex. 15. The hypothalamus is the main visceral control center. Visceral control refers to regulation of the activities of the visceral organs, including autonomic motor activity and endocrine functions. 16. The primary sensory cortex enables conscious awareness of a sensation. The sensory association area places the sensory stimulus into a context that gives meaning to the stimulus. 17. The premotor cortex plans complex movements. The primary motor cortex signals the execution of these movements. 18. Contralateral (“opposite side”) projection refers to the crossing over of nerve fibers to the opposite side of the body, such that the right side of the body is controlled or perceived by the left side of the brain. 19. The visual cortex and association area are located in the occipital lobe. Visual deficits would result from injury to this region. 20. Projection fibers connect the cerebral cortex to more caudal regions of the CNS. 21. The caudate nucleus is located just lateral to the lateral ventricles. 22. The reticular nuclei receive input from all major ascending sensory tracts. These nuclei project to the cerebrum (via relays through the thalamus), thus maintaining alertness. 23. The amygdala is the brain nucleus for processing and responding to fear. 24. The falx cerebri lies in the longitudinal fissure. 25. Cerebrospinal fluid (CSF) is produced by the choroid plexuses in the roof of the brain ventricles. CSF returns to the blood vascular system through the arachnoid villi, which empty into the dural sinuses. 26. Discriminative touch sensations are carried on the dorsal column pathways (fasciculus cuneatus and fasciculus gracilis). 27. The dorsal column and spinothalamic pathways pass through the thalamus. The spinocerebellar pathway does not. 28. The pyramidal pathways (lateral and ventral corticospinal) originate from the primary motor cortex. 29. The ascending spinocerebellar tracts do not cross over. The descending vestibulospinal tract and some fibers of the reticulospinal tract do not cross over. 30. Most of the ascending and descending pathways project contralaterally. 31. The thalamus and the somatosensory cortex are active in a newborn. The frontal lobe (the location of rational thought) is not fully developed until early adulthood.

Review Questions 1. (1) c; (2) f; (3) e; (4) g; (5) b; (6) e; (7) i; (8) a; (9) g; (10) h; (11) d 2. b 3. d 4. (1) G; (2) W; (3) W; (4) G; (5) W; (6) G; (7) W 5. a

Chapter 14

Check Your Understanding 1. Touch, pain, pressure, vibration, temperature, and proprioception from the somatic organs (skin, body wall, limbs) are general somatic sensations. Taste and smell are special visceral sensations. 2. All spinal nerves carry both sensory and motor fibers, but some cranial nerves are exclusively sensory or primarily motor in function. 3. Nociceptors respond to painful stimuli. These sensory receptors are free nerve endings. 4. Proprioceptors are part of the somatic sensory system (outer tube). 5. Encapsulated receptors are mechanoreceptors (respond to pressure, discriminative touch, vibration, and stretch). 6. The glossopharyngeal nerve (CN IX), the vagus (CN X), and the accessory nerve (CN XI) pass through the jugular foramen. 7. The optic nerve (CN II) carries the special somatic sensation (SSS) for vision, and the vestibulocochlear nerve (CN VIII) carries SSS for hearing and equilibrium. 8. The trigeminal nerve

(CN V) is the “great sensory nerve of the face.” The facial nerve (CN VII) carries motor innervation to the muscles of the face. **9.** A lesion to the dorsal root of spinal nerve T₄ would result in sensory deficits from the muscles and skin of the anterior and posterior trunk in the region of thoracic vertebra T₄ and rib 4. There would be no motor deficits. A lesion to the dorsal ramus of T₄ would result in sensory and motor deficits in the skin and epaxial (dorsal) muscles in the vicinity of thoracic vertebra T₄. **10.** (a) Cervical nerve C₅ exits below cervical vertebra C₄. (b) Lumbar nerve L₃ exits below lumbar vertebra L₃. **11.** The diaphragm is innervated by spinal segments C₃, C₄, and C₅. Innervation from segments C₃ and C₄ would not be affected by an injury at C₅; therefore, independent breathing is possible with an injury in this location. **12.** The radial nerve innervates all of the extensor muscles of the arm and forearm. **13.** Sensory innervation from the medial portion of the hand would be lost, as would the ability to abduct and adduct the hand and extend the fingers (loss of motor innervation to the interossei and medial lumbricals). **14.** The muscles of the upper limb are innervated by nerves off the brachial plexus (C₅–T₁). Injury at C₅ would result in loss of function below the area of injury; thus, the muscles of the upper limb would be paralyzed. **15.** The femoral nerve innervates the muscles of the anterior compartment of the thigh; the obturator nerve innervates the muscles of the medial compartment of the thigh; and the sciatic nerve innervates the muscles of the posterior compartment of the thigh (tibial branch primarily). **16.** The nerves innervating the elbow are the musculocutaneous, radial, median, and ulnar nerves. **17.** Reviewing the dermatome map in Figure 14.16 shows that the skin on the anterolateral surface of the leg is innervated by spinal nerve L₅. Herniation at this level can result in loss of sensation at this dermatome. **18.** Shingles blisters at the level of the navel indicate viral infection in spinal nerve T₉ or T₁₀. **19.** (a) neuralgia = pain in a nerve; (b) paresthesia = beyond sensation, abnormal sensation; (c) neuropathy = disease of the nerves. **20.** Postpolio syndrome is not due to reactivation of the polio virus. It is thought that this syndrome results from the normal degeneration of motor neurons associated with age. Because the motor units of polio survivors are enlarged, loss of motor neurons results in noticeable loss of muscle function.

