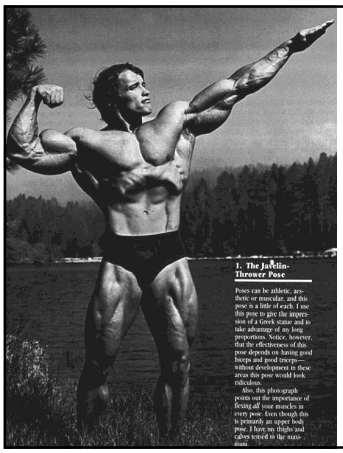


Chapter 39:
Action and Support:
The Muscles and Skeleton

Muscle Tissue (Muscle = "little mouse"):

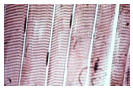
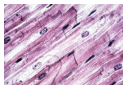
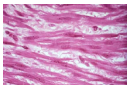
- Composed of single cell type
  - Exerts force by contracting (shortening)

Chemical energy (ATP) —Transformation→ Mechanical Energy

Function of Muscle:

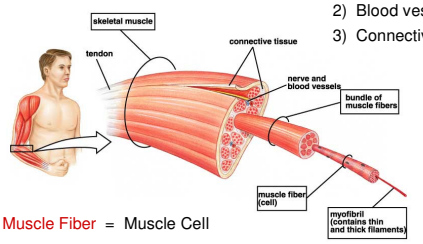
1) Produce movement
2) Maintain posture
3) Support soft tissue (e.g. abdominal wall)
4) Guard entrance / exit (e.g. lips / anus)
5) Maintain body temperature (e.g. shivering)

Types of Muscle Tissue:

	 Skeletal Muscle	 Cardiac Muscle	 Smooth Muscle
Appearance	Striated	Striated	Not Striated
Function	Skeletal Movement	Pump Blood	Move Substances Through Hollow Tubes
# of Nuclei / Cell	Many	One	One
Contraction Speed	Slow to Fast	Intermediate	Slow
Control	Voluntary	Involuntary	Involuntary

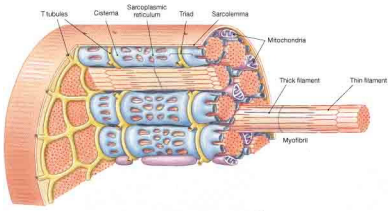
1) Skeletal Muscle:

- Human Body = > 700 unique skeletal muscles
- Muscle structure and function are closely linked:
  - Tendon: Attach muscle to skeleton (Connective Tissue)
  - Whole muscle consists of:
    1) Muscle Fiber Bundles
    2) Blood vessels/Nerves
    3) Connective Tissue Wrap



Muscle Fiber = Muscle Cell (Figure 39.2)

Microanatomy of Muscle:

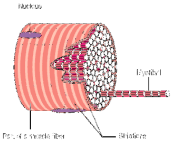


Each Muscle Fiber Contains:

T-tubules: Network of passageways through fiber (conduct APs)
Sacroplasmic Reticulum: Specialized endoplasmic reticulum
- Contain calcium ions (Ca^{++})

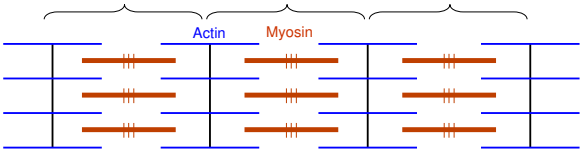
Myofibrils: Cylindrical structures containing contractile fibers

Microanatomy of Muscle:



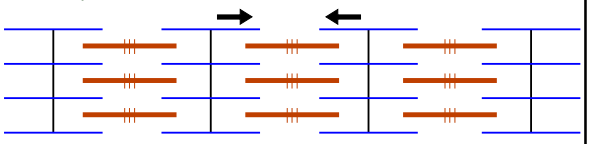
Myofibril contractile fibers (protein):
1) Actin (Thin filament)
2) Myosin (Thick filament)

Sarcomere: Repeating units of myofilaments (~ 10,000 / cell)



Microanatomy of Muscle:

Interactions between the thick and thin filaments of sarcomeres are responsible for muscle contraction



Microanatomy of Muscle:

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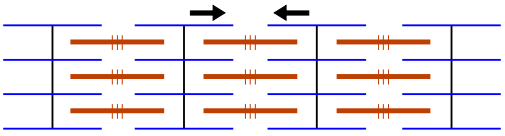
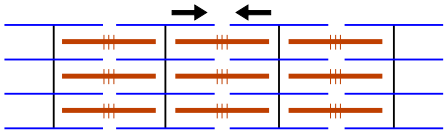


