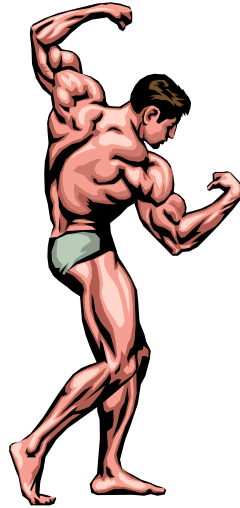


Bio& 241 A&P 1
Unit 3 / Lecture 2



Functions of the Muscular System

- 1. Produce body movements**
- 2. Stabilize body positions**
- 3. Regulate organ volume**
- 4. Move substances within the body**
- 5. Produce heat (thermogenesis)**

Properties of Muscle Tissue

1. **Electrical excitability**
(electrical impulses called action potentials)
1. **Contractility**
 - a. Isometric contraction: No shortening of muscle
 - b. Isotonic contraction: Shortening of muscle
3. **Extensibility** (stretch without being damaged)
4. **Elasticity** (return to its original shape)

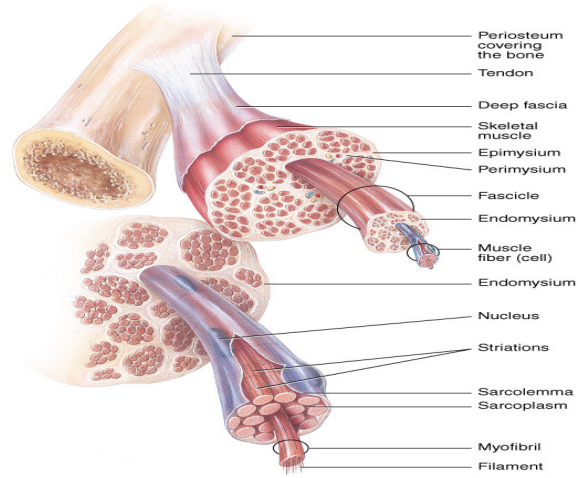
Three Types of Muscle Tissue that comprise the Muscular System

1. **Skeletal muscle: creates the movement associated with bones and joints.**
2. **Smooth muscle: associated with hollow organs, blood vessels, and ducts.**
3. **Cardiac muscle: found within the heart where it creates the pumping action of the heart.**

Organization of Skeletal Muscles at the gross level

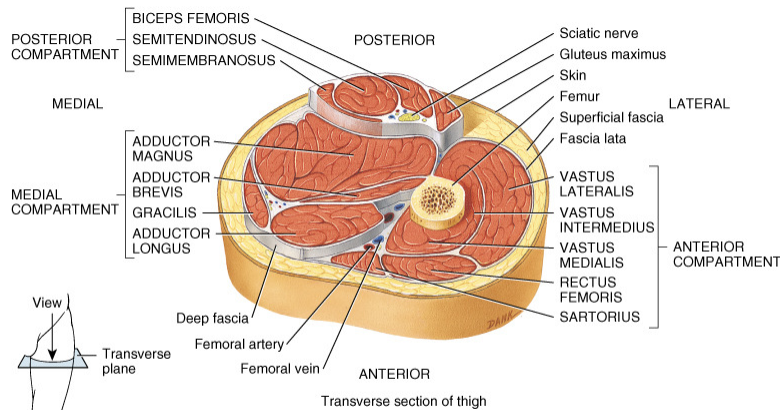
- CT layers
Directly associated
With muscles:
1. Epimysium
 2. Perimysium
 3. Endomysium

- Other CT
1. Fascia
 2. Aponeurosis



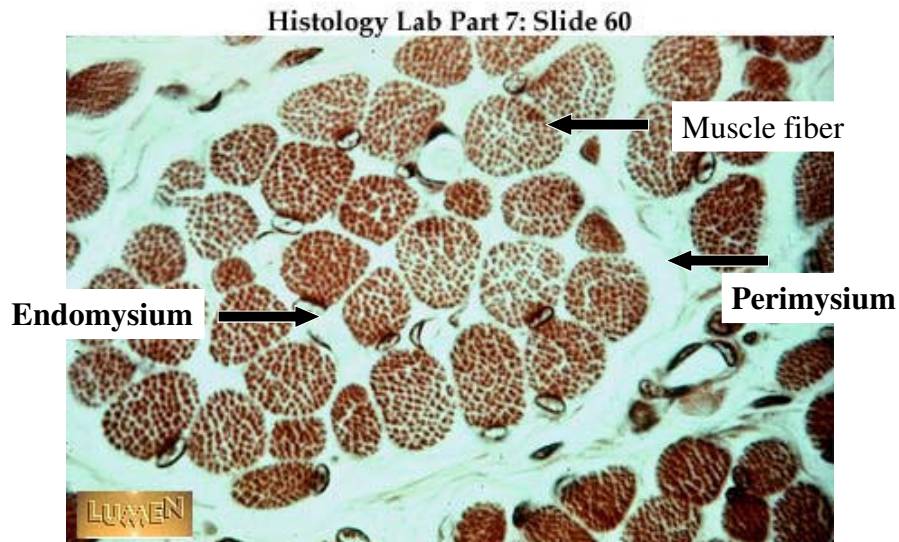
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Organization of Skeletal Muscles at the gross level



