

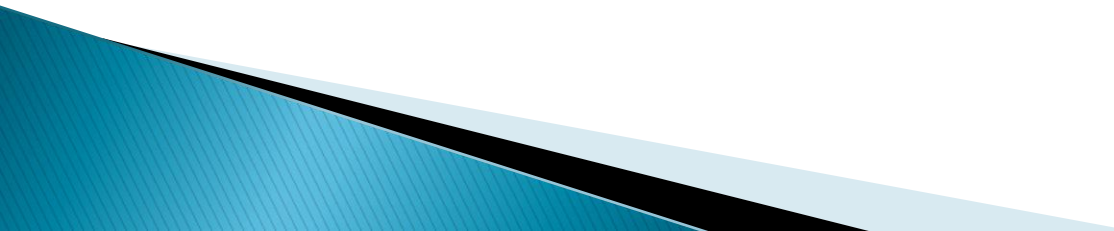
EXERCISE PHYSIOLOGY

By

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Difference between Exercise Physiology & Sports Physiology:

- ❑ Exercise Physiology : Study of how bodies structure & function are altered when we are exposed to acute & chronic bouts of exercise.
 - ❑ Sports Physiology: It applies the concepts of exercise physiology to training the athlete and enhancing the athlete's sports performance.
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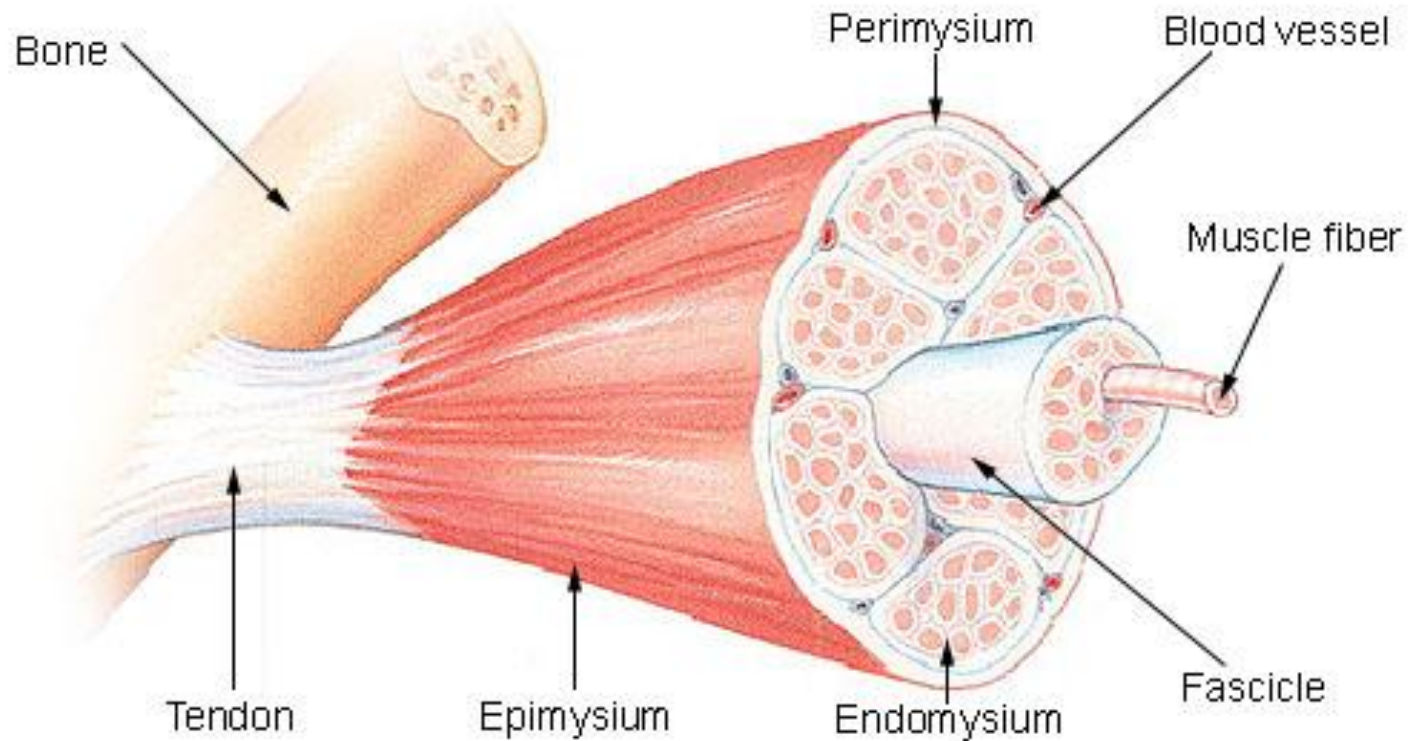
STRUCTURE OF SKELETAL MUSCLE

