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ORGANIZATION OF SKELETAL MUSCLE

Suman Kumar Mekap
Asst. Professor (Pharmacology)
CUTM, Bhubaneswar



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ORGANIZATION OF SKELETAL MUSCLE

- All activities that involve movement depend on muscles
- 650 muscles in the human body
- Various purposes for muscles for:
 - Locomotion
 - Upright posture
 - Balancing on two legs
 - Support of internal organs
 - Controlling valves and body openings
 - Production of heat
 - Movement of materials along internal tubes
- Three types of muscles in the human body
 - Skeletal
 - Cardiac
 - Smooth



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ORGANIZATION OF SKELETAL MUSCLE

- Skeletal muscles are muscles which are attached to the skeleton.
- 40% of human body mass
- Skeletal muscles are responsible for mainly locomotion, and contraction and *voluntary* relaxation.



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ORGANIZATION OF SKELETAL MUSCLE

- Muscle (*whole organ*)
- Fascicle (*portion of muscle*)
- Muscle Fiber (*single muscle cell*)
- Myofibril (*muscle cell organelle*)
- Sarcomere (*portion of myofibril*)
- Myofilament (*part of sarcomere*)



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STRUCTURE OF SKELETAL MUSCLE

- Skeletal muscles are composed of clusters of muscle cells.
 - Muscle fibers
 - Myofibers
 - Myocytes
- A muscle consists of packages of muscle cells called **fascicles**
- A muscle cell is long and spindle shaped



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STRUCTURE OF SKELETAL MUSCLE

• Cell structure

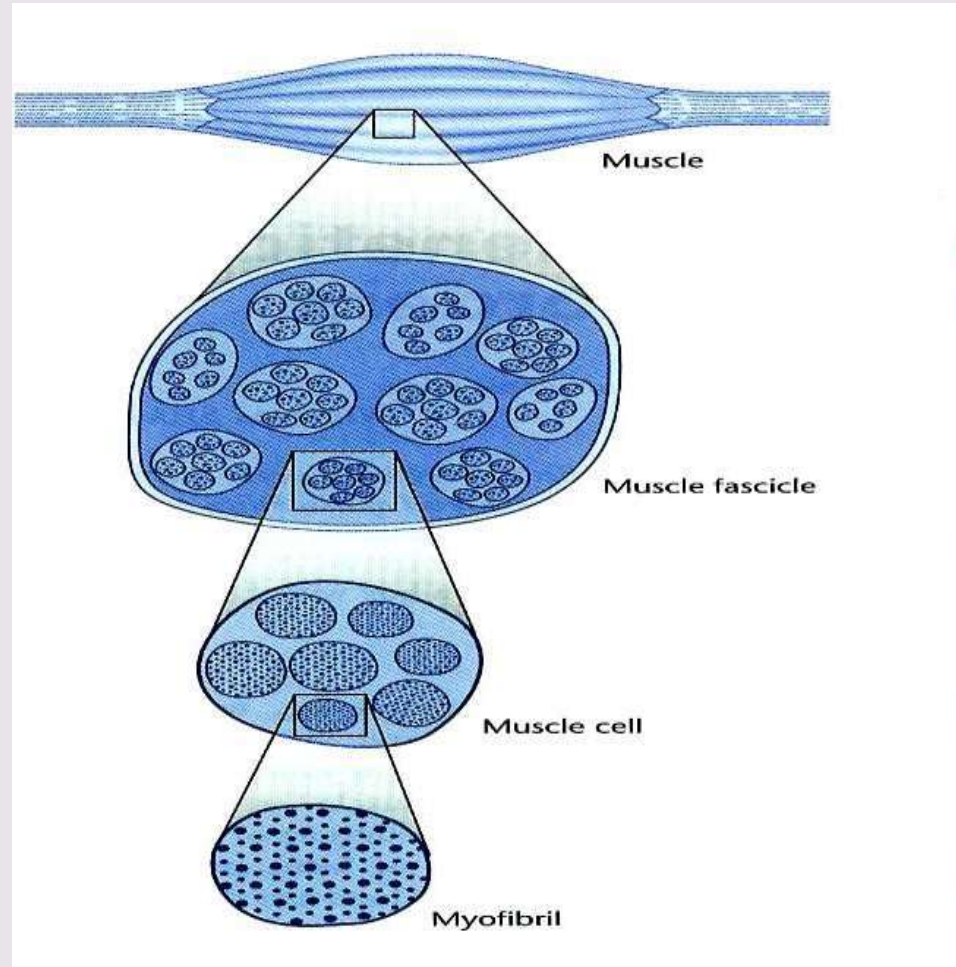
- Muscles cells contain many nuclei
- The plasma membrane→ *sarcolemma*
- The cytoplasm→ *sarcoplasm*
- Length
 - ranges from 0.1cm to more the 30cm in length
- Diameter
 - ranges from 0.001cm to 0.01cm in diameter
- Myofibrils→
 - elongated protein molecules
 - aligned in parallel arrangements
 - extend the full length of the cell.



