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

UNIT-II (Integumentary system)

CLASS:7

TOPIC – Physiology of muscle contraction, neuromuscular junction

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.

It consists of three main components:

1.**Motor Neuron Terminal:**

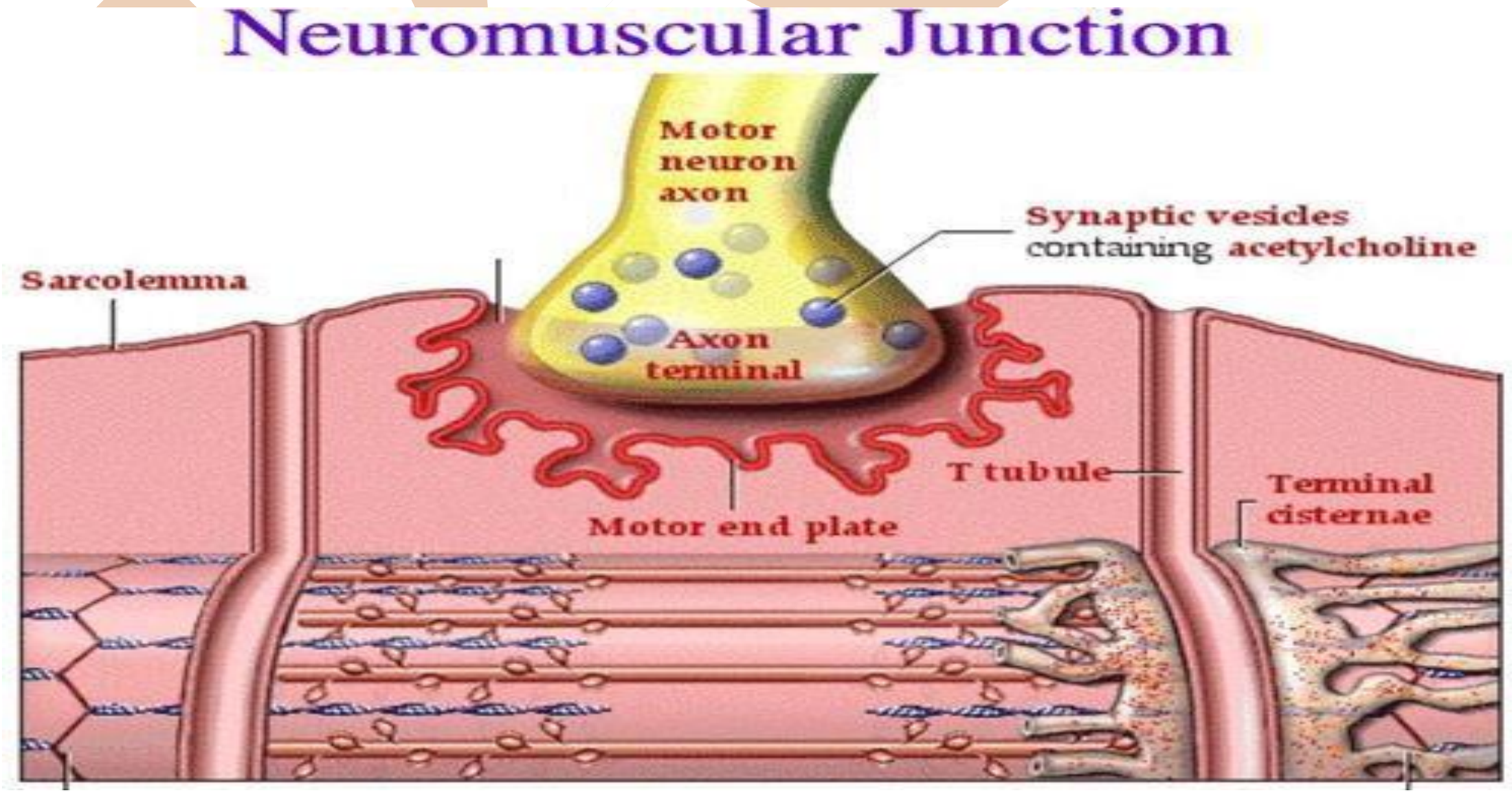
- Visualize a nerve cell ending in a terminal called the presynaptic terminal.
- This terminal has bulges filled with synaptic vesicles containing neurotransmitters (e.g., acetylcholine).

