Tikrit University
College of Veterinary Medicine

muscular system

Subject name: physiology

Subject year:2nd

Lecturer name:Wasan Sarhan, Muneef Saab

Academic Email:wasansarhan@tu.edu.iq

muneef.s962@tu.edu.iq

SCAN ME
Lecturers link

Functions of the muscular system

1. **Locomotion**

2. **Vasoconstriction** and **vasodilatation**- constriction and dilation of blood vessel Walls are the results of smooth muscle contraction.

3. **Peristalsis –** wavelike motion along the digestive tract is produced by the Smooth muscle.

4. **Cardiac motion**

5. **Posture maintenance-** contraction of skeletal muscles maintains body posture and muscle tone.

6. **Heat generation –** about 75% of **ATP** energy used in muscle contraction is released as heat.

Muscle characteristics:

Striation: only present in skeletal and cardiac muscles. Absent in

smooth muscle.

Nucleus: smooth and cardiac muscles are uninculcated (one nucleus per cell), skeletal muscle is multinucleated (several nuclei per cell).

Transverse tubule (T tubule): well developed in skeletal and cardiac muscles to transport calcium. Absent in smooth muscle.

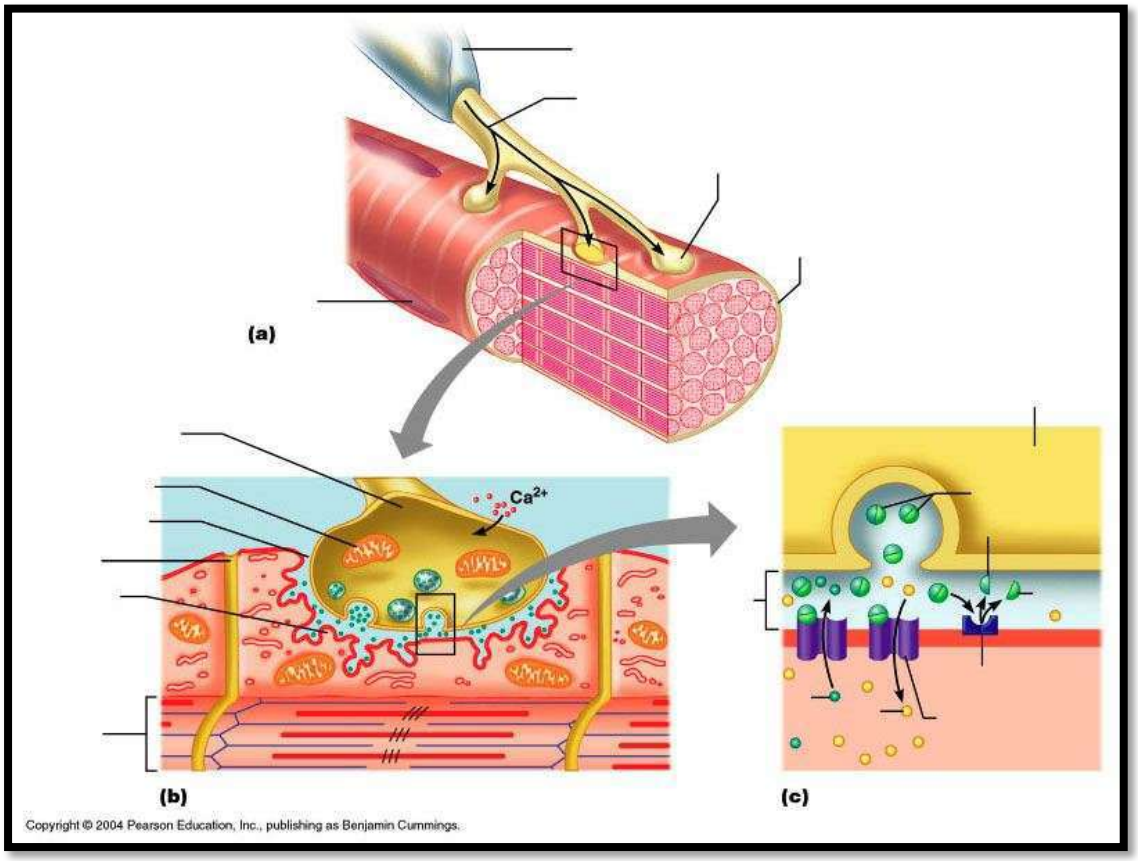
Intercalated disk: specialized intercellular junction that only occurs in cardiac muscle.

