

### Intro

**Cardiac Muscle** found only in the heart and shares characteristics of both skeletal and smooth muscles

### Basic Vocabulary

**Sarcoplasmic Reticulum** modified endoplasmic reticulum composed of a fine network of interconnected tubules into which  $Ca^{++}$  is actively transported and stored

**T-Tubules** invagination of the plasma membrane at each sarcomere

**Foot Proteins** proteins that span the gap between the lateral sacs and the transverse tubules and mediate a change in permeability to  $Ca^{++}$  by the lateral sacs; also known as ryanodine receptors because they are locked open by the plant chemical ryanodin

**Lateral Sacs** enlarged regions of the sarcoplasmic reticulum that come into close contact with the transverse tubules

**Dihydropyridine Receptors** receptor proteins in the transverse tubule membrane that come into contact with the foot proteins; voltage dependent and gate the change in permeability of the foot proteins to  $Ca^{++}$

### Thin Filament

**Actin** globular cytoskeletal protein linked to form two long chains arranged in a double helical strands

**Tropomyosin** pairs of threadlike filamentous proteins that lie alongside the grooves formed by the actin helix

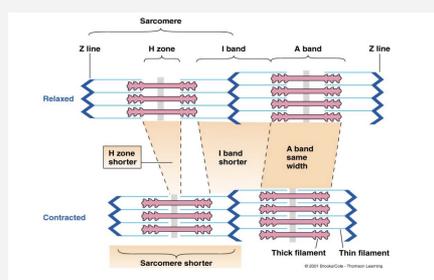
**Troponin** protein complex composed of three subunits, one that binds to actin, one that binds to tropomyosin, and one that binds to  $Ca^{++}$ ; multiple copies of this complex are bound to the strands of actin and tropomyosin

### Striated and Unstriated Muscles

**Striated Muscles** *Skeletal and Cardiac Muscles* Visually has striped lines across the muscle

**Unstriated Muscles** *Smooth Muscles* Has no striped lines

### Sarcomere Nomenclature



### Excitation-Contraction Coupling

1. ACh released by axon of motor neurons binds to receptors on the motor end plate
2. Action potential generated in response to binding of ACh and subsequent end plate potential is propagated across surface of membrane and down T-Tubule of muscle cell

### Excitation-Contraction Coupling (cont)

3. Action potential triggers  $Ca^{++}$  release from the sarcoplasmic reticulum
4.  $Ca^{++}$  ions released from lateral sacs bind to troponin on actin filaments; tropomyosin physically moved aside to uncover cross-bridge binding sites on actin
5. Myosin cross bridges attach to actin and bend, pulling actin filaments towards the center of the sarcomere; powered by energy provided by ATP
6.  $Ca^{++}$  actively taken up by sarcoplasmic reticulum when there is no longer local action potentials
7. With  $Ca^{++}$  no longer bound to troponin, tropomyosin slips back to its blocking position over the binding sites on actin; contraction ends; actin slides back to original resting position

### Thick Filament

**Myosin** cytoskeletal protein composed of two interwoven subunits, each with a long tail and a globular head region

**Actin Binding Site** specialized region of the myosin head capable of binding to actin

**Myosin ATPase** specialized region of the myosin head capable of ATP hydrolysis

### Voluntary and Involuntary Muscles

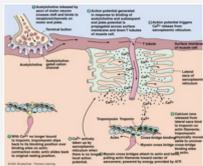
**Voluntary Muscles** *Skeletal Muscles*

**Involuntary Muscles** *Cardiac and Smooth Muscles*

## Sarcomere Vocabulary

Sarcomere	functional unit of a muscle
Z-Line	defines boundary of sarcomere; site where thin filaments attach
A-Band	made up of thick filaments along with portions of thin filaments that overlap
H-Zone	lighter area within middle of A-band where thin filaments do not reach
M-Line	extends vertically down middle of A-band within center of H-zone
I-Band	consists of remaining portion of thin filaments that do not project into A-band

## Excitation-Contraction Coupling



## Intercalated Discs

specialized cell-to-cell junctions found in cardiac muscle tissue

contains desmosomes (maintaining the structural integrity and mechanical stability of the heart)

also contains gap junctions (allows electrical signals (action potentials) to pass directly between cells)

located at the ends of the cardiac muscle cells which form a zigzag connection between them