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.
- This binding triggers an electrical signal in the muscle fiber, leading to the release of calcium ions from the sarcoplasmic reticulum.
- The presence of calcium ions initiates muscle contraction by allowing actin and myosin filaments to interact.



STRUCTURE OF A SKELETAL MUSCLE FIBER:

The structure of a skeletal muscle is highly organized and consists of various components that work together to enable muscle contraction. Here's a brief overview:

1. **Muscle Fiber (Muscle Cell):**
   - The basic structural unit of a skeletal muscle is the muscle fiber, also known as a muscle cell.
   - Muscle fibers are elongated, multinucleated cells that run the length of the muscle.
2. **Fascicles:**
   - Muscle fibers are grouped into bundles called fascicles. Fascicles are surrounded by connective tissue called perimysium.
3. **Muscle Belly:**
   - The entire muscle is formed by the grouping of fascicles. The bulk of the muscle that we typically see and feel is called the muscle belly.
4. **Tendons:**
   - At each end of the muscle, collagenous fibers extend to form tendons.
   - Tendons attach muscles to bones, allowing for the transmission of forces generated during muscle contraction to produce movement.
5. **Epimysium:**
   - The entire muscle is surrounded by a layer of connective tissue called epimysium.
   - Epimysium helps protect and provide structural support to the entire muscle.
6. **Perimysium:**
   - Within the muscle, the fascicles are surrounded by another layer of connective tissue called perimysium.
   - Perimysium houses blood vessels and nerves that supply the muscle fibers within the fascicles.
7. **Endomysium:**
   - Each individual muscle fiber is enveloped by a delicate connective tissue layer known as endomysium.
   - Endomysium contains capillaries and nerves that supply and interact with individual muscle fibers.
8. **Sarcolemma:**

- The plasma membrane of a muscle fiber is called the sarcolemma.
- It surrounds the muscle fiber and contains receptors for neurotransmitters involved in muscle contraction.

9.**Sarcoplasm:**

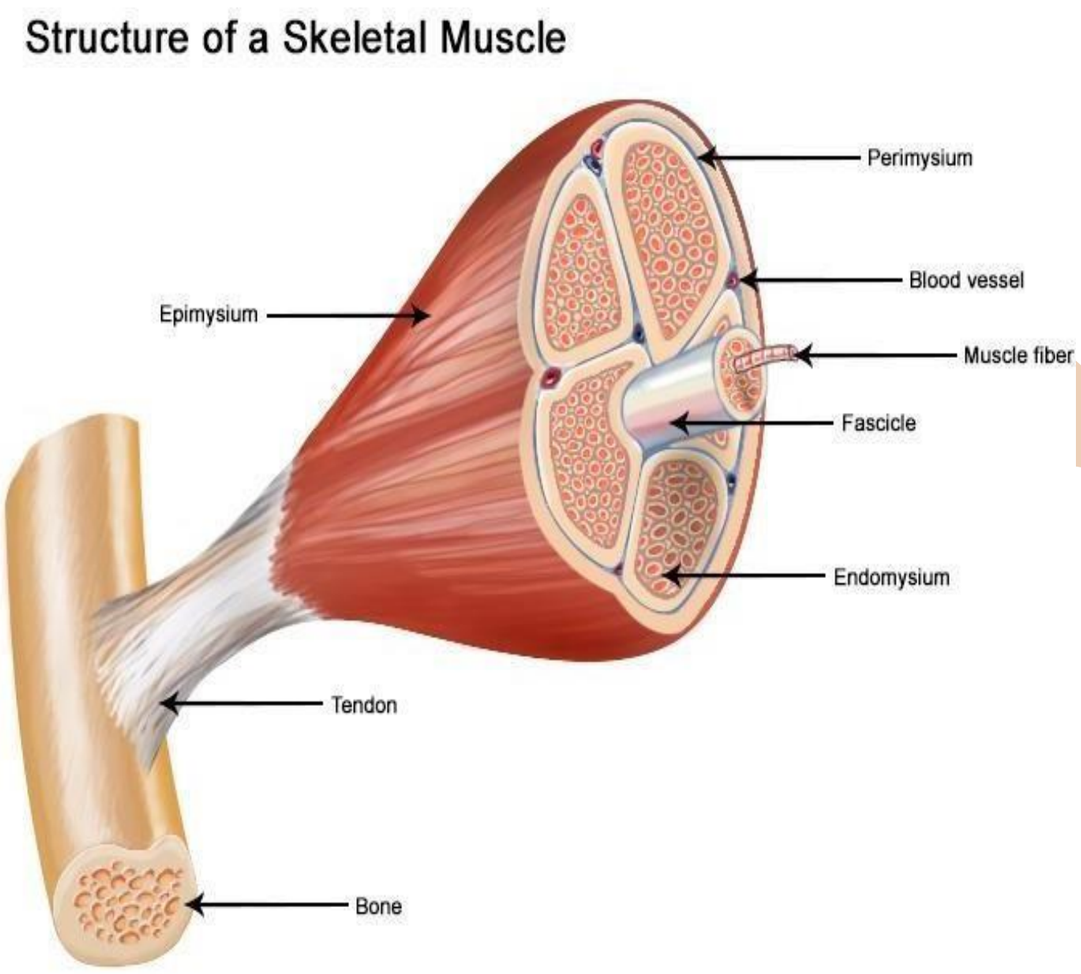
- The cytoplasm of a muscle fiber is called sarcoplasm.