Review Questions 1. c 2. b 3. (1) d; (2) c; (3) f; (4) b; (5) e; (6) a 4. (1) f; (2) i; (3) b; (4) g,h,j; (5) e; (6) i; (7) i; (8) k; (9) j; (10) c,d,f,k; (11) c 5. (1) b,6; (2) d,8; (3) c,2; (4) c,5; (5) a,4; (6) a, 3&9; (7) a,7; (8) a,7; (9) d,1 6. c 7. c 8. c 9. b 10. a and e

Chapter 15

Check Your Understanding 1. Postganglionic axons are nonmyelinated. 2. The sympathetic division of the ANS has been activated in this near-miss scenario. 3. Sympathetic ganglia are located near the spinal cord and vertebral column (in the sympathetic trunk or collateral ganglia). Most parasympathetic ganglia are located in or near the target organ. 4. Traditionally the ANS is considered a motor division; therefore, it does not include the visceral sensory fibers. 5. Sacral spinal nerves (S₂–S₄) carry preganglionic parasympathetic fibers. 6. (a) Vagal stimulation of the heart decreases heart rate. (b) Vagal stimulation of the small intestine increases motility and secretion. (c) Vagal stimulation of the salivary glands stimulates secretion. 7. The preganglionic fibers synapse in ganglia located along the pathway of the trigeminal nerve (CN V). Postganglionic fibers then travel along CN V to

reach their target organs. 8. The white rami communicantes carry preganglionic outflow from the thoracic and lumbar regions of the cord into the sympathetic trunk. The gray rami communicantes are postganglionic fibers that exit off the sympathetic trunk onto a spinal nerve at each level of the sympathetic trunk. 9. Sympathetic innervation to the abdominal organs decreases activity of the glands and muscles of the digestive system. 10. The thoracic plexuses contain preganglionic parasympathetic fibers and postganglionic sympathetic fibers. The abdominal plexuses also contain preganglionic parasympathetic fibers and postganglionic sympathetic fibers. In addition, preganglionic sympathetic fibers travel through the abdominal plexuses (via the splanchnic nerves) to reach the collateral ganglia. 11. Most visceral pain fibers follow the sympathetic pathway back to the CNS. 12. A peripheral reflex does not involve the CNS at all. Some peripheral reflexes synapse in the sympathetic ganglia, and others occur entirely within the body wall of the target organ (enteric nervous system). 13. The hypothalamus is the main control center of the ANS. 14. Postganglionic neurons are formed from neural crest tissue. 15. The parasympathetic division is deficient in achalasia of the cardia. Raynaud's disease is due to an exaggerated sympathetic vasoconstriction in response to cold.

Review Questions 1. d 2. (1) S; (2) P; (3) P; (4) S; (5) S; (6) P; (7) S; (8) S; (9) P; (10) S; (11) P; (12) S; (13) S; (14) S; (15) S 3. c 4. d 5. b 6. d 7. c 8. a