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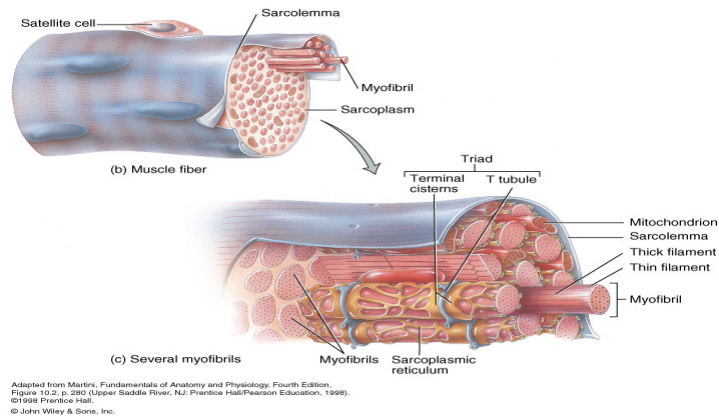
Organization of Skeletal Muscles at the gross level



Characteristics of Skeletal Muscle

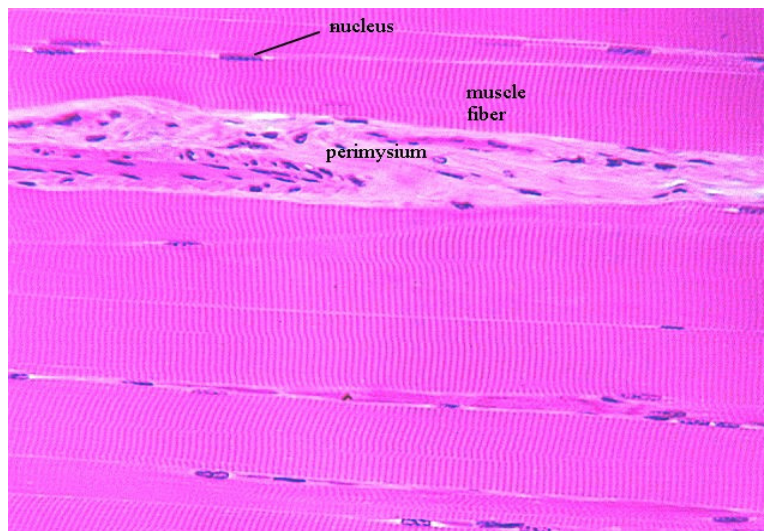
1. Long cylindrical fibers that are multi-nucleated
2. Striated, composed of sarcomeres
3. Abundant sarcoplasmic reticulum for Ca^{2+} storage
4. Contains transverse tubules
5. No gap junctions between cells
6. No autorhythmicity, voluntary nervous control
7. Fast speed of contraction
8. Acetylcholine regulation
9. Limited regeneration via satellite cells