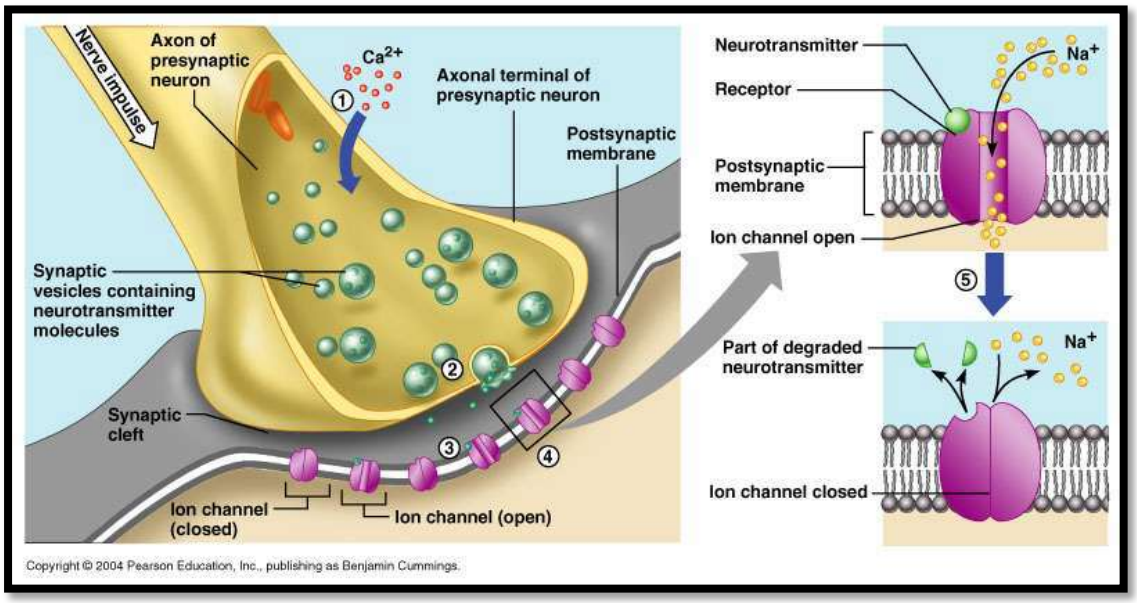
Control: skeletal muscle is always under voluntary control, with some exceptions (the tongue and pili arrector muscles in the dermis). smooth and cardiac muscles are under involuntary control.

Innervation: motor unit

a) a **motor nerve** and a **myofibril** from a **neuromuscular junction** where gap (called **synapse**) occurs between the two structures. at the end of motor nerve, neurotransmitter (i.e. acetylcholine) is stored in **synaptic vesicles** which will release the neurotransmitter using exocytosis upon the stimulation of a nerve impulse. Across

the synapse the surface the of myofibril contains **receptors** that can bind with the neurotransmitter





Skeletal muscle fiber

1. Each skeletal muscle fiber is a single muscle cell , which is the unit of contraction .

2. Muscle fibers are cylindrical cells with many nuclei .

3. The cell membrane is called . Sarcolemma, the cytoplasm is called

sarcoplasm .