Chapter 16

Check Your Understanding 1. The receptor cells for taste are epithelial cells. 2. Olfactory receptors are bipolar neurons. These cells are replaced when damaged, making them among the few neurons that undergo replacement throughout adult life. 3. The conjunctiva is a transparent mucous membrane that covers the inner surfaces of the eyelids and the anterior surface of the eye. 4. The lateral rectus is not functioning if the eye is turned in medially. This muscle is innervated by the abducens nerve (CN VI). 5. The cornea is part of the external fibrous layer of the eye, continuous with the sclera. It is a transparent layer covering the anterior one-sixth of the eye. The cornea is composed of dense connective tissue sandwiched between two layers of epithelium. It forms part of the light-bending apparatus of the eye. The choroid is part of the middle vascular layer of the eye. It is a highly vascular, pigmented membrane covering the posterior five-sixths of the eye. Blood vessels of the choroid nourish the eye, and its pigments absorb light. 6. Macular degeneration diminishes the clarity of the visual field straight ahead. 7. The aqueous humor is a clear watery fluid that fills the anterior segment. It supplies nutrients and oxygen to the avascular lens and cornea. It is constantly produced and drained, a process that maintains constant intraocular pressure. 8. The lens becomes rounder when close objects are viewed. 9. The resting eye is set for distance vision. Accommodation for viewing close objects requires elasticity of the lens. As we age, the lens becomes less elastic and cannot accommodate for near vision well. 10. Axons from ganglion cells from the medial half of the retina extend through the right optic nerve and pass through the optic chiasma to the left optic tract. They synapse in the left lateral geniculate nucleus of the thalamus with neurons that extend via the optic radiation to the left primary visual cortex. 11. The retina forms from the outpocketing of the neural tube. 12. The tympanic membrane (eardrum) separates the external acoustic meatus from the middle ear cavity. 13. The four openings

into the middle ear cavity are the pharyngotympanic tube, the round window, the oval window, and the mastoid antrum. 14. The malleus is the auditory ossicle that abuts the tympanic membrane. 15. The membranous labyrinth is a continuous series of membranous sacs and ducts filled with endolymph that contain the sensory receptors for hearing and equilibrium. The bony labyrinth is the cavity within the petrous portion of the temporal bone that surrounds the membranous labyrinth. 16. Perilymph is located in the scala vestibuli and the scala tympani of the cochlea. 17. The vestibular membrane forms the roof of the cochlear duct; the basilar membrane forms the floor; and the tectorial membrane sits atop the sensory hair cells. Vibrations in the tectorial membrane stimulate the hair cells of the spiral organ. 18. The maculae of the utricle and the saccule monitor stationary head position and linear acceleration. 19. Sensorineural deafness results from damage to the cells of the spiral ganglion. 20. The membranous labyrinth is formed from ectoderm. 21. The vestibular nuclei of the medulla and the cerebellum are the major processing centers for input from the vestibular nerves.

Review Questions 1. a 2. d 3. c 4. b 5. b 6. b 7. e 8. b 9. c 10. b 11. d 12. b

Chapter 17

Check Your Understanding 1. Hormones circulate throughout the body in the bloodstream. They leave the bloodstream at the capillaries and enter the tissue fluid. Although hormones encounter all types of cells, they influence the activity only of their target cells. 2. Endocrine secretions are regulated via humoral stimuli (concentrations of specific substances in the blood); nervous stimuli (direct nerve innervation); or hormonal stimuli (releasing and inhibiting hormones secreted by other endocrine tissues). 3. Tropic hormones secreted by the pituitary regulate the secretion of hormones by other endocrine glands. The nontropic pituitary hormones act directly on nonendocrine target tissues. 4. The hormones secreted by the posterior pituitary are produced in the neuron cell bodies located in the hypothalamus. The anterior pituitary hormones are produced by the cells of this gland. 5. (a) The target organs for oxytocin are the uterus and the breast. (b) ACTH acts on the adrenal cortex. (c) FSH acts on the ovaries in females and the testes in males. (d) The target organ for ADH is the kidneys. 6. A patient with hypothyroidism would not have concerns about blood calcium regulation because this disorder refers to low levels of thyroid hormone, not calcitonin levels. 7. Aldosterone is produced in the outer layer, the zona glomerulosa, of the adrenal cortex. 8. The adrenal medulla secretes the hormones norepinephrine (a sympathetic neurotransmitter) and epinephrine when stimulated by preganglionic sympathetic neurons. The cells of the adrenal medulla have no axonal processes, but rather release their secretions into the blood of nearby capillaries. 9. Glucocorticoid secretion is stimulated by ACTH, which is produced by the anterior pituitary. 10. The endocrine cells of the pancreas are distributed throughout the pancreas in clusters of cells called the pancreatic islets. 11. In a developing fetus, estrogens and progesterone are produced by the placenta. 12. Addison's disease results from hyposecretion of the adrenal cortex. Typical symptoms are low blood pressure, dehydration, fatigue, and loss of appetite. Graves' disease is caused by hypersecretion of the thyroid. Symptoms are elevated metabolic rate, rapid heart rate, sweating, and weight loss. Cushing's disease results from hypersecretion of glucocorticoid hormones from the adrenal cortex. High blood

glucose levels, lethargy, swollen face, and development of a “buffalo hump” are symptoms.

