بسم اللہ الرحمن الرحیم

سات تباہ کُن گناہ

حدیثِ نبوی صلی اللہ علیہ وسلم

حضرت ابو ہریرہؓ سے روایت ہے کہ نبی کریم صلی اللہ علیہ وسلم نے فرمایا:

''سات تباہ کُن گناہوں سے بچو'' لوگوں نے پوچھا وہ کونسے گناہ ہیں؟

آپؐ نے فرمایا: 1۔اللہ کے ساتھ کسی کو شریک کرنا 2۔جادو کرنا

3۔کسی کو ناحق مار ڈالنا 4۔سُود کھانا 5۔یتیم کا مال ہڑپ کر جانا

6۔میدانِ جہاد سے بھاگ جانا 7۔نیک عورتوں پر تہمت لگانا

(بخاری، مسلم، ابوداؤد، سنن النسائی)

BIOMECHANICS OF SKELETAL MUSCLES

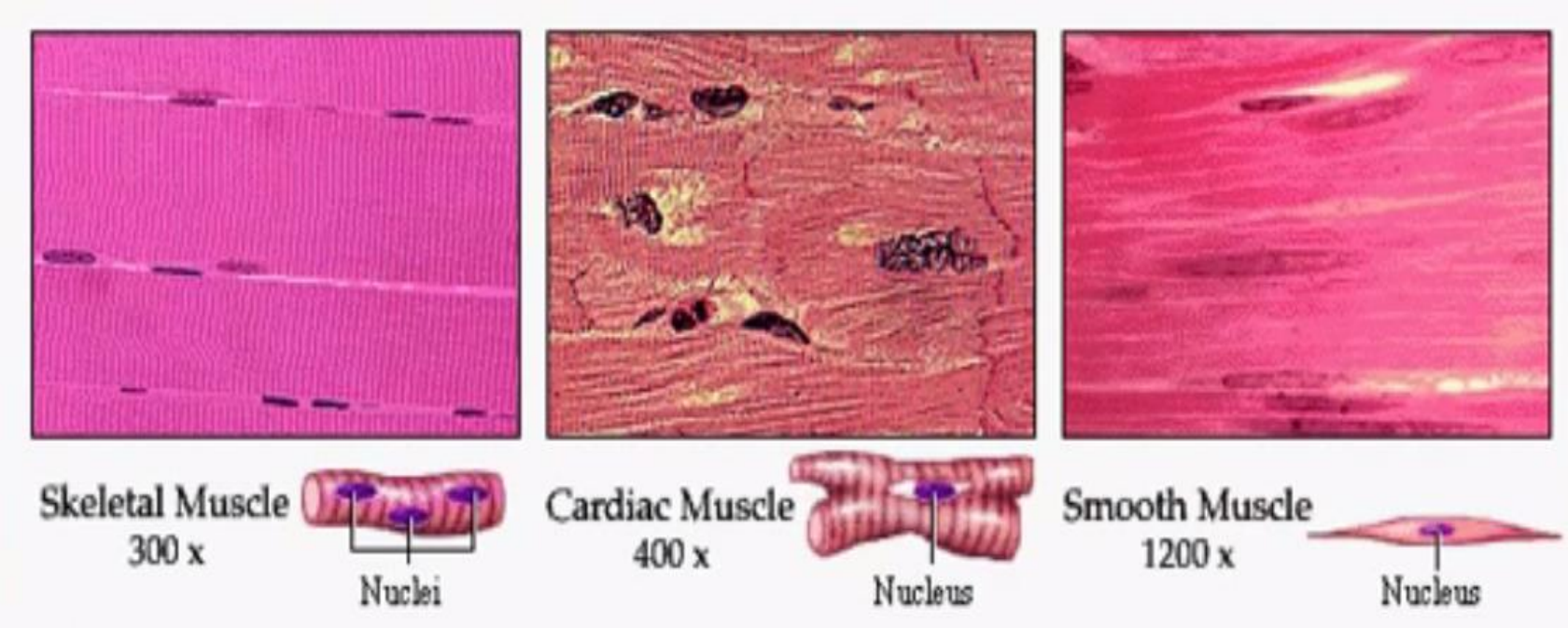
DR.AYESHA MUSTAFA(DPT),
M.Phil(gold medilist)
SARGODHA MEDICAL COLLEGE

Revive

www.revivepysio.com

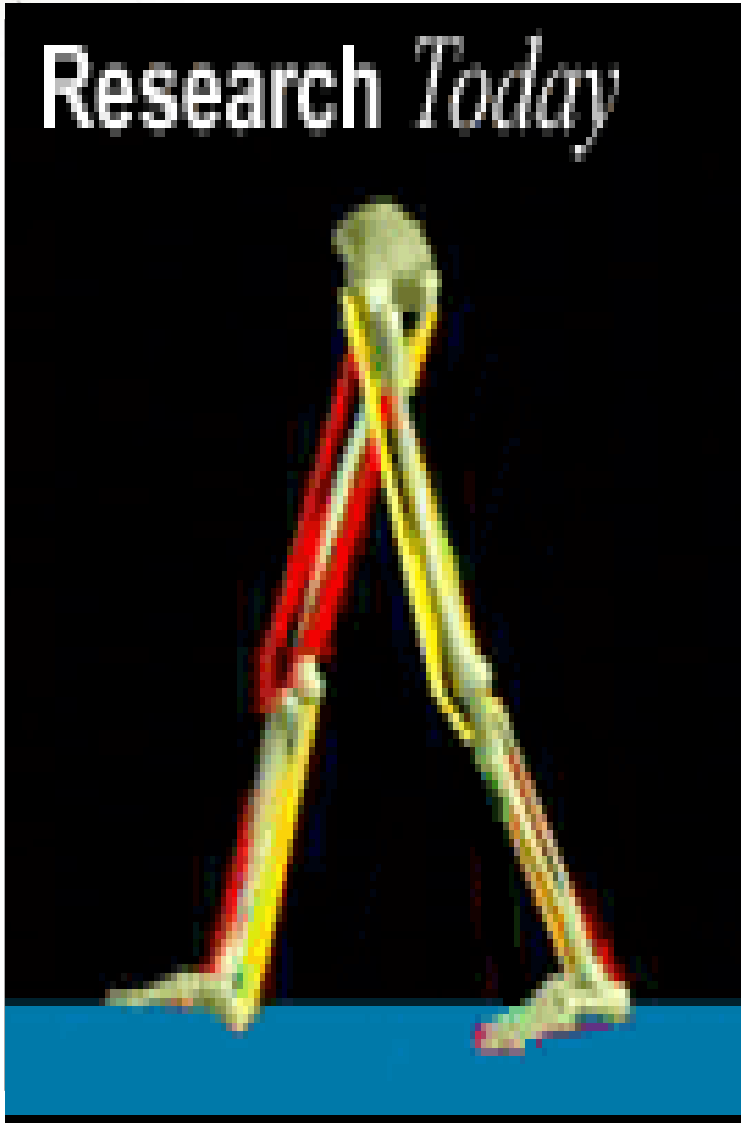
Muscles

- **cardiac muscle:** composes the heart
- **Smooth muscle**: lines hollow internal organs
- **skeletal (striated or voluntary)** muscle: attached to skeleton via tendon & perform movement



Characteristics of Skeletal Muscle

- Skeletal muscle 40-45% of body weight
  - more than 430 muscles
  - 80 pairs produce vigorous movement
  - **Dynamic:** locomotion of segments
- **Static:** maintains body posture
- **Irritability** – ability to receive and respond to a stimulus
- **Contractility** – ability to shorten when an adequate stimulus is received

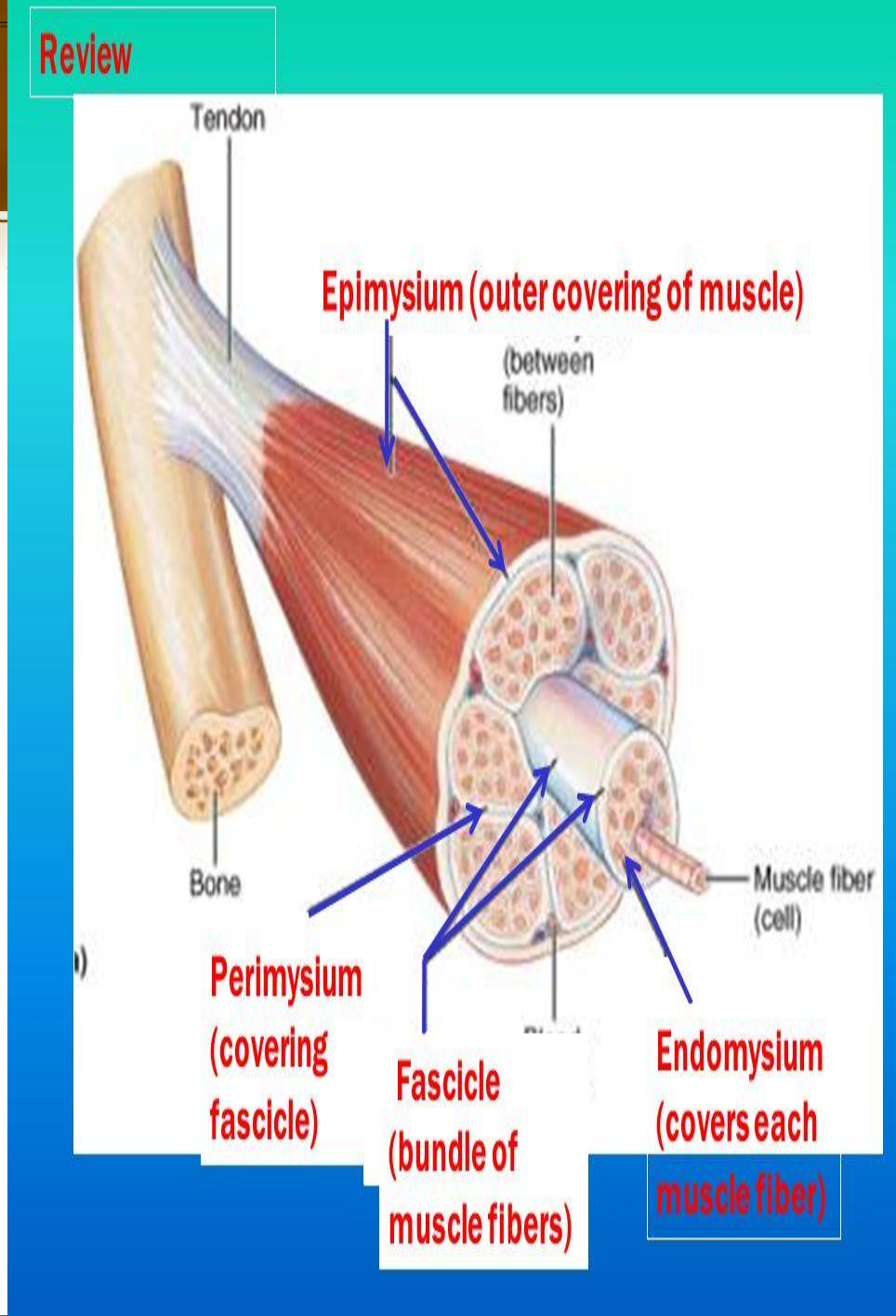


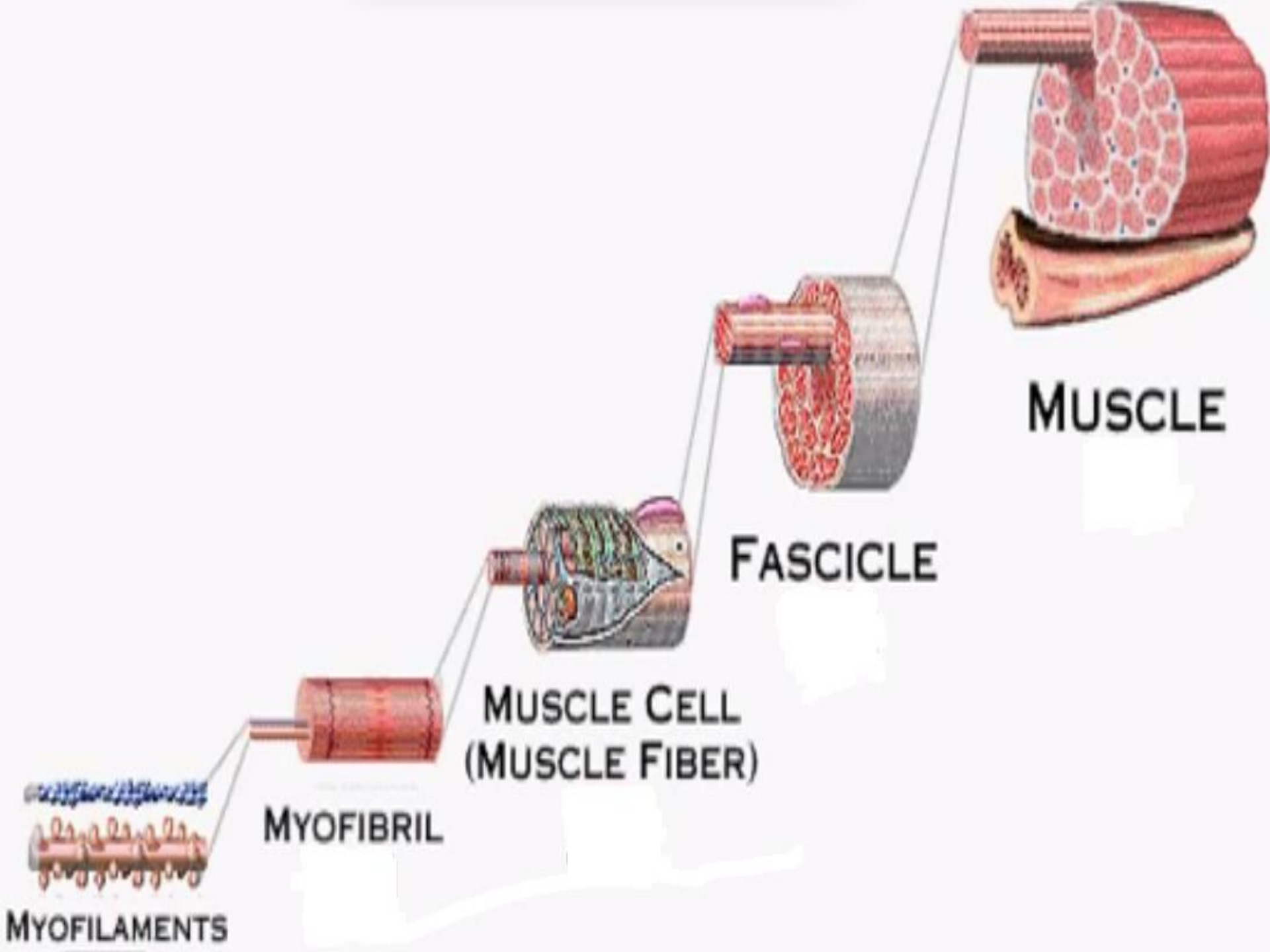
Characteristics of skeletal Muscles

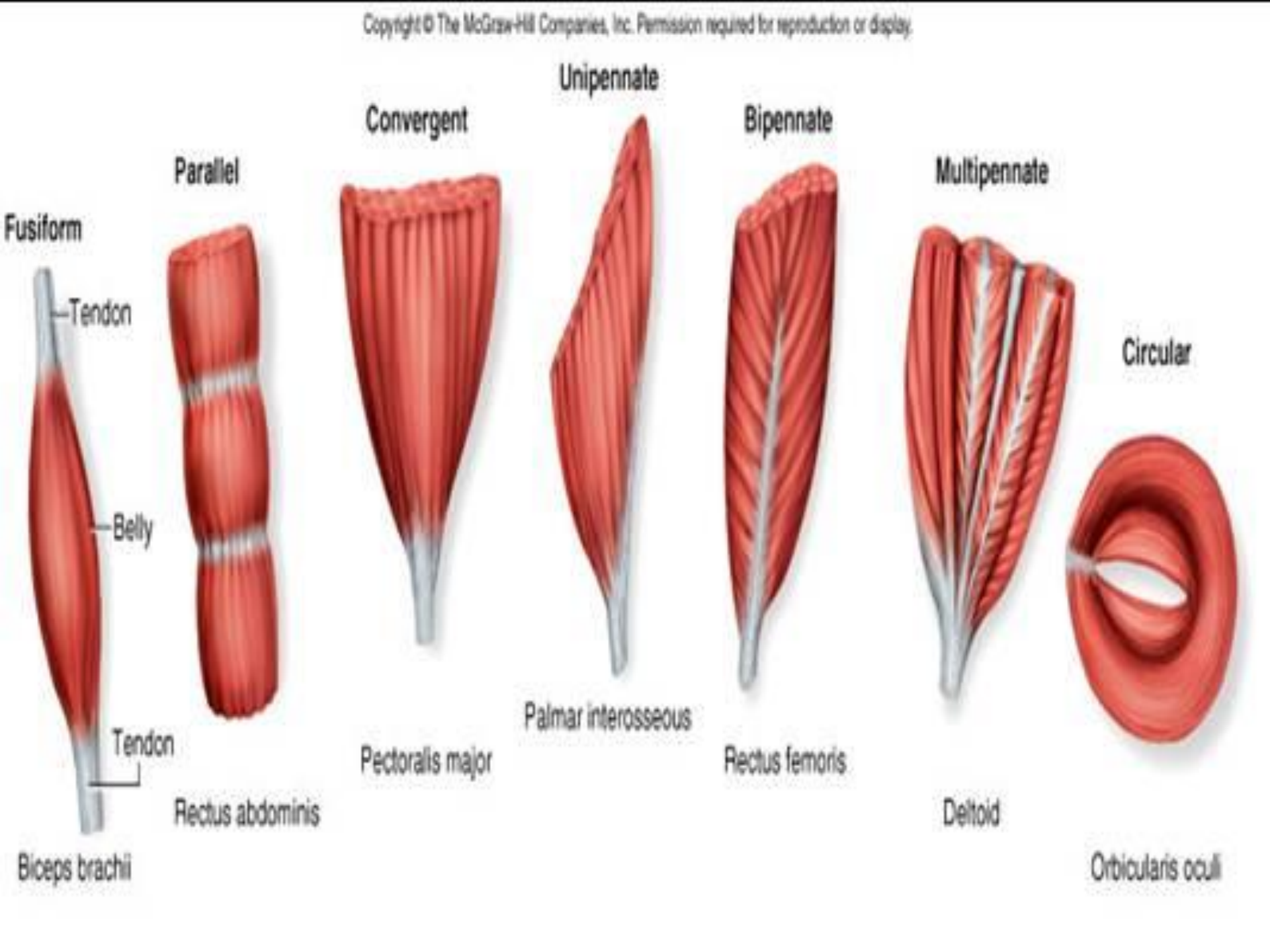
- Muscle cells are elongated
- Two attachments(origin & insertion)
- Contraction of muscles is due t movement of microfilaments
- All muscles share some terminology
  - Prefix *myo* refers to muscle
  - Prefix *mys* refers to muscle
  - Prefix *sarco* refers to flesh