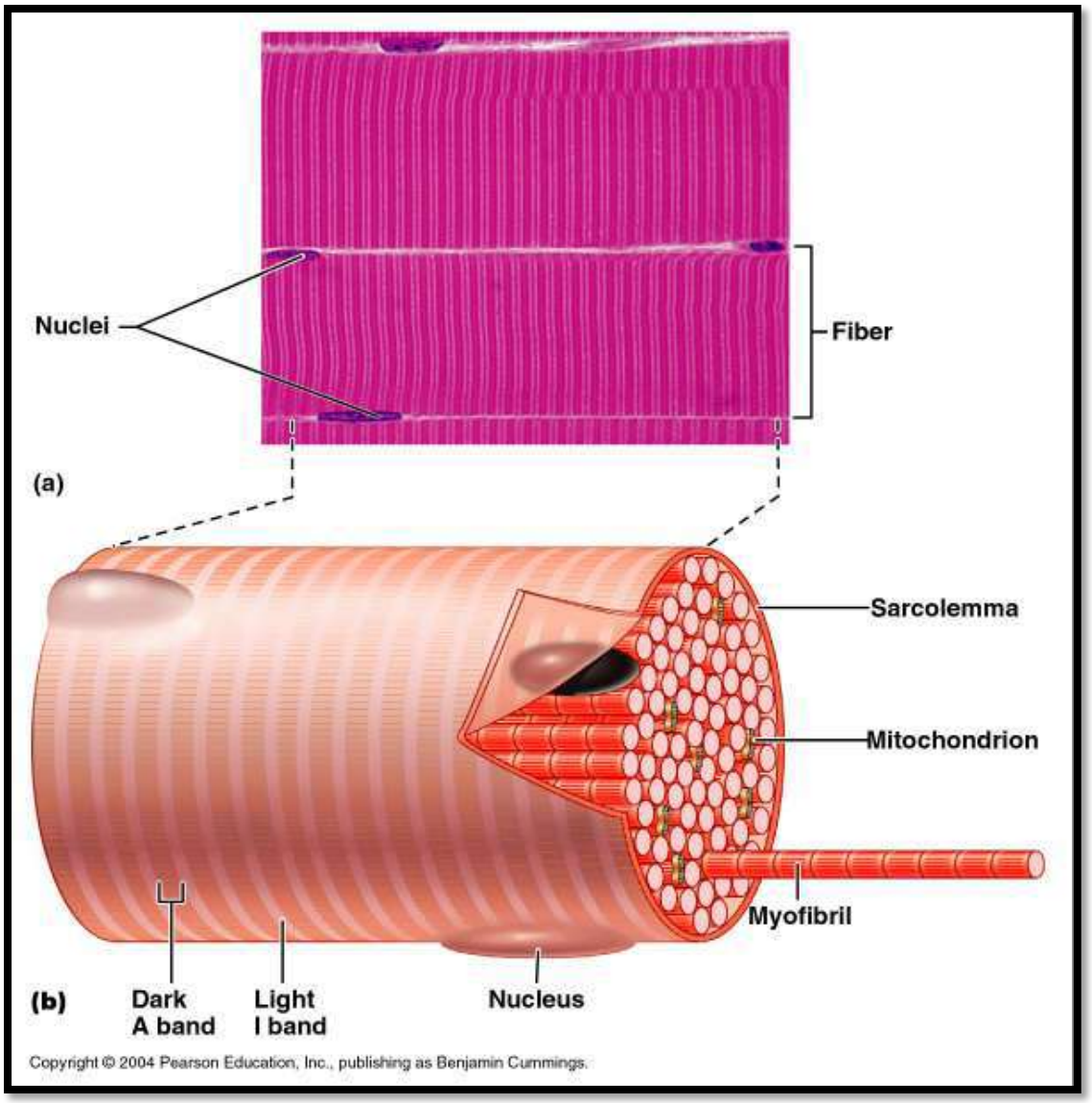
4. The sarcoplasm contains abundant , parallel thread like myofibrils , that run in parallel fashion .