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STRUCTURE OF SKELETAL MUSCLE

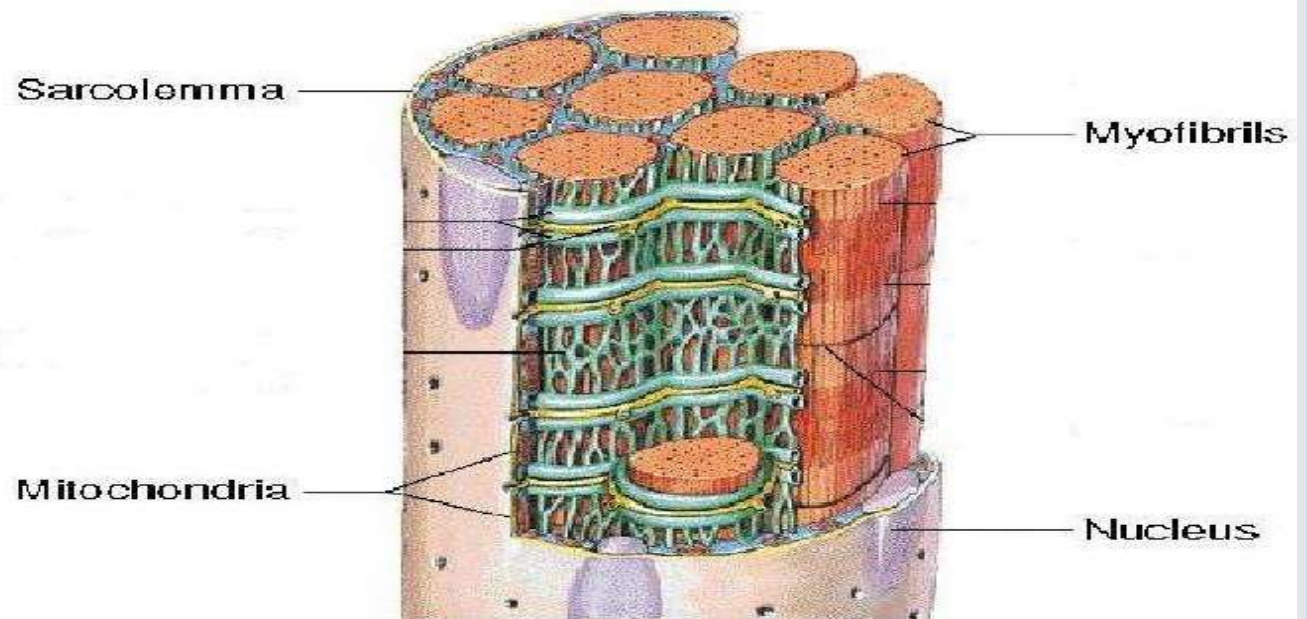




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STRUCTURE OF SKELETAL MUSCLE





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STRUCTURE OF SKELETAL MUSCLE

- The myofibril consists of protein chains called **myofilaments**.
- Myofilaments have a symmetrical, alternating pattern of thick and thin elements.

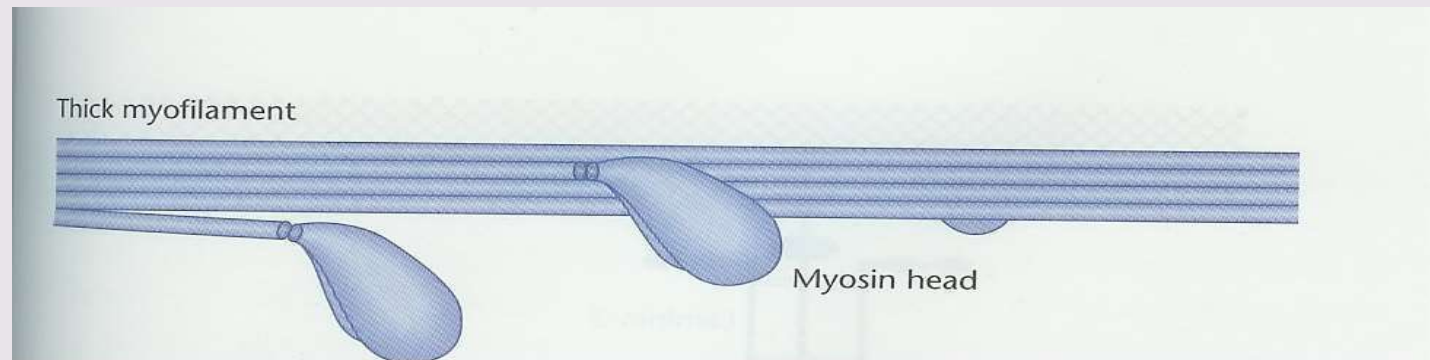


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STRUCTURE OF SKELETAL MUSCLE

