Nerve and Muscle physiology (N&M)

The skeletal muscle

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Basic information

Lecture title: #2 – Sohag –N1 – Skeletal Muscle – Hassan Elalaf

Date : Thursday 19th , March , 2019

Lecturer: Dr/ Hassan Elalaf

Target students : 1st – Nursing – Sohag University

Subject (syllabus): Human medical Physiology

Domain: Skeletal muscle

Topics of the lecture

A. Types of muscles

B. Organization and structure of skeletal muscle

C. Excitation – contraction coupling

Topics of the lecture

A. Types of muscles

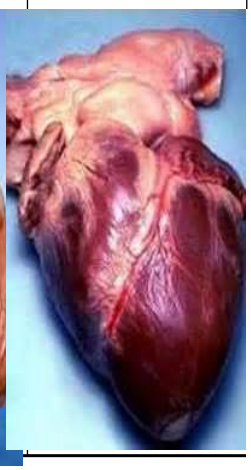
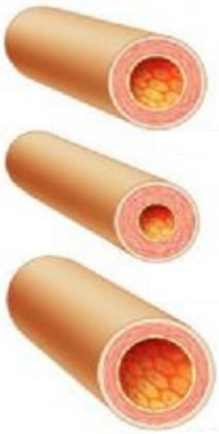
B. Organization and structure of skeletal muscle

C. Excitation – contraction coupling

Types of muscles

	Skeletal	*Cardiac*	*Smooth*
L.M	Striated	Striated	Non-satiated
Control	Voluntary	involuntary	involuntary
Nervous control	Somatic. nerves	Autonomic nerves	Autonomic nerves
Example	Body muscles attached to skeleton	Heart	Blood vessels, GIT , bronchi

Types of muscles

	Skeletal	*Cardiac*	*Smooth*
			

Skeletal muscles

	Skeletal
L.M	Striated
Control	Voluntary
Nervous control	Somatic. nerves
Example	Body muscles attached to skeleton

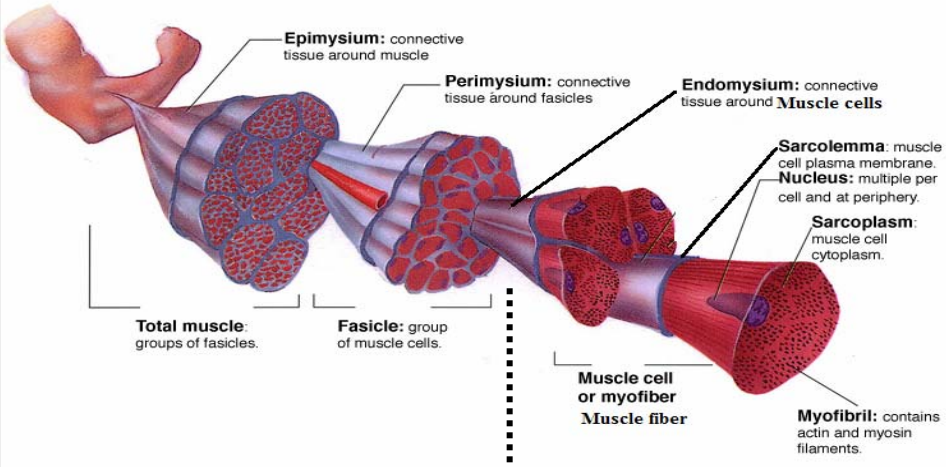
Topics of the lecture

A. Types of muscles

B. Organization and structure of skeletal muscle

C. Motor end plate

Organization and structure of skeletal muscle



Seen by naked unassisted eye | Seen ONLY under microscope

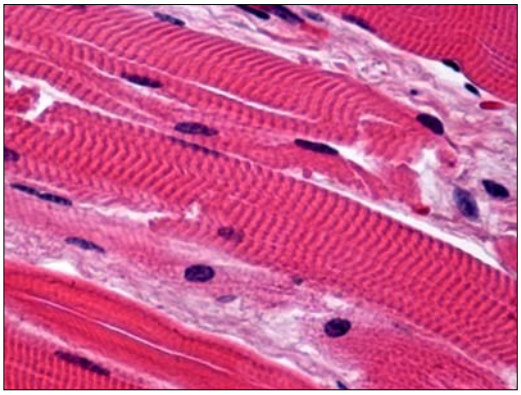
structure of skeletal muscle cell

Muscle cell = muscle fiber = Myofiber

Each Muscle cell (muscle fiber – Myofiber) has,

- Cell membrane (Sarcolemma).
- Many nuclei .???????
- Cytoplasm (Sarcoplasm)
- Mitochomdria
- Myofibrils (contractile proteins) = Actin myofilaments and Myosin myofilamants

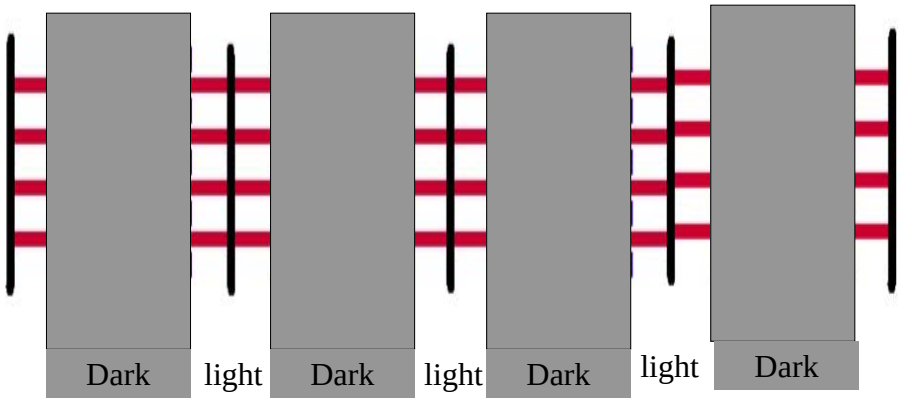
skeletal muscle (Striated muscle) ?



Myofibrils = Actin myofilaments and Myosin myofilamants

= Myosin filament (**Thick** filament)

= Actin filament (Thin filament)

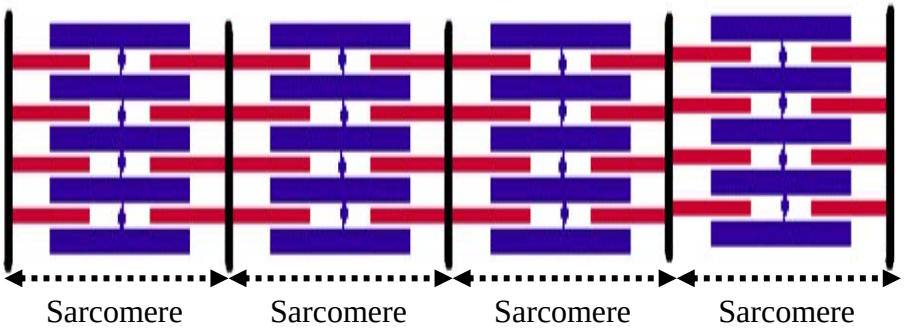


Myofibrils = Actin myofilaments and Myosin myofilamants

= Myosin filament (**Thick** filament)

= Actin filament (Thin filament)

= Z line = in between line



Each Sarcomere contain One Myosin and ends of 2 Actins

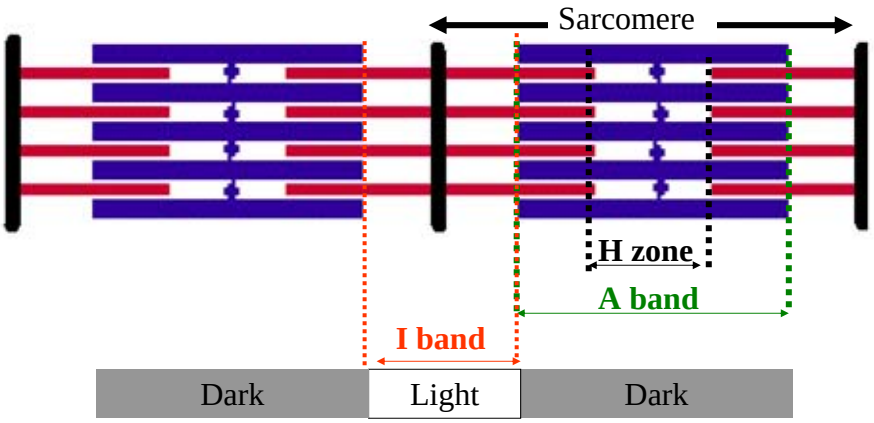
M and AA

Sarcomere (functional unit)