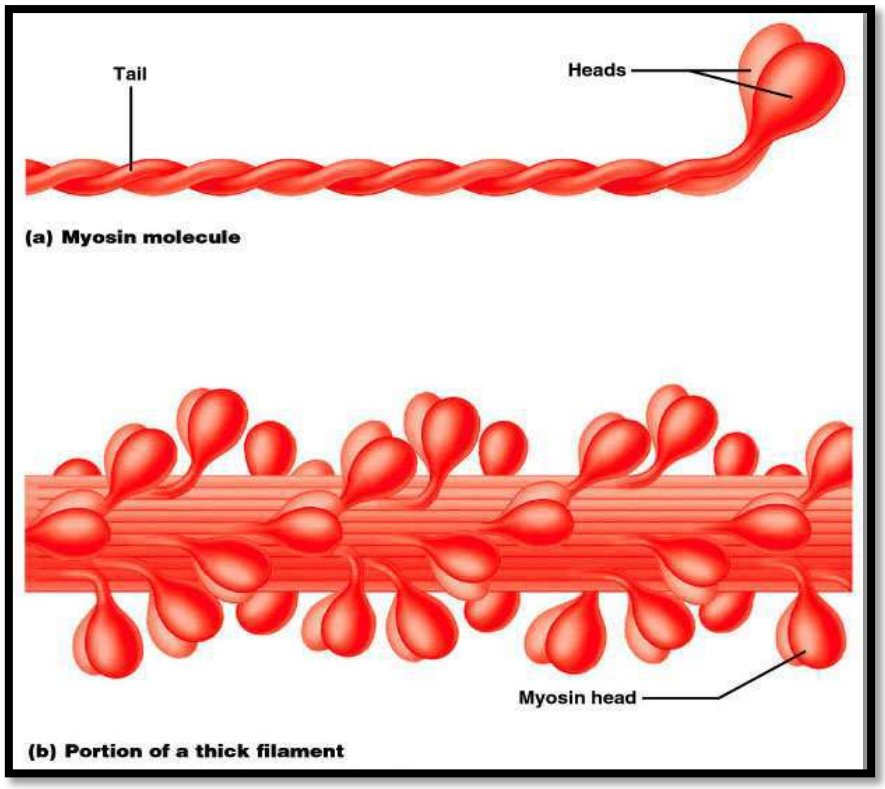
5. The myofibrils contain 2 kinds of protein filaments .

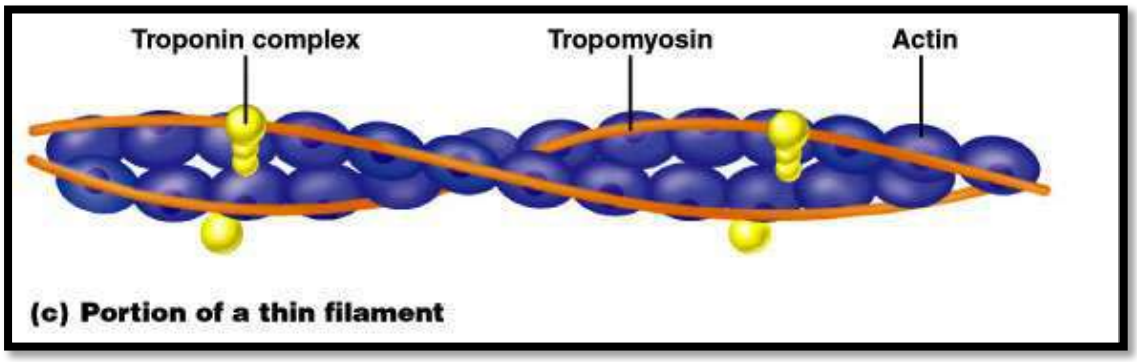
a. Thick filaments –composed of myosin .

b. Thin filaments – composed of Actin , troponin and tropomyosin .

c. striations are produced by alternating light and dark filaments .


Nuclei
Fiber
(a)
Sarcolemma
Mitochondrion
Myofibril
(b)
Dark
A band
Light
I band
Nucleus
Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings.