Composition & structure Muscle

- Epimysium- ensheaths the entire muscle.
- Perimysium – around a fascicle (bundle) of fibers
- Endomysium – around single muscle fiber



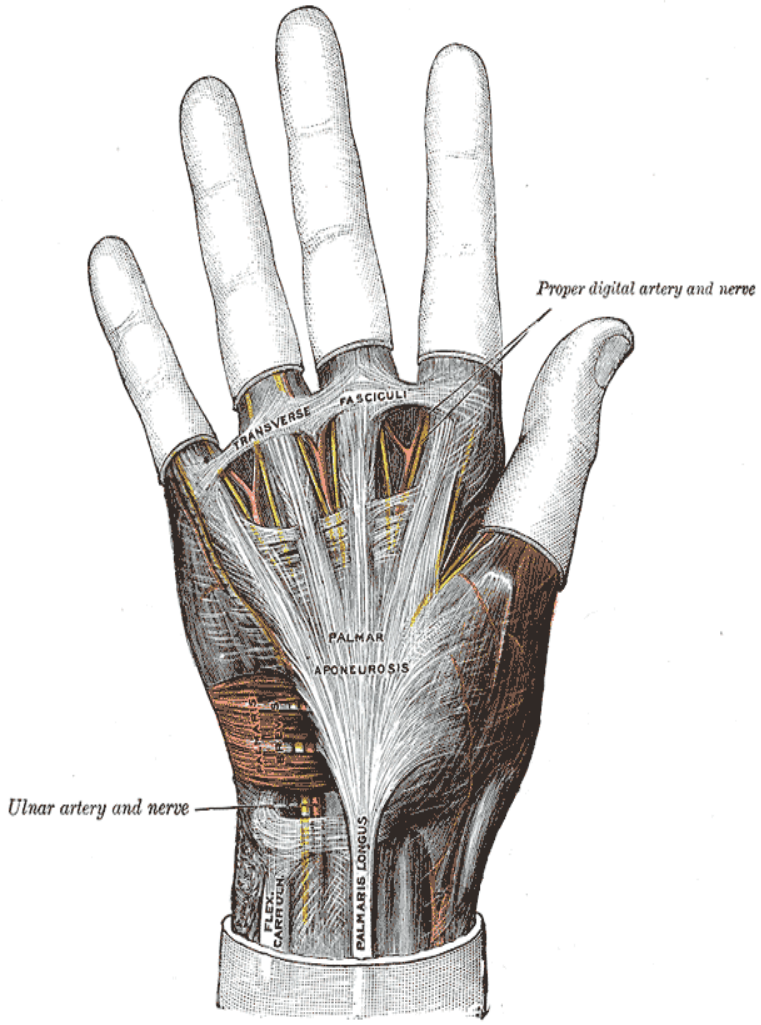

MUSCLE
FASCICLE
MUSCLE CELL
(MUSCLE FIBER)
MYOFIBRIL
MYOFILAMENTS



Skeletal Muscle Attachments

- **Epimysium** blends into a connective tissue attachment called Tendon – cord-like structure

  Aponeuroses – sheet-like structure
- Sites of muscle attachment
  - Bones
  - Connective tissue coverings



Composition & structure of skeletal muscles

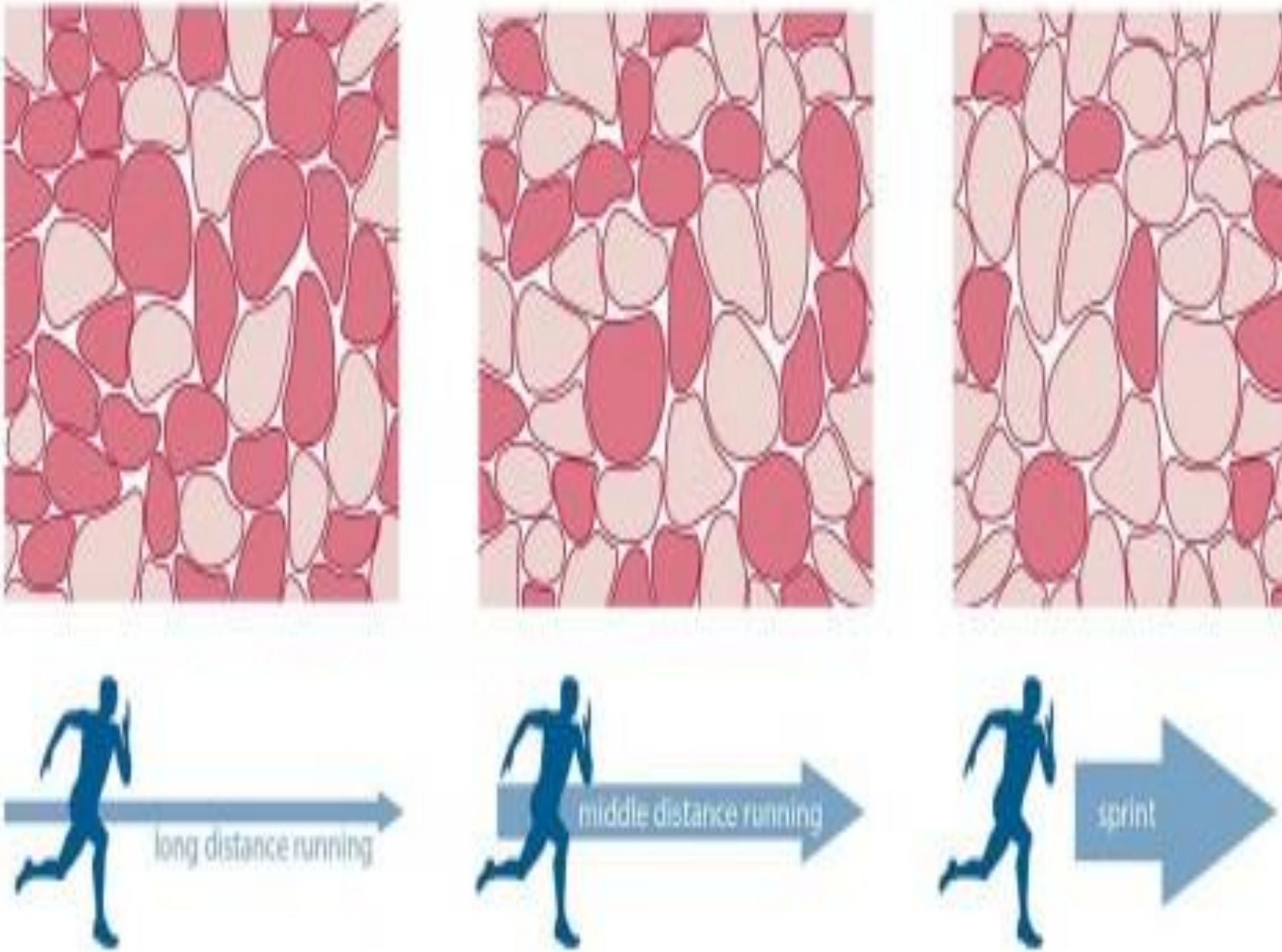
- Two parts (on basis of neural connections)
- Muscle spindle(intrafusal fibers & extrafusal fibers)
- Golgi tendon organs
- Characteristics on bases of color of muscles fibers:
- Red fibers(slow twitch, type 1)
- White fibers (fast twitch type 2)

SLOW TWITCH VS FAST TWITCH MUSCLE FIBRES

By: Chirag Navadia @MedRx

FEATURES	TYPE I MUSCLE FIBER	TYPE II MUSCLE FIBER
FORCE OF CONTRACTION	Slow	Fast
RED COLOR	High (aka Red Fibers)	Low (aka White Fibers)
MITOCHONDRIA & MYOGLOBIN	High	Low
OXIDATIVE CAPACITY	High	Low
CAPILLARY DENSITY & FATIGUE RESISTANCE	High	Low
MAIN SOURCE OF ENERGY	Triglycerides	Glycogen & Creatine Phosphate
DURATION OF USE	Long	Short
GLYCOGEN & GLYCOLYTIC CAPACITY	Low	High
POWER	Stamina	Strength
HIGH AMOUNT IN...	Postural Muscles (Axial)	Peripheral Muscles
INCREASED IN...	Marathon Runner (Gastrocnemius) Swimmer (Post. Deltoid)	Sprinter (Gastrocnemius) Pole Vaulting, Shot Putter


Red Turtle


long distance running
middle distance running
sprint

Muscle Differentiation (types of fibers)

	I (slow-twitch oxidative)	**IIA** (fast-twitch oxidative glycolytic)	**IIB** fast-twitch glycolytic
Contraction speed	Slow	fast	fast
Myosin-ATPase activity	Low	High	High
Primary source of ATP production	Oxidative phosphorylation	Oxidative phosphorylation	Anaerobic glycolysis
No. of mitochondria	Many	Many	Few
Capillaries	Many	Many	Few
Myoglobin contents	High	High	Low
Muscle Color	Red	Red	White
Glycogen content Glycolytic enzyme activiyt	Low low	Intermediate intermediate	High high
Fiber diameter	small	Intermediate	Large
Rate of fatigue	slow	Intermediate	Fast

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(بخاری، مسلم، ابوداؤد، سنن النسائی)

Microscopic Anatomy of Skeletal Muscle

- Cells are multinucleate
- Nuclei are just beneath the sarcolemma
- Sarcoplasm (glycogen & fat,)mitochondric, SR
- Muscle fiber contain myofibral (actin & myosin

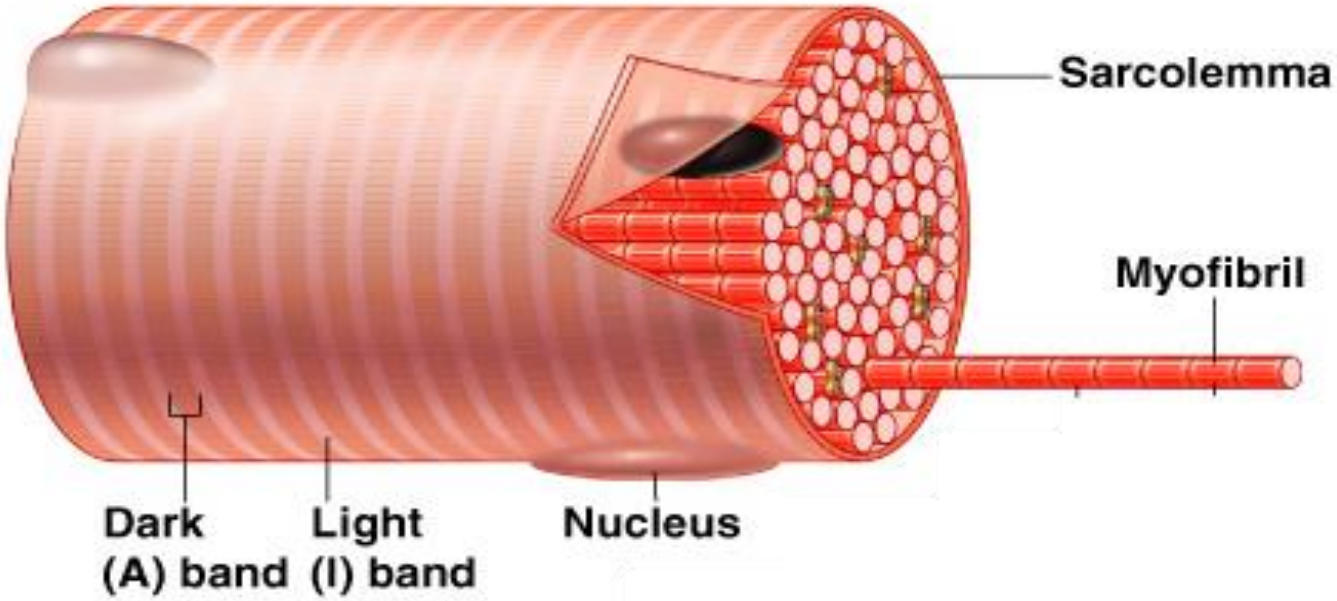
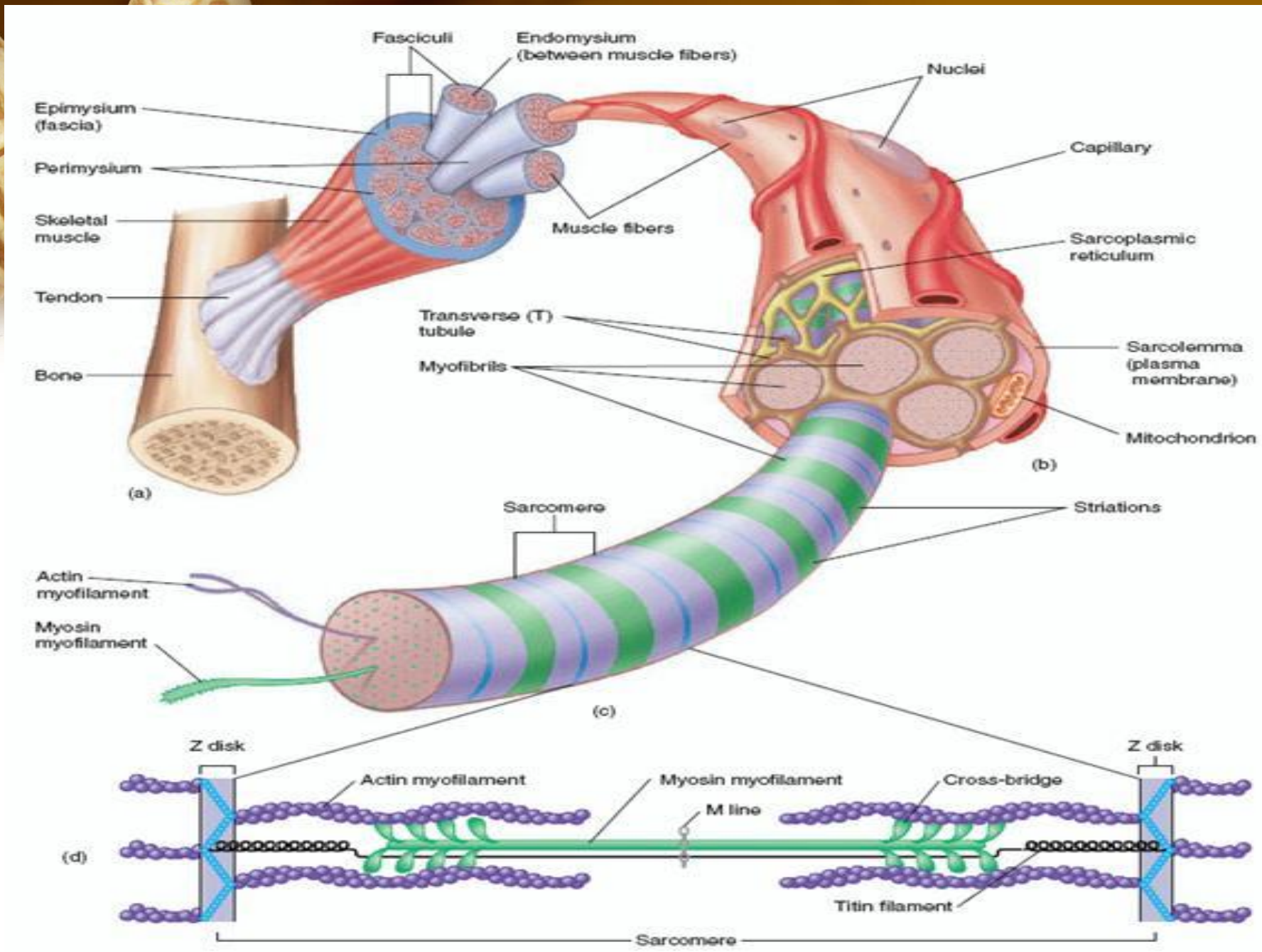
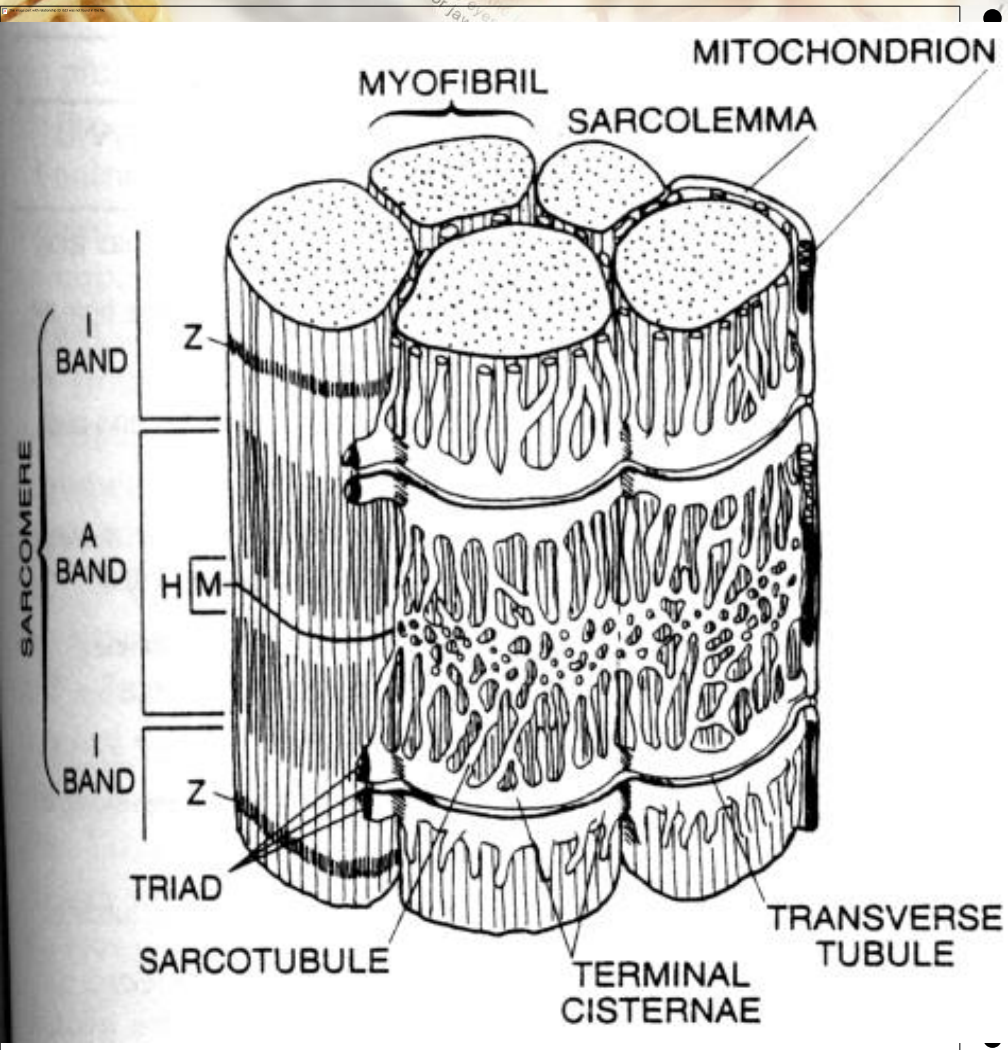