= Myosin filament (**Thick** filament)

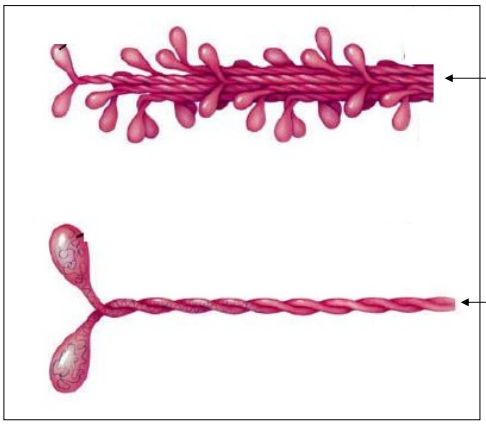
= Actin filament (Thin filament)

= Z line



Myosin Filament (Thick filament structure)

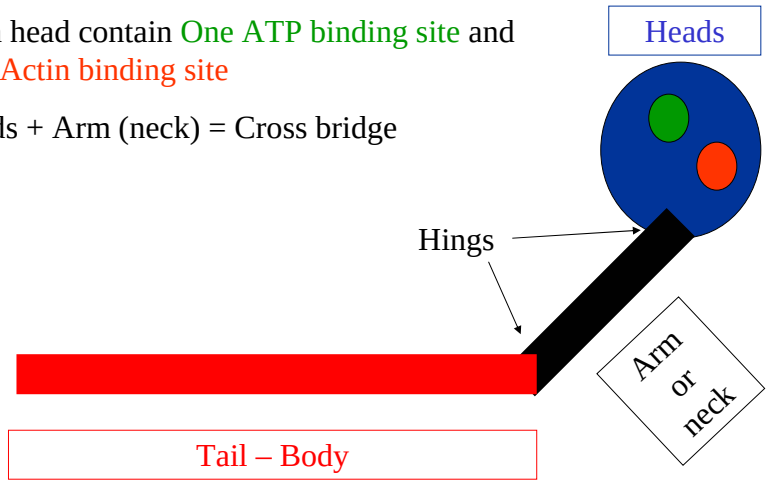
Each Mysosin filament is composed of Myosin Molecules



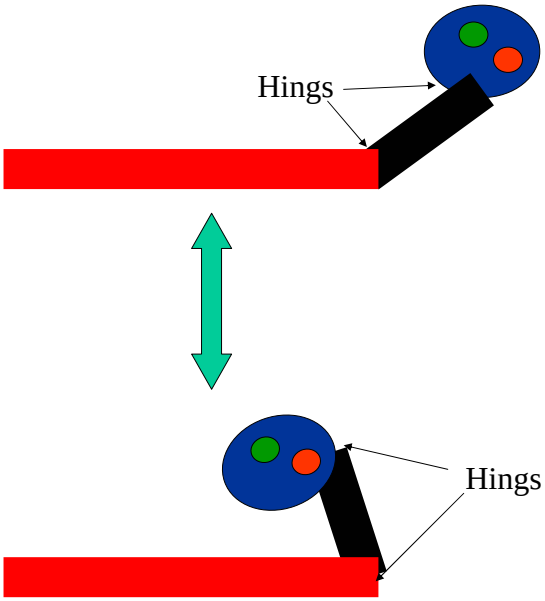
Myosin Molecule structure

Each head contain One ATP binding site and One Actin binding site

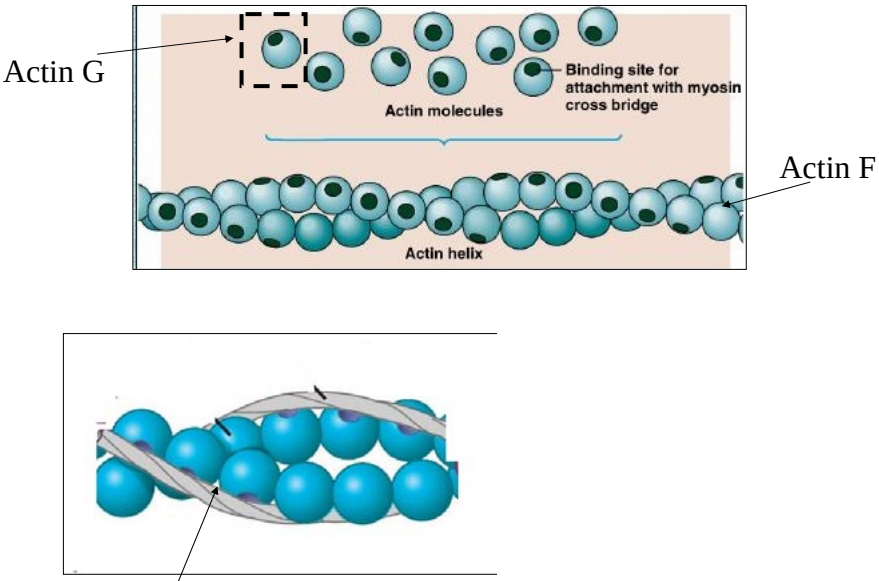
Heads + Arm (neck) = Cross bridge



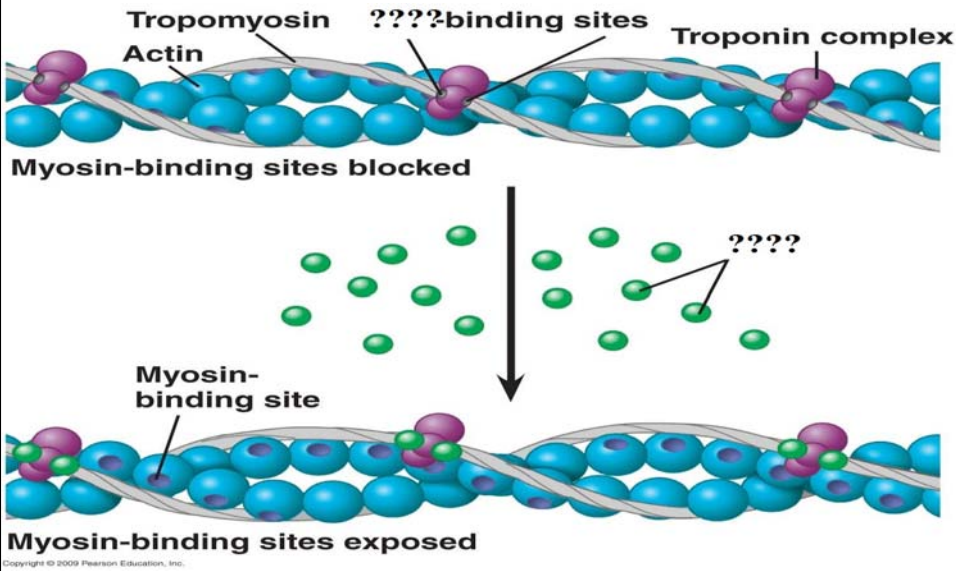
Myosin Molecule structure



Actin filament structure



Actin filament structure



Actin filament structure

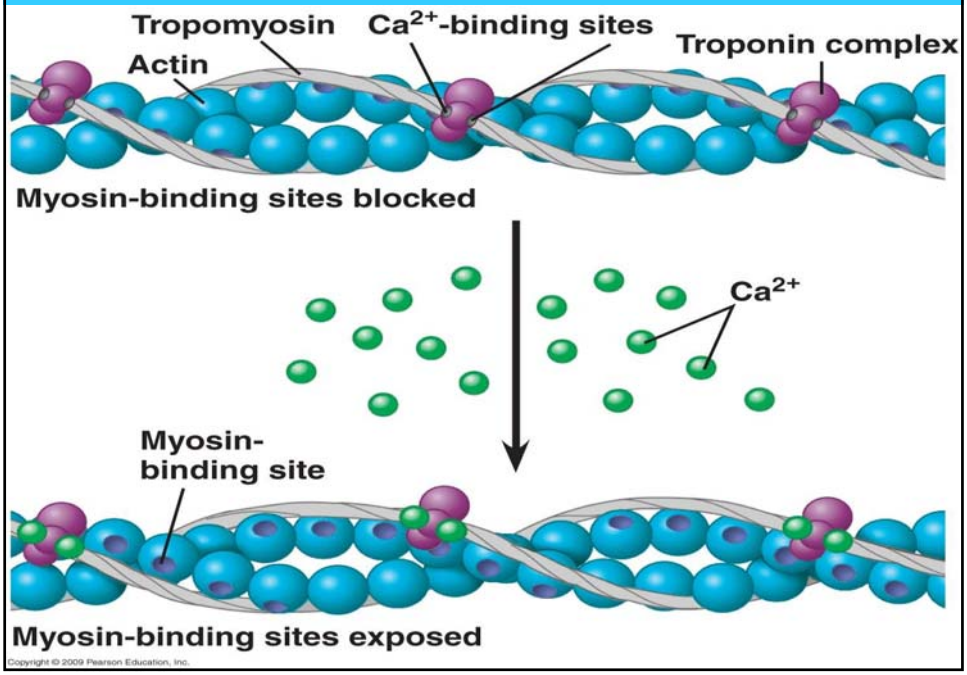
Actin filament is composed of,

•Actin F , which contians binding sites with heads of Myosin

•Tropomyosin which block interaction between Head of myosin and its binding site on action molecule if contraction is not needed .

