

# Muscular System

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## Function of the Muscular System

- Provides movement for the body and its parts, maintains posture, generates heat and stabilizes joints.
- Essential function is to shorten.

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## Types of Muscles

- Skeletal
- Smooth
- Cardiac

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Characteristic	Skeletal	Cardiac	Smooth
Body location			
Attached to bones or, for some facial muscles, to skin	Walls of the heart	Mostly in walls of hollow visceral organs other than the heart	
Cell shape and appearance			
Regulation of contraction	Single, very long, cylindrical, multinucleated cells with very obvious striations	Branching chains of cells; striations; intercalated discs	Single, fusiform, uninucleated; no striations
Speed of contraction	Voluntary; via nervous system controls	Involuntary; the heart has a pacemaker; also nervous system controls; hormones	Involuntary; nervous system controls; hormones; chemicals; stretch
Rhythmic contraction	Slow to fast No	Slow Yes	Very slow Yes, in some

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## Skeletal Muscle

- Attached to the body's skeleton.
- Multinucleated cells reaching 1 foot in length.
- Striated muscle
- Voluntary

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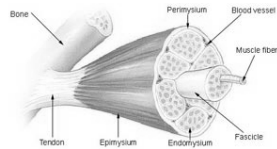
## Parts of the Skeletal Muscle

- Endomysium-delicate connective tissue that surrounds the muscle fiber.
- Perimysium-courser fibrc membrane that surround several muscle fibers cal fascicle.
- Tough overcoat that surrounds the fascicles which blend into the tendon.

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## Tendons

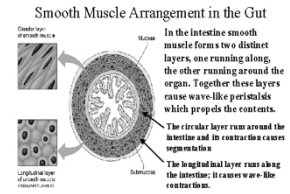
- Anchor muscle to bone.
- Tough and durable.
- Conserve space and can move over joints.



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## Smooth Muscle

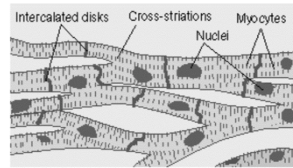
- No striations and involuntary.
- One nucleus and arranged in sheets.



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## Cardiac Muscle

- Involuntary, striated and branched found only in the heart.



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## Muscle Functions

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## Produce Movement

- Controls almost all of the movements of the human body.
- Enable us to respond quickly to external stimuli.

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## Maintain Posture

- Make one tiny adjustment after another to maintain an erect or seated posture despite the pull of gravity.

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### Stabilize Joints

- Muscle and tendons keep the joints stable.

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### Generate Heat

- Heat is the by-product of muscle activity.
- ATP is used to contract the muscle and three quarters of the energy escapes as heat.
- 40% of the body's mass is skeletal muscle that can generate the heat.

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### Skeletal Muscle Activity

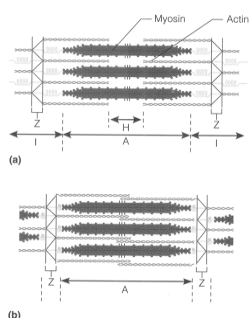
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### Stimulate and Contract a Skeletal Muscle Cells

- Irritability-Ability to receive and respond to a stimulus.
- Contractility-The ability to shorten when an adequate stimuli is received.

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### Striated Skeletal Muscle