Striation pattern of skeletal muscles: 2 parts

1. The I bands (The light bands) - Extends from the edge of one stack of thick filaments to the edge of next stack of thick filaments .

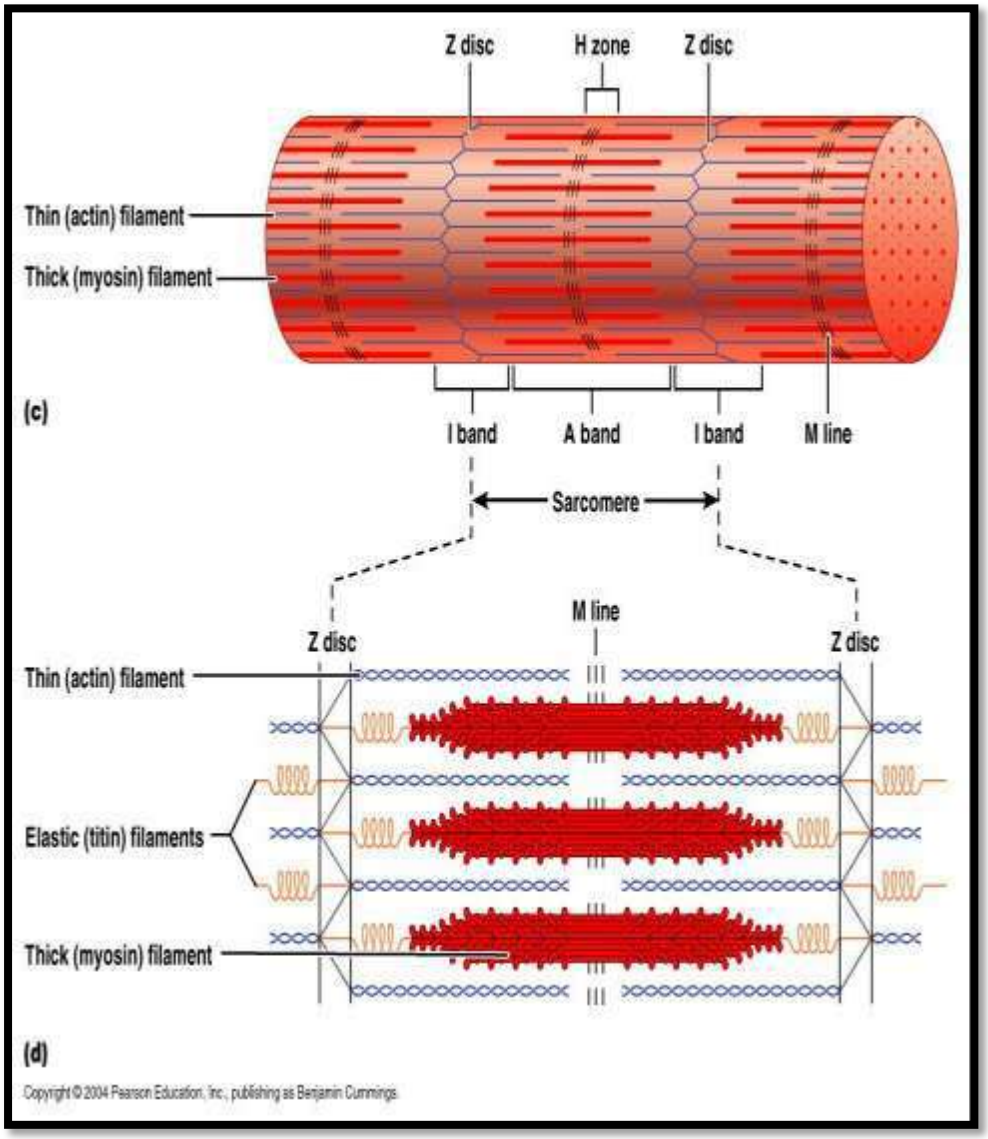
- The I band is composed of thin actin filaments .