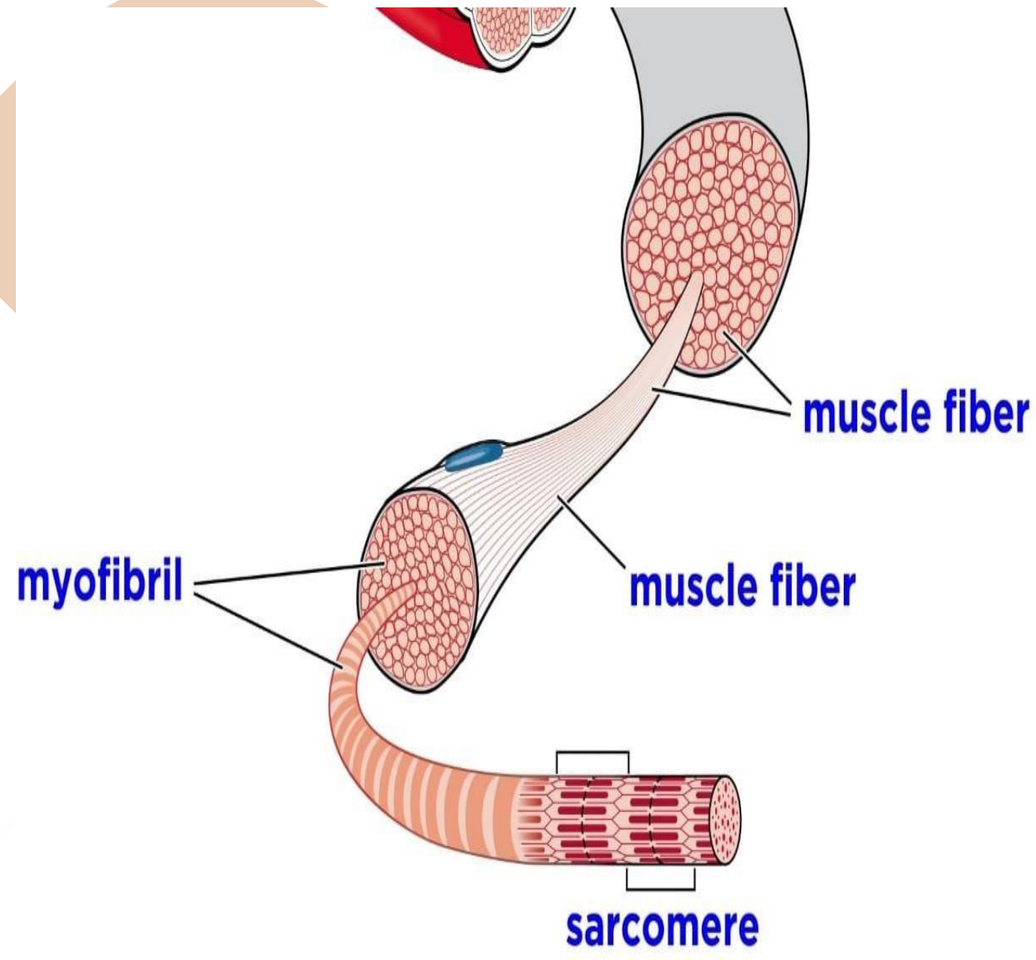
It contains the typical cellular components and also specialized structures like myofibrils.

