

## HUMAN ANATOMY AND PHYSIOLOGY-I, BP-101(T)

### UNIT-II (Integumentary system)

CLASS:6

### TOPIC – Organisation of Skeletal muscle, Neuromuscular Junction

#### MUSCULAR SYSTEM

##### INTRODUCTION:

- The body contains 3 types of muscle tissue.
- The differences in these types of muscle are due to their microscopic structure, their location in the body and their function and how their functions are controlled: either voluntary or involuntary (autonomic).

##### A. Skeletal muscles:

- Attach to the skeleton are responsible for voluntary body movements.
- The fibers are multi-nucleated and transversely striated and are grouped in parallel bundles called fasciculi.
- The skeletal muscles are the only voluntary muscles in the body.

##### B. Smooth muscles:

- Occur mainly in blood vessels and tubular organs of the GI tract, reproductive, urinary and respiratory systems.
- The muscle fibers are unstriated and contain a single nucleus.
- These muscles are under autonomic control they are involuntary.

##### C. Cardiac muscle:

- It is found only in the wall of the heart and has the unique property of auto-rhythmicity.
- Its contractions are involuntary and have an intrinsic rhythm.
- No external stimuli is needed to make it contract.
- It has intercalated discs that help hold adjacent cells together and transmit the force of contraction from cell to cell.
- It is also striated.

#### **SKELETAL MUSCLE SYSTEM**

- When referring to the muscular system, we are referring to skeletal muscle only.
- The body has more than 600 skeletal muscles.
- Technically speaking, each one of these muscles is an organ. It is composed of muscle tissue, nerve and connective tissue

#### • **FUNCTIONS OF THE MUSCULAR SYSTEM:**

##### A) Movement:

- The primary function of skeletal muscle in the body is movement.
- Even the smallest areas such as the eyeball and the ear have associated muscles responsible for their movements.
- The contraction of skeletal muscle is also important in functions such as breathing and movement of bodily fluids.
- The stimulation of individual muscle fibers maintains a state of muscle contraction known as tonus. This is important in maintaining the movement of blood and lymph throughout the body.

- The involuntary contraction of smooth muscle is also essential for movement of fluids and material through the body. Likewise the involuntary pumping of the cardiac muscle keeps blood flowing through the body.

#### B. Body heat production:

- The body maintains a fairly constant temperature. Physiologically this is one of the principles of homeostasis - the body's ability to regulate its functions. Muscle metabolism produces heat as an end product.
- Because muscles constitute about 40-45% of the body's weight and are in a constant state of fiber activity, they are the primary source of body heat.
- The rate of heat production rises with increased muscle activity. This also explains why emaciated (thin) and elderly people, who have reduced muscle mass have difficulty staying warm.

#### C. Posture and Support of body:

- The skeletal system provides a framework for body support but the muscles do all the heavy lifting.
- Skeletal muscles maintain posture (position), stabilize the joints and support the viscera (internal organ). Postural muscles of the head, neck and trunk are working even when you think you are relaxed.

### PROPERTIES OF MUSCLE:

#### A) Irritability (Electrical Excitability):

- Muscle responds to electrical stimulation from nerve impulses.

#### B) Contractility:

- Muscle responds to stimuli by contracting lengthwise, or shortening.

#### C) Extensibility:

- Once stimulus has subsided and the muscle fiber is relaxed it is capable of being stretched beyond its resting length by the contraction of an opposing muscle.
- Muscle can be stretched up to 30% of its resting length. The fibers are then prepared for another contraction.

#### D) Elasticity:

- Muscle fibers, after being stretched, have a tendency to recoil to their original resting length.

### BLOOD AND NERVE SUPPLY TO THE MUSCLE:

- Muscles have a high rate of metabolic activity and require an extensive blood supply to receive nutrients and eliminate wastes.
- Skeletal muscle cannot contract without stimulation by a nerve impulse.
- The muscle requires extensive innervation to ensure the connection of each muscle fiber with a nerve cell.