Organization of Skeletal Muscles at the microscopic level

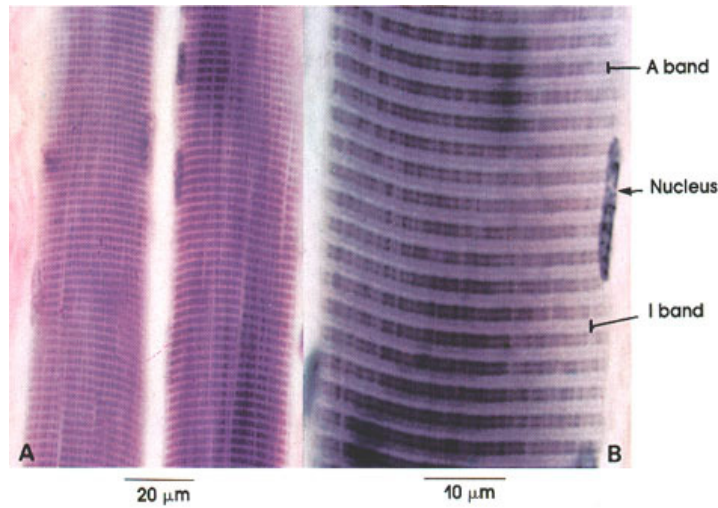


Sarcolemma: cytoplasmic membrane plus endomysium

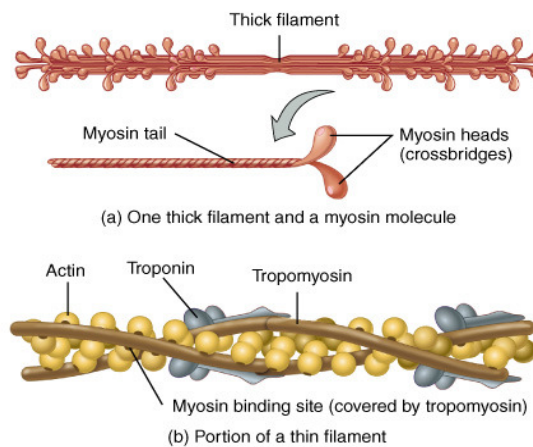
Organization of Skeletal Muscles at the microscopic level



Organization of Skeletal Muscles at the microscopic level

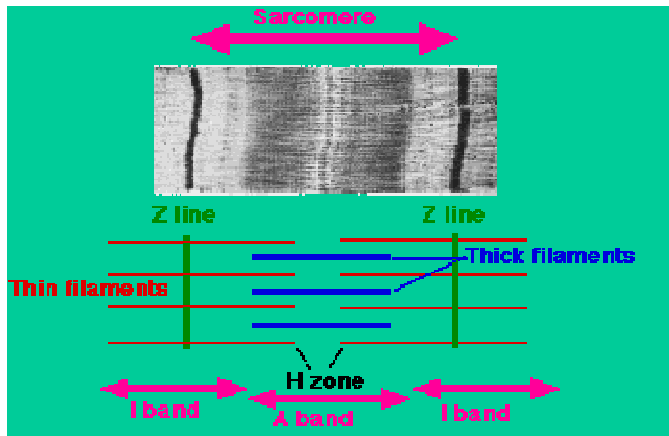


Organization of Skeletal Muscles at the microscopic level: Contractile Proteins

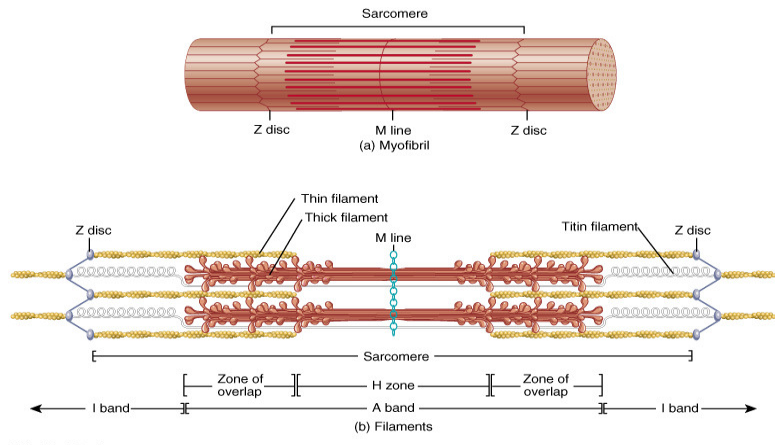


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Organization of Skeletal Muscles at the microscopic level



Organization of Skeletal Muscles at the microscopic level

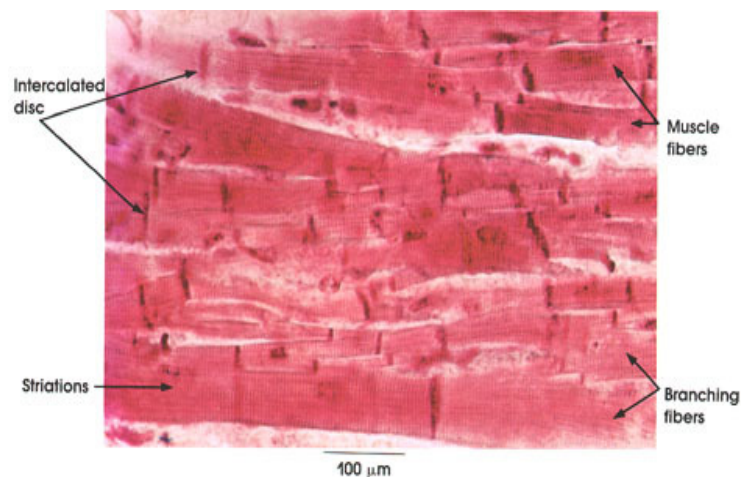


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Characteristics of Cardiac Muscle

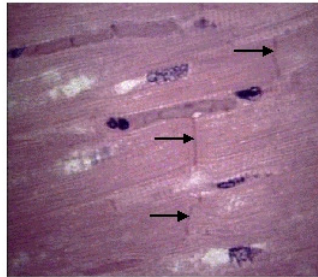
1. Branched cylindrical fibers with one centrally-located nucleus
2. Intercalated discs join neighboring fibers, contain gap junctions
3. Striated, composed of sarcomeres
4. Some sarcoplasmic reticulum for Ca^{2+} storage
5. Contains transverse tubules aligned with z-disc
6. Autorhythmicity, involuntary nervous control
7. Moderate speed of contraction
8. Acetylcholine, norepinephrine regulation
9. No regeneration