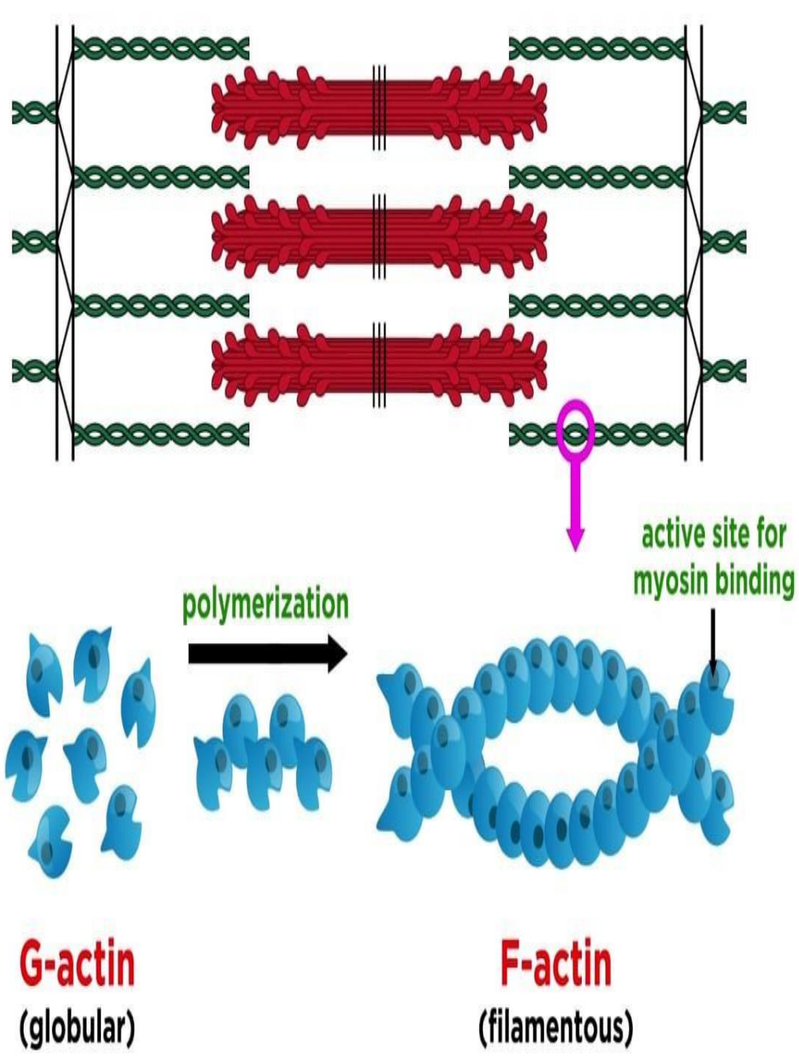
10. Myofibrils:

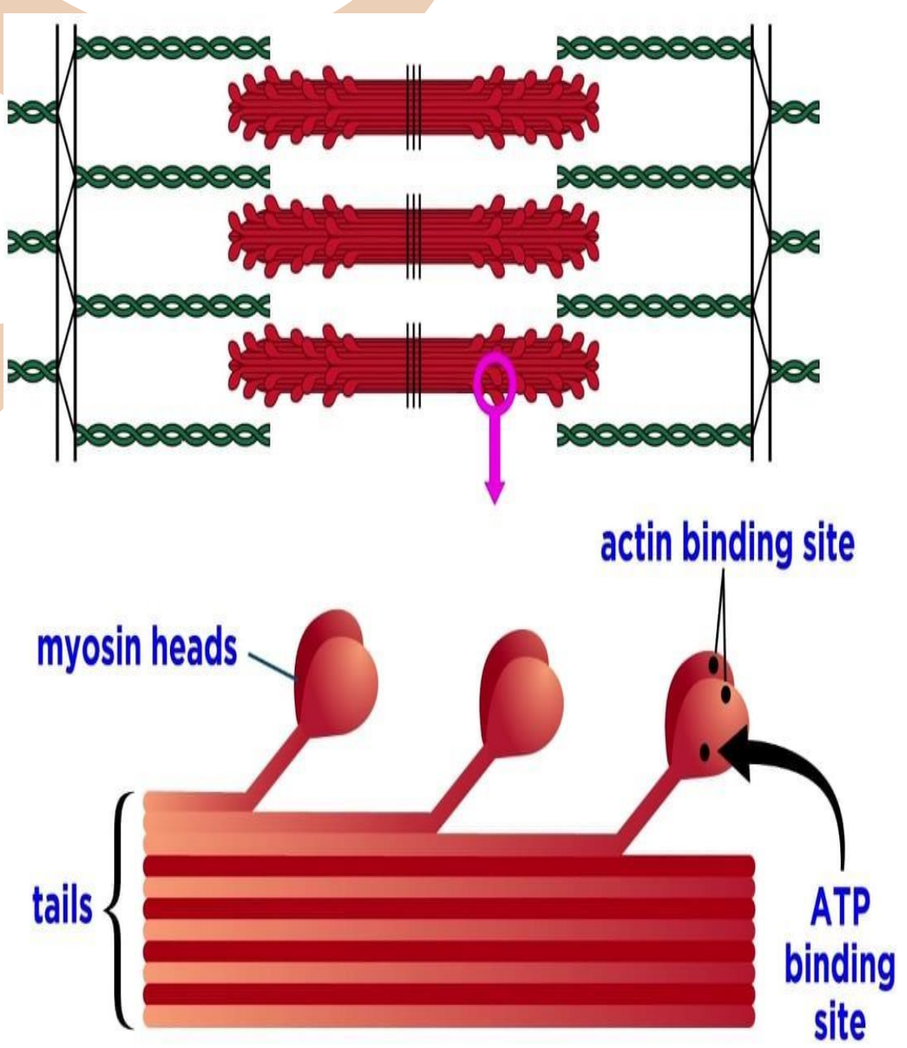
Myofibrils are thread-like structures within muscle fibers that contain the contractile proteins actin and myosin.

- These proteins are organized into repeating units called sarcomeres, which are the functional units of muscle contraction.









PHYSIOLOGY OF MUSCLE CONTRACTION:

Muscle contraction is a complex physiological process that involves the generation of force by muscle fibers. This process is tightly regulated and involves various cellular and molecular events. Here is a simplified overview of the physiology of muscle contraction:

1. **Neuromuscular Signal:**

- The process begins with a neural signal. Action potentials (nerve impulses) travel down motor neurons to reach theneuromuscular junction, where the motor neuron meets the muscle fiber.

2. **Release of Neurotransmitter:**

- At the neuromuscular junction, the action potential triggers the release of neurotransmitters, usually acetylcholine(ACh), from synaptic vesicles in the motor neuron terminal.

3. **Activation of Muscle Fiber:**

- Acetylcholine binds to receptors on the sarcolemma (muscle cell membrane), leading to the generation of an actionpotential in the muscle fiber.

4. **Propagation of Action Potential:**

- The action potential travels along the sarcolemma and penetrates deep into the muscle fiber through structures calledtransverse tubules (T-tubules).

5. **Calcium Release:**

- The action potential in the T-tubules signals the release of calcium ions (Ca2+) from the sarcoplasmic reticulum, aspecialized organelle within the muscle cell.

6. **Cross-Bridge Formation:**

- Calcium ions bind to troponin, a regulatory protein on the actin filaments within the muscle fibers.

This binding causes a conformational change in troponin, exposing binding sites on actin for myosin.