Review Questions 1. d 2. (a) 2; (b) 5; (c) 1; (d) 4; (e) 3 3. a 4. c 5. a 6. (1) c; (2) b; (3) a; (4) c; (5) a; (6) b; (7) f; (8) b; (9) a; (10) a; (11) a; (12) e 7. d

Chapter 18

Check Your Understanding 1. The percentage of blood volume composed of erythrocytes is called the hematocrit. Its normal value is around 45%. 2. The three main plasma proteins are albumin (prevents water from leaving the bloodstream), globulins (antibodies and proteins that transport lipids, iron, and copper) and fibrinogen (involved with blood clotting). 3. Erythrocytes and platelets do not contain nuclei. 4. *Leukocyte* refers to all types of white blood cells; lymphocytes are specific white blood cells that are part of the immune system. 5. Wright's stain is composed of the acidic stain eosin, which binds to basic cellular elements and stains them pink, and the basic stain methylene blue, which binds to acidic cellular elements, staining them blue to purple in color. The cytoplasm of neutrophils takes up both stains, thus their name, “neutral.” Eosinophils are “eosin loving,” and the cytoplasmic granules stain pink. The granules in basophils (“basic loving”) take up the basic stain methylene blue, and the cytoplasm of these cells is blue to purple in color. 6. In adults, blood stem cells are located in the spongy bone of the axial skeleton and limb girdles and in the proximal epiphysis of the humerus and femur. 7. The fibrous network within red bone marrow is formed from reticular connective tissue. 8. Lymphocytes form from lymphoid stem cells. All other blood cells form from myeloid stem cells. 9. Symptoms of anemia are fatigue, shortness of breath, and low body temperature. Low levels of erythrocytes or hemoglobin concentration result in poor oxygenation of body tissues. 10. The spleen and the liver are the major fetal hematopoietic organs before month 7. 11. The T cells in cord blood are immature and therefore less likely to cause tissue rejection.

Review Questions 1. b 2. d 3. b 4. c 5. e 6. a 7. d 8. d 9. c 10. b 11. d

Chapter 19

Check Your Understanding 1. The right side of the heart receives and pumps deoxygenated blood. 2. The apex of the heart is located on the left mid-clavicular line at intercostal space 5 (ICS 5). 3. The epicardium is the visceral layer of the serous pericardium. 4. (a) Pectinate muscles are located in both atria. (b) Papillary muscles are found in both ventricles. (c) The fossa ovalis is in the right atrium. (d) The trabeculae carneae are muscular ridges located in both ventricles. 5. The superior vena cava, inferior vena cava, and coronary sinus are the three major veins that empty into the right atrium. (The anterior cardiac veins, small veins that drain the right ventricle, also empty into the right atrium.) 6. From the aortic semilunar valve, blood enters into the aorta, the great artery that carries oxygenated blood to the systemic circuit. 7. During ventricular systole, the AV valves are closed, and the semilunar valves are open. 8. A stenotic valve has a narrowed opening due to fusion or stiffening of the cusps and thus doesn't open properly. An incompetent valve is a leaky valve that doesn't close completely. Both valve disorders reduce the efficiency of the heart. 9. Gap junctions allow the stimulus to contract to be passed from one muscle cell to an adjacent cell. This linkage between muscle cells enables all the muscle cells in a heart chamber to contract at the same time. 10. The “pacemaker” of the heart is the

sinoatrial (SA) node. It is located in the right atrium and is composed of specialized cardiac muscle cells that initiate the electrical signal that sets heart rate. 11. Sympathetic innervation to the heart increases heart rate and increases strength of contraction. Parasympathetic innervation only influences heart rate; it decreases heart rate. 12. The left coronary artery supplies blood to the left ventricle via two branches: The anterior wall receives blood from the left interventricular artery, and the posterior wall is supplied by the circumflex artery. 13. Risk factors for coronary artery disease include high blood pressure, smoking, high cholesterol levels, diabetes, inactivity, and family history of heart disease. For lucky individuals, the first symptom is angina; for unlucky individuals, a fatal heart attack is the first symptom. 14. An opening in the interventricular septum would allow oxygenated and deoxygenated blood to mix. Because the left ventricle is stronger, more blood is shunted from the left ventricle to the right ventricle. 15. The embryonic ventricle forms the left ventricle. 16. Regular and vigorous exercise is the most important factor for maintaining a healthy heart throughout life.