Organization of Cardiac Muscles at the microscopic level



Organization of Cardiac Muscles at the microscopic level

CARDIAC MUSCLE CELLS WITH INTERCALATED DISKS

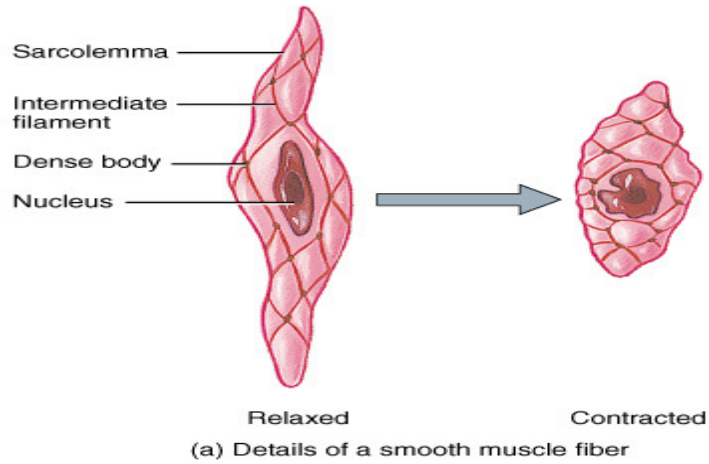


The intercalated (arrows) discs are specialized cell junctions between CMF's. They are located at Z lines and carry out important functions for the cell. The disc contains gap junctions which permit the rapid conduction of chemical and electrical activities between CMF's. The disc also represents the location of firm adhesions between CMF's. This allows these cells to "pull together" during a contraction.

Characteristics of Smooth Muscle

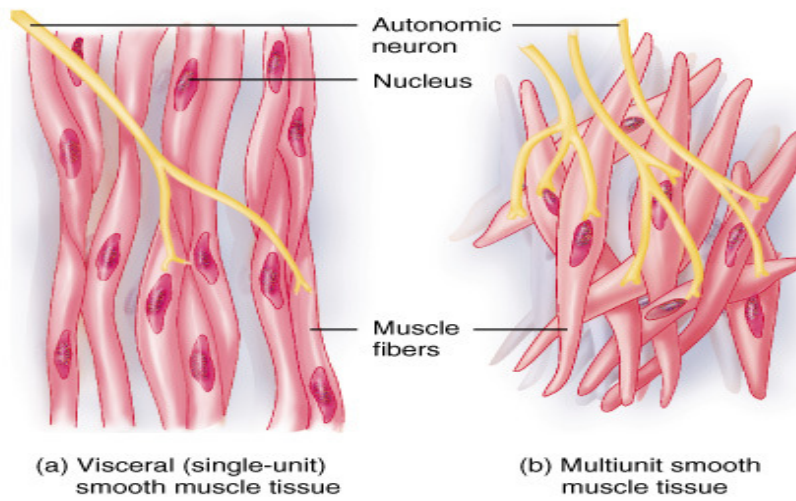
1. Spindle-shaped fibers with single nucleus
2. Not striated, not composed of sarcomeres
3. Only scant sarcoplasmic reticulum for Ca²⁺ storage
4. Contains no transverse tubules
5. Gap junctions between cells in visceral organs
6. Autorhythmicity, involuntary nervous control
7. Slow speed of contraction
8. Acetylcholine, norepinephrine regulation
9. Considerable regeneration via spericytes

Histology of Smooth Muscle



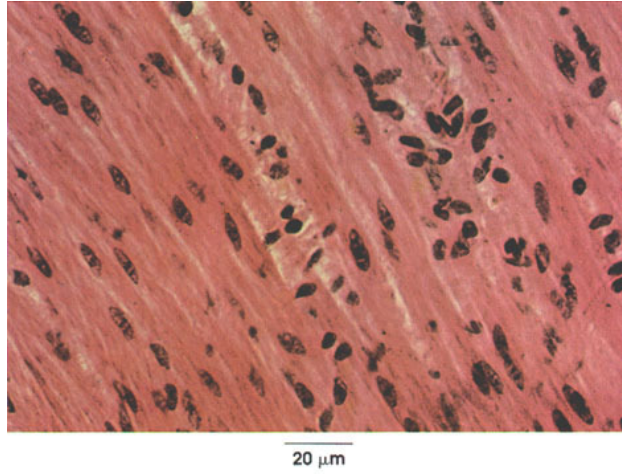
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Histology of Smooth Muscle