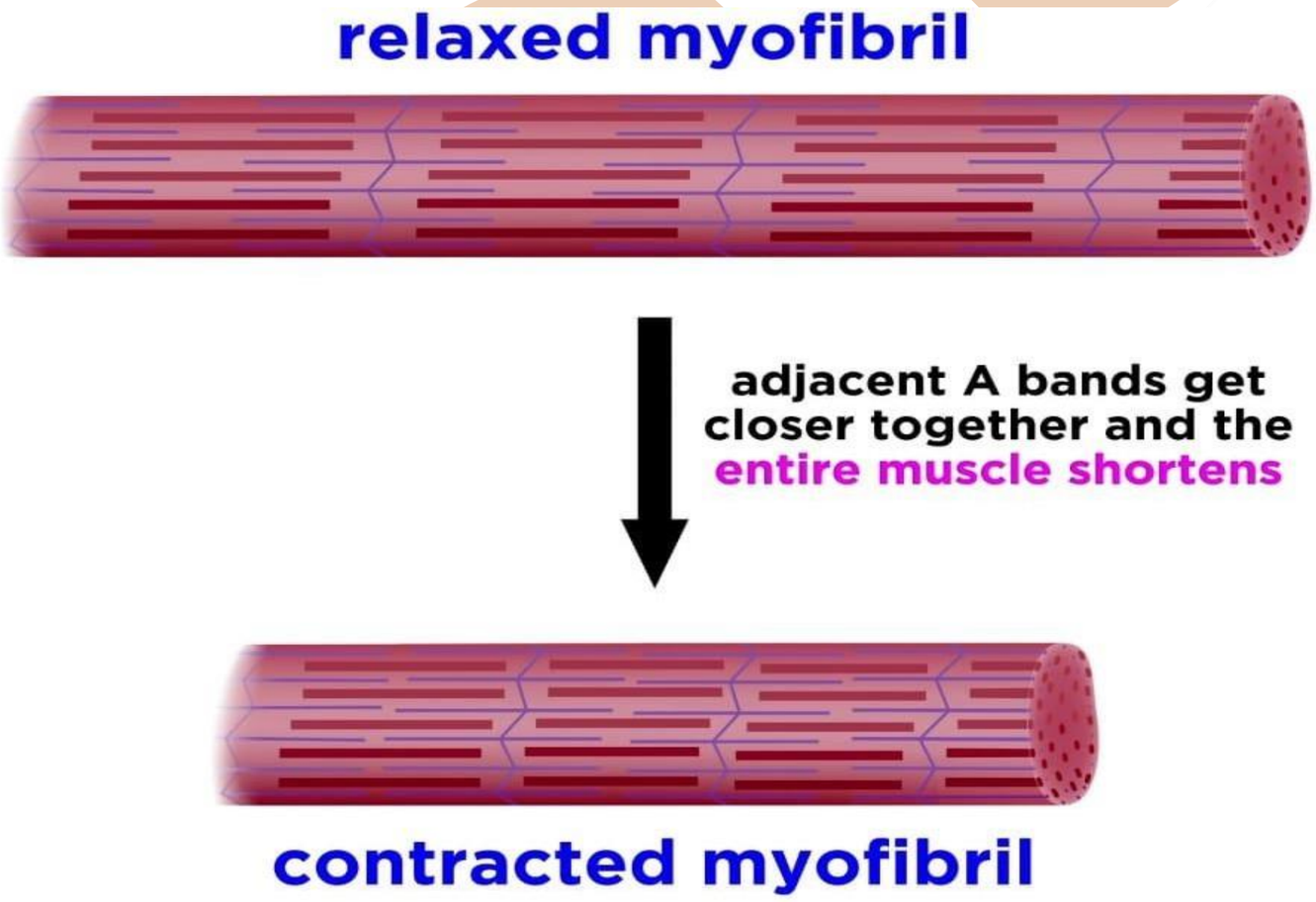
7. **Sliding Filament Mechanism:**
- Myosin heads bind to the exposed sites on actin, forming cross-bridges.
- ATP is hydrolyzed, providing energy for myosin heads to pull actin filaments toward the center of the sarcomere.

8.**Muscle Contraction:**
- The repeated formation and breakdown of cross-bridges result in the sliding of actin filaments over myosin filaments.
- This shortens the sarcomere, leading to muscle contraction.

9.**ATP Replenishment:**
- ATP is required for the detachment of myosin heads from actin.
- ATP is continuously hydrolyzed and regenerated to sustain muscle contraction.

10. **Termination of Contraction:**
- When the neural signal ceases, calcium ions are actively pumped back into the sarcoplasmic reticulum.
- With reduced calcium concentration, troponin returns to its original conformation, blocking the actin binding sites, and muscle contraction ceases.

PHYSIOLOGY OF MUSCLE CONTRACTION



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.