LESSON ASSIGNMENT

LESSON 2

The Human Muscular System.

TEXT ASSIGNMENT

Paragraphs 2-1 through 2-4.

LESSON OBJECTIVES

2-1. Given a group of definitions and one of the following terms: dermatological agent, antiseborrheic agent, astringent, keratolytic agent, or keratoplastic agent, select the definition of that term.

2-2. Given a list of properties, select the properties of muscle tissue.

2-3. Given one of the properties of muscle tissue and a group of statements, select the statements that best describe that property.

2-4. From a list, select the types of muscle tissue found in the human body.

2-5. Given the name of a type of muscle tissue found in the body and a group of statements, select the statement that best describes the physiology of that type of tissue.

2-6. Given the name of a type of muscle tissue found in the body and a group of statements, select the statement that best describes the physiology of that type of tissue.

2-7. Given a statement relating to muscle physiology and a list of the types of muscle tissue, select the type of muscle tissue to which the statement applies.

SUGGESTION

After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.
LESSON 2
THE HUMAN MUSCULAR SYSTEM

2-1. BACKGROUND

Muscular tissue is useful to the body because it contracts and thereby produces movement. The contraction of striated muscle attached to bone results in movement of the skeleton. Cardiac muscle contracts rhythmically and acts as a pump to move blood through the cardiovascular system. The contraction of smooth or visceral muscle results in the movement of materials inside the body, such as the propulsion of food through the digestive tract.

2-2. TERMS ASSOCIATED WITH THE HUMAN MUSCULAR SYSTEM

a. **Motor Unit.** A motor unit is a single motor neuron and the number of striated muscle fibers activated by it (innervation). The importance of the motor unit is that its fibers work in unison.

b. **Tonus.** Tonus is defined as a slight continuous contraction of muscle tissue that aids in the maintenance of posture and in the return of blood to the heart.

c. **All or None Law.** Under the influence of nervous stimulation, a single muscle fiber will always contract to its maximum capacity.

2-3. PROPERTIES OF MUSCLE TISSUE

Muscles have certain key properties.

a. **Irritability.** Irritability refers to the ability of a muscle to respond to a stimulus.

b. **Contractability.** Contractability refers to the muscle’s ability to shorten in length.

c. **Extensibility.** Extensibility refers to a muscle’s ability to extend in length.

d. **Elasticity.** Elasticity refers to a muscle’s ability to stretch and return to its normal position.
2-4. TYPES OF MUSCLE TISSUE

a. Skeletal Muscle. Each skeletal muscle is an individual organ of the human body. Each is composed of several types of tissues, mainly striated muscle fibers, and fibrous connective tissue (FCT). Each is attached to and moves bones. Bones are parts of the skeleton serving as levers. The large portion of a muscle is known as its belly or fleshy belly. The muscle is attached to bones by tendons or aponeuroses. Tendons and aponeuroses are similar to each other. However, tendons are cord-like, and aponeuroses are broad and flat. The fleshy portion may be directly connected to the bone. If it is attached to the bone, it is called a “fleshy attachment.”

(1) Anatomy. The muscle cells of skeletal muscles are elongated and are called fibers. The fibers of the skeletal muscles are striated (a striped appearance) to give strength. Movement of the skeleton, such as lifting a leg, is voluntary, as are all of the movements characterized by the skeletal system.

(2) Physiology. The neuromuscular junction consists of a nerve fiber and a skeletal muscle fiber. The nerve fiber is branched at the end to form a structure called the end plate. This end plate invaginates into the muscle fiber, but it always stays outside the membrane of the muscle. The sole feet are located at the tips of the numerous branches of the end plate. The space between the fiber membrane and the sole foot are referred to as the synaptic cleft. A gelatinous substance fills the synaptic cleft. Mitochondria that supposedly synthesize the substance acetylcholine are located in the sole foot. Numerous small vesicles (bags) serve as storage locations for acetylcholine. The enzyme cholinesterase, which is used to destroy acetylcholine, is also found in the area of the synaptic cleft.

(a) Secretion of acetylcholine. The vesicles release acetylcholine when a nerve impulse reaches the neuromuscular junction. Shortly after the acetylcholine is released (around two milliseconds), it diffuses and no longer has any effect upon the muscle. During the short time, the acetylcholine produces its effects upon the muscle; the muscle becomes very permeable to sodium ions (Na⁺). Because of the influx of sodium ions into the muscle, the electrical potential of the membrane increases. Hence, the muscle fiber is stimulated. Figure 2-1 illustrates the contraction of skeletal muscle.

(b) Destruction of acetylcholine. Shortly after the acetylcholine is released, cholinesterase begins to destroy it. Such a rapid destruction of the acetylcholine prevents it from re-stimulating the muscle until another nerve impulse reaches the neuromuscular junction. Figure 2-2 illustrates the relaxation of the muscle tissue.
Figure 2-1. Contracted skeletal muscle.

Figure 2-2. Relaxed skeletal muscle.
(3) **Disorders.**

(a) **Muscle cramps.** Muscle cramps are persistent involuntary contractions of the skeletal muscles. Muscle cramps can be caused by over-exercise, lack of blood flow, or severe cold.

(b) **Myasthenia gravis.** Myasthenia gravis is a major disorder of the skeletal muscle system. Muscle weakness and excessive fatigue characterize it. In myasthenia gravis, the muscular system is marked by progressive paralysis of the muscles, which is caused by an abnormal condition at the neuromuscular junction due to a lack of acetylcholine or an excess of cholinesterase. If there is either too little acetylcholine or an excess of cholinesterase, a contraction will not occur.

b. **Cardiac Muscle.** The muscles of the heart are called cardiac muscles.