Review Questions 1. d 2. b 3. b 4. (1) intima; (2) externa; (3) externa; (4) externa; (5) media; (6) intima 5. a 6. b 7. c 8. b 9. c 10. d 11. a 12. d 13. a 14. b 15. c 16. a

Chapter 20

Check Your Understanding 1. Capillary walls are composed of a single layer of endothelial cells through which diffusion can occur readily. Capillary diameter is similar to that of a red blood cell (RBC), which maximizes the surface contact between the RBC and the capillary walls and thus maximizes gas diffusion. In addition, capillaries are permeable, so fluid and dissolved molecules move readily from the blood plasma to the tissue fluid. 2. The thick smooth muscle of the tunica media and the internal and external elastic membranes that surround this layer function to keep blood pulsing through arteries. Venous blood flow is maintained by valves that prevent backflow, by normal body movement, and by the skeletal muscle pump. 3. (a) Vasa vasorum are small vessels in the tunica externa of larger arteries that supply the outer layers of these large vessels. (b) Arterial anastomoses are junctions between two different arteries that supply a common organ. (c) Varicose veins form when the valves of a vein fail and blood pools in the vessel. (d) An artery is a vessel that carries blood away from the heart. 4. The pulmonary artery is illustrated in blue because it is carrying deoxygenated blood (toward the lung to be oxygenated). This vessel is carrying blood away from the heart; thus, it is an artery. 5. The brachiocephalic trunk supplies the head, neck, thorax, and upper limb on the right side. The left common carotid artery supplies the left portions of the head and neck, and the left subclavian artery supplies the thorax and upper limb on the left side. 6. The four major vessels that supply blood to the brain are the right and left internal carotid arteries and the right and left vertebral arteries. The internal carotids branch off the common carotid arteries; the vertebral arteries branch off the subclavian arteries. 7. (a) The femoral artery in the thigh; (b) the brachial artery in the arm; (c) the radial artery at the wrist; (d) the dorsalis pedis artery in the foot; (e) the common carotid artery in the neck. 8. The celiac trunk supplies the stomach, liver, gallbladder, pancreas, spleen, and part of the small intestine. The superior mesenteric artery supplies the small intestine, the ascending colon, and part of the transverse colon. The inferior mesenteric artery supplies the distal portion of the transverse colon, the descending colon, and rectum. 9. The hepatic portal

vein drains the organs of the digestive tract, enters the liver, and empties into the liver sinusoids. The hepatic veins drain blood from the liver and empty into the inferior vena cava. 10. (a) The cephalic vein is a superficial vein of the upper limb. (b) The popliteal vein is located on the posterior knee in the popliteal fossa. (c) The transverse sinus is in the head. It is one of the dural sinuses that drains the brain. (d) The saphenous vein is a superficial vein of the lower limb. (e) The azygos vein runs along the right posterior thoracic wall. 11. The median cubital vein is a common site for withdrawing blood. The saphenous vein is commonly used in coronary artery bypass surgery. 12. Factors that contribute to atherosclerosis are smoking, a high-fat diet, and a sedentary lifestyle. 13. The basement membrane of capillaries thickens in diabetes mellitus. This reduces the rate of the diffusion of gases and nutrients to the body tissues. 14. The umbilical vein carries the most highly oxygenated blood in the fetus. 15. The ductus arteriosus extends between the pulmonary trunk and the aorta. Blood in the pulmonary trunk is shunted to the aorta, and thus the pulmonary circuit is bypassed.

Review Questions 1. c 2. c 3. a 4. b 5. e 6. b 7. a,c 8. c 9. a 10. d 11. d

Chapter 21

Check Your Understanding 1. The endothelial cells of lymphatic capillaries have few intercellular junctions, and the edges of adjacent cells overlap, forming easily opened minivalves. Blood capillaries contain intercellular clefts between adjacent cells and, in some cases, pores that cause these vessels to be permeable. 2. The sentinel node in a throat cancer patient would be a cervical node; in a breast cancer patient, it would be an axillary node; in a cervical cancer patient, it would be an inguinal node. 3. Intestinal trunk; thoracic duct; left internal jugular and left subclavian veins. 4. Cytotoxic T lymphocytes gain immunocompetence in the thymus. 5. Infection caused by a bacterial agent will activate B lymphocytes. 6. B lymphocytes are in the lymphoid follicles. Each lymphoid follicle is derived from the activation of a single B cell. Cell division occurs at the germinal center, producing new B cells that then migrate from the follicle to become plasma cells. 7. In the red pulp of the spleen, defective blood cells are phagocytized by macrophages. 8. In the lymph nodes, T lymphocytes are located in the deeper portions of the cortex and in the medullary cords of the medulla. 9. Aggregated lymphoid nodules are located in the ileum of the small intestine. 10. The red lines indicate lymphangitis, inflammation of a lymphatic vessel due to infection. 11. The thymus is derived from endoderm. The tonsils, spleen, and lymph nodes are all from mesoderm.