- Thick myofilament
- consists of a large number of bundled **myosin molecules** aligned in overlapping arrays.
- hexameric proteins with two identical heavy chains and two pairs of different light chains.
 - regulatory light chain (RLC)
 - essential light chain (ELC)



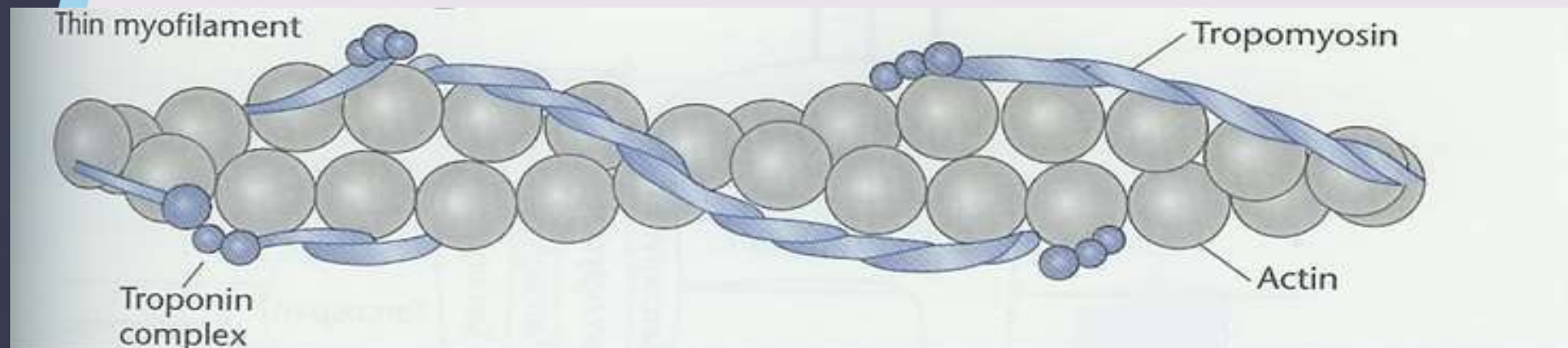


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STRUCTURE OF SKELETAL MUSCLE

- The thin myofilament (F-actin, filamentous actin)
 - made up of two helically intertwined chains of G-actin (globular actin) units.
- Other proteins that bind to the actin molecules:
 - Tropomyosin
 - The Troponin complex → made up of three members





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PHYSIOLOGY OF MUSCLE CONTRACTION

- **SLIDING FILAMENT MECHANISM :**

- The length of skeletal muscle shortens during contraction because the thick and thin filaments slide over one another. The process is known as the sliding filament mechanism.
- The thick filament contains 300 myosin molecules.
- It contains two parts:
 1. **Myosin tail**
 2. **Myosin heads**
- Myosin tail forms the shaft of the thick filament and heads project towards the thin filament.
- Thin filaments contain actin, troponin and tropomyosin.



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PHYSIOLOGY OF MUSCLE CONTRACTION

- Myosin tail forms the shaft of the thick filament and heads project towards the thin filament.
- Thin filaments contain actin, troponin and tropomyosin.
- At the onset of contraction, the sarcoplasmic reticulum releases calcium ions into the cytosol.
- There they bind to troponin and cause troponin-tropomyosin complexes to move away from the binding site on actin.
- Once the binding sites are free, the repeating sequence of events of the contraction cycle occurs that causes the filaments to slide on each other.



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PHYSIOLOGY OF MUSCLE CONTRACTION

- The contraction cycle consists of 4 steps
 - 1. ATP hydrolysis.**
 - 2. Attachment of myosin to actin to form cross-bridges.**
 - 3. Power stroke.**
 - 4. Detachment of myosin from actin.**



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PHYSIOLOGY OF MUSCLE CONTRACTION

1. ATP hydrolysis :

- The myosin head includes an ATP- binding site and an ATPase, an enzyme that hydrolyses ATP into ADP and phosphate group.
- This hydrolysis gives energy to myosin head.
- ADP and a phosphate group remain attached to the myosin head.



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PHYSIOLOGY OF MUSCLE CONTRACTION

2. Attachment of myosin to actin to form cross- bridges:

- The energized myosin head attaches to the myosin binding site on actin and releases the previously hydrolyzed phosphate group.
- When the myosin head attach to actin during contraction, they are referred to as cross-bridges.



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PHYSIOLOGY OF MUSCLE CONTRACTION

3. Power stroke :

- Once the cross bridges are formed, the power stroke occurs.
- The cross-bridge rotate towards the center of the sarcomere and release the ADP molecule.
- The cross-bridge generates a force which slides the thin filament over the thick filament.



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PHYSIOLOGY OF MUSCLE CONTRACTION

4. Detachment of myosin from actin:

- At the end of power stroke, the cross-bridge remains firmly attached to actin until it binds another molecule of ATP.
- As ATP binds to the ATP binding site on the myosin head, the myosin head detaches from actin.