(1) **Anatomy.** Cardiac muscle is made up of branched, striated fibers and responds to stimuli as if it were a single muscle fiber. Cardiac tissue is responsible for the propulsion of blood through the circulatory system. The contraction and relaxation of the heart move the blood.

(2) **Physiology.** In order for an individual to live (without the assistance of life-support equipment), his heart must never stop beating. Cardiac muscle must maintain a steady rhythm and not become fatigued. Cardiac muscle does not become fatigued because it can use both glucose and lactic acid, its waste product. The contraction of the cardiac muscle is involuntary and does not directly respond to any nervous stimulation. This property is referred to as inherent rhythmicity. The heart rate may be modified by the autonomic nervous system. Sympathetic or adrenergic stimulation will increase heart rate and parasympathetic or cholinergic stimulation will decrease heart rate. To ensure rhythmical contractibility, cardiac muscle must be supplied with appropriate ions in proper concentrations. These ions are supplied in the blood. Too little sodium leads to weak and rapid heart contractions. Too much potassium makes the cardiac muscle cells lose their excitability and complete heart blockage can occur. Excessive levels of calcium in the blood can lead to increased contractibility of the cardiac muscle. Extremely high levels of the calcium ion in the heart tissue can cause the heart to remain in a state of contraction.

(3) **Disorders.** An irregular heart beat pattern is called an arrhythmia. There are different types of cardiac arrhythmias (that is, flutter or fibrillation). Arrhythmias can sometimes be treated with drugs. More specific information on arrhythmias and the drugs used to treat them will be given to you in another subcourse (MD0806, Therapeutics III).
c. **Smooth Muscle.** All muscles that are not found in the heart or are not attached to the skeletal system are called smooth muscles.

(1) **Anatomy.** The fibers of smooth muscles are elongated and nonstriated. The size of the fiber varies with the location of the muscle. For example, the smallest smooth muscles are found in the blood vessels and the largest are found in the digestive tract. Smooth muscle is responsible for such important functions as peristalsis, blood pressure, and air volume. Peristalsis is the rhythmic wave-like motion of the alimentary canal and other tubular organs caused by waves of contraction passing along the smooth muscle in the tube. Smooth muscle is involved in blood pressure by altering the diameter of blood vessels. It is involved in the control of air volume by altering the diameter of the bronchial tubes. Smooth muscle contracts involuntarily—it is an unconscious act.

(2) **Physiology.** The same chemical substances are found in smooth muscle as are found in skeletal muscle. Contraction of smooth muscle tissue occurs by the activation by ions—just the same as with skeletal muscles: Contraction occurs during depolarization of the muscle membrane, and it stops after repolarization. Smooth muscle tissue does not contract as rapidly as skeletal muscle tissue. Furthermore, the relaxation of the smooth muscle following contraction is likewise slower than in skeletal muscle. Smooth muscle is capable of maintaining tonic contractions over a long period of time. Smooth muscle can undergo changes in length without significant change in tension. This is called stress-relaxation.

**Continue with Exercises**

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EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response which best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson, and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. The term tonus is best defined as:
   a. The process by which all muscle fibers always contract to their maximum capacity.
   b. The ability of a muscle to stretch and return to its normal position.
   c. A slight continuous contraction of muscle tissue which aids in the maintenance of posture and in the return of blood to the heart.
   d. The ability of a muscle fiber to contract and expand in order to meet the requirements of extension.

2. Which of the following is a property of muscle tissue? (More than one response may be correct.)
   a. Irritability.
   b. Malleability.
   c. Extensibility.

3. Elasticity, one of the properties of muscle tissue, is best defined as:
   a. The ability of a muscle to stretch and return to its normal position.
   b. The ability of a muscle to shorten in length.
   c. The ability of a muscle to respond to a stimulus.
   d. The ability of a muscle to extend in length.
4. Which of the following is a type of muscle tissue found in the human body? (More than one response may be correct.)

a. Skeletal muscle tissue.
b. Adipose muscle tissue.
c. Cardiac muscle tissue.
d. Smooth muscle tissue.

5. Which of the following statements best describes skeletal muscle?

a. Muscle tissue that is made up of branched, striated fibers and responds to stimuli as if it were a single muscle fiber.
b. Muscle fibers that are striated and elongated.
c. Muscle fibers that are elongated and non-striated.
d. Muscle tissue which is branched and striated and is found in the alimentary canal.

6. Which of the following statements best describes the physiology involved with cardiac muscle tissue?

a. The contraction is involuntary and does not respond directly to any nervous stimulation.
b. In this tissue, relaxation occurs during depolarization of the muscle membrane and stops after repolarization.
c. In this tissue, the chemical acetylcholine is released by the vesicles in the neuromuscular junction with a resultant influx of potassium ions into the muscle.
d. The secretion of acetylcholinesterase near the neuromuscular junction produces the contraction of this type of tissue.

Check Your Answers on Next Page
SOLUTIONS TO EXERCISES, LESSON 2

1. c (para 2-2b)

2. a (para 2-3a)
   c (para 2-3c)

3. a (para 2-3d)

4. a (para 2-4a)
   c (para 2-4b)
   d (para 2-4c)

5. b (para 2-4a(1))

6. a (para 2-4b(2))