Review Questions 1. d 2. b 3. d 4. a 5. (1) b; (2) b; (3) a; (4) b; (5) c 6. (1) c; (2) d; (3) e; (4) a; (5) b 7. a 8. c 9. c 10. d

Chapter 22

Check Your Understanding 1. The nasal cavity, including the nasal conchae, paranasal sinuses, and the nasopharynx, is covered with respiratory mucosa. This mucous membrane functions to warm, filter, and moisten inhaled air. 2. External respiration is gas exchange between the blood and the air in the air sacs of the lungs. Internal respiration is gas exchange between the blood and the body tissues. Cellular respiration is the use of oxygen by cells to convert glucose into cellular energy (ATP). 3. The pharynx, commonly called the throat, is located posterior to the nasal and oral cavities and extends inferiorly to the larynx and esophagus. The larynx, or voice box, is at the top of the trachea. It houses the vocal

cords and functions as a gateway to prevent food from entering the airway. **4.** The inferior boundary of the nasopharynx is the uvula, that of the oropharynx is the epiglottis, and that of the laryngopharynx are the openings of the larynx and esophagus. **5.** The vocal folds attach to the arytenoid cartilages posteriorly and extend anteriorly to the thyroid cartilage. **6.** The mucous membrane lining the trachea and large bronchi secretes mucus, which traps dust and foreign particles. The ciliated epithelium sweeps this dust-laden mucus up toward the pharynx, where it is swallowed. In the alveoli, alveolar macrophages remove foreign particles by phagocytosis. **7.** At the level of the bronchioles (tubules with a diameter of 1 mm or less) cartilage plates are no longer present in the tube wall. Elastin is found in the tubule walls throughout the bronchial tree, all the way down to the alveoli. **8.** The respiratory membrane is composed of the endothelial cells of the pulmonary capillaries, the simple squamous epithelium (type I cells) of the alveolar wall, and the fused basal lamina of these tissues. **9.** The horizontal fissure separates the superior and middle lobes of the right lung. **10.** From superior to inferior, the pulmonary artery, the main bronchus, and the pulmonary vein enter the left lung at the hilum. **11.** A stab wound at rib 7 in the midclavicular line would not puncture a lung, but it would puncture the pleural cavity (see Figure 22.13). **12.** Contraction of the diaphragm increases the volume of the thoracic cavity. This volume change decreases the pressure in the pleural cavity, causing air to enter the lungs. **13.** If the pleural cavity is punctured in a stab wound, atmospheric air enters the pleural cavity—thus the “sucking” sound produced by this injury. The loss of the pressure differential between the lung and the pleural cavity results in collapse of the lung. **14.** The accessory inspiratory muscles include the scalenes, sternocleidomastoid, and pectoralis minor, which all aid in elevating the ribs. Primarily it is the abdominal muscles (the obliques and transversus abdominis) that are active during forced expiration. **15.** The respiratory centers of the brain stem (ventral respiratory group or VRG, with input from neurons in the pons and dorsal respiratory group) set the basic respiratory rhythm. The VRG neurons stimulate the somatic motor neurons that innervate the respiratory muscles. **16.** Emphysema destroys the alveolar walls in the respiratory zone. **17.** “Smoker’s cough” is a symptom of chronic bronchitis, a COPD disease. Excess secretion of mucus, bronchial inflammation, and fibrosis in response to chronic exposure to smoke cause persistent and productive coughing. **18.** The lungs are not fully formed until late in fetal development. Specifically, the alveoli form at 24 weeks, and type II alveolar cells begin to produce surfactant at 26 weeks.

Review Questions 1. c 2. a 3. (1) d; (2) d; (3) d; (4) c; (5) c; (6) c 4. (1) d; (2) c; (3) f; (4) a; (5) b; (6) e 5. a 6. a 7. a,d 8. d 9. b 10. a 11. a 12. (1) e; (2) a; (3) b; (4) d; (5) c 13. b 14. d 15. d 16. (1) e; (2) h; (3) c; (4) b; (5) g; (6) a; (7) f; (8) d 17. a 18. (1) a; (2) b; (3) c; (4) a; (5) b; (6) c; (7) b

Chapter 23

Check Your Understanding 1. Propulsion occurs throughout the alimentary canal, from the oral cavity to the anus. 2. The abdominal cavity is the region ventral body cavity extending from the diaphragm to the pelvis. The peritoneal cavity is the space between the parietal and visceral serous membranes: the parietal peritoneum and visceral peritoneum. The pancreas, duodenum, ascending colon, descending colon, and rectum are secondarily retroperitoneal. 3. (a) The mesenteries to the liver are the falciform ligament and the lesser omentum, both ventral

