Physiology

Lecture 4

The muscular system

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The Muscular System

myology (myo- muscle; -logy study of): is The scientific study of muscles, Through contraction and relaxation.

muscular tissue performs four important functions:

- producing body movements.
- stabilizing body positions.
- moving substances within the body and regulating organ volume.
- producing heat.

Muscles are classified by three different methods, based on different factors:

1. **<u>Depending upon striations</u>**

- **Striated Muscle**: Striated muscle is the muscle which has a large number of cross-striations (transverse lines)

EX: Skeletal muscle and cardiac muscle

- **Non-striated Muscle:** Muscle which does not have cross-striations is called non-striated muscle.

EX: smooth muscle.

2. **<u>Depending upon control</u>**

- **Voluntary Muscle:** Voluntary muscle is the muscle that is controlled by the will.

EX: Skeletal muscles.

- **Involuntary Muscle:** Muscle that cannot be controlled by the will is called involuntary muscle.

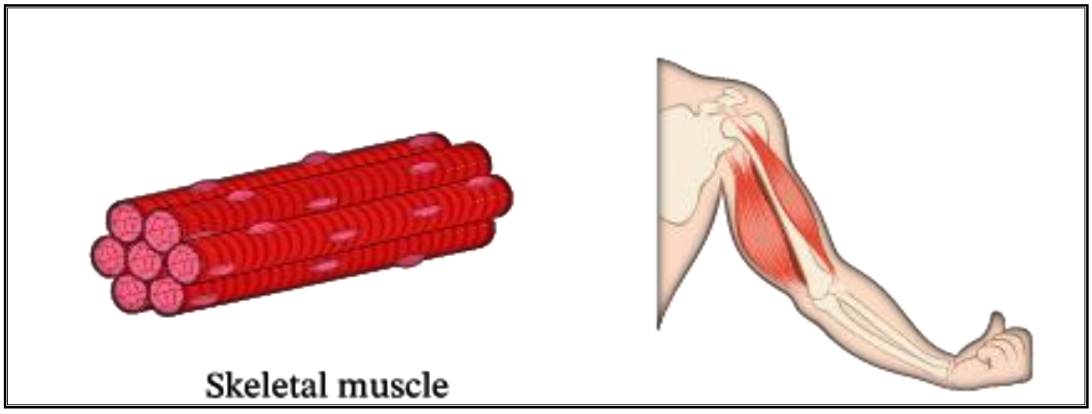
EX: Cardiac muscle and smooth muscle.

3. Depending upon situation

- **Skeletal Muscle:**

  Skeletal muscles are voluntary muscles, meaning you control how and when they move and work. Nerves in your somatic nervous system send signals to make them function.

  EX: If you reach for a book on a shelf, you're using skeletal muscles in your neck, arm and shoulder.

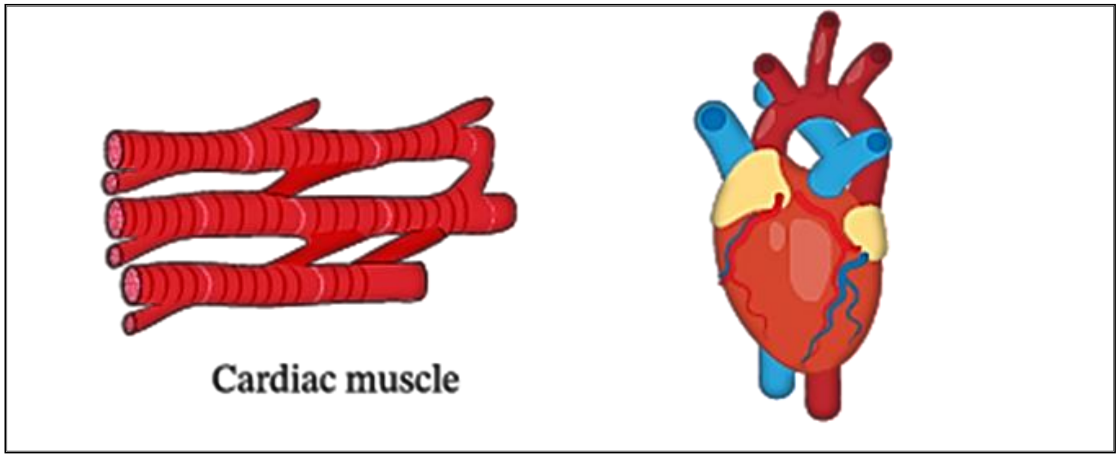


- **Cardiac muscles:**

  Cardiac muscles are only in your heart. They help your heart pump blood throughout your body.