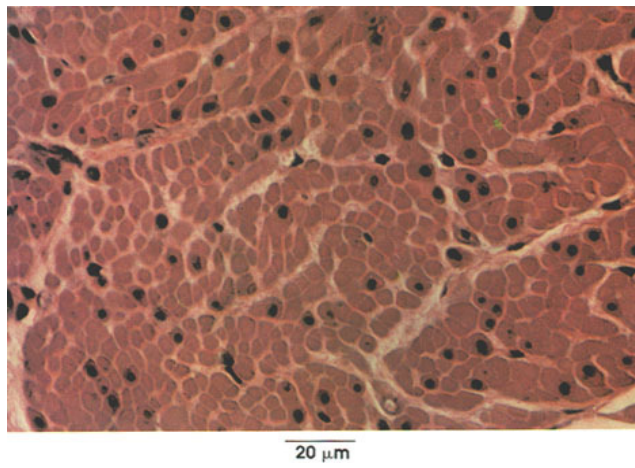


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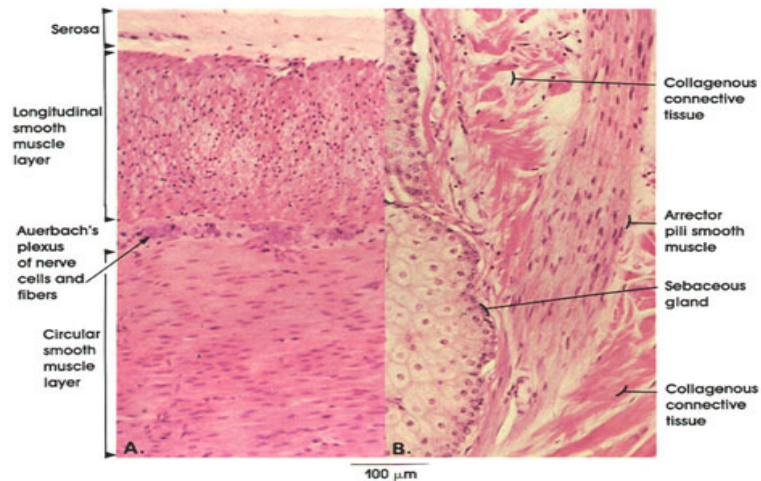
Histology of Smooth Muscle



Histology of Smooth Muscle



Histology of Smooth Muscle



Sequence of Events in Skeletal Muscle Contraction

1. Action potential (electrical stimulation) from somatic (motor) nerve stimulates skeletal muscle fibers (cells) at neuromuscular junction
2. "AP" causes the opening of Na⁺ channels on the sarcolemma thus causing a wave of depolarization to travel from the neuromuscular junction.
3. Depolarization event is communicated deep into the sarcoplasm via t-tubules.
4. Depolarization of sarcoplasmic reticulum causes the opening of Ca²⁺ channels and the subsequent release of calcium from sarcoplasmic reticulum
5. Calcium binds to troponin, troponin molecules change shape causing tropomyosin to move off of crossbridge binding sites on actin

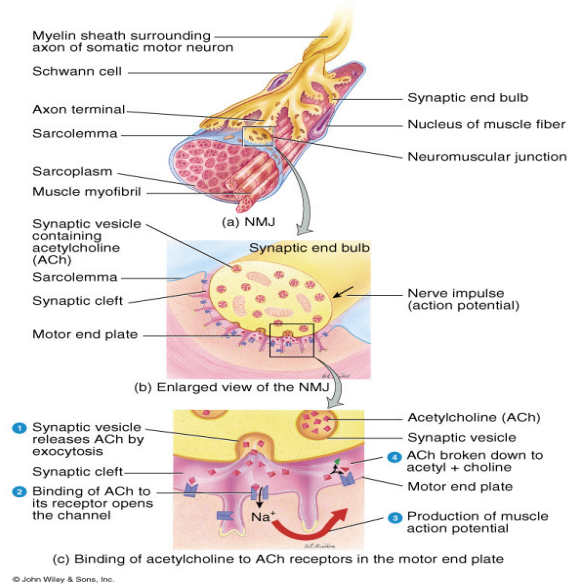
Sequence of Events in Skeletal Muscle Contraction

6. Myosin crossbridges bind to crossbridge binding sites on actin
7. ATPase acts on ATP in the binding site on the myosin to convert it into ADP + Pi + ENERGY
8. Released kinetic energy causes a “power-stroke” which causes actin to slide over myosin (i.e. a contraction occurs)
9. Sarcolemma repolarizes due to the opening of potassium channels.
10. Calcium channels close and an active transport pump carries calcium back to sarcoplasmic reticulum, troponin returns to pre-calcium shape, and ATP reforms to release the actin-myosin bond