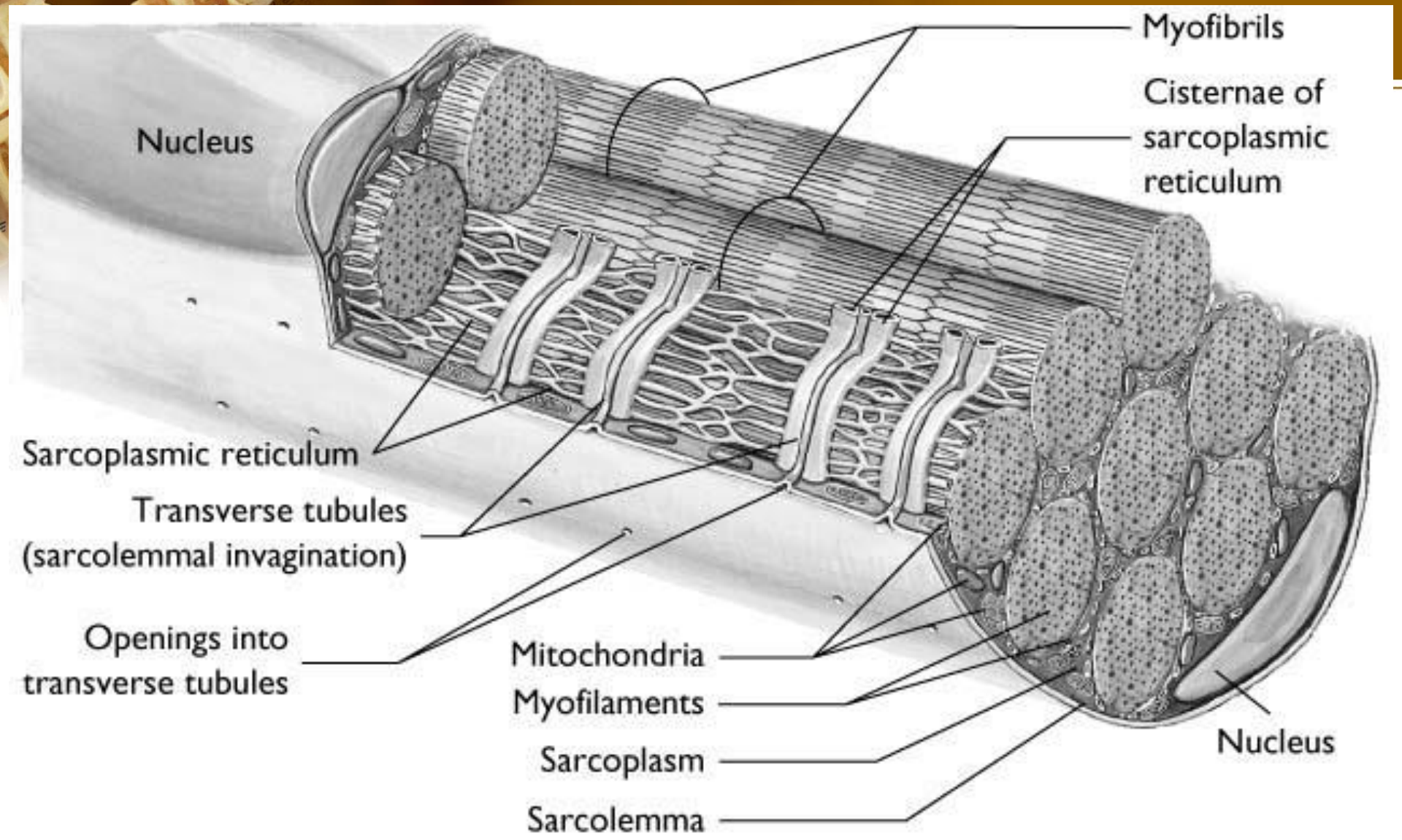
Figure 6.3


Fasciculi
Endomysium
(between muscle fibers)
Nuclei
Epimysium
(fascia)
Capillary
Perimysium
Skeletal
muscle
Muscle fibers
Sarcoplasmic
reticulum
Tendon
Transverse (T)
tubule
Sarcolemma
(plasma
membrane)
Myofibrils
Bone
Mitochondrion
(a)
(b)
Sarcomere
Striations
Actin
myofilament
Myosin
myofilament
(c)
Z disk
Z disk
Actin myofilament
Myosin myofilament
Cross-bridge
M line
(d)
Titin filament
Sarcomere

Sarcoplasmic reticulum



- Network of tubules & sacs
- Parallel to myofibrils
- Enlarged & fused at junction between A & I bands: transverse sacs (terminal cisternae)
- **Triad {terminal cisternae of transverse tubule}**
- **T system:** duct for fluids help in propagation of electrical stimulus for contraction (action potential)
- **Sarcoplasmic reticulum store calcium**


Myofibrils
Cisternae of sarcoplasmic reticulum
Nucleus
Sarcoplasmic reticulum
Transverse tubules (sarcolemmal invagination)
Openings into transverse tubules
Mitochondria
Myofilaments
Sarcoplasm
Sarcolemma
Nucleus

Microscopic Anatomy of Skeletal Muscle

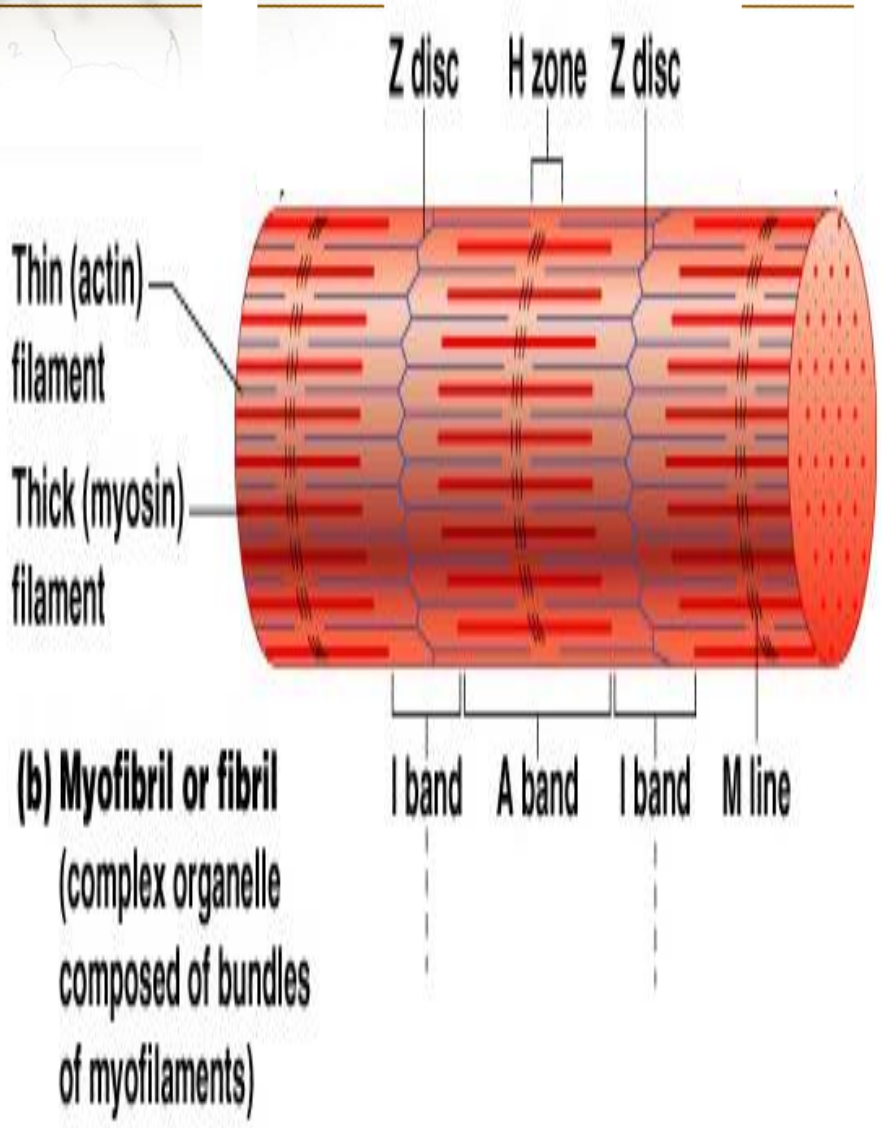
- Myofibril
  - Bundles of myofilaments
  - Myofilaments are aligned to give distinct bands
  - I band =

light band

A band =

dark band

❖Organization of these bands called sarcomere: contractile unit of muscle fibers



Microscopic Anatomy of Skeletal Muscle

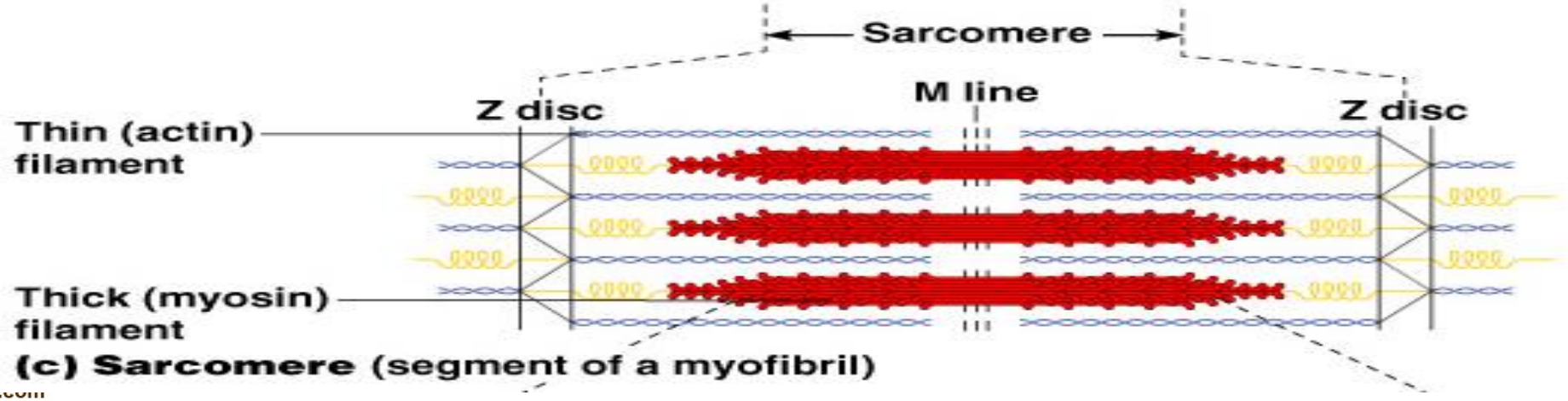
structure of sarcomere

A bands: thick filaments in centre of sarcomerse

I bands: thin filaments not overlap with thick filaments. Thin filament (actin 5nm) + thick filament (myosin 15 nm)

Z line: short elements that links thin filaments

H zone: gap between ends of thin filaments in center



Microscopic Anatomy of Skeletal Muscle

- Myosin filaments have heads

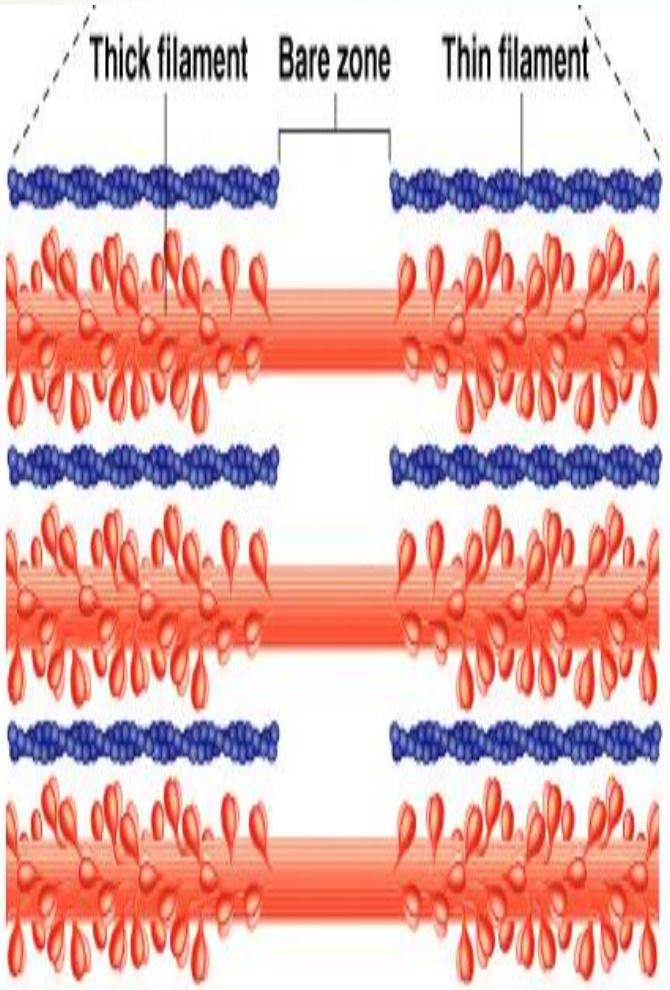
Or (extensions, or cross bridges)

- Myosin and actin overlap somewhat during contraction

- At rest, there is

a bare zone that

lacks actin filaments

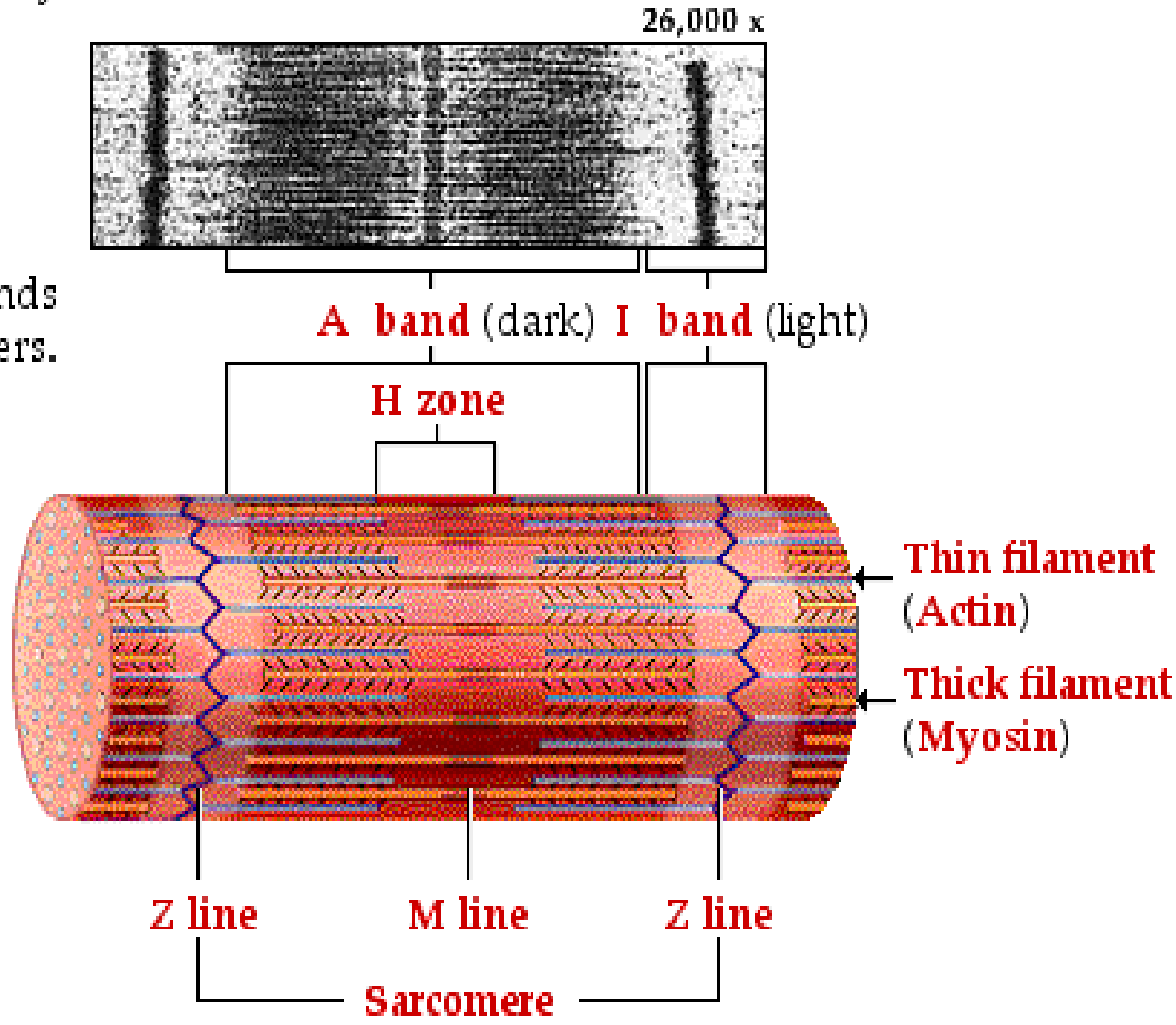


(d) Myofilament structure (within one sarcomere)