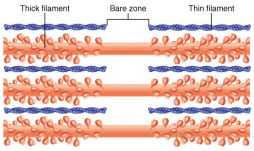
Microanatomy of Muscle:

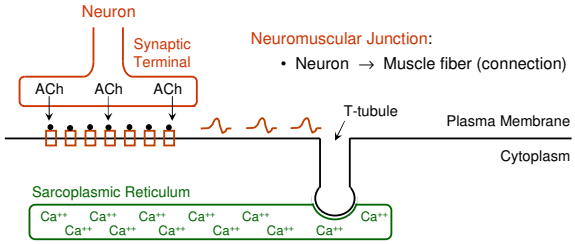
Sliding Filament Theory

Interactions between the thick and thin filaments of sarcomeres are responsible for muscle contraction

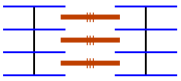


Requires ATP
(600 trillion / second / cell)





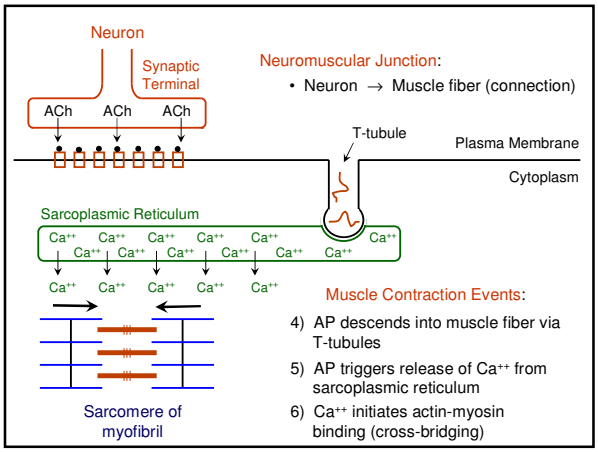
Neuromuscular Junction:
- Neuron → Muscle fiber (connection)



Sarcomere of myofibril

Muscle Contraction Events:

1) Acetylcholine (ACh - neurotransmitter) released from synaptic knob
2) ACh binds to receptors on muscle fiber; generates AP (electrical impulse)
3) Action potential conducted along plasma membrane

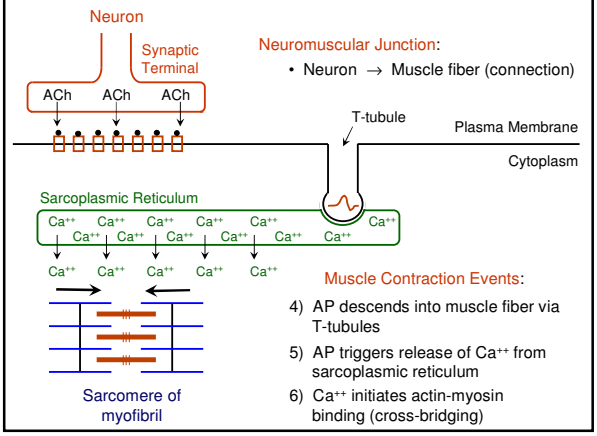


Neuromuscular Junction:
- Neuron → Muscle fiber (connection)

Sarcomere of myofibril

Muscle Contraction Events:

4) AP descends into muscle fiber via T-tubules
5) AP triggers release of Ca^{++} from sarcoplasmic reticulum
6) Ca^{++} initiates actin-myosin binding (cross-bridging)



Neuromuscular Junction:
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Sarcomere of myofibril

Muscle Contraction Events:

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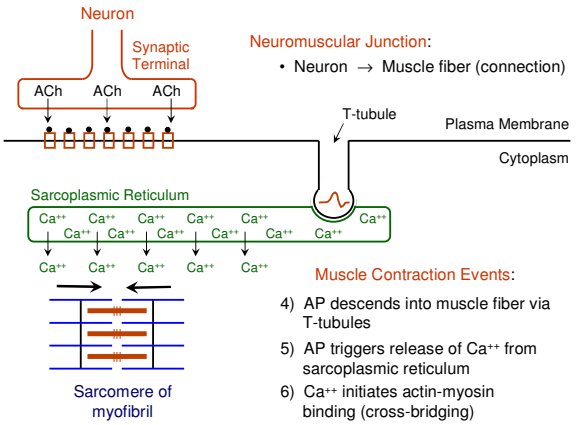