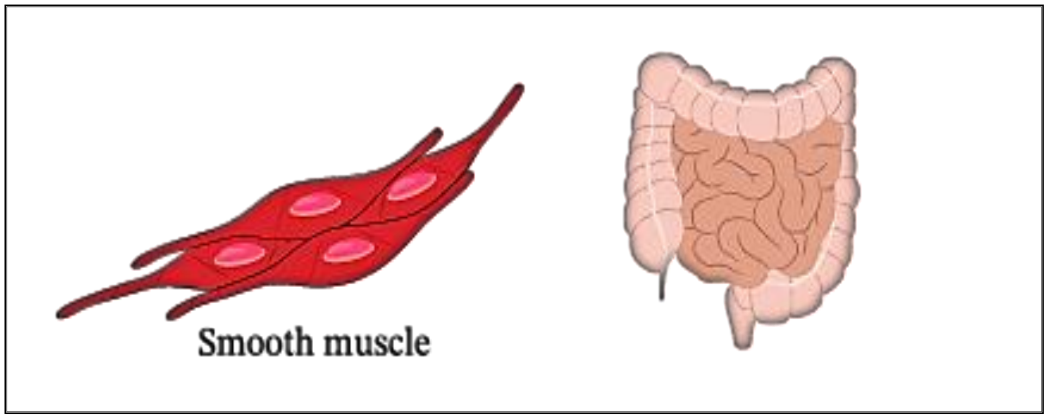
  They're involuntary muscles that your autonomic nervous system controls.

  That means they work without you having to think about it.

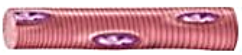


- Smooth muscle

makes up your organs, blood vessels, digestive tract, skin and other areas. Smooth muscles are involuntary, too. So, your autonomic nervous system controls them as well. For example, muscles in your urinary system help rid your body of waste and toxins.



The different between three type of Muscles

	Location	Function	Appearance	Control
Skeletal 	skeleton	movement, heat, posture	**striated**, multi-nucleated (eccentric), fibers parallel	**voluntary**
Cardiac 	heart	pump blood continuously	**striated**, one central nucleus	**involuntary**
Visceral (smooth muscle) 	G.I. tract, uterus, eye, blood vessels	Peristalsis, blood pressure, pupil size, erects hairs	**no striations**, one central nucleus	**involuntary**

The sliding filament theory

is the explanation for how muscles contract to produce force. the actin and myosin filaments within the sarcomeres of muscle fibers bind to create cross-bridges and slide past one another, creating a contraction. The sliding filament theory explains how these cross-bridges are formed and the subsequent contraction of muscle.

summary the sliding filament theory of muscle contraction can be broken down into four distinct stages, these are;

1. Muscle activation: The motor nerve stimulates an action potential (impulse) to pass down a neuron to the neuromuscular junction.
This stimulates the sarcoplasmic reticulum to release calcium into the muscle cell.

2. Muscle contraction: Calcium floods into the muscle cell binding with troponin allowing actin and myosin to bind.
The actin and myosin cross bridges bind and contract using ATP as energy (ATP is an energy compound that all cells use to fuel their activity.

3. Recharging: ATP is re-synthesised (re-manufactured) allowing actin and myosin to maintain their strong binding state

4. Relaxation: Relaxation occurs when stimulation of the nerve stops.
Calcium is then pumped back into the sarcoplasmic reticulum breaking the link between actin and myosin. Actin and myosin return to their unbound state causing the muscle to relax.
Alternatively relaxation (failure) will also occur when ATP is no longer available.

Properties of Muscle Fibers

☒ Biochemical properties

- Oxidative capacity
- Type of ATPase

☒ Contractile properties

- Maximal force production
- Speed of contraction
- Muscle fiber efficiency

Fiber Types and Performance

☒ **Power athletes**

- Sprinters
- Possess high percentage of fast fibers

☒ Endurance athletes

- Distance runners
- Have high percentage of slow fibers

☒ Others

- Weight lifters and nonathletes
- Have about 50% slow and 50% fast fibers

Individual Fiber Types

Fast fibers	Slow fibers
• **Type IIb fibers** **-Fast-twitch fibers** **-Fast-glycolytic fibers** • **Type IIa fibers** **-Intermediate fibers** **-Fast-oxidative glycolytic fibers**	• Type I fibers -Slow-twitch fibers -Slow-oxidative fibers