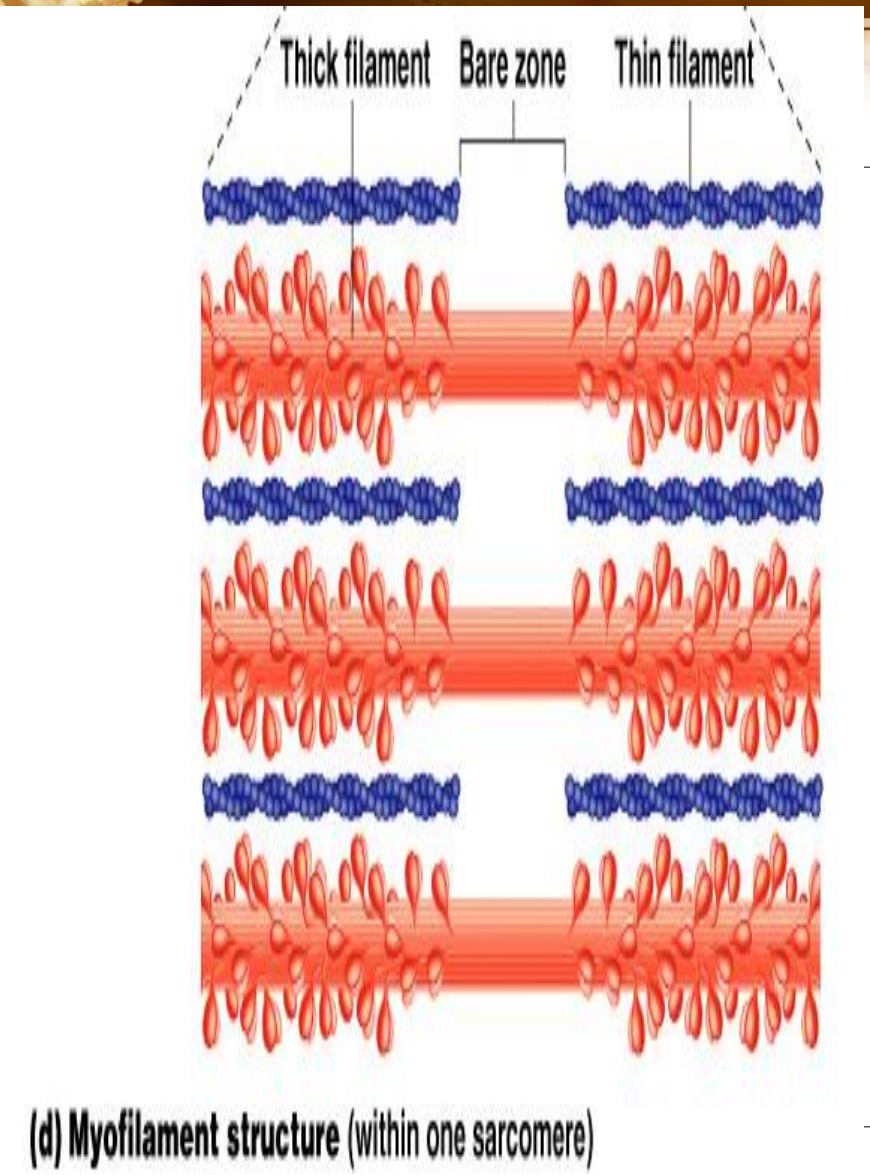
Arrangement of Myofilaments

The arrangement of thick and thin myofilaments forms light and dark alternating bands (striations) along the myofibril.

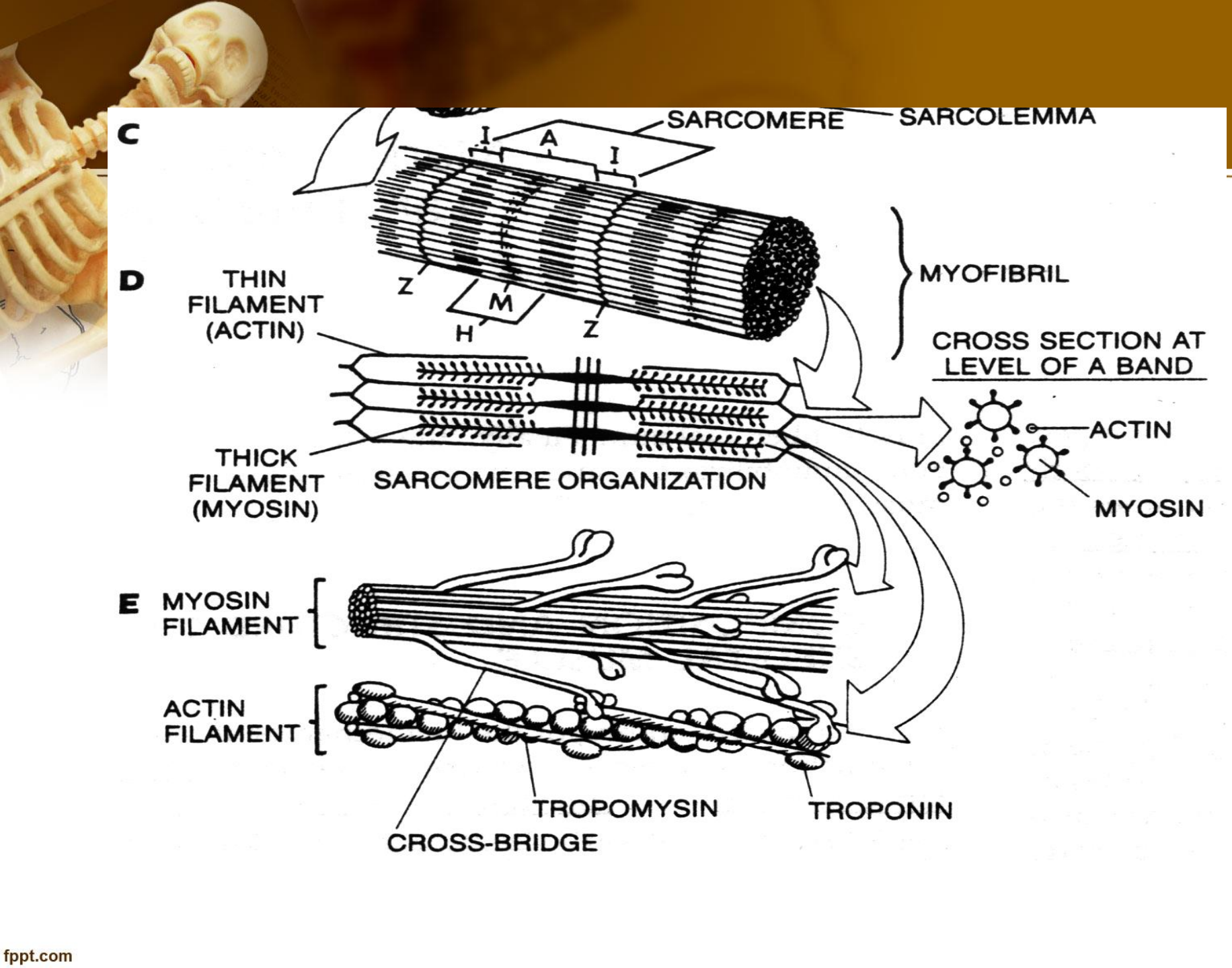
Features of these bands are identified by letters.



Molecular composition of myofibril

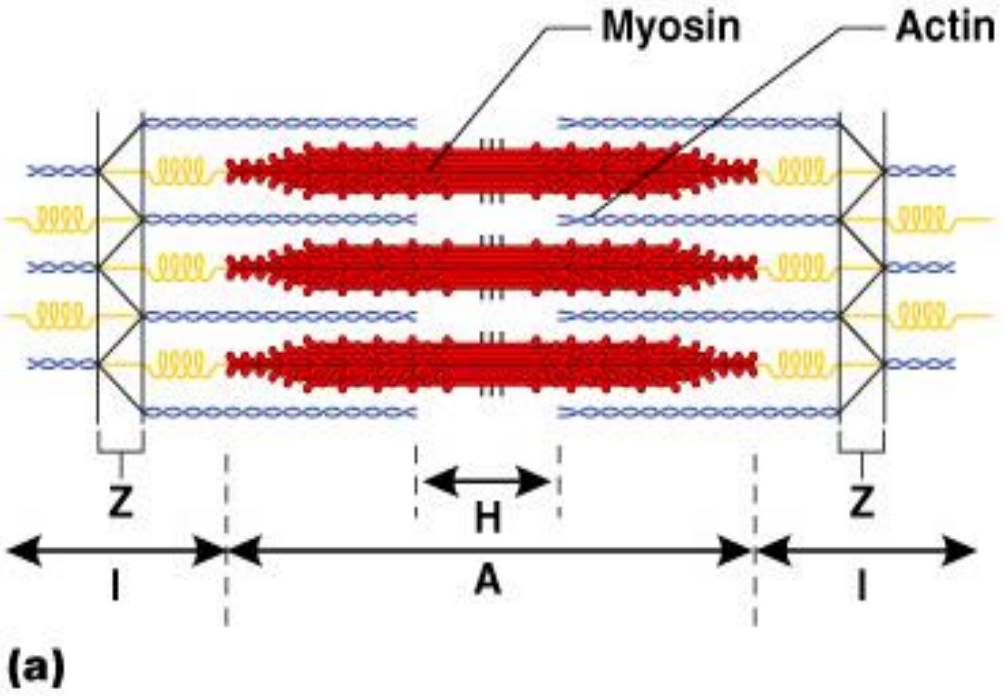


- **Myosin** composed of individual molecules each has a globular head and tail
- **Actin has double helix**; two strands of beads spiraling around each other
- Cross-bridge: actin & myosin overlap (A band)
- **Troponin & tropomysin regulate making and breaking contact between actin & myosin**

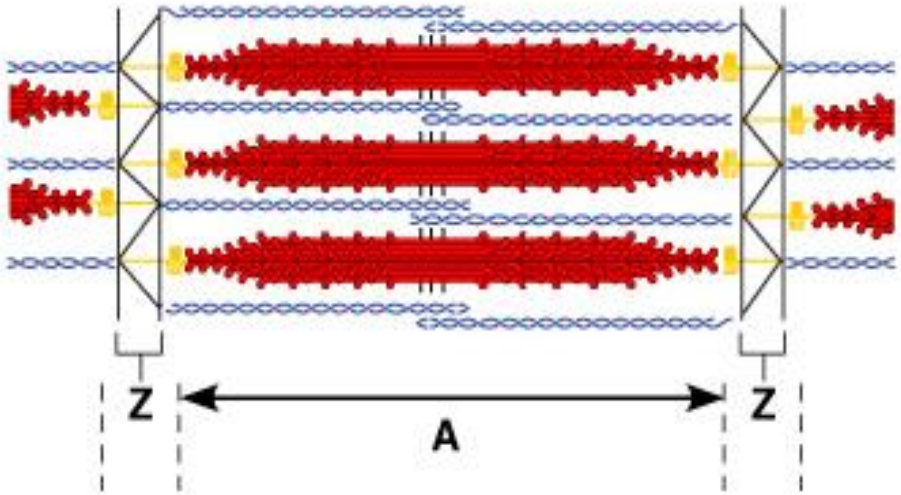

C
SARCOMERE
SARCOLEMMA
I
A
I
D
THIN FILAMENT (ACTIN)
Z
M
H
Z
MYOFIBRIL
CROSS SECTION AT LEVEL OF A BAND
ACTIN
MYOSIN
THICK FILAMENT (MYOSIN)
SARCOMERE ORGANIZATION
E
MYOSIN FILAMENT
ACTIN FILAMENT
TROPOMYSIN
TROPONIN
CROSS-BRIDGE

The Sliding Filament Theory

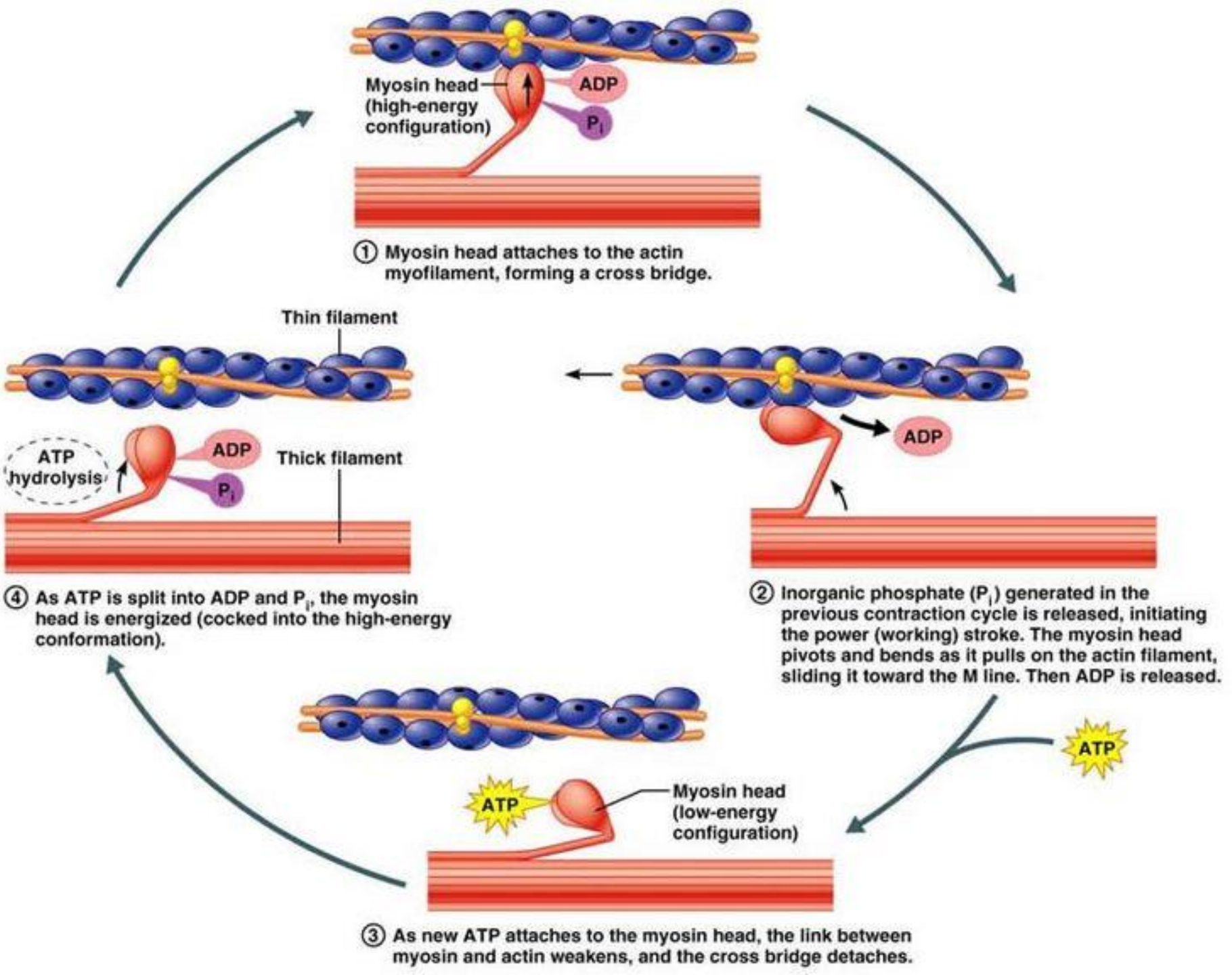
- Activation by nerve causes myosin heads to attach to binding sites on the thin filament (cross-bridges)
- Myosin heads then bind to the next site of the thin filament and so on….



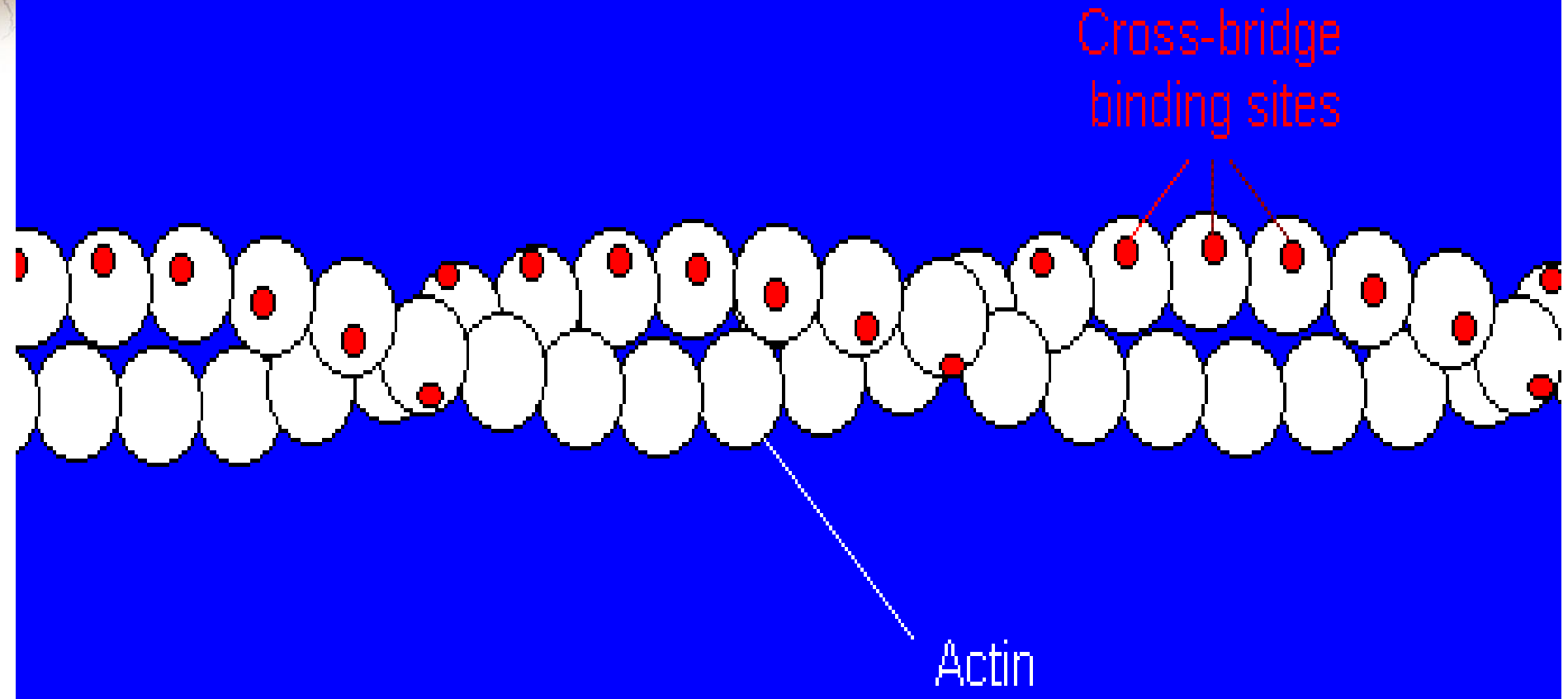
(a)