•Troponin ,upon appropriate signal , move tropomyosin away from binding site at actin F so head of myosin can bind

Actin filament structure

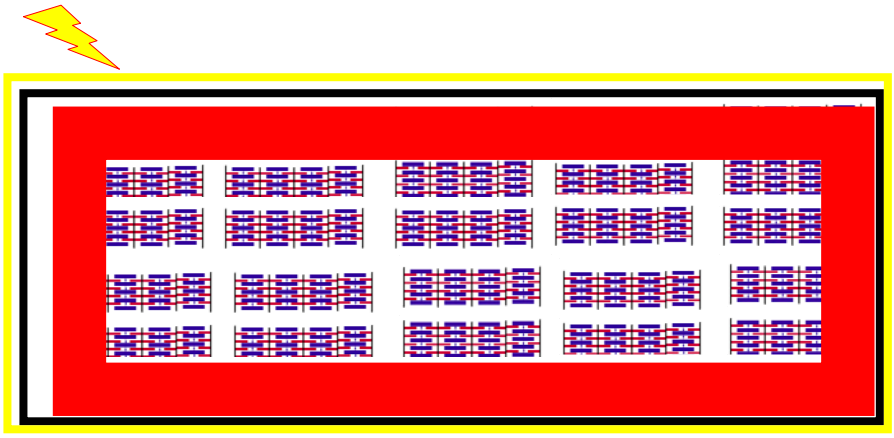


Actin filament structure

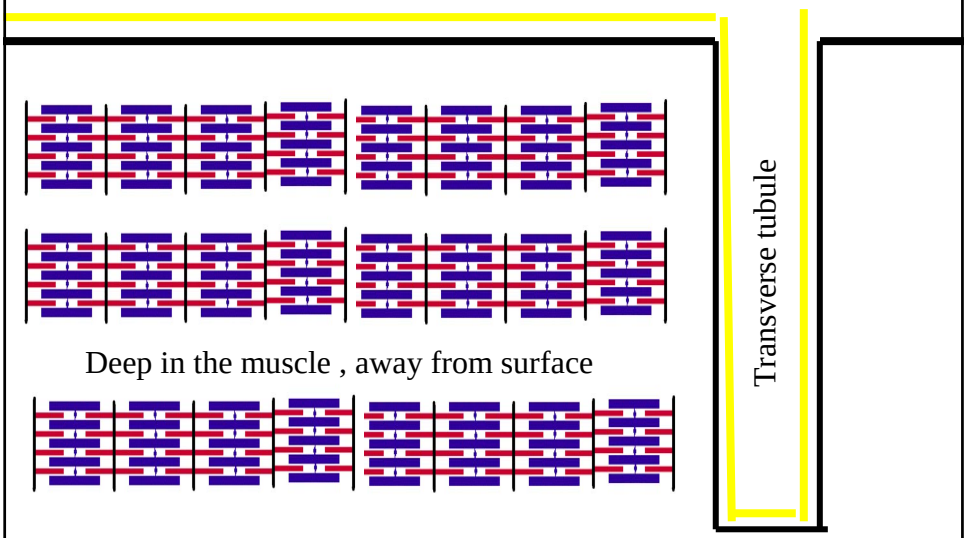
Troponin ,is composed of 3 subunits(parts),

- Troponin I , always bind to Actin
- Troponin T , always bind to Tropomysoin
- Troponin C , binding site for Ca

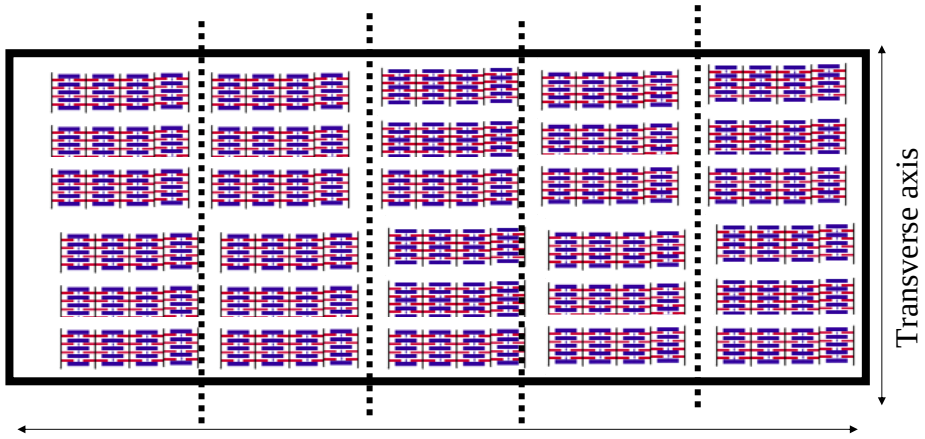
T –tubules (why)



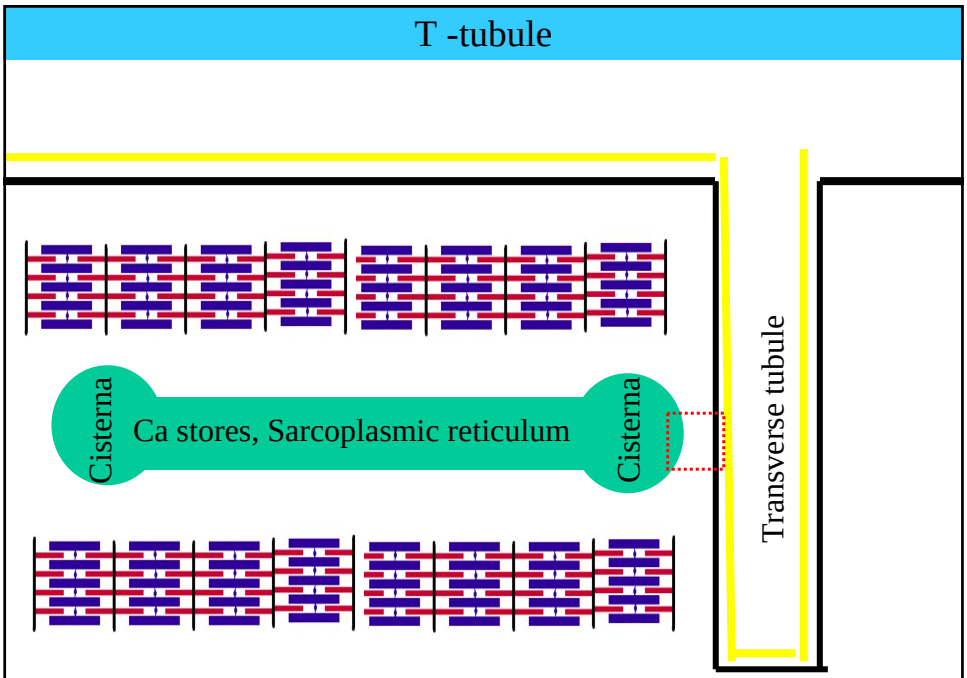
T –tubule (how)



