

CHAPTER TEN

Answers to WHAT DID YOU LEARN?

1. The properties of muscle tissue are excitability, contractility, elasticity, and extensibility.
2. Skeletal muscle moves body parts, maintains posture, regulates temperature, stores and moves materials, and supports organs.
3. The three connective tissue layers are the outer epimysium, the central perimysium, and the inner endomysium. The epimysium is a layer of dense irregular connective tissue that surrounds the whole skeletal muscle. The perimysium is a connective tissue layer that surrounds each fascicle. The endomysium is the innermost connective tissue layer, and is a thin sheath of delicate loose connective tissue that surrounds each muscle fiber.
4. The origin is the stationary or less movable attachment of a muscle, whereas the insertion is the more movable attachment. In the limbs, the origin typically lies proximal to the insertion. Usually, the insertion is pulled toward the origin.
5. Transverse tubules are invaginations of the sarcolemma that extend deep into the sarcoplasm of the muscle fiber and wrap around every myofibril. Terminal cisternae are expanded chambers in the sarcoplasmic reticulum, between the thin and thick filaments at the zones of overlap. One transverse tubule is sandwiched between a pair of terminal cisternae, forming a triad.
6. Myofibrils are small, cylindrical structures located within the sarcoplasm of a skeletal muscle. Myofibrils consist of bundles of thick and thin protein filaments, generally called myofilaments.
7. Thick filaments are composed of myosin only. The proteins in thin filaments are actin, tropomyosin, and troponin.
8. The striated appearance of skeletal muscle is due to size and density differences between thick filaments and thin filaments. The dark bands within a muscle fiber are called A bands, while the alternating light bands are called I bands. The A band is the region occupied entirely by the thick filament with some overlap by thin filaments at either side. The I band is a region of thin filaments only.
9. A neuromuscular junction is the site where the membrane of a motor neuron fiber and the sarcolemma of the skeletal muscle fiber meet. The ends of the nerve fibers are called synaptic terminals. Each synaptic terminal overlies a region of the skeletal muscle fiber membrane called the motor end plate. Chemical communication between the synaptic terminal of the neuron and the motor end plate of the skeletal muscle fiber occurs at the neuromuscular junction.
10. The ACh receptors in the motor end plate membrane act like closed doors to prevent ions from moving across the membrane. When these receptors bind ACh, the “door” opens and allows ions to cross the membrane, causing a change in the transmembrane voltage and ultimately resulting in a muscle impulse.

11. When the muscle fiber is at rest, tropomyosin prevents the interactions between thin and thick filaments. Tropomyosin is a double-helical protein that covers the active sites for myosin on the individual actin molecules, thus preventing the actin-myosin interaction necessary for contraction of a muscle. As a result of a muscle impulse, the heads of the myosin molecules bind to active sites on the actin molecules, and then the heads swing toward the center of the A band, pulling the attached thin filaments toward the center of the A band and shortening the muscle fiber.
12. When a muscle fiber is at rest, tropomyosin molecules are held in place in the thin filaments by troponin in order to cover the active sites for myosin binding to actin. When a muscle impulse passes along the T-tubule membrane, calcium ions are released from the terminal cisternae, and some of the calcium binds to troponin. This causes a change in the conformation of the troponin molecule. As a result, the tropomyosin is moved away from the active sites on the thin filaments, allowing cross bridges to form between the thick and thin filaments, and a contraction begins.
13. Muscle tone is the resting tension in a skeletal muscle. Random stimulation of motor units maintains this resting tension.
14. During an isometric contraction, the length of the muscle does not change because the tension produced by this contracting muscle never exceeds the resistance, so the muscle does not shorten. In an isotonic contraction, the tension produced exceeds the resistance, and the muscle fibers shorten, resulting in movement. In the arm muscles, an isometric contraction occurs when a person tries to lift a weight that is too heavy, while an isotonic allows a person to lift a book.
15. In hypertrophy, each muscle fiber develops more myofibrils, and each myofibril contains a larger number of myofilaments. This results in increased fiber size.
16. The three types of skeletal muscle fibers are fast, intermediate, and slow. Fast fibers (white fibers) have a large diameter, and they contain large glycogen reserves, densely packed myofibrils, and relatively few mitochondria. Fast-fiber muscles produce powerful contractions because they contain a large number of sarcomeres. These contractions use vast quantities of ATP; therefore, their prolonged activity causes the fast fibers to rapidly fatigue. Intermediate fibers exhibit properties that are somewhere between those of fast fibers and slow fibers. The intermediate fibers contract faster than the slow fibers and slower than the fast fibers. Histologically, they resemble fast fibers, but they have a greater resistance to fatigue. Slow fibers are usually about half the diameter of fast fibers, contract more slowly, and are specialized to continue contracting for extended periods of time. Their vascular supply is more extensive than the network of capillaries around fast muscle fibers; thus, they receive more nutrients and oxygen. Slow fibers are also called red fibers because they contain the red pigment myoglobin. Additionally, they have a relatively large number of mitochondria. This permits slow muscle fibers to produce a greater amount of ATP than fast-fiber muscles while contractions are under way, making the cell less dependent on anaerobic metabolism.

17. The four main types of skeletal muscle fiber organization are circular muscles, convergent muscles, parallel muscles, and pennate muscles.
18. An agonist, also called a prime mover, is a muscle that contracts to produce a particular movement, such as extension of the forearm. The triceps brachii is an agonist of the forearm causing extension. A muscle that assists the prime mover in performing its action is a synergist. The contraction of a synergist usually either contributes to tension exerted close to the insertion of the muscle or stabilizes the point of origin. Usually, synergists are most useful at the start of a movement when the agonist is stretched and cannot exert much power. Synergists may also assist an agonist by preventing movement at a joint and thereby stabilizing the origin of the agonist. These synergistic muscles are called fixators.
19. Muscles can be named according to (1) orientation of muscle fibers, (2) muscle attachments, (3) specific body regions, (4) muscle shape, (5) muscle size, (6) muscle heads/tendons of origin, (7) muscle function/movement, and (8) muscle position at body surface.
20. Smooth muscle is composed of short muscle fibers that have a fusiform shape and a single, centrally located nucleus. Although smooth muscle fibers have both thick and thin filaments, they are not precisely aligned, so no striations or sarcomeres are visible. Dense bodies are small concentrations of protein scattered throughout the sarcoplasm of the smooth muscle fiber and on the inner face of the sarcolemma. Thin filaments are attached to dense bodies by elements of the cytoskeleton.