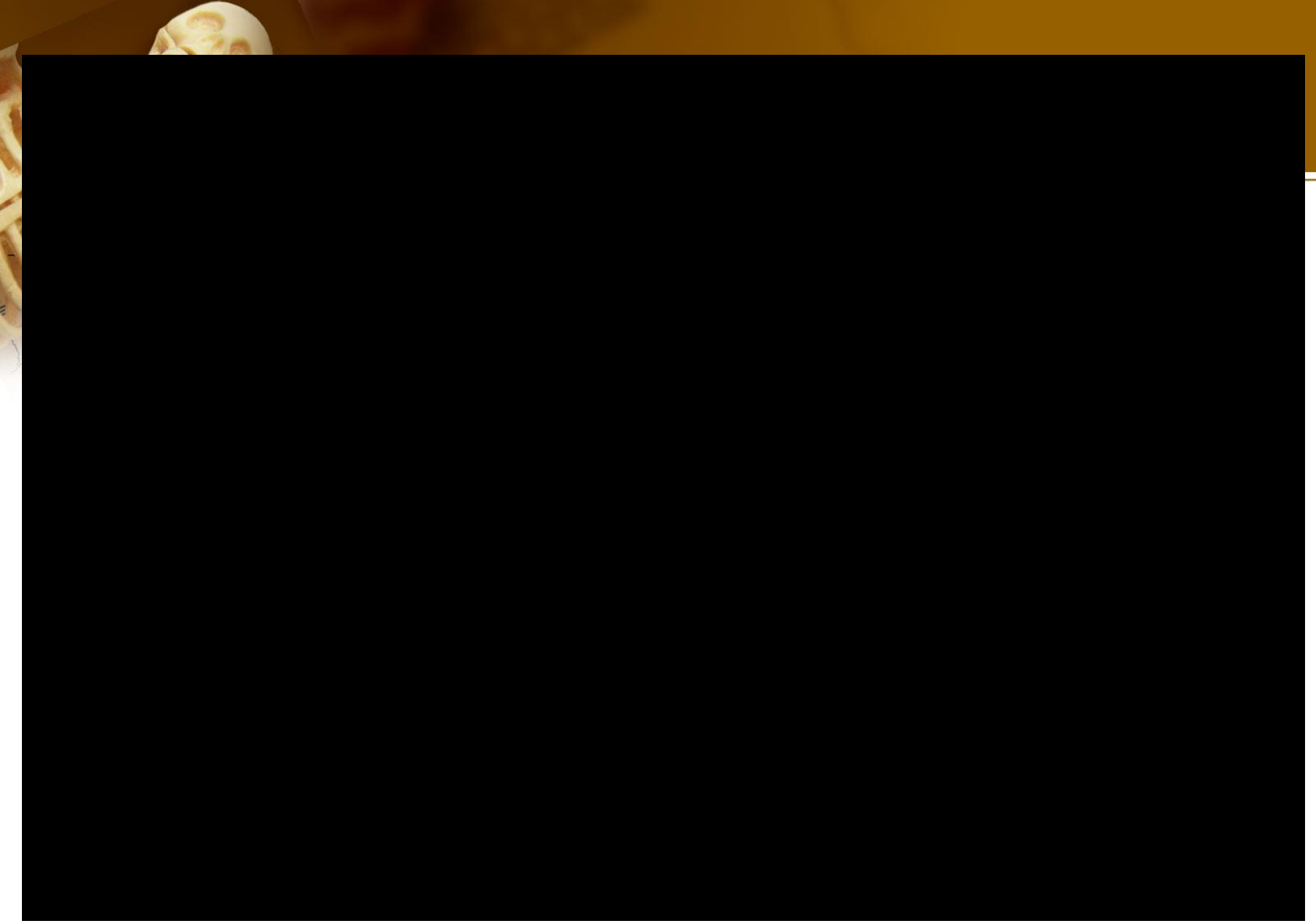


(b)


Myosin head
(high-energy
configuration)
ADP
P_i
① Myosin head attaches to the actin myofilament, forming a cross bridge.
② Inorganic phosphate (P_i) generated in the previous contraction cycle is released, initiating the power (working) stroke. The myosin head pivots and bends as it pulls on the actin filament, sliding it toward the M line. Then ADP is released.
ADP
ATP
Myosin head
(low-energy
configuration)
ATP
③ As new ATP attaches to the myosin head, the link between myosin and actin weakens, and the cross bridge detaches.
④ As ATP is split into ADP and P_i, the myosin head is energized (cocked into the high-energy conformation).
ATP
hydrolysis
ADP
P_i
Thin filament
Thick filament

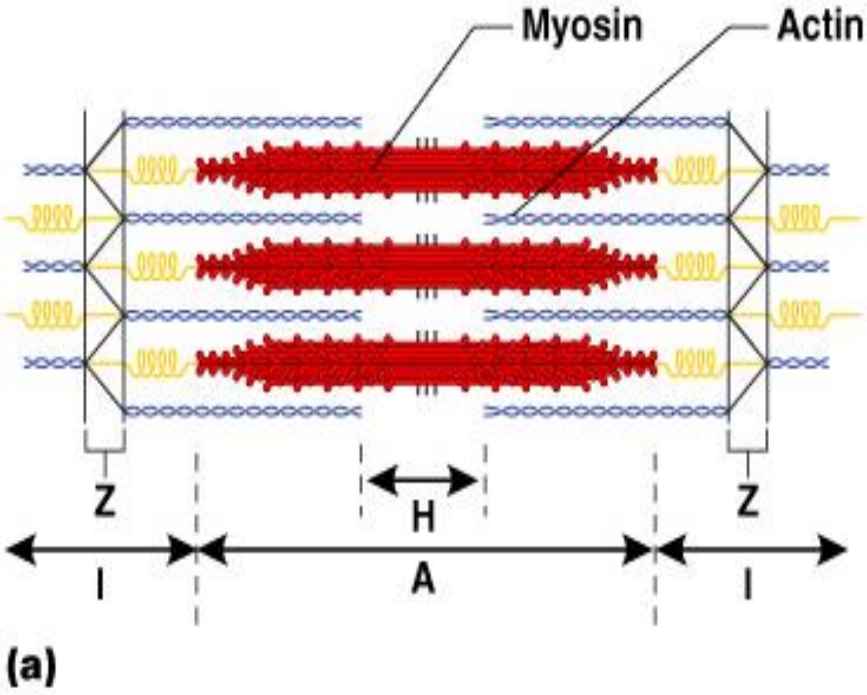
Cross Bridge Cycle - the Components



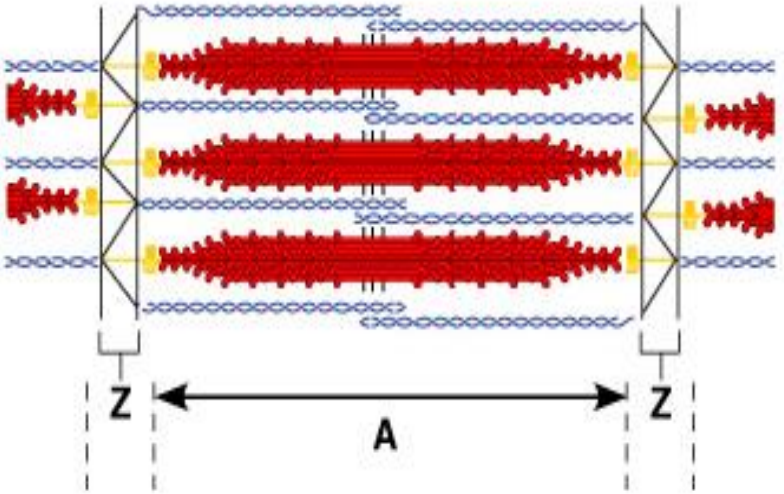


Molecular basis of muscle contraction

- **Sliding filament theory:**
- Relative movement of actin & myosin filaments yields active sarcomere shortening
- Myosin heads or cross-bridges generate contraction force
- Sliding of actin filaments toward center of sarcomere: decrease in I band and decrease in H zone as Z lines move closer



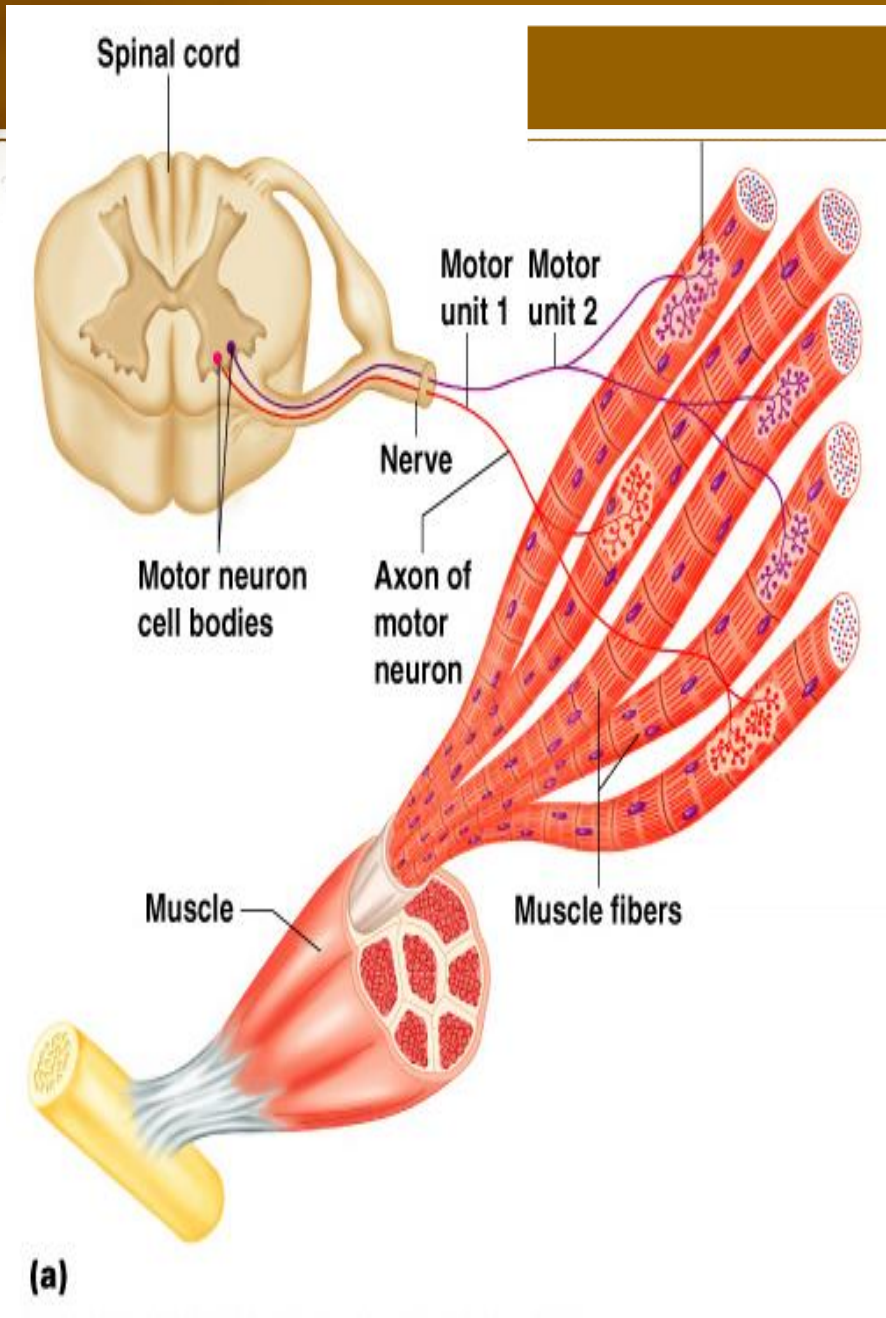
(a)



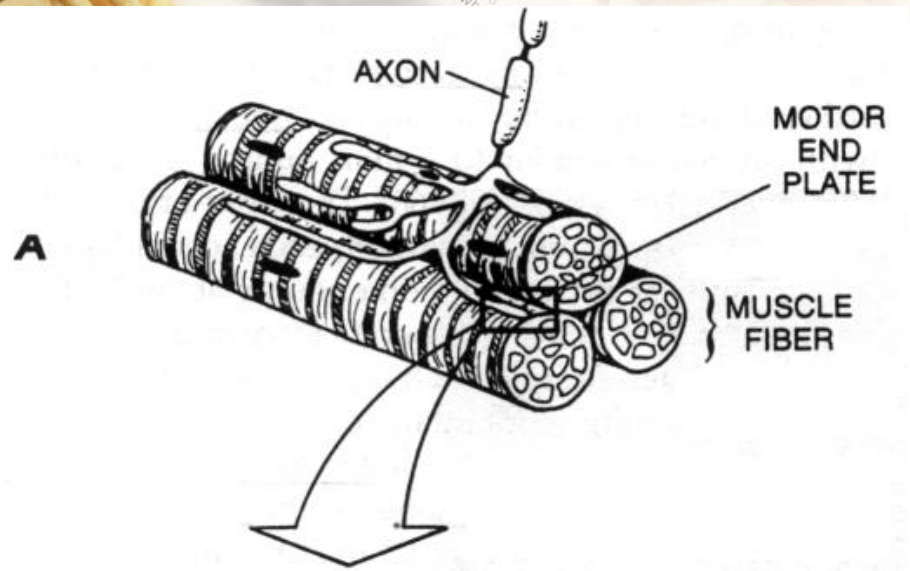
(b)

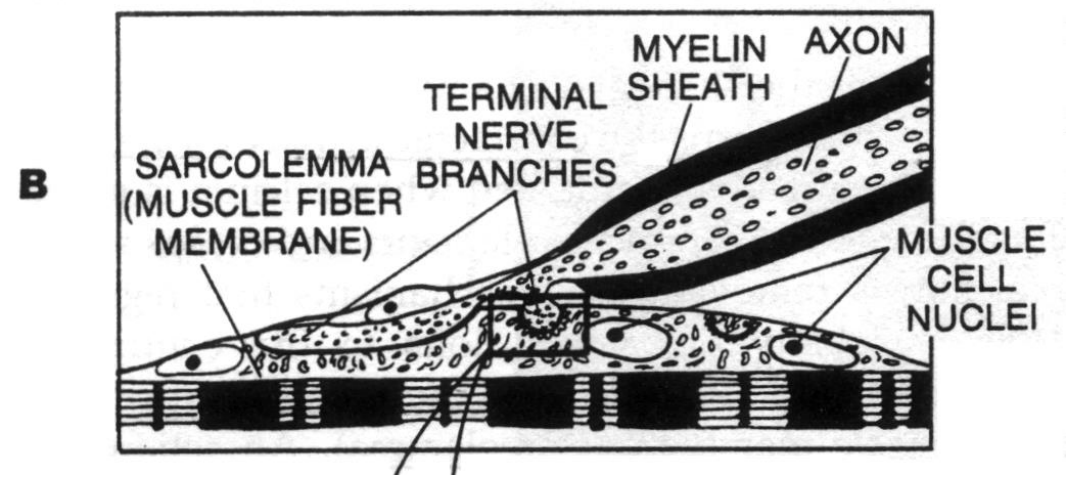
Molecular basis of muscle contraction

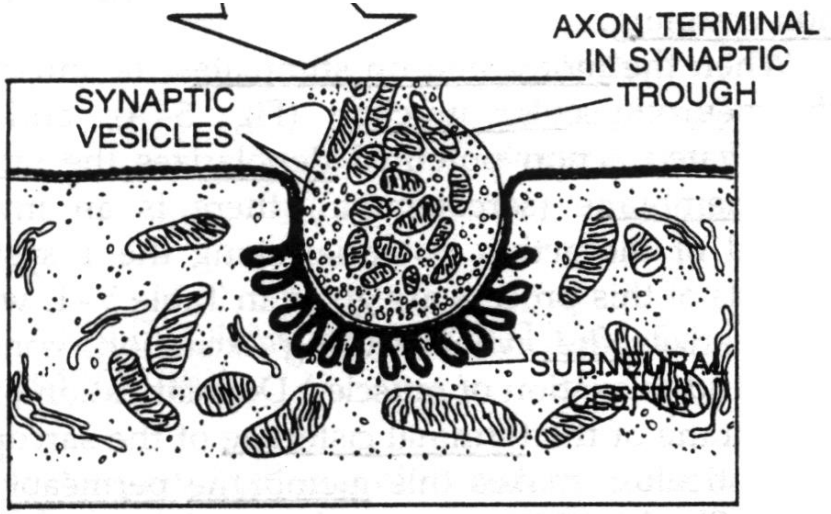
- **Motor unit:**
- Muscle supplied by nerve contain both sensory & motor fibers lie in anterior horn of spinal cord or in nucleus of cranial nerves influenced by many sources.
- Motor neuron and muscle to which it supplied called motor unit.
- Motor neuron divide 5-150 branches each of which terminates in a motor end plate beneath sarcolema.