2. The A bands (The dark bands) – composed of thick myosin filaments , overlapping thin filaments (actin) .

- myosin filaments are held together by Z lines (not attached) .

- A band consist of a region Where the thick and thin filaments overlap , and a region called central region (H zone) , consisting of only thick filaments . In the center of A band is a dark band called the M line .

Sarcomere : The segment of myofibrils that extends from one Z line to the next Z line.



Cross bridge Attachment:

The activated myosin heads are attracted to the exposed binding sites on actin and cross bridge attachment occurs .

Power stroke : The sliding action , which occurs at the same time for thousands of actin and myosin molecules is referred to as the power stroke.

Role of Ca+ in muscle contraction:

1. Promotes neurotransmitter release .

2. Triggers Ca+ release from SR .

3. Triggers sliding of my filaments and ATpase activity .

4. promotes glycogen breakdown & ATP synthesis .

Sliding Filament Theory

1. A myofiber , together with all of its myofibrils , shortens by movement of the insertion towards the origin of the muscle .

2. Shortening of the myofibrils is caused by shortening of the sarcomere

(The distance between Z lines is reduced) .

3. shortening of the sarcomere is accomplished by each filament remains the same during contraction .

4. sliding is produced by power strokes of myosin cross bridges , which pull the thin actin over the thick myosin .

5. The A band remains the same length during contraction , but are pulled toward the origin of the muscle .

6. Adjacent A bands are pulled closer together as the I bands between them shorten .

7. The H band shorten during contraction as the thin filaments on the sides of the sarcomeres are pulled towards the middle.

Major Events of muscle contraction :

1. The distal end of a motor neuron releases Acetylcholine .

2. Acetylcholine diffuse across the gap at the neuromuscular junction .

3. The sarcolemma is stimulated , and a muscle impulse travels over the surface of the muscle fiber and deep into the fiber through the transverse tubules and reaches the sarcoplasmic reticulum .

4. Ca2+ ions diffuse from the sarcoplasmic reticulum into the sarcoplasm bind to troponin molecules .

5. Tropomyosin molecules move and expose specific sites on actin filament .

6. Actin and myosin filaments form linkages .

7. Actin filaments are pulled inward by myosin cross – bridges .

8. muscle fiber shortens as a contraction occurs .