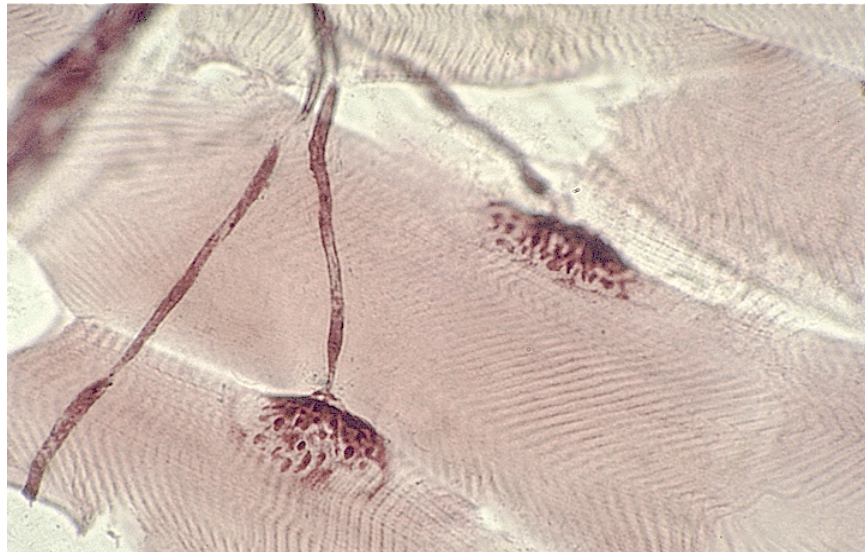
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Neuromuscular junction



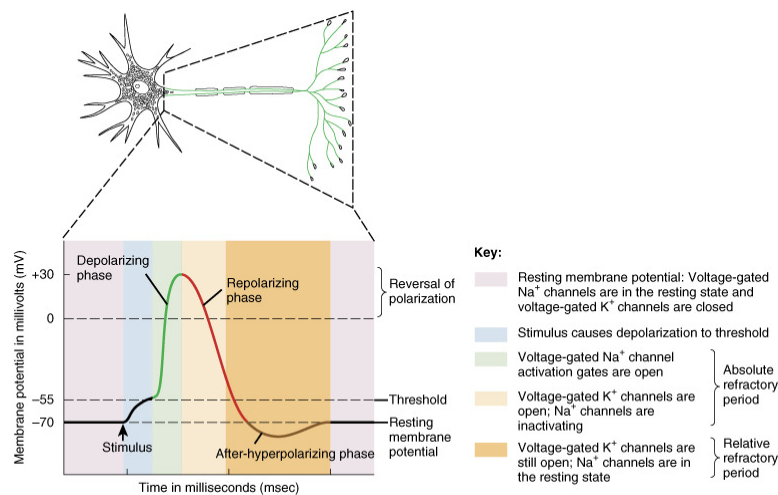
Neuromuscular junction, microscopic view



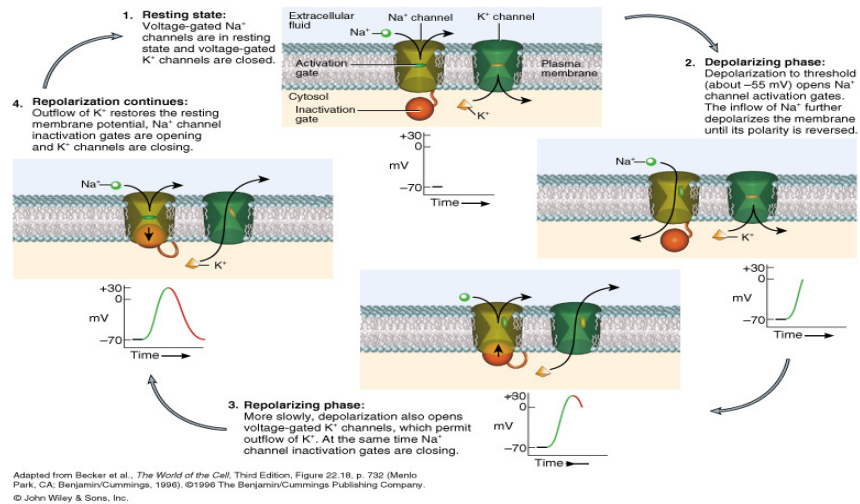
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Sarcolemma membrane states