Muscle cell and transverse tubule



T -tubule



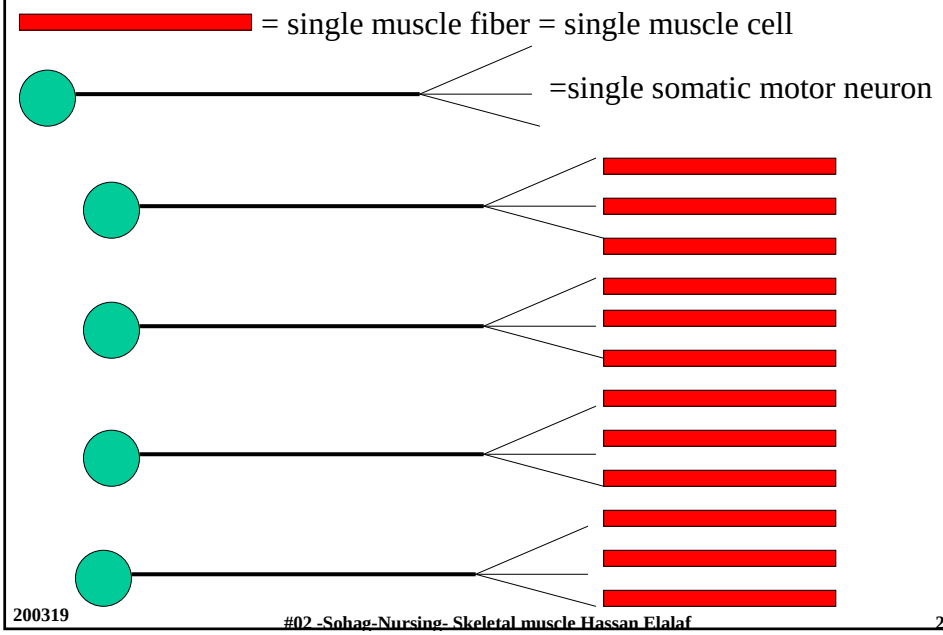
Topics of the lecture

A. Types of muscles

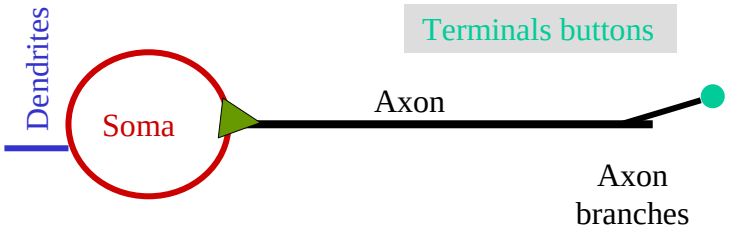
B. Organization and structure of skeletal muscle

C. Excitation – contraction coupling

C. How skeletal muscle is controlled



Structure of the neuron (nerve cell)