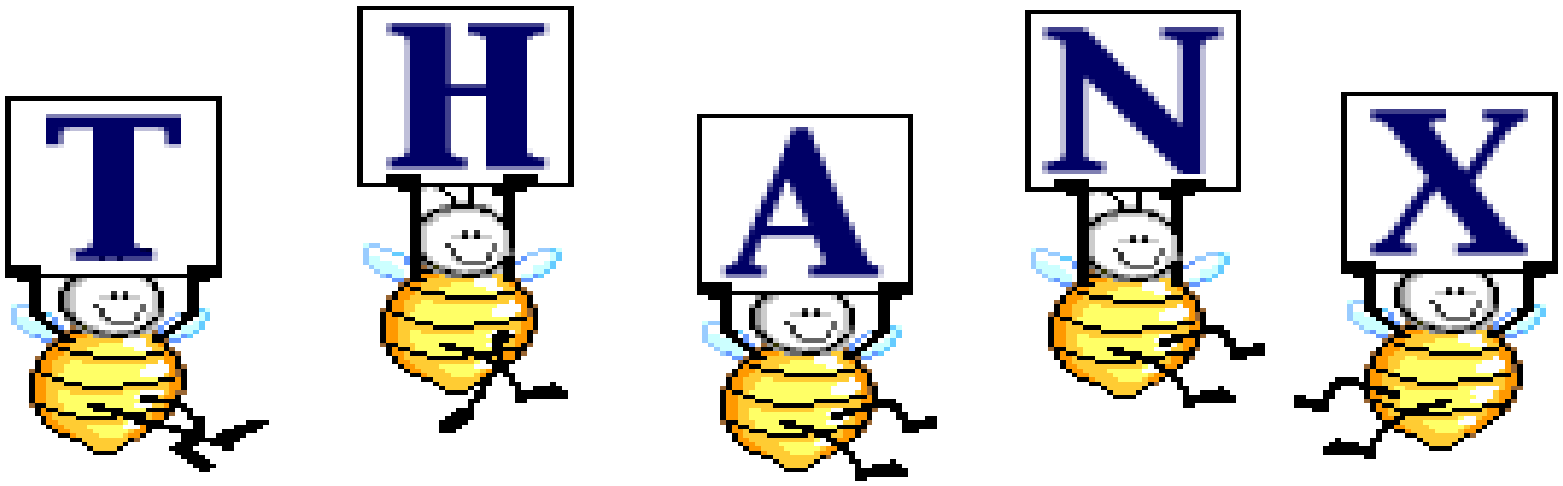


Motor unit









بسم اللہ الرحمن الرحیم

حضور نبی کریم ﷺ نے فرمایا:-

مجھے بچوں کی پانچ عادتیں بہت پسند ہیں۔

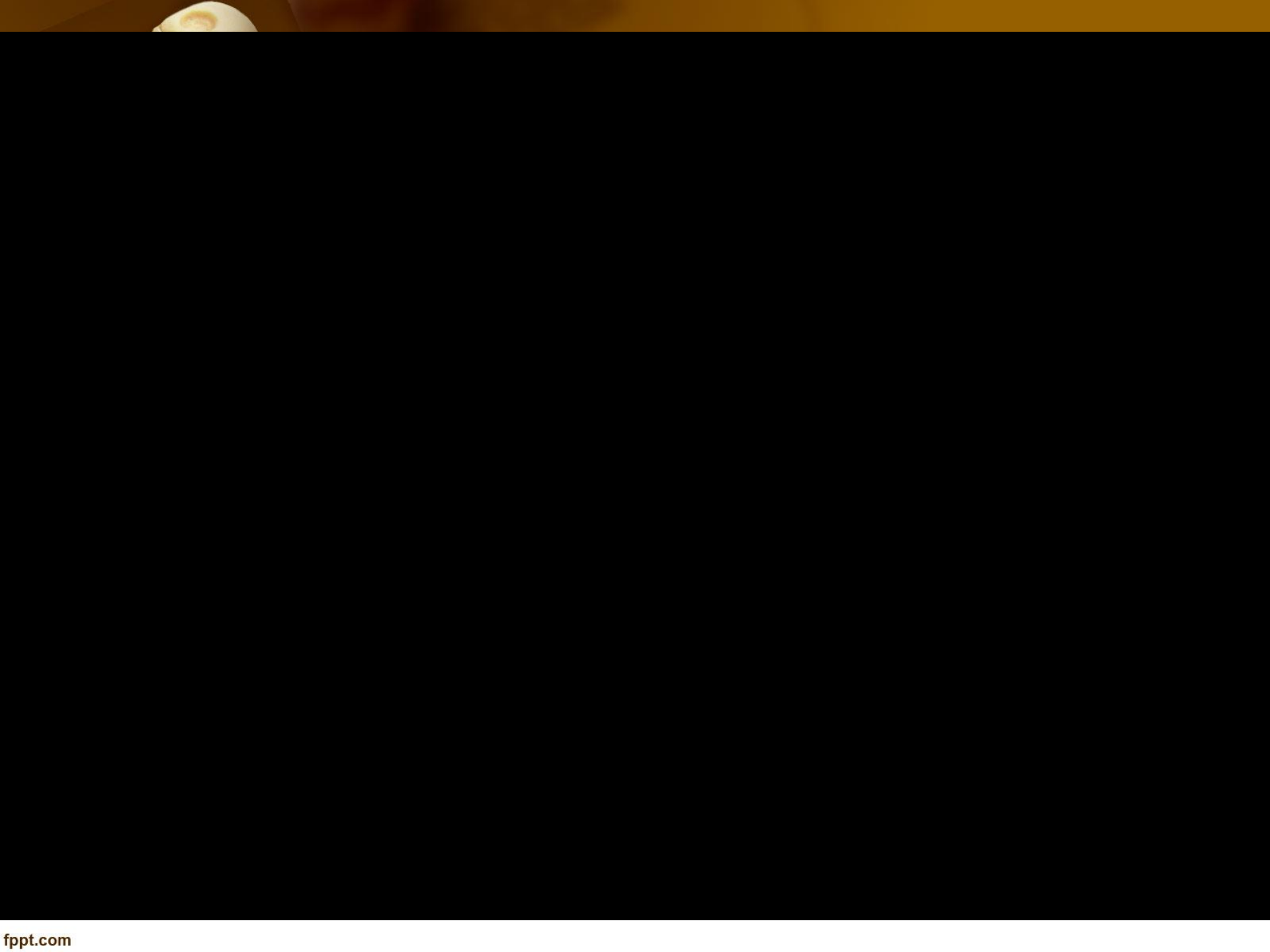
☆ وہ رو کر مانگتے ہیں اور اپنی بات منوا لیتے ہیں۔

☆ وہ مٹی سے کھیلتے ہیں اور غرور تکبر خاک میں ملا دیتے ہیں۔

☆ جو مل جائے کھا لیتے ہیں زیادہ جمع یا ذخیرہ کرنے کی ہوس نہیں رکھتے۔

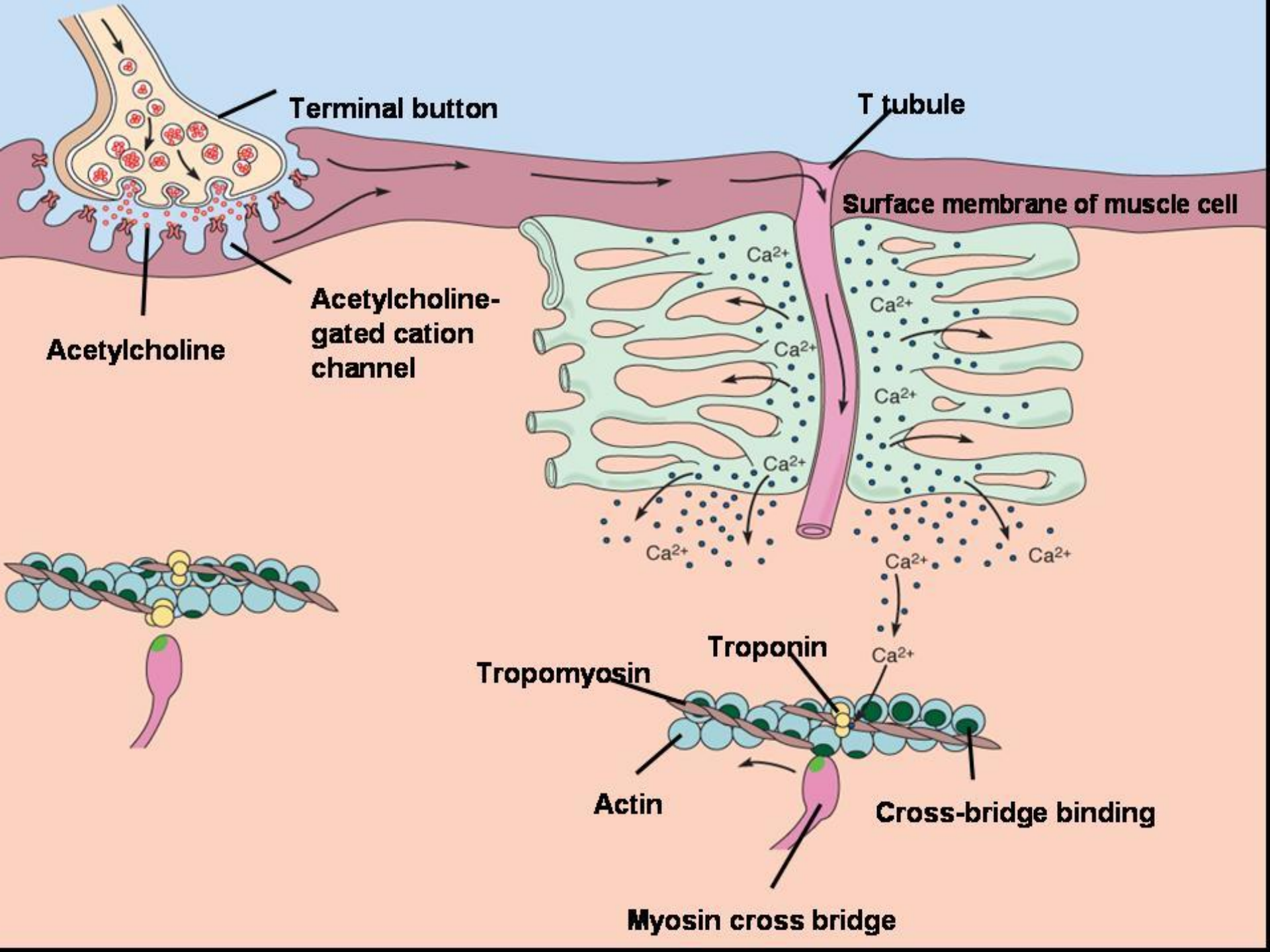
☆ لڑتے ہیں جھگڑتے ہیں اور پھر صلح کر لیتے ہیں یعنی دل میں حسد بغض اور کینہ نہیں رکھتے۔

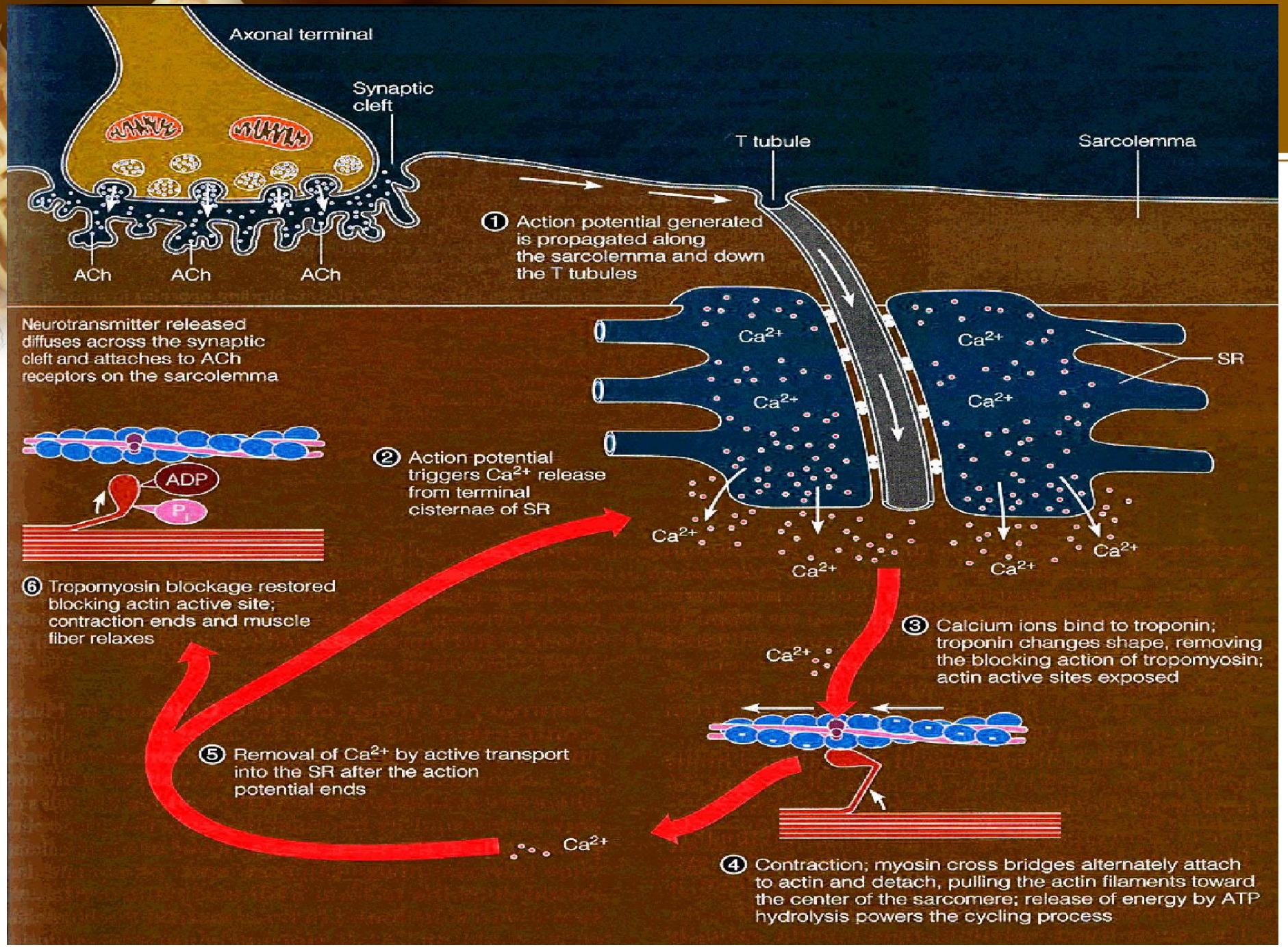
☆ مٹی کے گھر بناتے ہیں۔ کھیل کر گرا دیتے ہیں یعنی وہ بتاتے ہیں کہ یہ دنیا باقی رہنے والی نہیں بلکہ ختم ہو جانے والی ہے۔

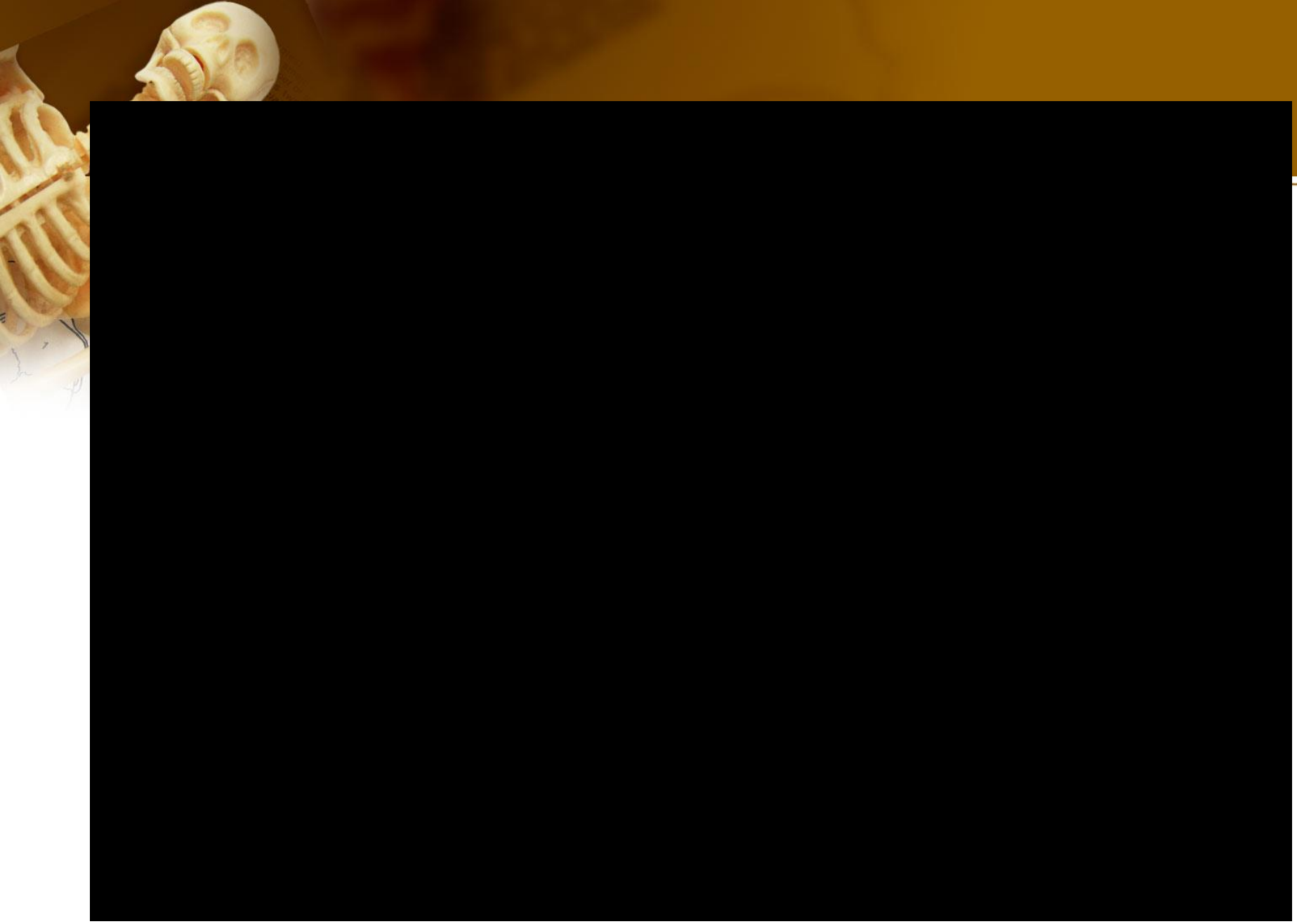


Initiation and propagation of action potential

- An **action potential** is initiated and propagated in a motor axon.
- This action potential causes the release of **acetylcholine** from the axon terminals at the neuromuscular junction.
- Acetylcholine is bound to **receptor sites** on the motor end plate membrane.
- Acetylcholine increases the permeability of the motor end plate to sodium and potassium ions. producing an **end-plate potential**.
- The end-plate potential depolarizes the muscle membrane sarcolemma), generating a **muscle action potential** that is propagated *over* the membrane surface