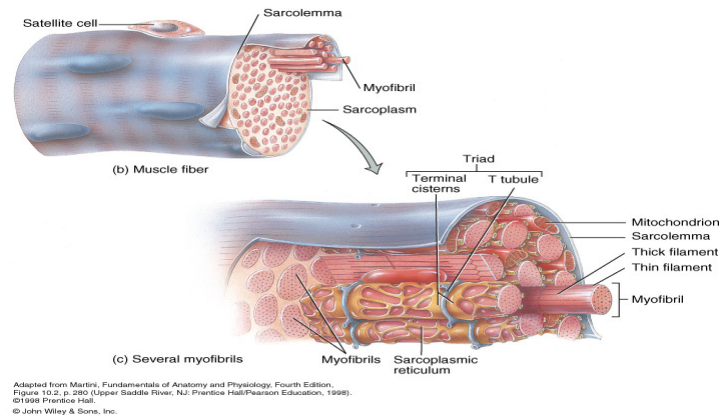
Action Potentials on the Sarcolemma



Sequence of Events in Skeletal Muscle Contraction

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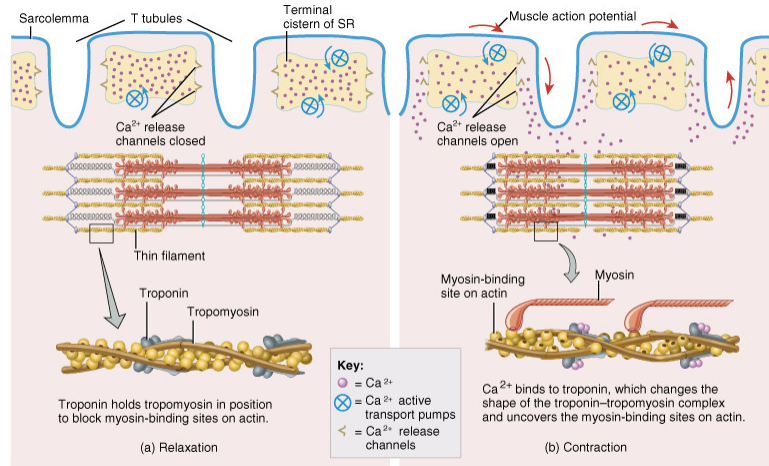
Organization of Skeletal Muscles at the microscopic level



Sequence of Events in Skeletal Muscle Contraction

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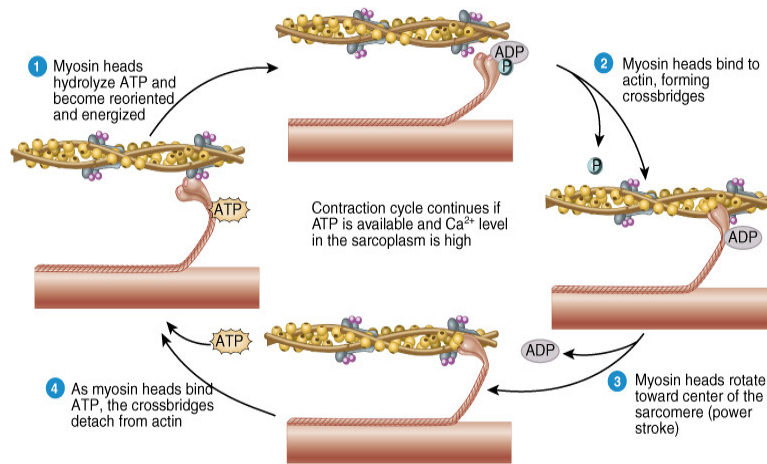
Calcium Troponin-Tropomyosin Interaction



Sequence of Events in Skeletal Muscle Contraction

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7. **ATPase acts on ATP in the binding site on the myosin to convert it into ADP + Pi + ENERGY**
8. **Released kinetic energy causes a “power-stroke” which causes actin to slide over myosin (i.e. a contraction occurs)**
9. **Sarcolemma repolarizes due to the opening of potassium channels.**
10. **Calcium channels close and an active transport pump carries calcium back to sarcoplasmic reticulum, troponin return to pre-calcium shape, and ATP reforms to release the actin-myosin bond**