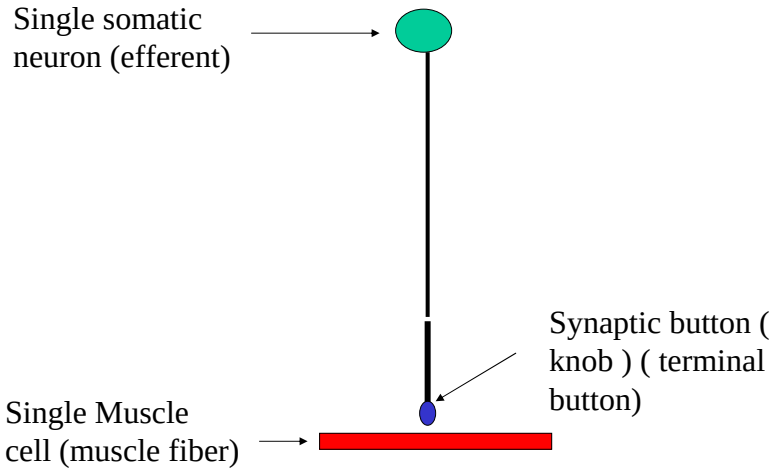
Target cells ,

•another neuron

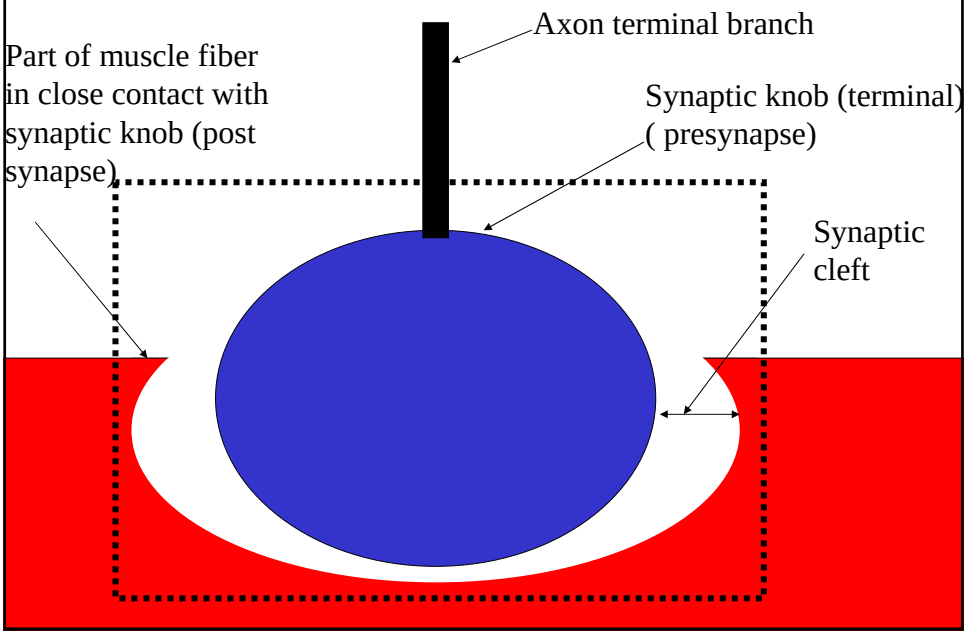
•Muscle

•gland

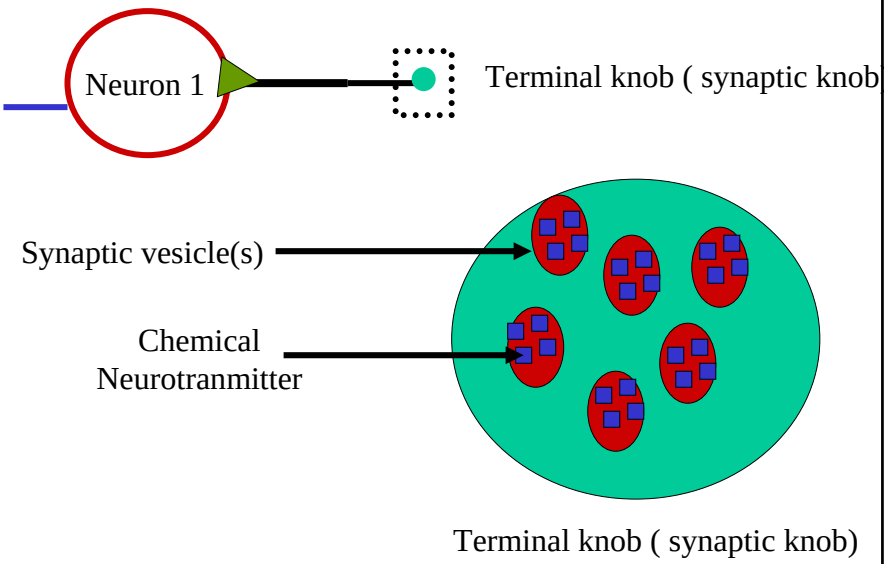
C. How skeletal muscle is controlled

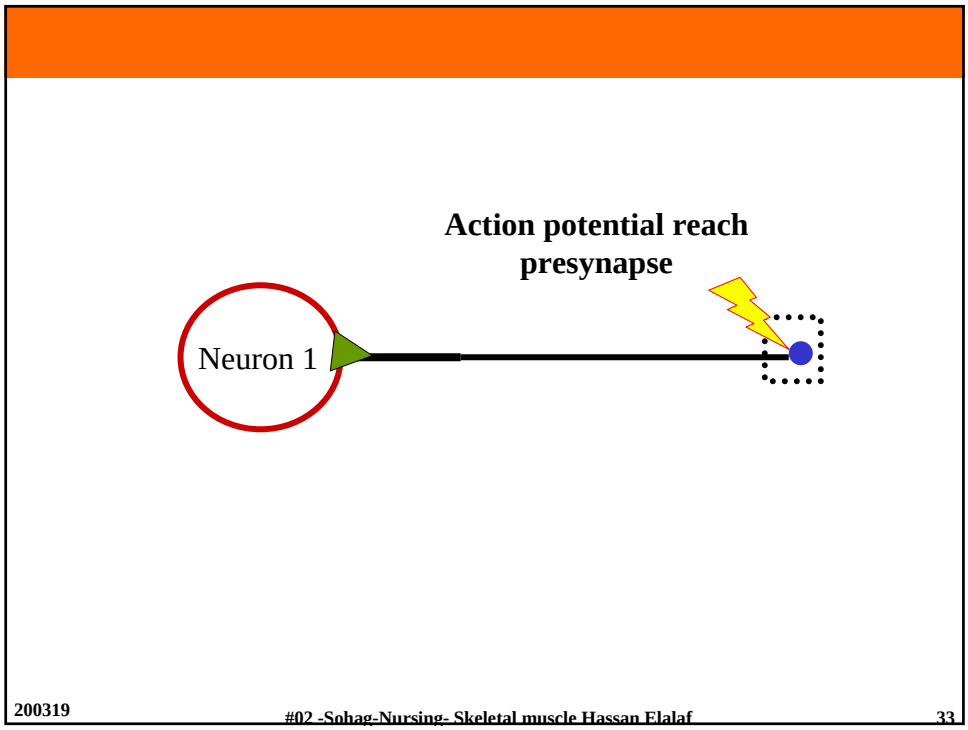


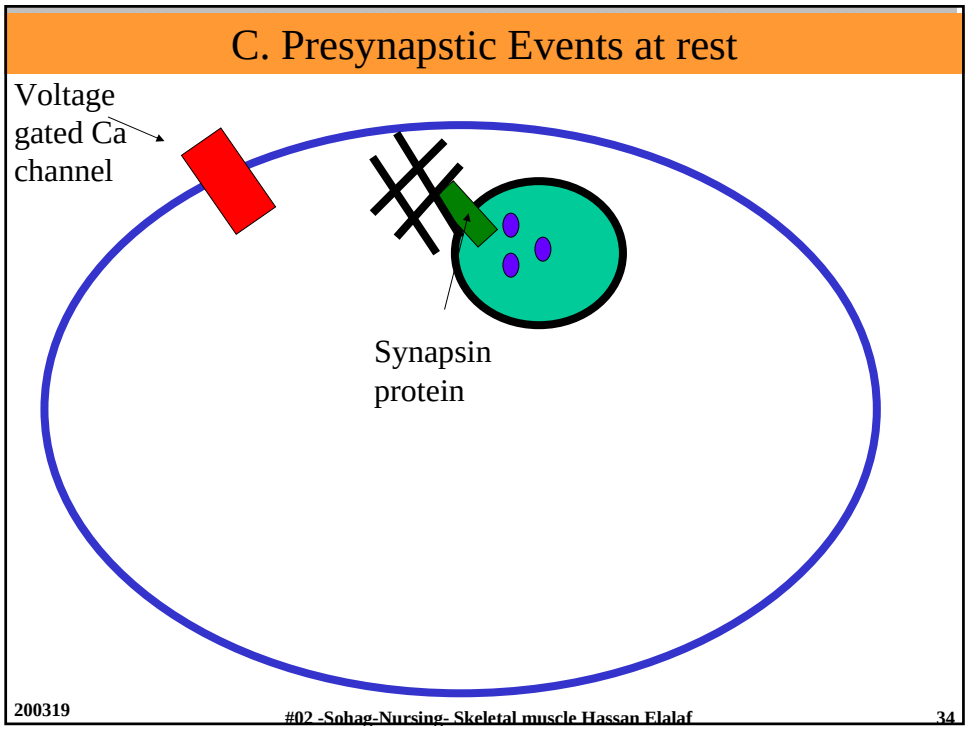
C. Myo-neural junction-(motor end plate) – (Synapse)



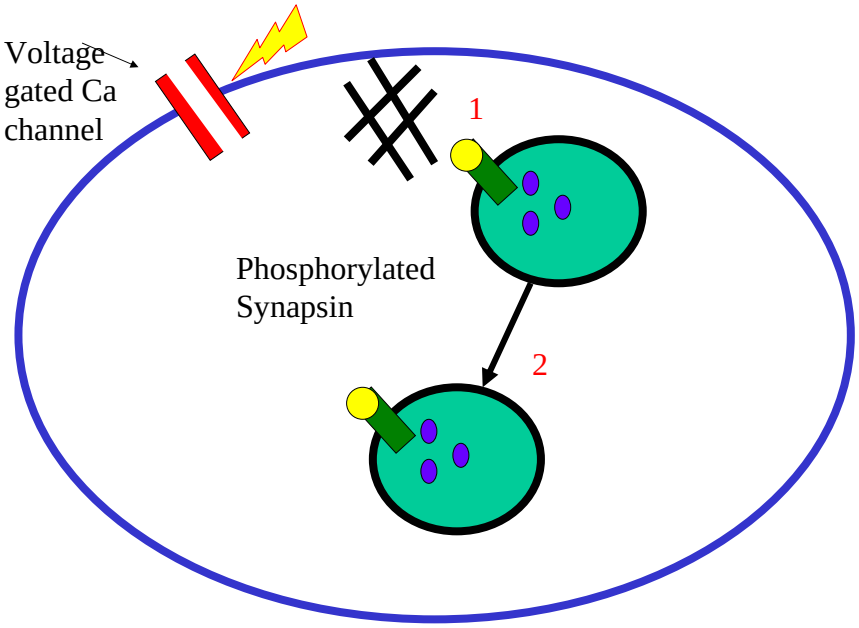
Synaptic vesicles




Action potential reach presynapse
Neuron 1


C. Presynapstic Events at rest
Voltage gated Ca channel
Synapsin protein

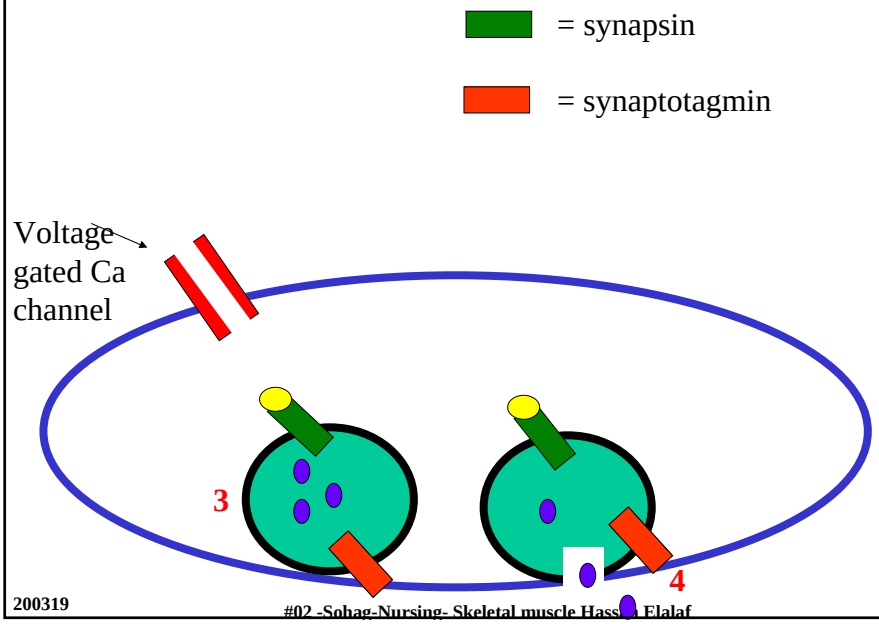
C. Presynapstic Events (with activity)



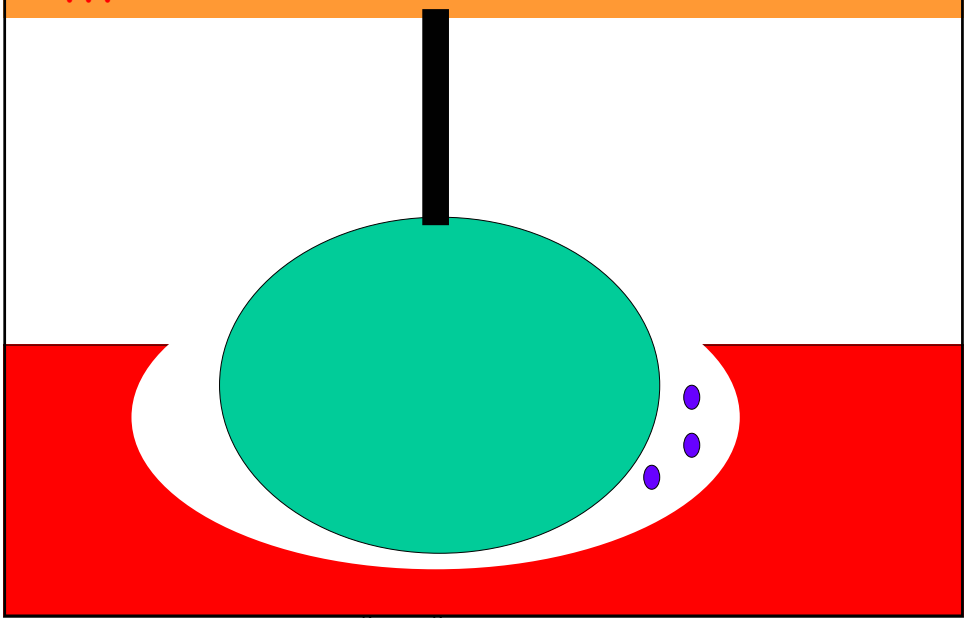
C. How Ca entry into presynpase detach vesicles

- Action potential reach presynapse
- Action potential open Voltage gated Ca channel at presynpase.
- Ca move from outside presynapse to inside it across opend channel.
- Ca bind calmodulin to for Ca –calmodulin complex
- This complex activate Protein Kinase II- enzyme used to phosphorylate – add a phosphate group to its target substrate.
- Phosphorylation of synapsin

C. Presynapstic Events (with activity)



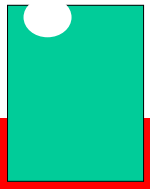
C. Ach (neurotranmitter pass through cleft to bind to ???