Smooth Muscle Contraction

1. Smooth muscles contain filaments of actin and myosin .

2. Lack transverse tubules and S.R. is not well developed .

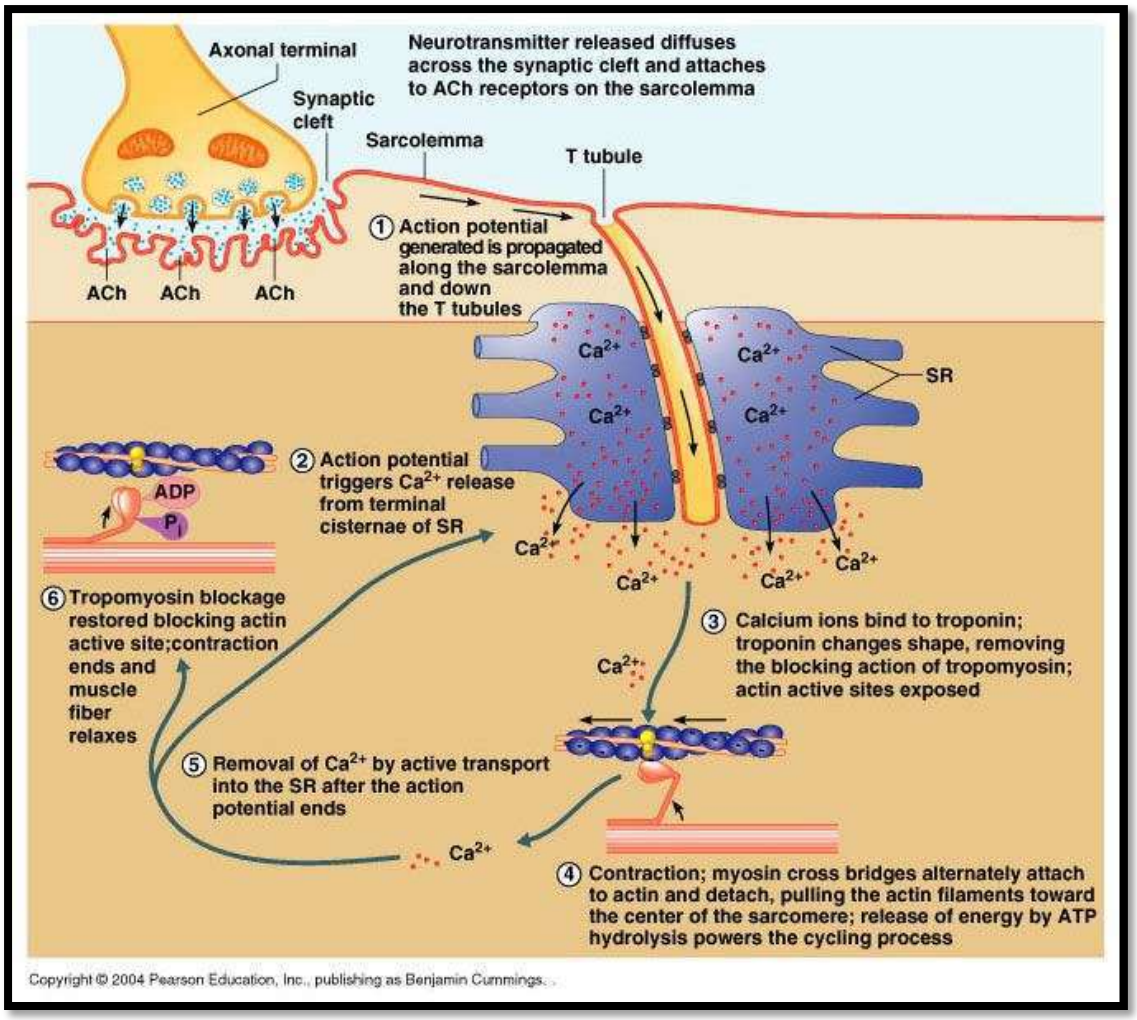
3. Display rhythmieity (spontaneous repeated contractions) , responsible for peristalsis (alternate contraction and relaxation) .

4. Lack troponin (protein that binds to Ca2+) , instead calmodulin binds to Ca2+ .

5. Both Acetylcholine & norepinephrine are neurotransmitters for smooth muscles .

6. Hormones and stretching affect smooth muscle contractions .

7. Can contract for a long period of time.



Cardiac muscle

a) unique arrangement of actin and myosin filaments produces the cross-striations (an optical illusion the microscope), and rapid contraction with powerful forces involved.

b) muscle cells are joined by **intercalated disks**, and allow muscle groups to form branching networks - both features are necessary for cardiac muscle to function as a unit (″ sancytium″).

c) **SR** and **T** tubules are well developed, so a large amount of calcium can be released rapidly through the T tubules.

d) contains more mitochondria in each muscle cell than skeletal and smooth muscles, providing more ATP energy for continuous contraction.

e) self- exciting muscle fibers form ″pacemakers″ which initiate spontaneous nerve impulses for autorthymic contraction . These pacemakers can be influenced by the autonomic nervous system and hormones.

Cardiac Muscle:

1. Contracts for a longer time than skeletal muscle

because transverse tubules supply extra Ca+2 ions .

2. intercalated disc connects the ends of adjacent muscles and hold cells together as a unit (syncytium) .

3. Fibers contracts as a unit .

4. Muscle fibers are self – exiting , rhythmic , and remain refractory until a contraction is completed.

5. No Tetanic contractions.