

Muscular System

I. Functions:

- A. Body Movement
 - 1. maintenance of posture
 - 2. communication
- B. Respiration
- C. Production of heat.
- D. Constriction of organs and vessels
- E. Heart beat.

II. Types:

- A. Skeletal
 - 1. striated
 - 2. long, cylindrical cells
 - 3. multinucleate
 - 4. voluntary
- B. Cardiac
 - 1. striated
 - 2. branched
 - 3. intercalated disks – connections that cause cells to act as one unit
 - 4. single nucleus
 - 5. Autorhythmic – periodic, spontaneous contraction
 - 6. involuntary
- C. Smooth
 - 1. non-striated
 - 2. spindle shaped
 - 3. single nucleus
 - 4. cell-to-cell attachments
 - 5. autorhythmic
 - 6. involuntary

III. Skeletal Muscle Structure

- A. Connective Tissue Coverings.
 - 1. Fascia, surrounds and separates each muscle. Connects to tendons
 - 2. epimysium – under fascia. around each whole muscle
 - 3. perimysium – surrounds individual bundles (fascicles)
 - 4. endomysium covers each muscle cell(fiber)
- B. Skeletal Muscle Fibers
 - 1. Contains myofibrils (Protein fibers)
 - a. Thick filaments are myosin.
 - b. Thin filaments are actin.
 - c. filaments produces striations.
 - 2. Separated into compartments called sarcomeres.
 - 3. Sarcoplasmic reticulum and transverse (T) tubules – contain calcium - activate the muscle contraction
- C. Neuromuscular Junction
 - 1. where motor neuron attaches to fiber
 - 2. Action Potential (AP), an electrical impulse, is transmitted from neuron to fiber
- D. Motor Units - motor neuron and the muscle fibers it controls

IV. Contraction

- A. Involves shortening of sarcomeres, by sliding filaments past each other
 - 1. Myosin has cross-bridges
 - 2. Actin has binding sites
- B. Process
 - 1. Action potential from a motor neuron enters the fiber
 - 2. Causes the sarcoplasmic reticulum and T tubules to release Ca into the sarcoplasm (cytoplasm)

3. Ca binds to actin and exposes sites for myosin to bind
4. They bind and form cross-bridges
5. ATP energy is stored in head of myosin, bending it towards center.
6. This shortens the sarcomere.
7. Another ATP comes along to release the bend.
8. If more ATP is available and Ca still being released it will continue to contract (go back to #5)

C. If no energy is available, muscle can stay contracted - rigor mortis

D. Energy

1. Fibers use much energy (ATP).
2. Many mitochondria are necessary
3. ATP cannot be stockpiled
4. Cells make Creatine phosphate to store energy, use it to make ATP when needed

E. Oxygen Supply

1. aerobic respiration makes ATP from glucose and O₂
2. anaerobic make ATP without O₂
 - a. makes lactic acid
 - b. irritates fibers, causes short term pain.

F. Oxygen Debt

1. refers to the amount of oxygen that your body requires to:
 - a. convert the lactic acid into glucose,
 - b. resynthesize ATP and creatine phosphate.
2. May take several hours.
3. based on intensity and length of exercise and shape of individual

G. Muscle Fatigue

1. loss of ability of maximum contraction
2. caused by lactic acid in the muscle.
3. Muscle cramps lack of ATP or electrolyte imbalance so that the muscle fibers cannot relax.

H. Heat Production - Contraction is a source through the loss of energy during chemical reactions

V. Muscular Responses

A. Threshold Stimulus - fiber does not respond to stimulation unless the stimulus is of a certain strength

B. All-or-None Response - When a muscle fiber contracts, it contracts to its full extent; no partial contractions.

C. A single, short contraction is referred to as a twitch.

1. Lag/Latent phase – time between stimulus and beginning of contraction
2. Contraction phase – time of contraction
3. Relaxation phase – time it relaxes

D. Sustained Contractions

1. Successive stimuli = successive twitches
2. Tetanus – muscle remains contracted.
3. Muscle tone
 - a. state of tension that is maintained continuously/minimally even when relaxed
 - b. gives posture

E. Slow and Fast Twitch – based on difference of myosin

1. Slow fibers – contract slowly, resistant to fatigue, better at aerobic
2. Fast fibers – contract quickly, fatigue quickly, better at anaerobic, white meat

VI. Skeletal Muscle Actions

A. Tendon connects muscle to bone

B. Origin (head) - immovable end of a muscle

C. Insertion - movable end

D. Belly – part of muscle between two

E. Types of Contraction

1. Isotonic Contractions – change length as it contracts and causes movement
 - a. Concentric – shortening of muscle
 - b. Eccentric – lengthening of muscle

2. Isometric Contractions - no change in the length of the contracting muscle.

F. Interaction of Muscles

1. Prime mover (agonist) – muscle provides most of the movement
2. Helper muscles are synergists
3. opposing muscles are antagonists
4. Flexor – bends a joint
5. Extensor - straightens a joint