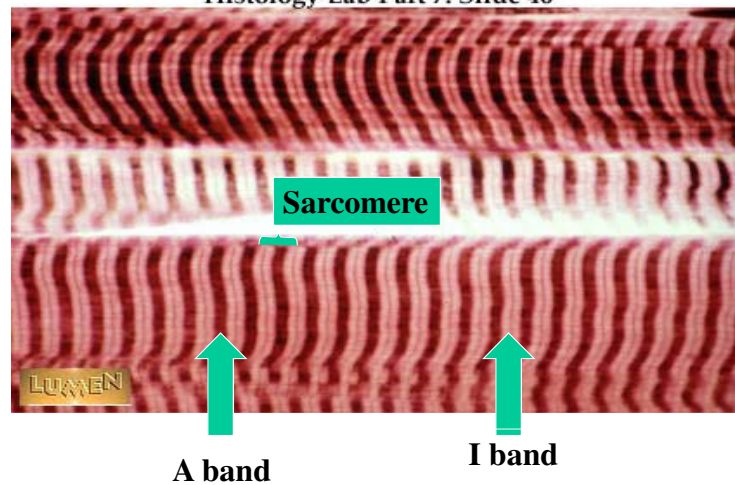
Actin-Myosin Interaction



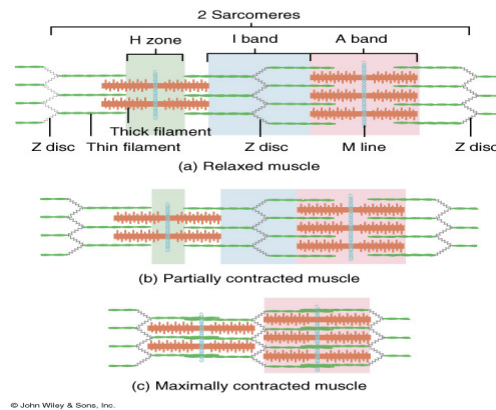
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Organization of Skeletal Muscles at the microscopic level

Histology Lab Part 7: Slide 46



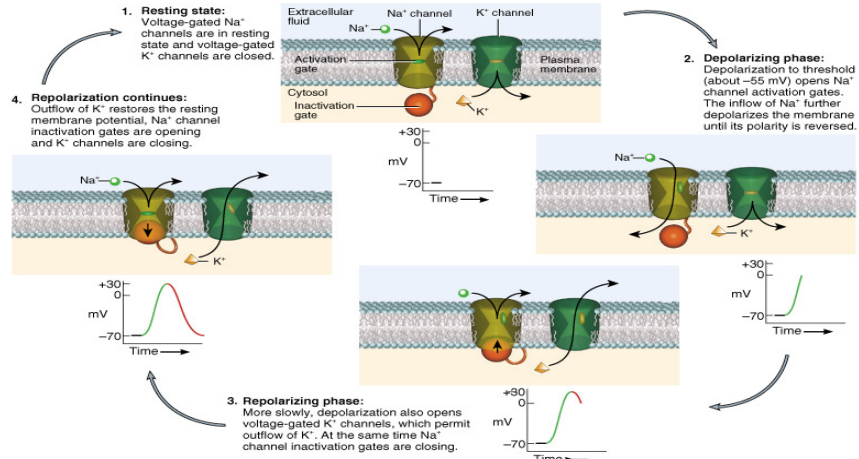
Results of actin-myosin interaction



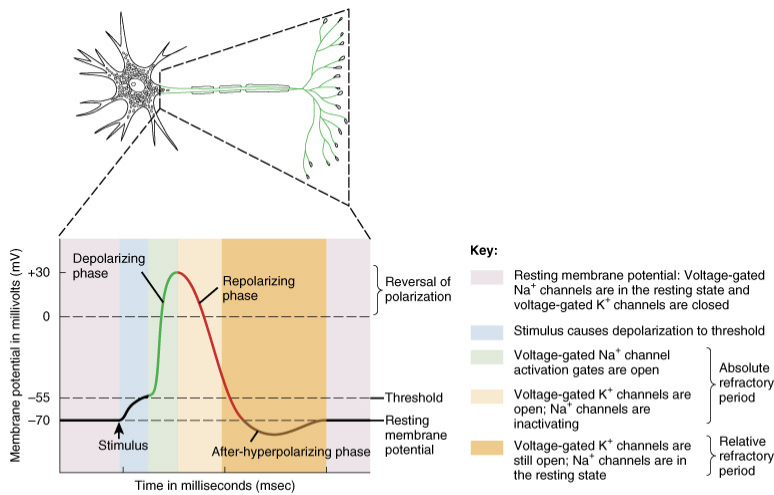
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Action Potentials on the Sarcolemma



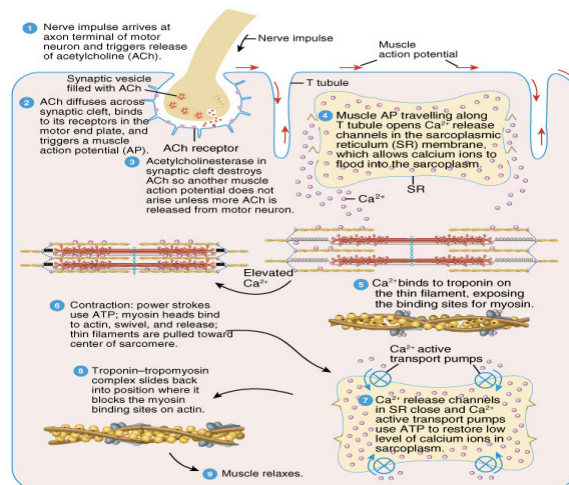
Sarcolemma membrane states



Sequence of Events in Skeletal Muscle Contraction

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Return of Calcium into the Sarcoplasmic Reticulum



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