mesenteries. (b) The mesenteries attached to the stomach are the greater omentum, a dorsal mesentery, and the lesser omentum. (c) The mesentery to the sigmoid colon is the sigmoid mesocolon, a dorsal mesentery. 4. Blood from a hemorrhaging spleen or liver would collect in the peritoneal cavity. 5. From the lumen outward, the sublayers of the mucosa are the epithelium, lamina propria and muscularis mucosae. The intrinsic glands are formed from the epithelial layer. 6. Peristalsis and segmentation result from contractions of the smooth muscle of the muscularis externa. 7. The cells of smooth muscle are elongated with tapering ends, contain a single centrally located nucleus, and are nonstriated. Smooth muscle is innervated by the ANS and contracts in response to hormones, stretching, and nerve stimulation. It is extremely fatigue resistant. Skeletal muscle is composed of multinucleated, striated, cylindrically shaped cells. Skeletal muscle is innervated by somatic motor neurons and is less fatigue resistant than smooth muscle. 8. Stratified squamous epithelium composes the mucosa of the oral cavity, oropharynx, and laryngopharynx. 9. The three salivary glands are the parotid, the submandibular, and the sublingual. Their secretions initiate the digestion of carbohydrates. 10. The trigeminal nerve (CN V) innervates the teeth: the maxillary branch (CN V₂) to the teeth in the upper jaw; the mandibular branch (CN V₃) to the teeth in the lower jaw. 11. The mucosal epithelium changes from stratified squamous in the esophagus to simple columnar in the stomach. The muscularis externa in the stomach has an additional deep layer, the oblique layer. 12. The stomach is located in the left hypochondriac, epigastric, and umbilical regions of the abdomen. 13. Chief cells produce pepsinogen; parietal cells produce HCl; the surface epithelia secrete bicarbonate-buffered mucus. 14. Intestinal epithelial cells live for 3–6 days. These cells are replaced by cells from the rapidly dividing undifferentiated epithelial cells that line the intestinal glands. 15. The portions of the large intestine are the cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, and anal canal. 16. The end products of carbohydrate and protein digestion are absorbed into the capillary network within the villus; absorbed fats are absorbed into the lacteal. 17. The right and left hepatic arteries carry oxygen-rich blood into the liver; the right and left hepatic portal veins carry nutrient rich blood into the liver; and the right and left hepatic ducts carry bile out of the liver. 18. The path of blood from the digestive tract through the liver lobule is as follows: from the hepatic portal vein, to the portal venules in the portal triad at the periphery of a liver lobule, through the liver sinusoids, into the central vein of the lobule. 19. The acinar cells of the pancreas produce and secrete digestive enzymes. These secretions empty into the duodenum. 20. Many diseases are passed through fecal contamination of food and water. Washing your hands after using the restroom is an effective means to prevent the spread of infection. 21. The mucosal epithelium is derived from endoderm. The submucosa and muscularis externa are derived from splanchnic lateral plate mesoderm. 22. The superior mesenteric artery supplies the structures that develop from the embryonic midgut.

Review Questions 1. d 2. b 3. c 4. c 5. d 6. b 7. e 8. e 9. a 10. c 11. b 12. b 13. (a) 1; (b) 6; (c) 12; (d) 3; (e) 7; (f) 10; (g) 2; (h) 5; (i) 9; (j) 11; (k) 4; (l) 8 14. (1) c; (2) d; (3) e; (4) b; (5) a

Chapter 24

Check Your Understanding 1. The kidneys are superficial to the parietal peritoneum, so they are not within the peritoneal cavity; they are retroperitoneal. They are, however, in the abdominal cavity. 2. The

kidneys extend from the eleventh or twelfth thoracic vertebra superiorly to the third lumbar vertebra inferiorly. The right kidney is slightly inferior to the left because the liver takes up much of the upper right abdominal quadrant. 3. The interlobar arteries and veins pass through the renal columns. 4. The glomerular capillaries, glomerular capsule, and the proximal and distal convoluted tubules are located exclusively in the renal cortex. The nephron loop and the collecting duct extend into the medulla. 5. Filtration occurs at the glomerular capillaries. Secretion and reabsorption occur across the peritubular capillaries. 6. The juxtaglomerular apparatus functions in blood pressure regulation. The cells at the terminal portion of the nephron loop are elongated where they abut the afferent arteriole. These cells monitor filtrate solute concentration and initiate a response when this concentration falls below a certain level. 7. The ureter carries urine from the kidney to the urinary bladder. The urethra carries urine from the urinary bladder to the outside of the body. 8. Transitional epithelium lines the ureter, bladder, and proximal urethra. 9. The external urethral sphincter is innervated by somatic (voluntary) motor neurons. 10. The urethra in females is much shorter than in males and is located close to the vaginal and anal openings. Bacteria from these regions can readily enter the urethra, particularly during sexual activity. 11. All three pairs of kidneys—pronephros, mesonephros, and metanephros—form from intermediate mesoderm. 12. A cloaca is the common opening of the digestive tract and the urinary and reproductive ducts.