Structure of skeletal muscle is divided into two types :

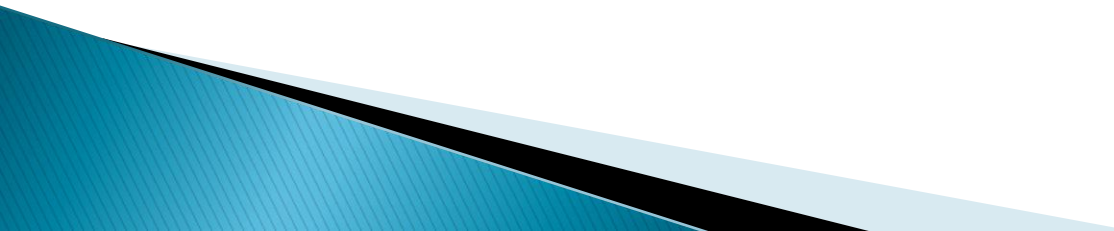
- ▶ a. Gross structure.
- ▶ B. Microscopic structure.

Gross structure.

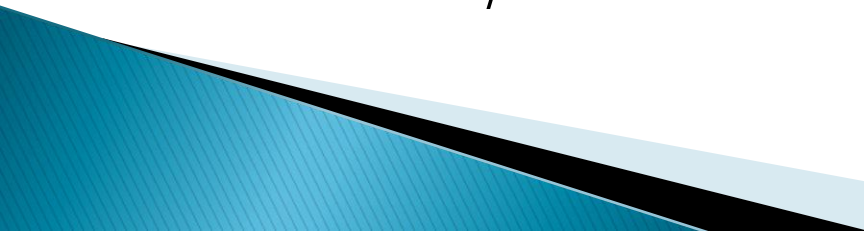
Structure of a Skeletal Muscle



Gross Structure:

- ▶ Outermost covering of the muscle (made of connective tissue) is EPIMYSIUM.
 - ▶ Bundles of Fasciculi; connective sheath surrounding each fasciculi is Perimysium.
 - ▶ Bundles of muscle fibres are covered by a sheath of connective tissue called Endomysium.
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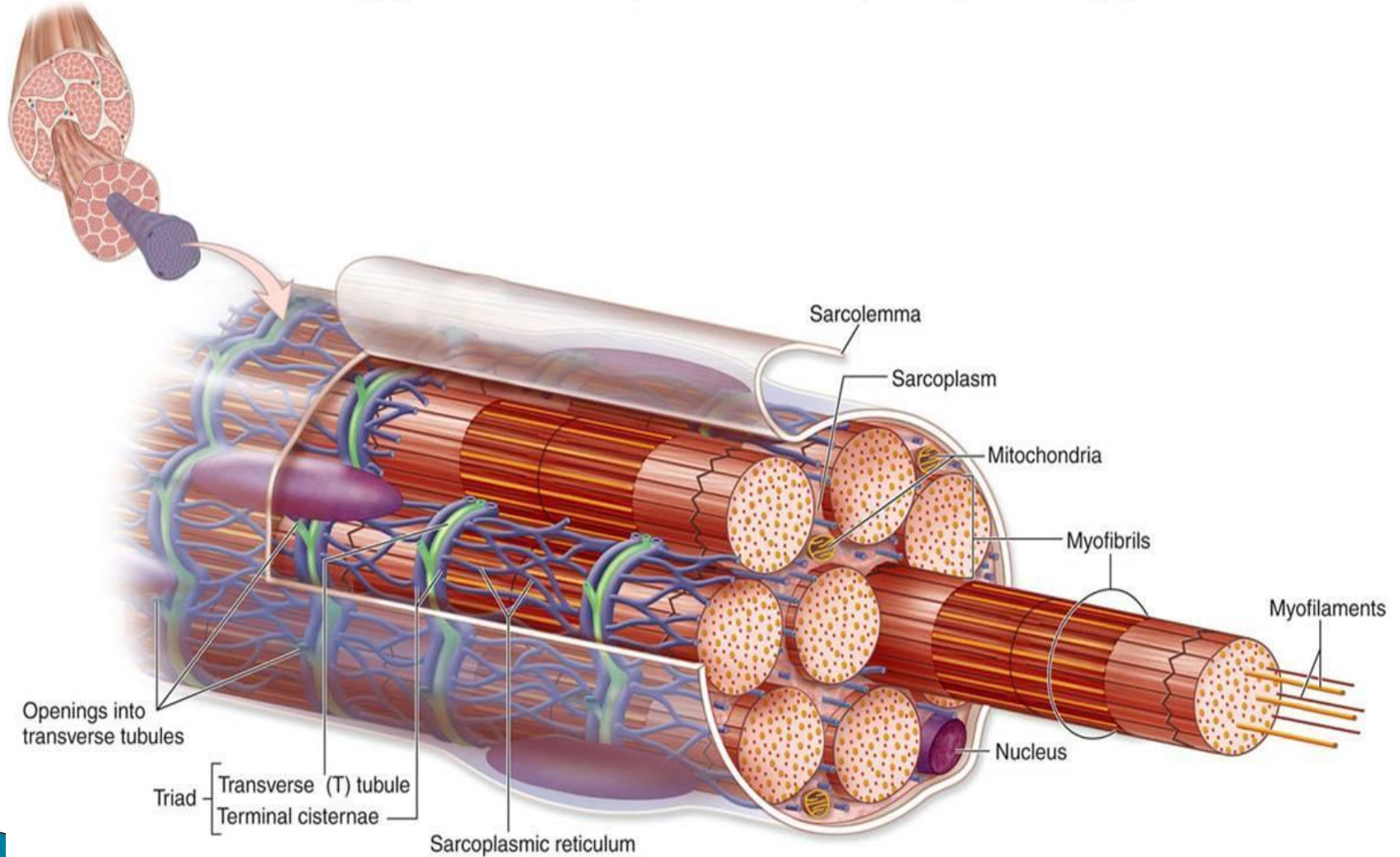
Structure of muscle fibre:

- ▶ Outermost covering is called Sarcolemma.
 - ▶ Filled with a jelly like substance called Sarcoplasm.
 - ▶ Contains fat, proteins, glycogen, necessary organelles.
 - ▶ Sarcoplasmic Reticulum : Made of network of tubules & vesicles; contains Longitudinal tubules.
 - ▶ Longitudinal tubules terminate to form Cisterns / outer vesicles.
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- ▶ Outer vessicles & T-tubules form a Tiad.
- ▶ Calcium ions are stored in outer vessicle.

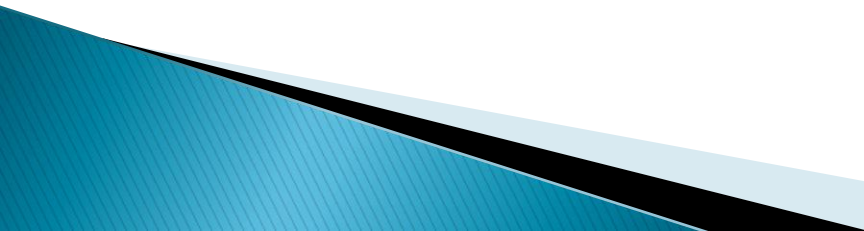
MICROSCOPIC STRUCTURE OF MUSCLE

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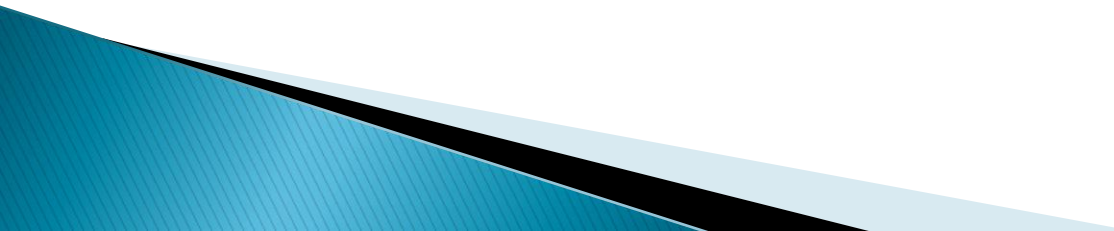
MICROSCOPIC STRUCTURE OF MUSCLE