There are 2 neural pathways for each muscle fiber:

#### a) Motor (efferent) neurons:

- It is a nerve cell that conducts impulses to the muscle fiber, stimulating it to contract.

#### b) Sensory (afferent) neurons:

- Nerve cells that conduct impulses away from the muscle to the CNS, which responds to the activity of the muscle fiber.
- Muscle fibers will atrophy (weaken) if not periodically stimulated to contract.

**Neuromuscular junction:**

**Definition:** The neuromuscular junction (NMJ) is a specialized synapse or connection between a motor neuron and a muscle fiber, where communication occurs to facilitate muscle contraction.

Key points about the neuromuscular junction:

**1. Structure:**

- The NMJ consists of a presynaptic terminal on the motor neuron, a synaptic cleft, and a postsynaptic membrane on the muscle fiber.
- The presynaptic terminal contains synaptic vesicles filled with neurotransmitter molecules, usually acetylcholine (ACh).

**2. Transmission of Nerve Impulse:**

- When an action potential reaches the presynaptic terminal, it triggers the release of neurotransmitters into the synaptic cleft.
- The neurotransmitter (e.g., ACh) diffuses across the synaptic cleft and binds to receptors on the postsynaptic membrane.

**3. Muscle Fiber Response:**

- The binding of neurotransmitters to receptors on the muscle fiber initiates an electrical signal on the muscle cell membrane (sarcolemma).
- This signal travels along the sarcolemma and into the transverse tubules (T-tubules) of the muscle fiber.

**4. Calcium Release:**

- The T-tubules stimulate the release of calcium ions ( $\text{Ca}^{2+}$ ) from the sarcoplasmic reticulum, a specialized organelle within the muscle fiber.
- Calcium ions play a crucial role in the contraction of muscle fibers.

**5. Muscle Contraction:**

- The presence of calcium triggers a series of events leading to the contraction of the muscle fiber.
- The contraction involves the sliding of actin and myosin filaments, resulting in the shortening of sarcomeres and, consequently, muscle contraction.

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| It consists of three main components: |
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**1. Motor Neuron Terminal:**

- Visualize a nerve cell ending in a terminal called the presynaptic terminal.
- This terminal has bulges filled with synaptic vesicles containing neurotransmitters (e.g., acetylcholine).

**2. Synaptic Cleft:**

- Picture a small gap, the synaptic cleft, separating the presynaptic terminal from the muscle fiber.

**3. Muscle Fiber Receptor Site:**

- On the other side of the synaptic cleft is the muscle fiber with a specialized region known as the postsynaptic membrane.
- The postsynaptic membrane has receptors that bind to the neurotransmitters released by the motor neuron.

**Flow of signals from the nerve cell to the muscle fiber:**

- The action potential travels down the motor neuron and reaches the presynaptic terminal.
- Neurotransmitters (e.g., acetylcholine) are released into the synaptic cleft.
- Neurotransmitters bind to receptors on the postsynaptic membrane of the muscle fiber.

### **IMPORTANT QUESTIONS:**

#### **2M QUESTIONS:**

1. Define skin and its functions.
2. Enlist the layers of skin.
3. Define muscle tone
4. Differentiate osteoclast and osteoblast.
5. Define skeletal system and its functions.
6. Differentiate tendon and ligament.
7. Define muscle contraction.
8. Define neuromuscular junction
9. Explain largest and shortest bones of human body
10. Name the largest nerve of human body.
11. Define: 1. Joint  
2. Synovial joint with examples.

#### **5M QUESTIONS:**

- 1) Explain the physiology of muscle contraction.
- 2) Write in details about structure and functions of skin.
- 3) Write a note on different types of joints.
- 4) Write features and functions of bones of axial and appendicular skeletal system.
- 5) Write in details about synovial joints and their function with the help of diagram.

#### **10M QUESTIONS:**

- 1) Write a note on different types of joints.
- 2) Write features and functions of bones of axial and appendicular skeletal system.
- 3) Write in details about synovial joints and their function with the help of diagram.