C. Ach (neurotranmitter pass through cleft to bind to ???

At rest,No ach.

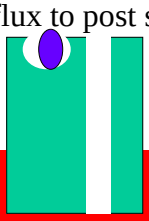
No, opening of Na channel closed by its absence (ligand gated Na channel



With activity ach. is present

opening of ligand gated Na channel

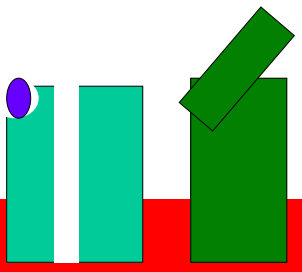
Na influx to post synpase



C. Ach (neurotranmitter pass through cleft to bind to ???

With activity, ach. is present

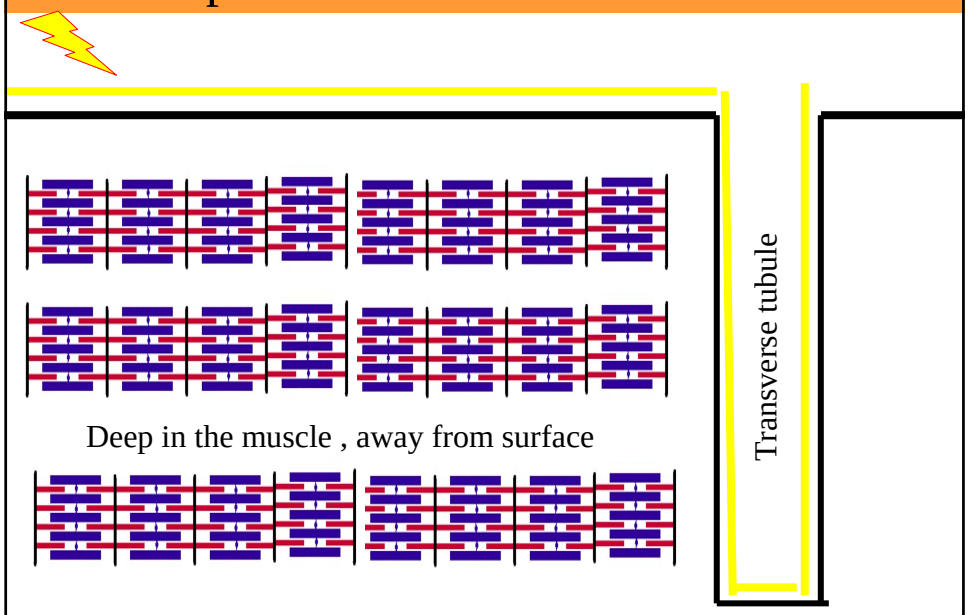
- opening of ligand gated Na channel
- Na influx to post synpase
- Depolarization
- Activation (opening)of Voltage gated Na channel ➡ action potential



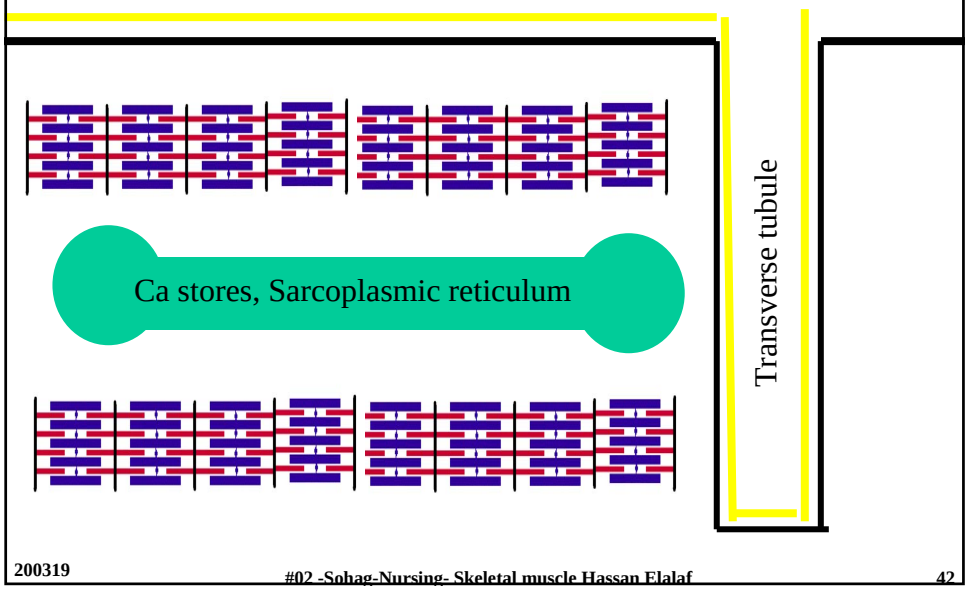
Ligand gated Na channel

Voltage gated Na channel

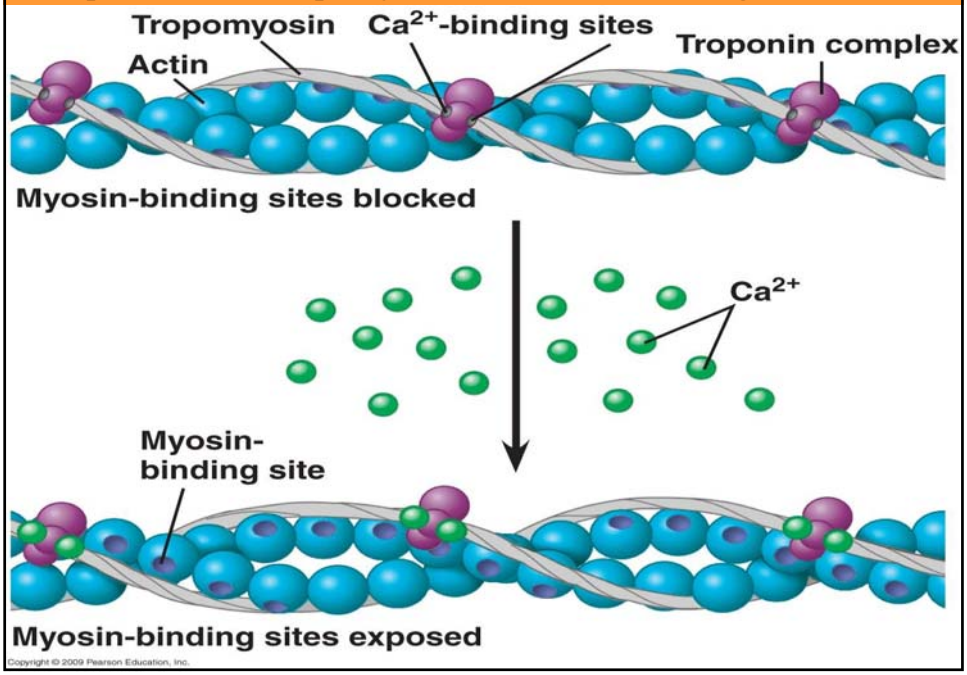
Action potential travell over sarcolemma