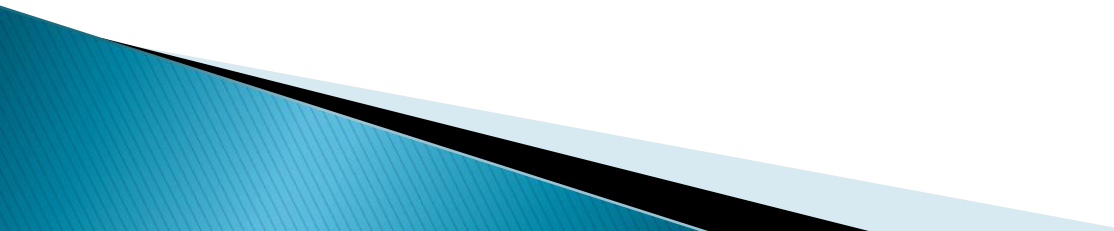
- ▶ Myofibril : Myofibril are protein thread like strands which are embedded in the sarcoplasm.
 - ▶ Constitutes two protein filaments : Actin & Myosin.
 - ▶ Actin & Myosin results in the formation of I-Band & A-Band.
 - ▶ I-Band constitutes of Actin filament (thin filament).
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- ▶ A-Band constitutes of Myosin filament (thick filament).
 - ▶ Adjoining actin filaments are connected by Z-Line.
 - ▶ H- Zone is found in between the A- Band.
 - ▶ Region of low density found in centre of H-Zone & Dark centre portion called the M-Line.
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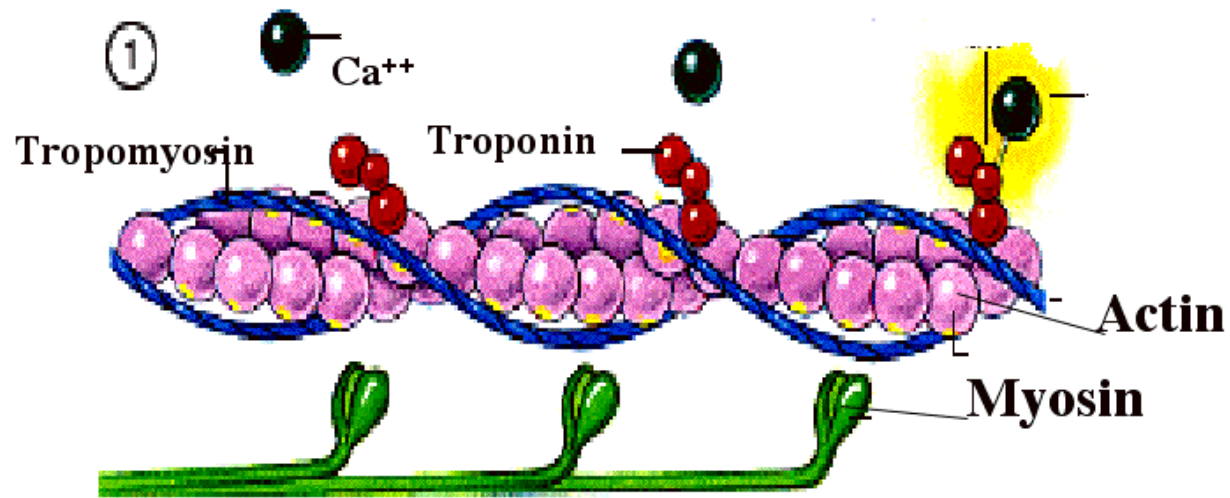
ACTIN FILAMENT

- ▶ Arranged like a double pearl necklace which is twisted into a spiral helix.
- ▶ Consists of Troponin & Tropomyosin.