Review Questions 1. d 2. (1) d; (2) c; (3) d; (4) c; (5) e 3. d 4. a 5. d 6. e 7. a 8. a 9. a 10. b 11. c 12. d 13. d 14. c 15. (a) 1; (b) 4; (c) 2; (d) 6; (e) 7; (f) 3; (g) 9; (h) 5; (i) 8; (j) 10 16. b 17. a 18. (1) a; (2) c; (3) b; (4) d; (5) c; (6) e

Chapter 25

Check Your Understanding 1. Interstitial cells are clustered in the loose connective tissue between the seminiferous tubules (thus their name). These cells secrete testosterone. 2. The tunica albuginea is the fibrous capsule covering the testis. The tunica vaginalis is superficial to the tunica albuginea. It is a two-layered serous sac (a remnant of the peritoneum) that partially surrounds the testis. 3. In the epididymis, sperm gain the ability to swim and the ability to fertilize the egg. 4. The ejaculatory duct is located at the junction of the ampulla of the ductus deferens and the duct of the seminal vesicle. This duct passes through the prostate and empties into the prostatic urethra. 5. Approximately 60% of the volume of semen is produced by the seminal vesicles. 6. The urethra passes through the corpus spongiosum and thus is called the spongy urethra. 7. Each primary spermatocyte produces four spermatids. 8. Sustentocytes help form sperm by nourishing spermatogenic cells and moving these cells toward the tubule lumen. Secretions from sustentocytes influence testosterone and FSH levels and function either to stimulate or to inhibit sperm formation. Tight junctions between adjacent sustentocytes form the blood-testis barrier, which protects sperm from attack by the immune system. 9. The head of the sperm contains the nucleus and the acrosome; the midpiece contains mitochondria; and the tail is a flagellum. 10. The uterine tubes are lined with ciliated and unciliated columnar epithelium. The beating of the cilia produces movement of the peritoneal fluid to draw the oocyte into the uterine tube. 11. Peritoneal folds that support the female reproductive structures are the broad ligament composed of the mesometrium to the uterus, the mesosalpinx to the uterine tubes, and the mesovarium and suspensory ligament to the ovary. 12. (a) The

fundus of the uterus is the region superior to the entrance of the uterine tubes. (b) The infundibulum is the lateral funnel-shaped opening of the uterine tube. (c) The endometrium is the innermost layer of the uterine wall. **13.** Follicle-stimulating hormone (from the anterior pituitary) stimulates follicle development in the ovary. **14.** Oogonia differentiate into oocytes during the fetal period in females. In males, spermatogonia differentiate into spermatocytes throughout a male's adult life. **15.** The corpus luteum is the remnant of the ovarian follicle after ovulation. The corpus luteum secretes progesterone, which stimulates the secretory phase of the uterine cycle. **16.** (a) The female labia majora are homologous to the male scrotum. (b) The clitoris is homologous to the penis. (c) The bulb of the vestibule is homologous to the corpus spongiosum. **17.** The

glandular portion of the breast develops midway through pregnancy. **18.** Once a sperm fuses to the plasma membrane of the oocyte, the cortical reaction prevents additional sperm from binding to and entering the egg. **19.** The decidua basalis is from the maternal endometrium; the chorionic villi are from the embryonic trophoblast. **20.** The placenta produces progesterone and human chorionic gonadotropin (HCG) throughout the pregnancy and produces estrogens and corticotropin-releasing hormone toward the end of gestation. **21.** (a) PSA tests are used to screen for prostate cancer. (b) Pap smears screen for cervical cancer. (c) Mammography screens for breast cancer. (d) Self-examination of the testicles is advised as screening for testicular cancer. **22.** In a male embryo, the mesonephric duct forms the efferent ductules, the epididymis, the

ductus deferens, and the ejaculatory duct. The paramesonephric ducts degenerate in a male embryo.

23. The testosterone-induced secondary sex characteristics in males are pubic, facial, and axillary hair; enlargement of the larynx; increased secretion of sebaceous glands; and increased skeletal and muscular mass. In females, estrogen-induced secondary sex characteristics include an increase in subcutaneous fat at the hips and breast and widening of the pelvic girdle.

Review Questions **1.** a **2.** (1) c; (2) b; (3) g; (4) h; (5) d; (6) e; (7) f; (8) i; (9) a; (10) j; (11) b,h; (12) i **3.** a **4.** (1) a; (2) b; (3) a; (4) b; (5) b; (6) a **5.** (1) e; (2) a; (3) a&c; (4) d; (5) b **6.** d **7.** a **8.** d **9.** c **10.** (1) b,j; (2) a,g; (3) c,f; (4) d,h; (5) e,i **11.** a,c,d,e,g,h,j