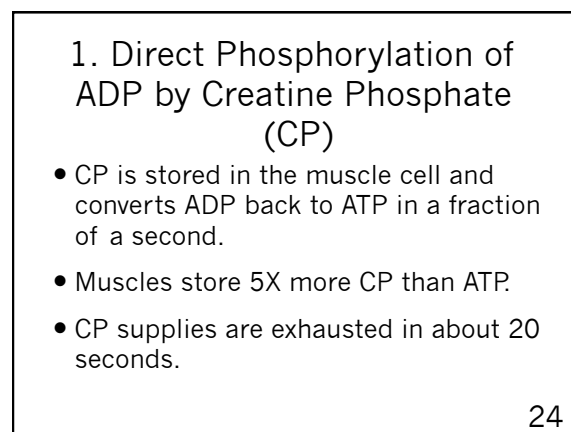
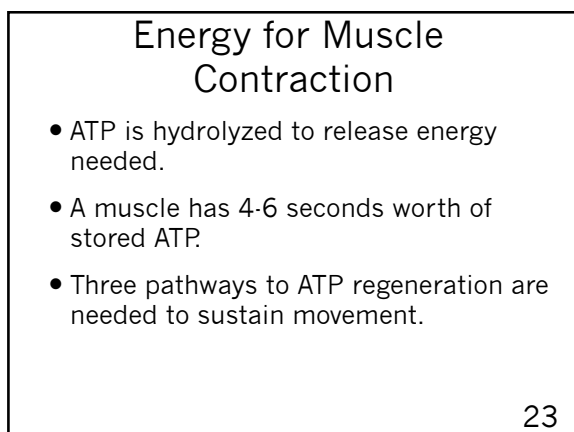
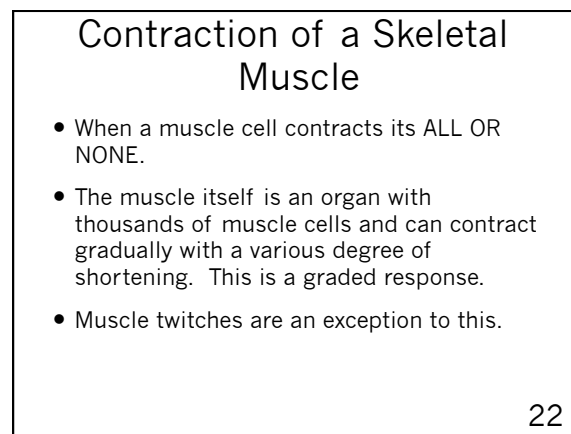
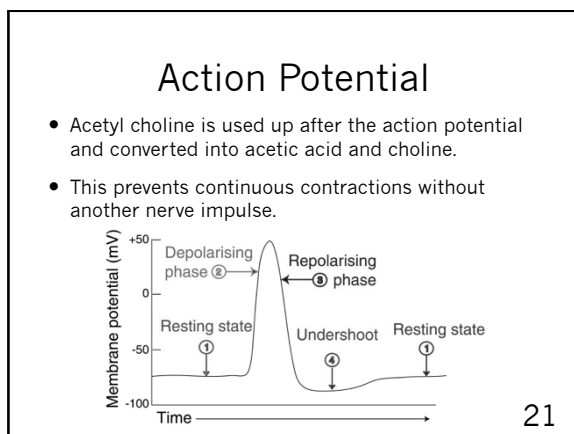
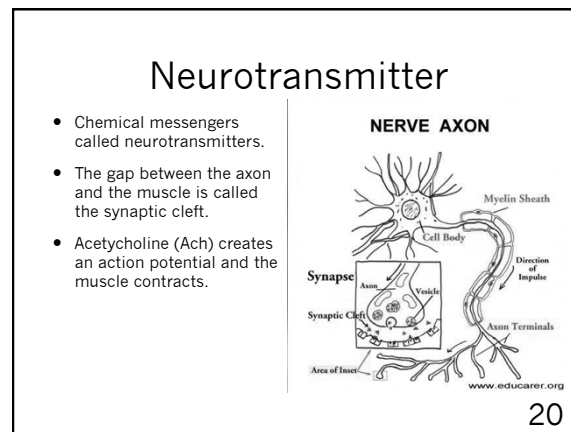
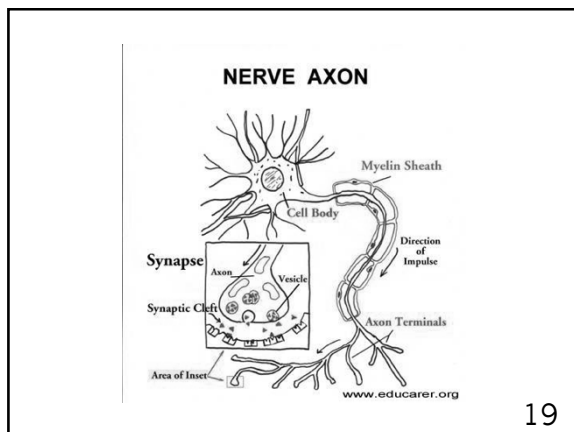