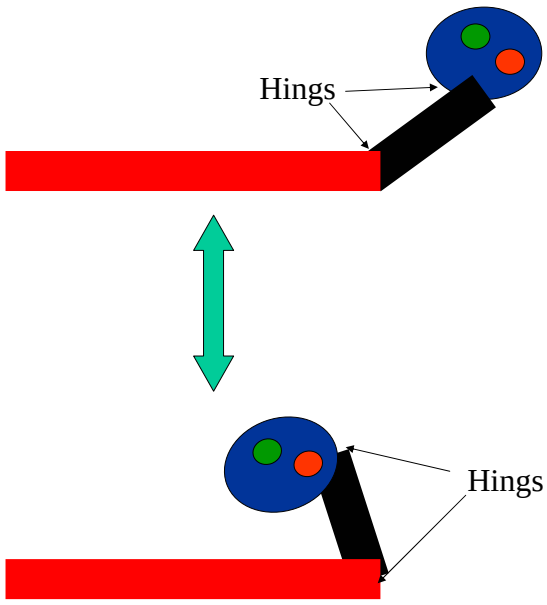
Ca release from its cellular stores



Troponin move tropomyosin to uncover binding site in actin



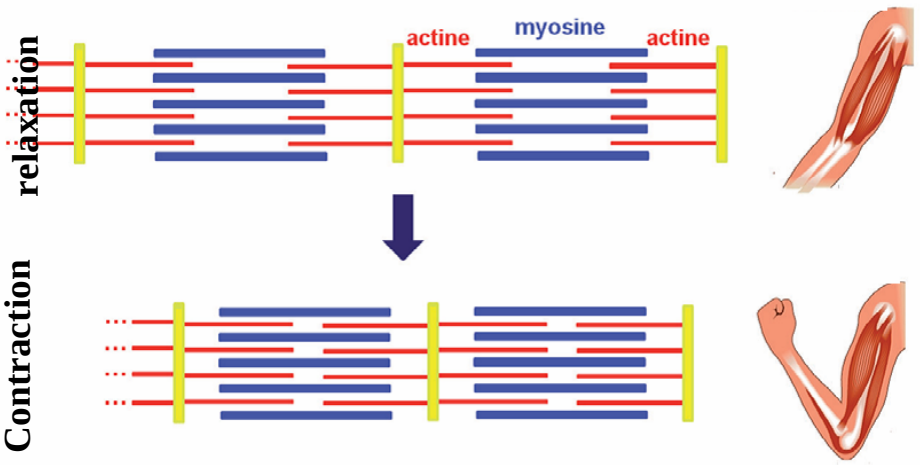
Conformational changes

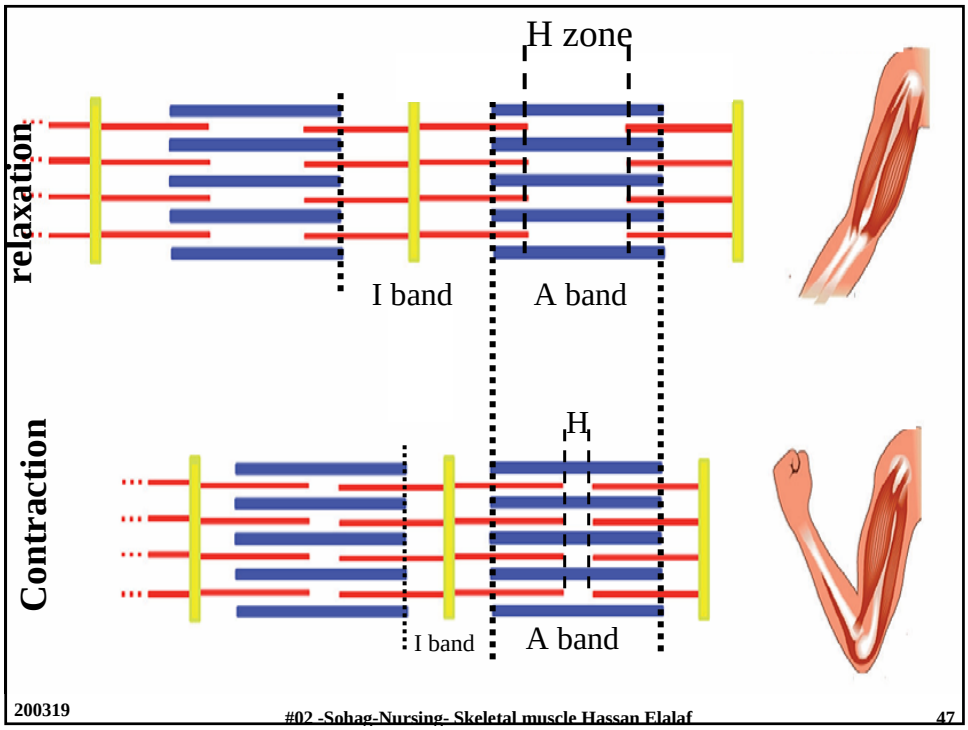


Sliding Filament Theory

Definition (Statement): Shortening of a muscle fiber occurs due to sliding of thin filaments over thick filaments toward the center of the sarcomere

Sliding Filament Theory - Evidence





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Sliding Filament Theory - Evidence

Evidence-

length of sarcomere decrease as the Z lines move closer together.

length of H zone decrease

length of I band decrease

length of A band does not change

A Band Always Constant

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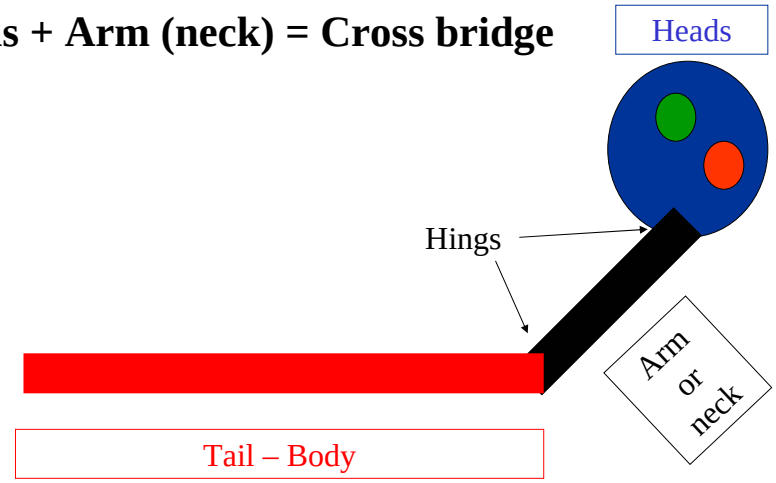
Cross bridge cycle

Each head contain One ATP binding site and One Actin binding site

Heads + Arm (neck) = Cross bridge



Cross –bridge Cycle

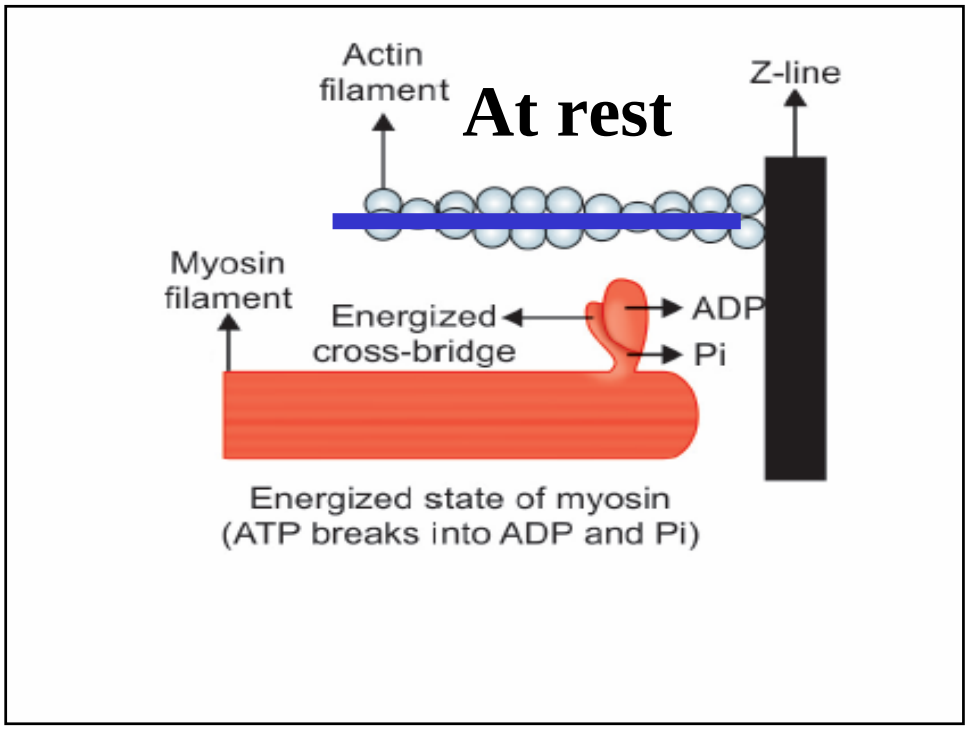
Definition: The sequence of events that occur during the interaction between the myosin cross-bridges and the actin molecules