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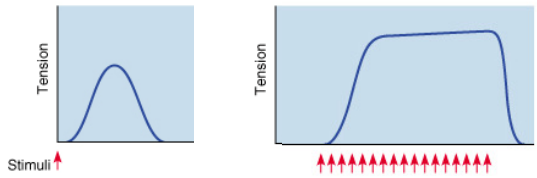
Control of Skeletal Muscle Contractions:

1) Length of Muscle Contraction → AP Frequency



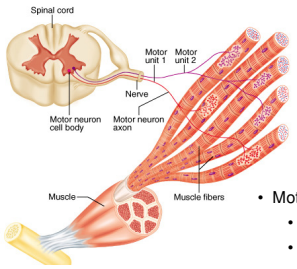
Low Frequency = Twitch
(short, rapid contraction)

High Frequency = Tetanus
(long, sustained contraction)

Control of Skeletal Muscle Contractions:

1) Strength of Muscle Contraction → # of Fibers Stimulated

Motor Unit: A single motor neuron and all the muscle fibers innervated by it (motor unit = all-or-none)



- Motor unit size dictates control:
  - Fine Control = 1-5 fibers (eye)
  - Gross Control = 1000's fibers (leg)

Skeletal System:

- Supporting framework for the body

Types of Animal Skeletons:

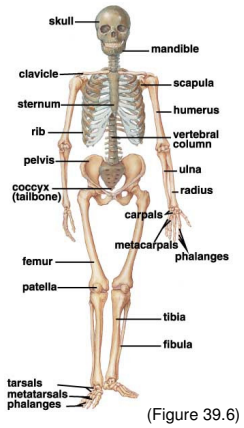
1) Hydrostatic Skeleton (e.g. earthworm, mollusk)
   - Fluid-filled compartments provides support
2) Exoskeleton (e.g. insects, crustaceans)
   - Rigid, external skeleton supporting body
3) Endoskeleton (e.g. humans)
   - Rigid, internal skeleton supporting body

Human Skeleton = 206 bones

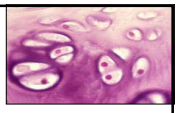
- Axial skeleton
  - Skull, vertebral column, rib cage
- Appendicular Skeleton
  - Extremities

Functions:

1) Supports body / protects organs
2) Locomotion
3) Blood cell production (red bone marrow)
4) Storage site
   - Calcium and Phosphorus
   - Energy (yellow bone marrow)
5) Sensory transduction (e.g. inner ear)



(Figure 39.6)



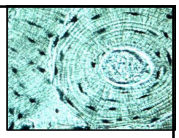
Skeletal Tissue Types:

1) Cartilage (connective tissue)
   - Provides flexible support / connections:
     a) Forms skeleton (early development)
     b) Covers end of bones (joints)
     c) Forms nose / ears
     d) Connects ribs to sternum
     e) Forms shock-absorbing pads (e.g. intervertebral discs)
   - Consists of living cells (chondrocytes) in protein matrix

↑
Secrete collagen fibers

- No direct blood supply

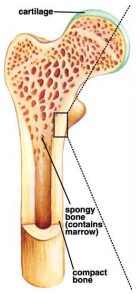
Skeletal Tissue Types:



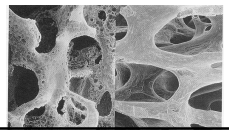
2) Bone (connective tissue)
   - Provides strong, rigid framework
   - Consists of:
     a) Collagen fibers (hardened with calcium phosphate deposits)
     b) Osteoblasts (build bone)
     c) Osteocytes (mature bone cells)
     d) Osteoclasts (dissolve bone)
   - Bone is constantly remodeled (5 - 10% each year)

Types of Bones:

1) Compact bone
   - Hard, outer shell
   - Site of muscle attachment
2) Spongy bone
   - Interior latticework (porous)
   - Contains bone marrow



- Bone density reaches peak at age 35
- Osteoporosis ("porous bone")
  - Predominates in women (8x)
  - Treatment:
    - Exercise; Ca++ supplements
    - Hormone replacement therapy



Body Movement:

Joint = Point at which two bones meet
- Ligament = Fibrous connective tissue attaching bones
- Antagonistic muscles drive movement:
  - Flexion = Decrease angle between bones
  - Extension = increase angle between bones

Types of Joints:

1) Hinge joint:
   - 2 - demensional movement (e.g. knee)
1) Ball-and-socket joint:
   - 3 - demensional movement (e.g. hip)