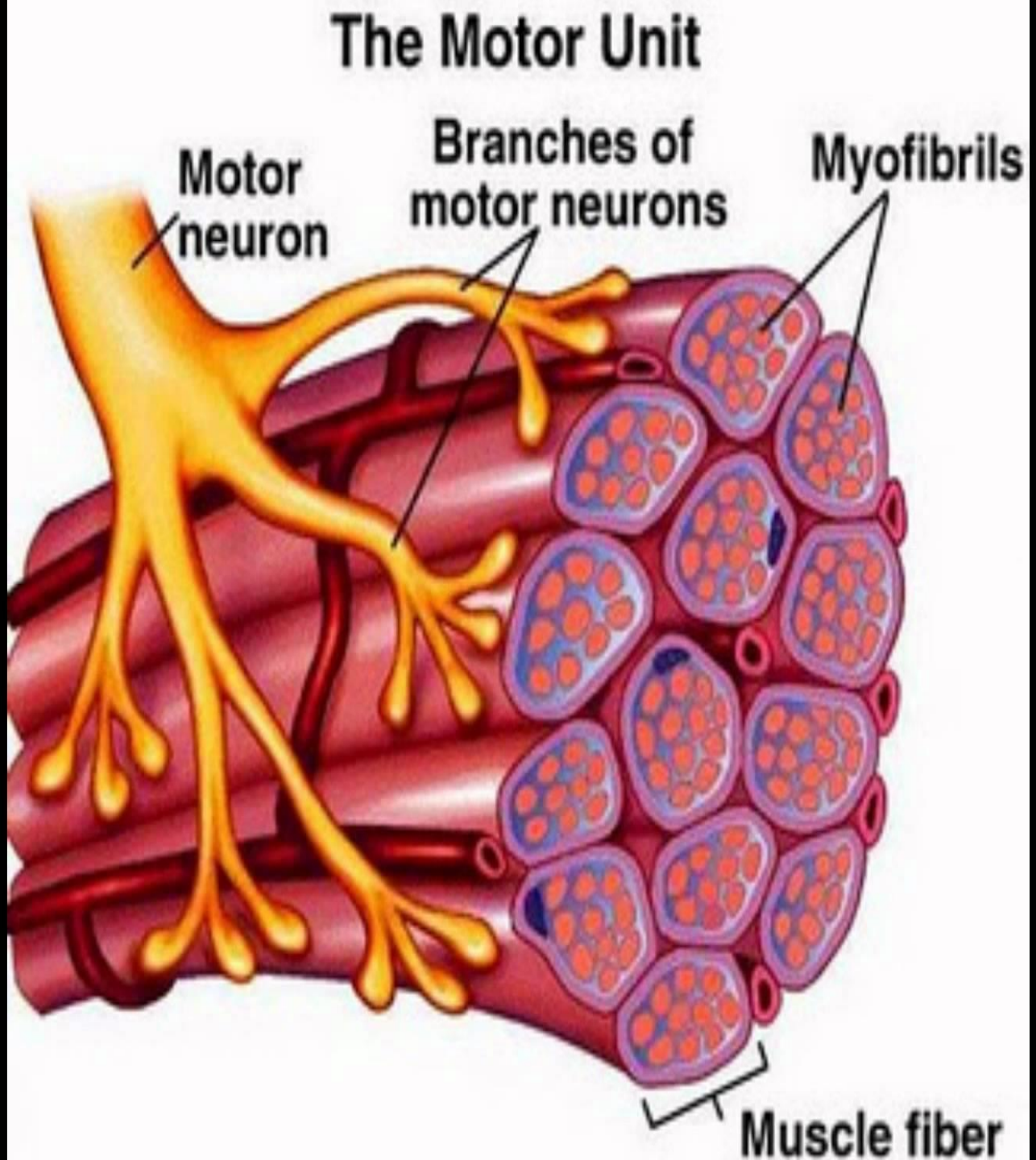

Terminal button
T tubule
Surface membrane of muscle cell
Acetylcholine
Acetylcholine-gated cation channel
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Ca2+
Troponin
Tropomyosin
Actin
Cross-bridge binding
Myosin cross bridge


Axonal terminal
Synaptic cleft
T tubule
Sarcolemma
ACh
ACh
ACh
1 Action potential generated is propagated along the sarcolemma and down the T tubules
Neurotransmitter released diffuses across the synaptic cleft and attaches to ACh receptors on the sarcolemma
SR
Ca2+
2 Action potential triggers Ca2+ release from terminal cisternae of SR
ADP
Pi
3 Calcium ions bind to troponin; troponin changes shape, removing the blocking action of tropomyosin; actin active sites exposed
4 Contraction; myosin cross bridges alternately attach to actin and detach, pulling the actin filaments toward the center of the sarcomere; release of energy by ATP hydrolysis powers the cycling process
5 Removal of Ca2+ by active transport into the SR after the action potential ends
6 Tropomyosin blockage restored blocking actin active site; contraction ends and muscle fiber relaxes

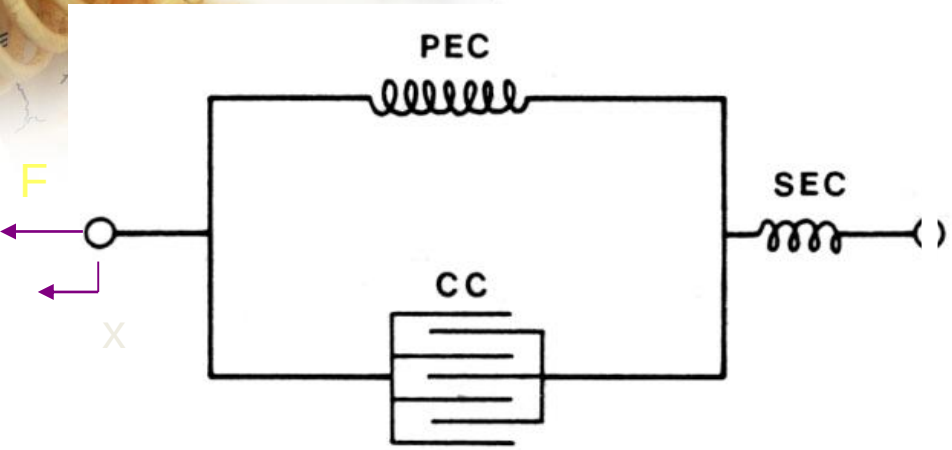


Molecular basis of muscle contraction

- A muscle fiber contracts when all sarcomere shorten simultaneously in an all-or-nothing fashion, which is called a **Twitch.**
- The mechanism by which the **electric signal trigger's** the chemical events of contraction is known as **Excitation-contraction coupling**


The Motor Unit
Motor neuron
Branches of motor neurons
Myofibrils
Muscle fiber

The Musculotendinous Unit



PEC: parallel elastic component
CC: contractile component
SEC: series elastic component

- Tendon- spring-like elastic component **in series** with contractile component (proteins)
- **Parallel** elastic component (epimysium, perimysium, endomysium, sarcolemma)

The Musculo-tendinous Unit

- The tendons and the connective tissues in and around the muscle belly are **elastic/coelastic** structures determine mechanical properties of muscle.
- When stretched during active contraction or passive extension of a muscle, tension is produced and **energy is stored**; when they **recoil** with muscle relaxation, this energy is released
- The series elastic fibers are more important in the production of tension than are the parallel elastic fibers.

Dispensability and elasticity of the elastic components(tendons))

- **Property helps**

1. TO Keep the muscle in **readiness** for contraction, smooth production and transmission of tension during contraction.
2. Assure that the contractile elements **return to their original** (resting) positions when contraction is terminated
3. **Prevent the passive overstretch thereby lessening the danger of muscle injury. (GTO)**

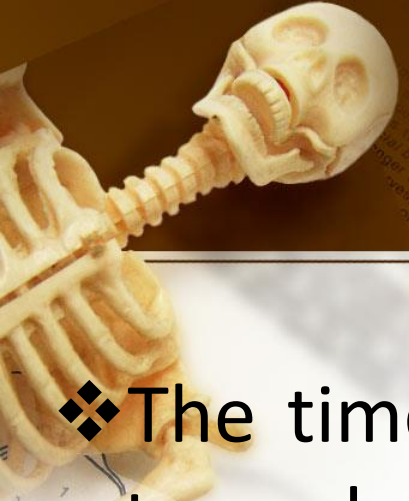
- **4.** Viscous property of these components allow To Absorb energy proportional to the rate of force application and to dissipate energy in a time dependent manner.
- **Example….**when a person attempts to stretch and touch the toes??? Stretch initially is elastic but if continue to stretch even further elongation is due to viscosity of muscle-tendon unit.

Mechanics of Muscle Contraction/Summation and Tetanic Contraction

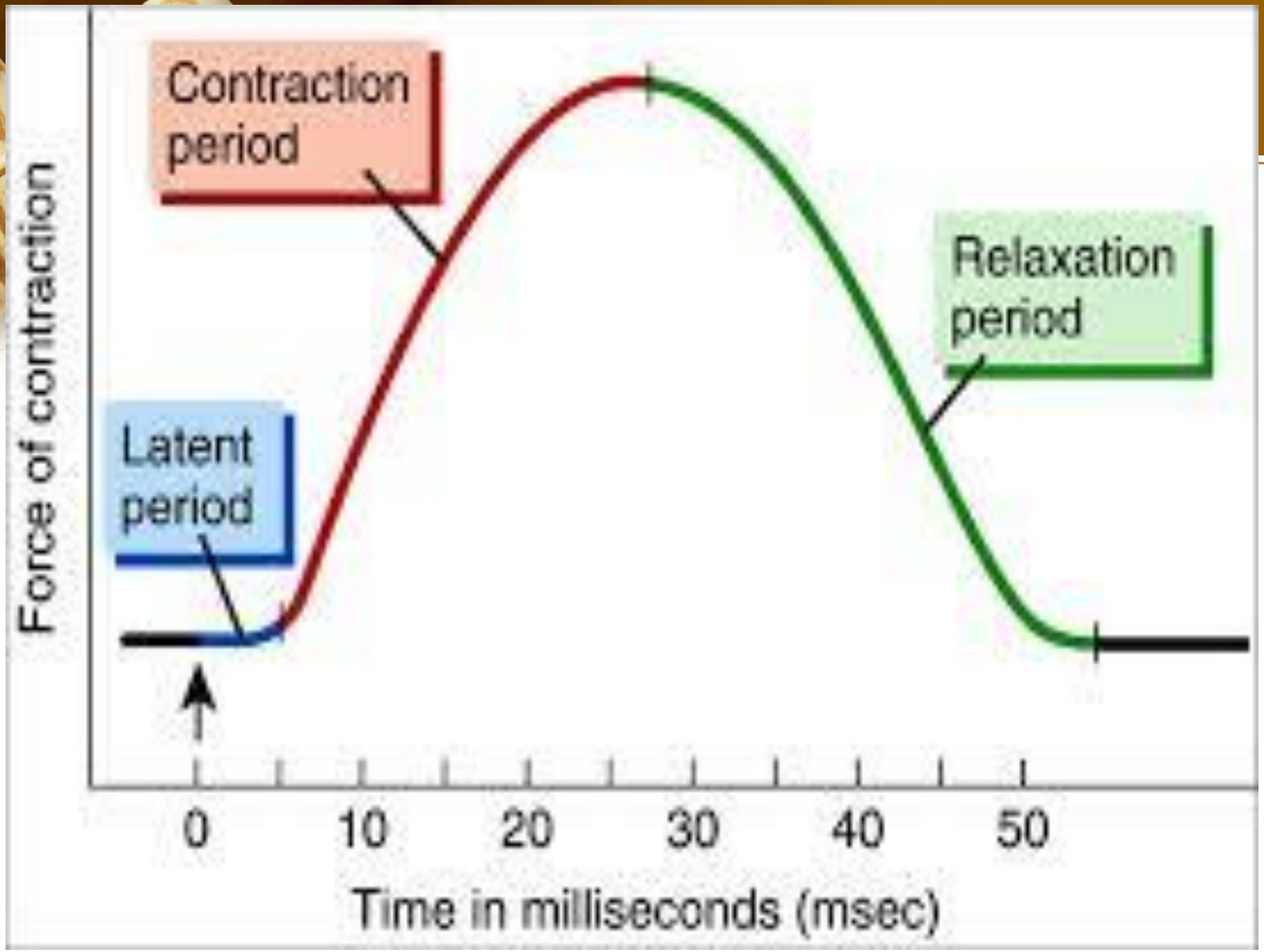
- Use of Electromyography
- **Time relationship** between the onset of electrical activity in the muscle and actual contraction of the muscle or muscle fiber.

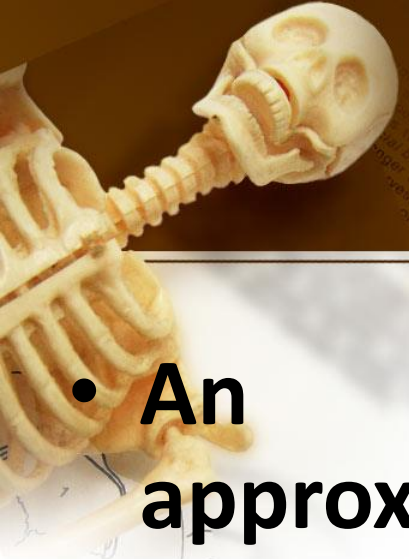
Summation and Tetanic Contraction

- Neural stimulation – **impulse**
- Mechanical response of a motor unit to a s**ingle stimulus**– -→**twitch**
- **Tonic type:** motor units that require more than a single stimulus before the initial development of tension.
- Following stimulation there is an interval of a few milliseconds known as the **latency period** before the tension in the muscle fibers begins to rise.

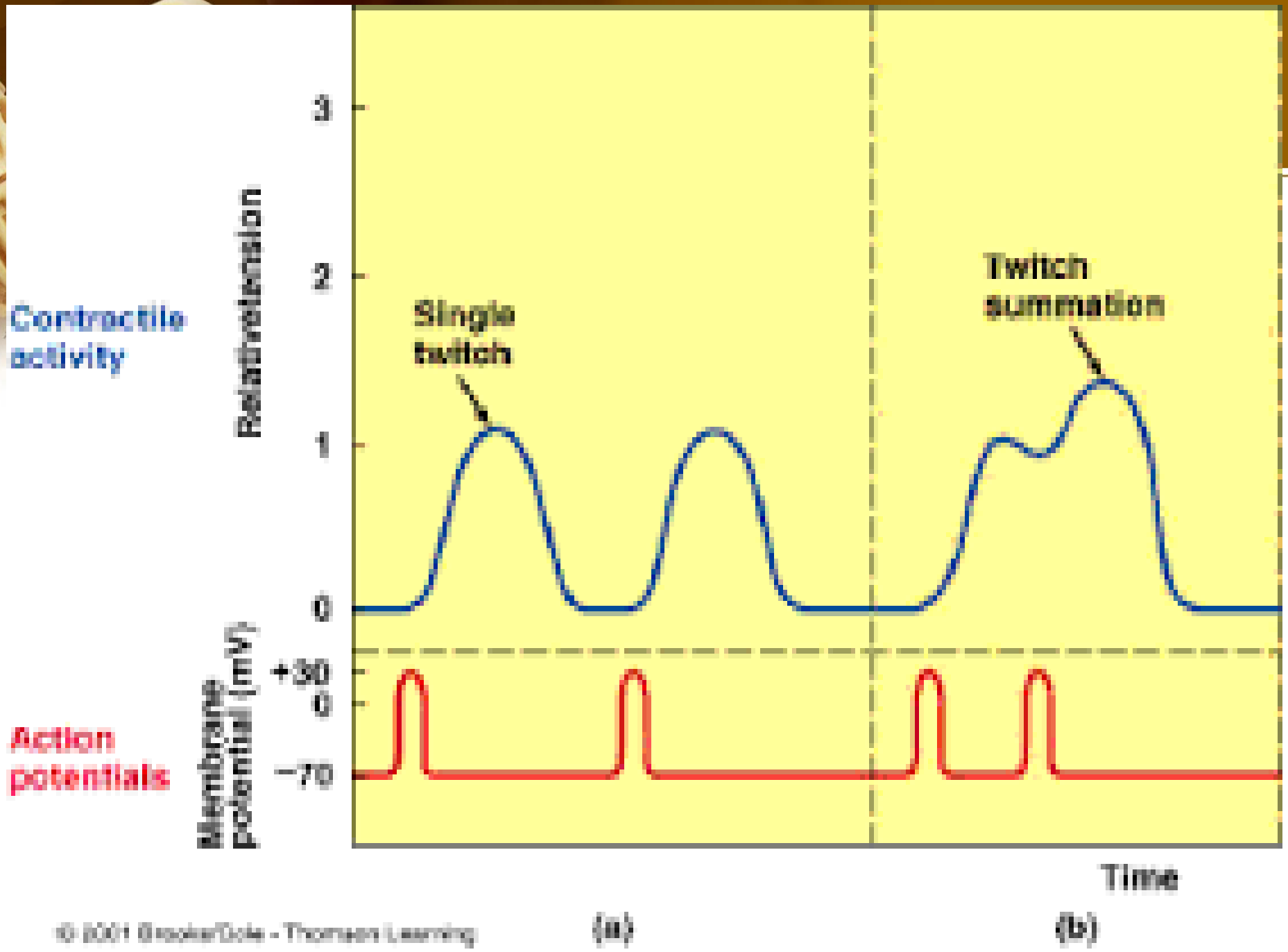


- ❖The time from the start of tension development to peak tension is the **contraction time**
- ❖Time from peak tension until the tension drops to zero is the **relaxation time**
- **Both times depend on Muscle fiber makeup**
- Some muscle fibers contract with a speed of only 10 m sec, others may take 100 m sec or longer.