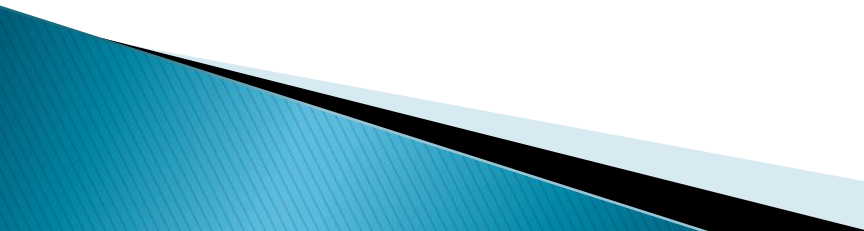
- ▶ Tropomyosin : a long string like portion found on surface of actin filaments. During rest condition tropomyosin filaments cover the active sites on the actin filament.
 - ▶ Troponin: a complex of three globular protein molecules, inserted at every two-third the distance of tropomyosin to actin.
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- ▶ MYOSIN FILAMENT
 - ▶ Myosin filaments (thicker filaments) occupy the A- Band.made up of fibrous protien called myosin.
 - ▶ Myosin cross – bridges are formed by the two heads & a part of the shaft which is an extension of the rod like structure.
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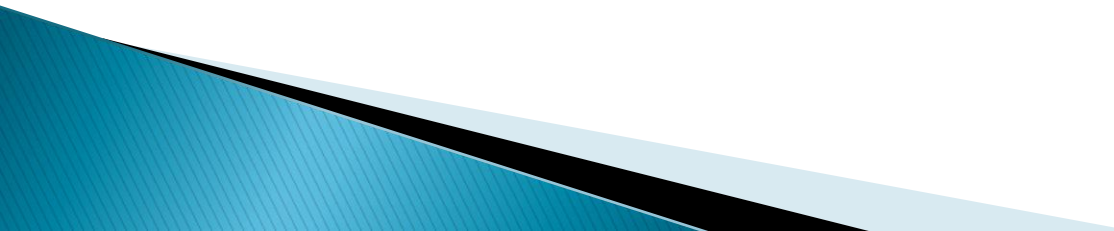
STRUCTURE OF ACTIN & MYOSIN FILAMENT



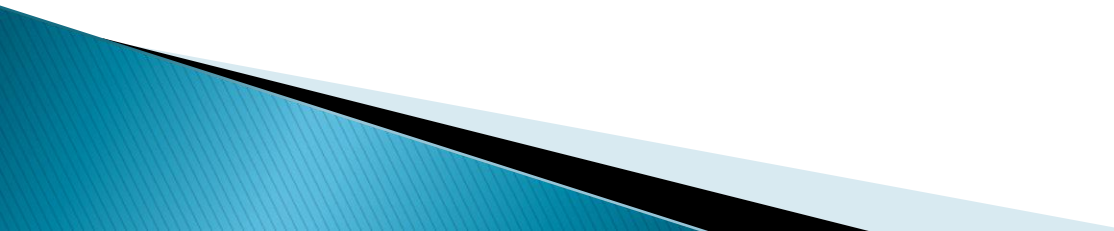
SLIDING FILAMENT THEORY OF MUSCULAR CONTRACTION

- ▶ This theory was proposed by H.E.Huxley(1969).It explains the mechanical & chemical basis of muscular contraction.
 - ▶ Actin slides over the myosin filament.
 - ▶ Theory states that when a muscle is stimulated through certain physiological & bio-chemical process actin slides over the myosin filament resulting in shortening of the muscle.
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Mechanical, physiological & biochemical process which are involved in this process can be explained in five different stages:

- ▶ a. Rest.
 - ▶ b. Excitation – Coupling.
 - ▶ c. Contraction.
 - ▶ d. Recharging.
 - ▶ e. Relaxation.
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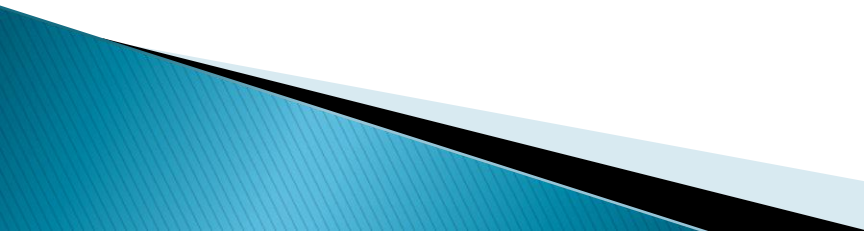
a. Rest :