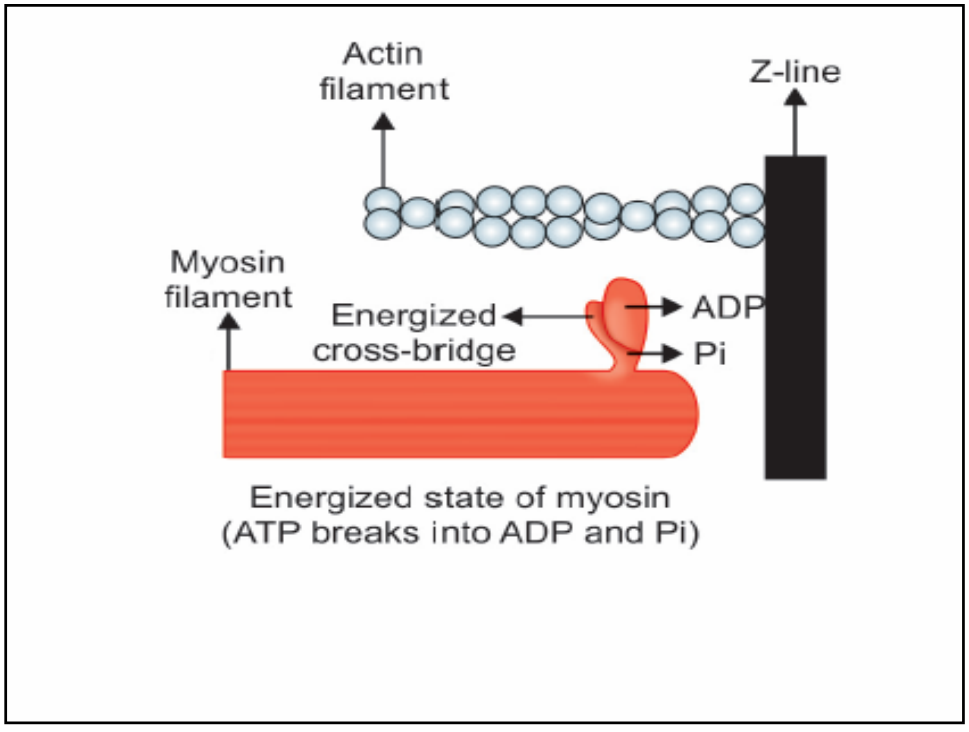
Steps

1-Binding i.e. Cross bridge (myosin head) attaches to thin filament (discussed before)

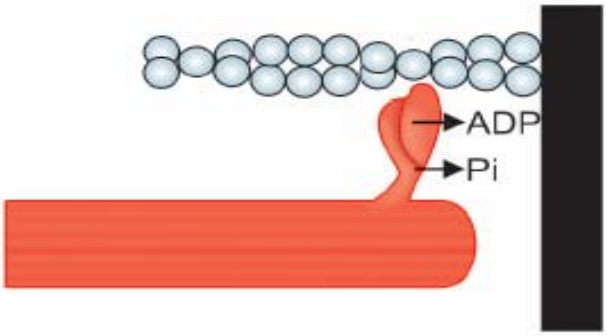
2-Bending i.e. Myosin head head move toward tail This Bending causing displacement of thin filament over thick filament (sliding)

3- Detachment of myosin of head from actin


Actin
filament
At rest
Z-line
Myosin
filament
Energized
cross-bridge
ADP
Pi
Energized state of myosin
(ATP breaks into ADP and Pi)


Actin
filament
Z-line
Myosin
filament
Energized
cross-bridge
ADP
Pi
Energized state of myosin
(ATP breaks into ADP and Pi)

Binding



Cross-bridge formation

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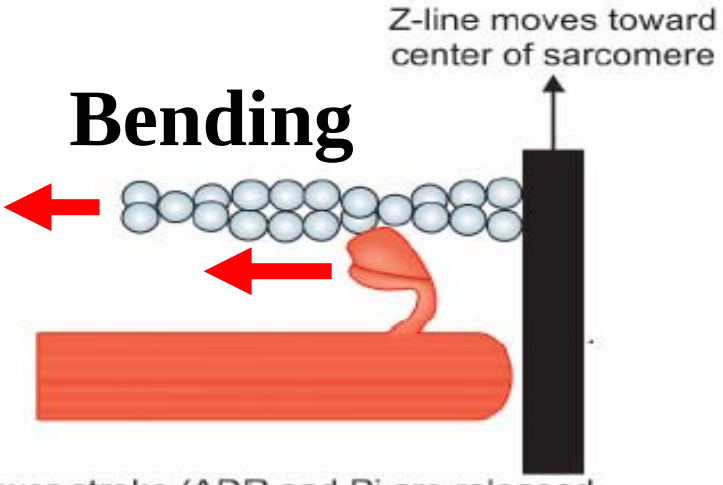
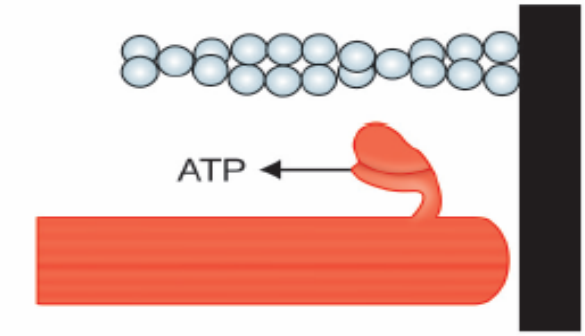
Bending



Power-stroke (ADP and Pi are released from actomyodin complex)

Detachment



Detachment of myosin from actin
(ATP binds with cross-bridge)

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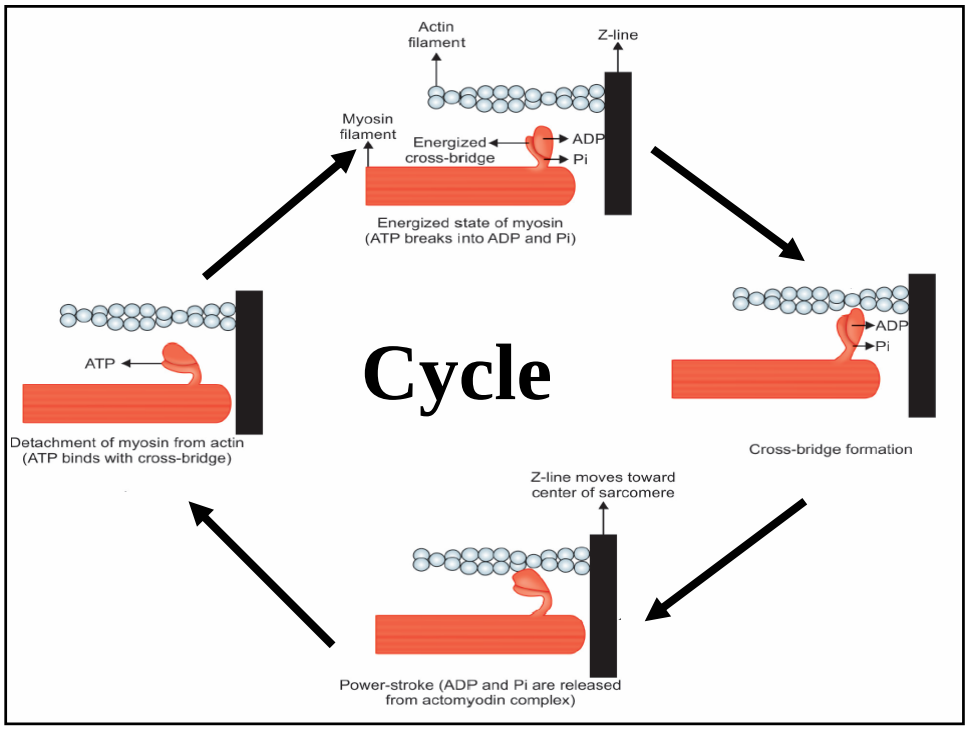
Cycle



•**Each** Cross bridge Pass through the **same steps** **in every cycle**

•**NOT ALL** the cross-bridges go through the **same step** at any instant during a cycle.

Topics of the lecture

A. Types of muscles

B. Organization and structure of skeletal muscle

C. Excitation – contraction coupling

Thanks,