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### Nerve Stimulus and the Action Potential

- One motor neuron can stimulate a few to over 100 muscle cells.
- This is called a motor unit.
- Happens when the nerve extension called an axon reaches the muscle and branches out. This branching is called the axon terminal.

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(a) Direct phosphorylation of ADP by reaction with creatine phosphate (CP)

Energy source: CP
Oxygen use: None Products: 1 ATP per CP, creatine Duration of energy provision: 15 sec

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## 2. Aerobic Respiration

- Normally through oxidative phosphorylation, the mitochondria use a series of metabolic pathways to convert the ADP back into ATP.
- This will happen nicely in normal muscle activity or even light exercise.
- Glucose is needed (yields 36 ATP's) but is slow and requires oxygen and releases carbon dioxide and water.

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(b) Aerobic respiration (oxidative phosphorylation)

Energy sources: glucose; pyruvic acid; free fatty acids from adipose tissue; amino acids from protein catabolism
Oxygen use: Required Products: 36 ATP per glucose, CO <sub>2</sub> , H <sub>2</sub> O Duration of energy provision: Hours

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## 3. Anaerobic Glycolysis and Lactic Acid Formation 28

- The breakdown of glucose without oxygen yielding only 2 ATP's.
- Pyruvic acid is formed.
- If enough oxygen is present, the pyruvic acid enters the aerobic pathway and things continue.
- If there is an inadequate amount of oxygen, pyruvic acid is converted into lactic acid. This causes muscle fatigue and soreness.

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(c) Anaerobic glycolysis and lactic acid formation

Energy source: glucose
Oxygen use: None Products: 2 ATP per glucose, lactic acid Duration of energy provision: 30-60 sec

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## Muscle Fatigue

- The muscle is unable to contract even though a stimulus is being sent.
- Results from oxygen debt.
- Occurs in marathon runners with simply collapse.
- Effects can start to reverse with rest and proper breathing.

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## Muscle Contractions

- Isotonic Contraction-Muscles shorten when the myofilaments slide past each other.
- Ex. Bending your knee or elbow
- Isometric Contraction-Contraction when the muscles do not shorten.
- Ex. Trying to pick up 400 pounds.

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## Muscle Tone

- Not consciously controlled.
- Some filaments are contracted while others are relaxed.

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## Effects of Exercise on Muscles

- Use it or lose it. Failure to move muscles will cause an inactivity of the muscle.
- Regular exercise increases a muscles strength and endurance.
- Examples include aerobics, jogging or biking.
- Endurance occurs because more blood reaches the muscles and causes more mitochondria to form.

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## Size of the Muscle

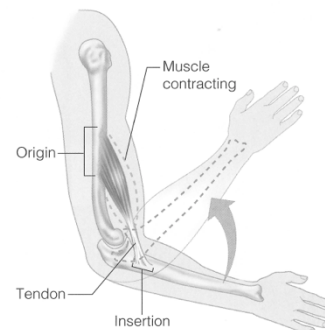
- Jogging or aerobics will not increase the size of the muscle only the endurance.
- To increase size, isometric exercises are necessary.

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## Muscle Attachment

- All skeletal muscles (around 600) are attached to bone or other connective tissue in no less than 2 places.
- The origin is attached to the immovable or less movable bone.
- Insertion is attached to the movable bone.
- With few exceptions, all muscles cross at least one joint.

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### Developmental Aspects (cont.)

- Integumentary System-Protects muscles by external enclosures.
- Skeletal System-Bones provide levers for muscle activity.
- Cardiovascular System-Delivers oxygen and nutrients and carries away wastes.

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