- ❑ Myosin cross – bridges extend towards the actin filament but do not form a bond with actin filament.
 - ❑ A molecule of ATP is present at the end of the cross–bridge.
 - ❑ During rest, this complex is called “Uncharged ATP Cross – Bridge complex”.
 - ❑ Due to absence of calcium ions actin filaments inhibits the binding of actin
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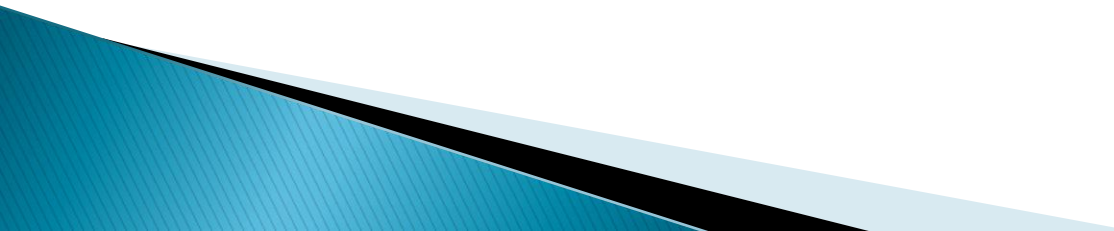
b. Excitation – Coupling :

- ❑ Nerve impulse reaches the neuromuscular junction through motor nerve, acetylcholine is released.
- ❑ It stimulates the generation of impulses in sarcolemma.
- ❑ Nerve impulses help in the release of Calcium ions from the vesicles of Sarcoplasmic reticulum.
- ❑ Calcium ions are immediately taken up by Troponin molecules.
- ❑ It leads to “turning on” of active sites of actin filament.
- ❑ Uncharged ATP cross-bridge leads to charged ATP cross-bridge complex. It leads to physical – chemical coupling of actin & myosin resulting in ACTOMYOSIN COMPLEX.

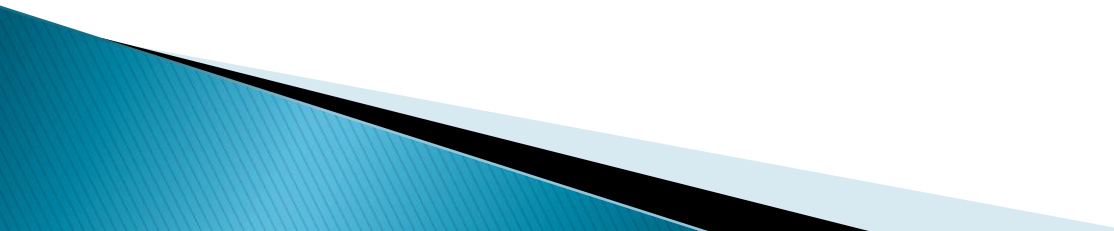
▶ c. Contraction

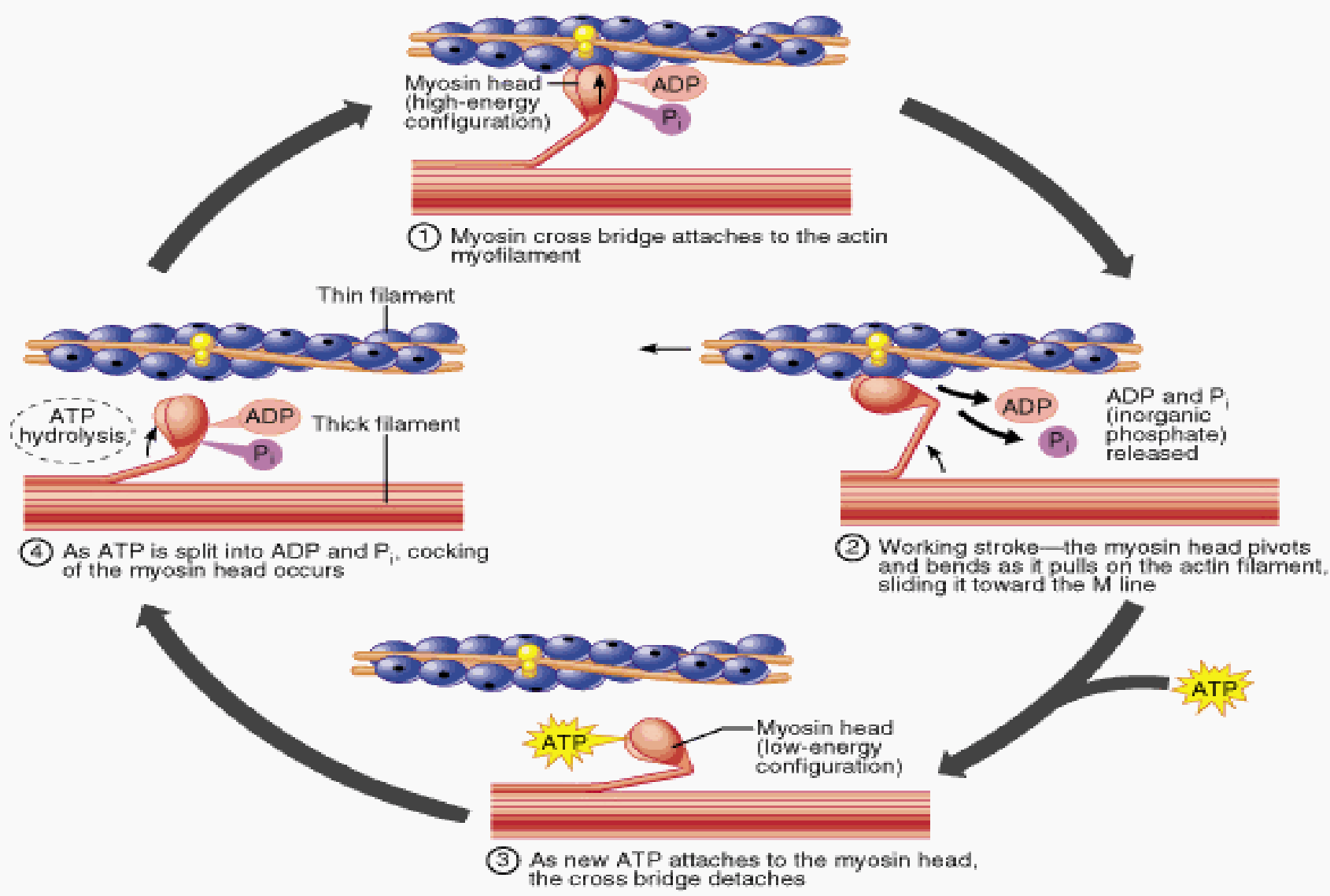
- ❑ Actomyosin formation activates enzyme MyosinATPase. It breaks the ATP molecule into ADP & Pi and Energy.
 - ❑ Release energy leads the cross bridge move to a new angle, such that actin slides over myosin.
 - ❑ Tension developed in muscle & it shortens.
 - ❑ H-Zone disappears; shortening of the I-band.
 - ❑ No change in the length of the A-Band occurs.
 - ❑ No change in the length of the actin & myosin filament.
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▶ d. Recharging

- ❑ Myosin cross bridges may make & break bond with active sites of actin filament.
 - ❑ Reloading the myosin cross-bridge with a fresh molecule of ATP through resynthesis.
 - ❑ Active site is made available for recycling.
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▶ e. Relaxation :

- ❑ Nerve impulse ceases, calcium ions are pumped back to outer vesicles.
 - ❑ Removal of calcium ions leads to “turn off” of actin filament.
 - ❑ No bond between actin & myosin filament.
 - ❑ Activity of myosin ATPase is stopped.
 - ❑ No more ATP is broken down.
 - ❑ Muscle filaments return to original position & muscle relaxes.
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CHARACTERISTICS OF SKELETAL MUSCLE

- ▶ 1. Contractibility.
 - ▶ 2. Extensibility.
 - ▶ 3. Elasticity.
 - ▶ 4. Irritability.
 - ▶ 5. Tonus.
 - ▶ 6. All or None Law.
 - ▶ 7. Fatigue.
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