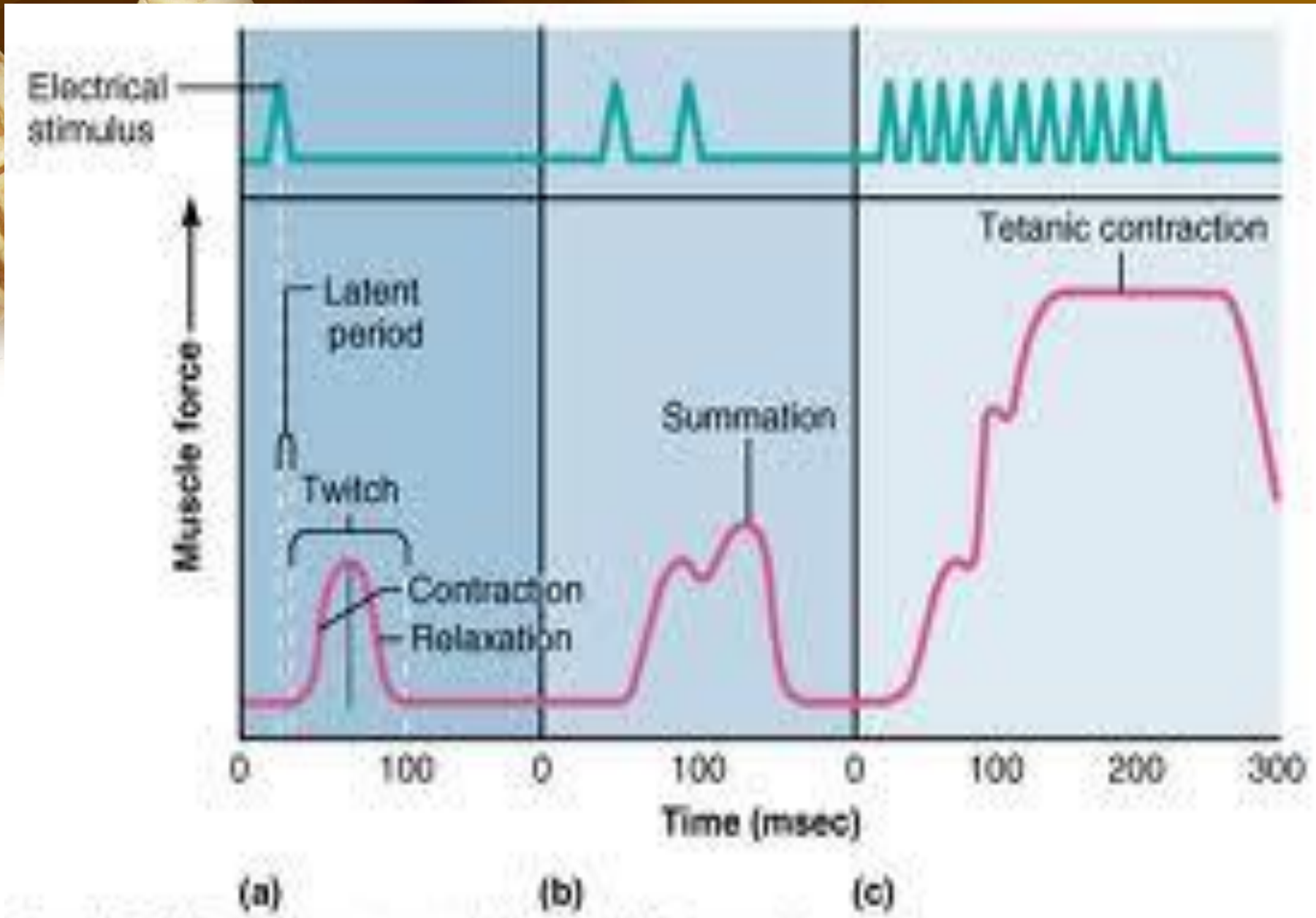

Contraction period
Relaxation period
Latent period
Force of contraction
0
10
20
30
40
50
Time in milliseconds (msec)



- **An action potential lasts only approximately 1 to 2 m sec**
- When mechanical responses to successive stimuli are added to an initial response, the result is known as **summation**
- If a second stimulus occurs during the latency period of the first muscle twitch, it produces no additional response and the muscle is said to be **completely refractory**.



- The greater **the frequency of stimulation** of the muscle fibers. the greater the tension produced in the muscle as a whole.
- A **maximal frequency** will be reached beyond which the tension of the muscle no longer increases.
- when this maximal tension is sustained as a result of summation, the muscle is said to contract **tetanically**.
- Rapidity of stimulation outstrips the contraction relaxation



- All-or-nothing event
- 2 ways to increase tension:
    - Stimulation rate
    - Recruitment of more motor unit
- Size principle
    - Smallest Motor Units recruited first
    - Largest Motor Units last

بسم اللہ الرحمن الرحیم

حدیث شریف

رسول اللہ صلی اللہ علیہ وسلم نے فرمایا:

"گناہوں سے توبہ کرنے والا ایسا ہے

جیسے اس نے گناہ کیا ہی نہیں"۔

ابن ماجہ، جلد ۲، حدیث ۲۰۵۴

Types Of Muscle Contraction

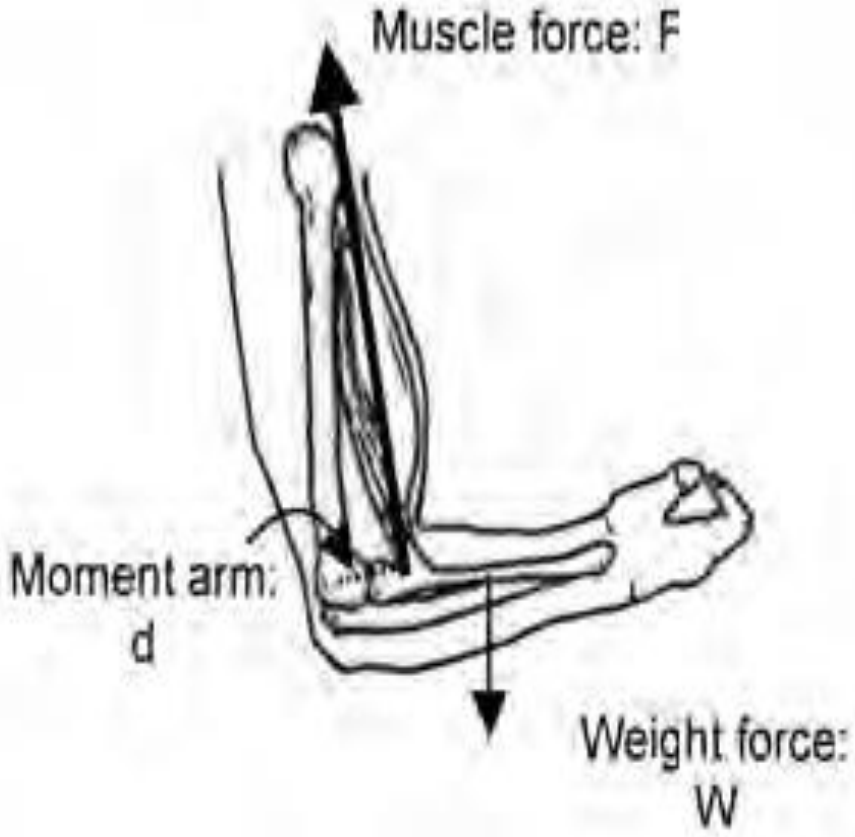
- **Isometric muscle work**
- **Isotonic muscle work (**tone constant, must not effect by leverage, so true sense not possible)

During contraction, the force exerted by a contracting muscle on the bony lever(s) known as the muscle tension, and external force exerted on the muscle is known as the resistance, or load(wt of body leavers).

As muscle exerts its force, it produce moment (torque), on joint. The moment is calculated as product of the muscle force and the perpendicular distance **between** its point of application and center of motion (known as the lever arm, or moment arm).

Muscle work depend on either resistance is overcome or not, hence above muscle work type produces.

- **Dynamic muscle work**
  - **Concentric Muscle work**
  - **Eccentric Muscle work**
  - Isoinertial muscle work (against same resistance…(e.g.. isometric)
  - Isokinetic muscle work(same speed)



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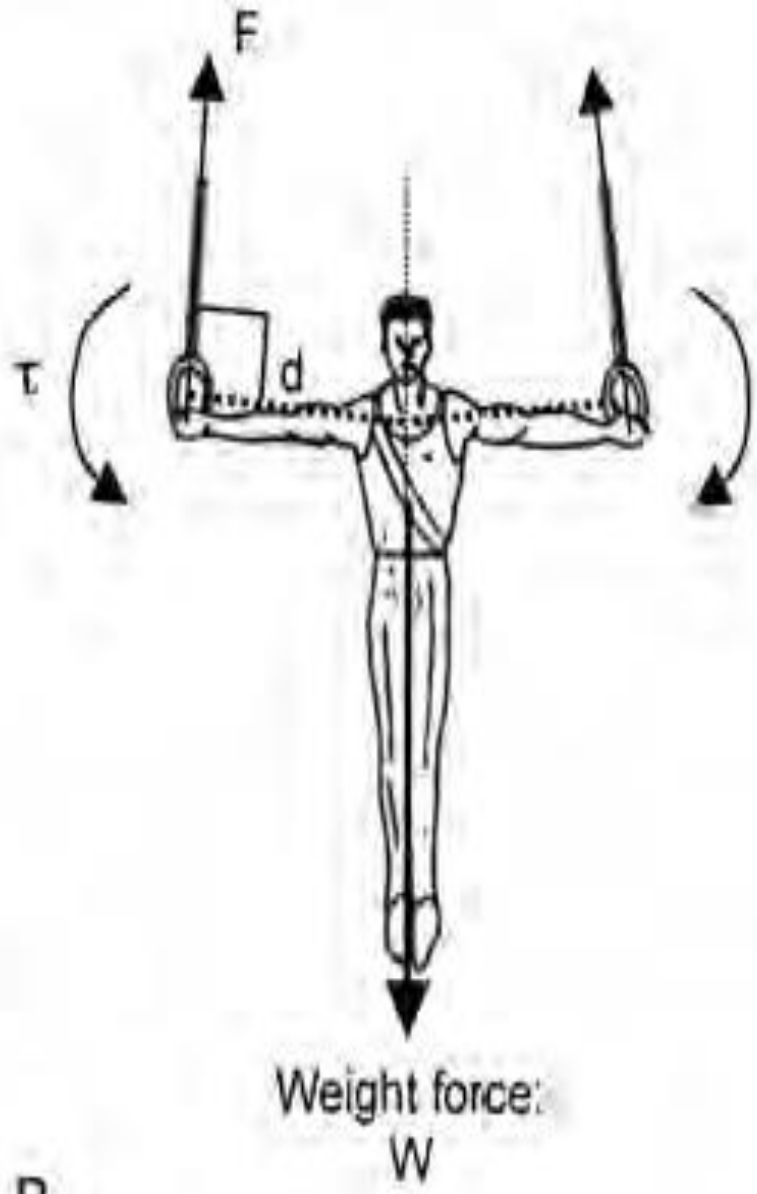
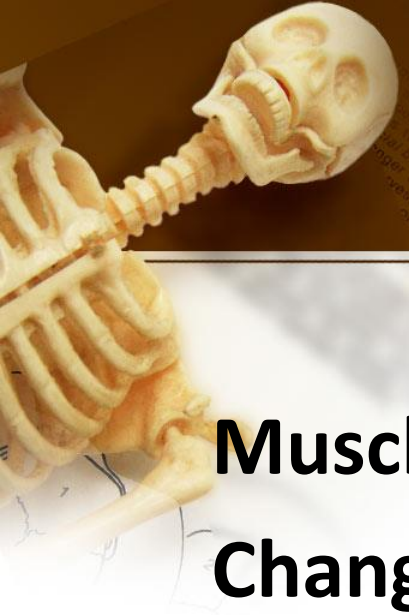


B

MECHANICAL PROPERTIES INFLUENCE FORCE PRODUCTION IN MUSCLE

- The total force that a muscle can produce is influenced by its mechanical properties
  - **Force –length characteristics**
  - **Force (load)– velocity characteristics**
  - **Force-time Relationship**
  - **Effect of skeletal muscle architecture**
  - **Effect Of Pre-stretching**
  - **Effect of temperature difference**
  - **Effect of fatigue**

Force –length characteristics

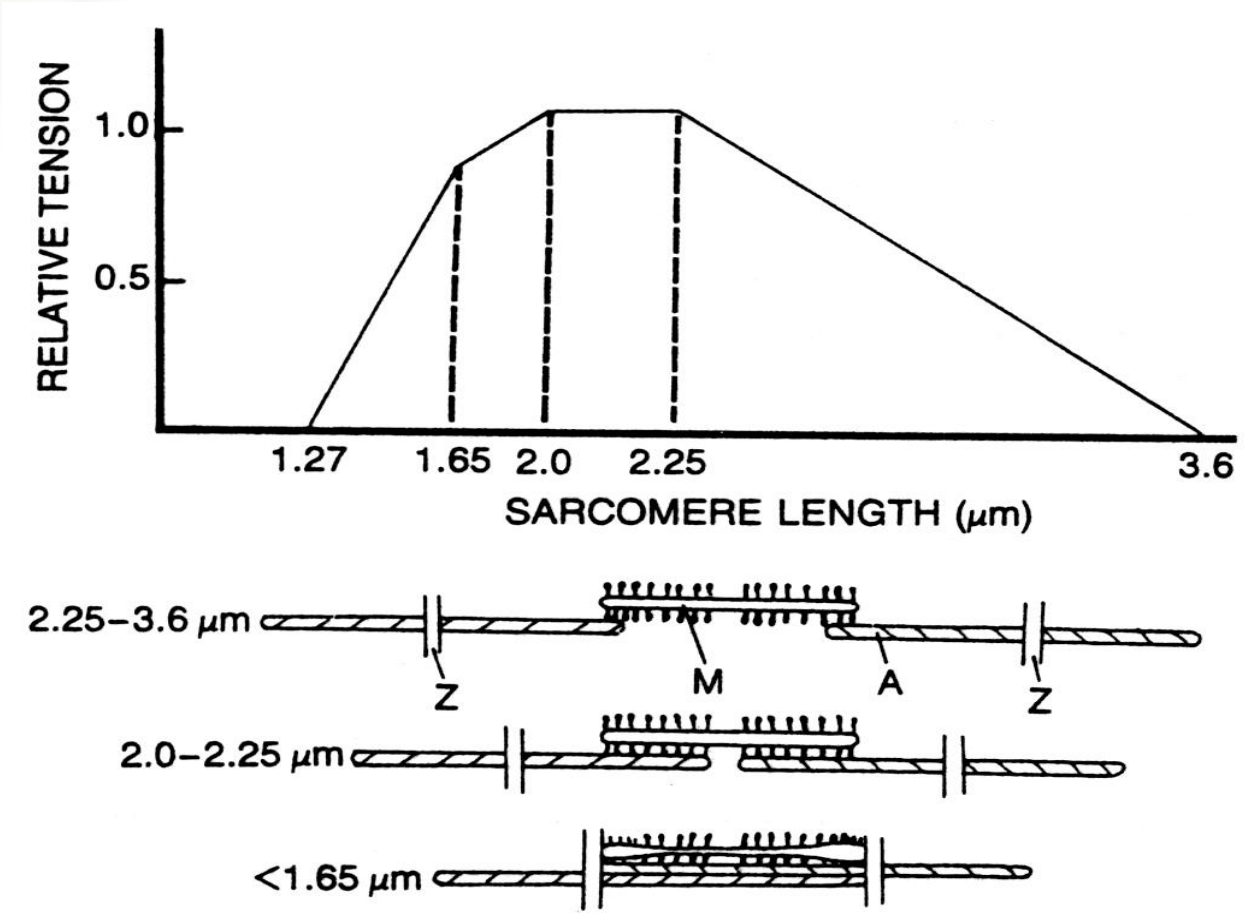


Muscle contract isometrically & tetanically.

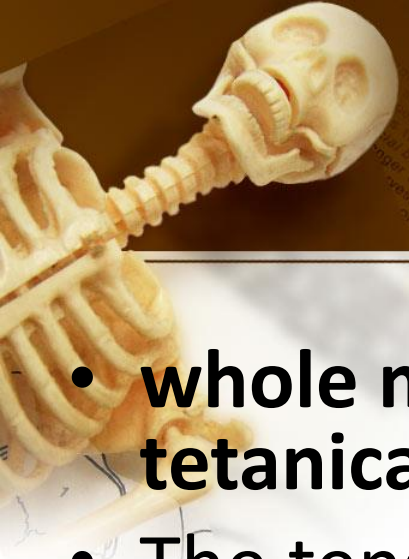
Change in tension with length of muscle fibers

- Resting 2.0-2.25 um, (max. no. of cross bridges;)---→max. tension
- 2.25-3.6 um (no. of cross bridge ↓)
- < 1.65 um (overlap of actin… no. of cross bridge ↓)

Length-tension Relationship



- Maximal tension is produced when the muscle fiber is approximately at its "slack," or **resting, length**.
- If the fiber is held at **shorter lengths**: the tension falls off slowly at first and then rapidly. (stress relaxation)
- If the fiber is lengthened beyond the **resting length:** tension progressively decreases.

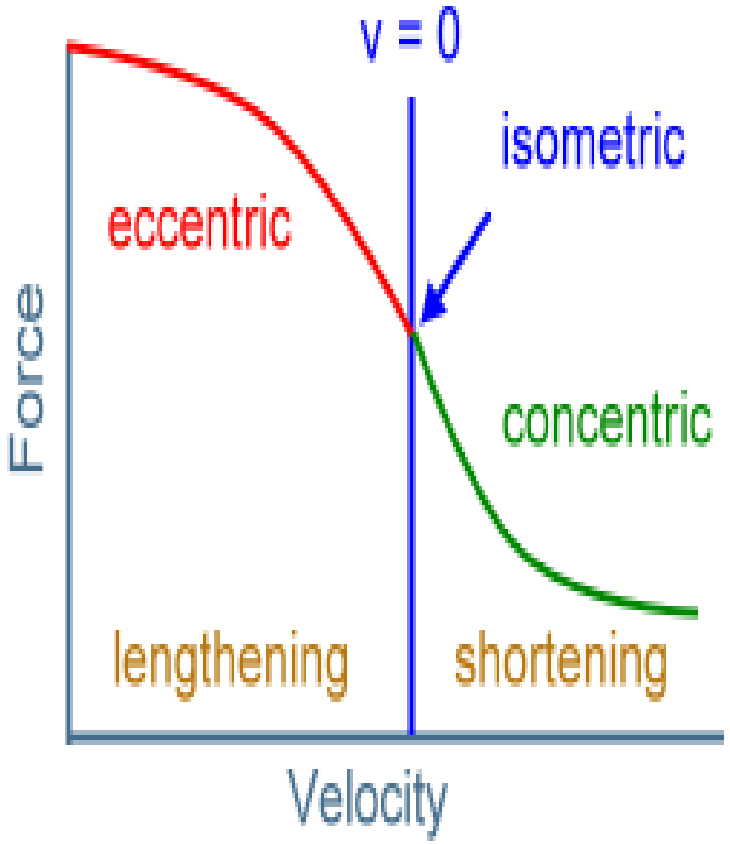


- **whole muscle contracting isometrically and tetanically**
- The tension produced by both active components and passive components must be taken into account
- **Active tension:** represents the tension developed by the contractile elements of the muscle
- **Passive tension :**muscle surpasses its resting length and the non-contractile muscle belly structures stretched. **Passive tension** is mainly developed in the parallel and series elastic components

- When the **belly contracts**, the combined active and passive tensions produce the total tension exerted (active>passive)
- When a muscle is **progressively stretched** beyond its resting length, the passive tension rises and the active tension decreases
- **One joint muscles** normally are not stretched enough for the passive tension to play an important role, but the case is different for **two-joint muscles**

Load-velocity Relationship

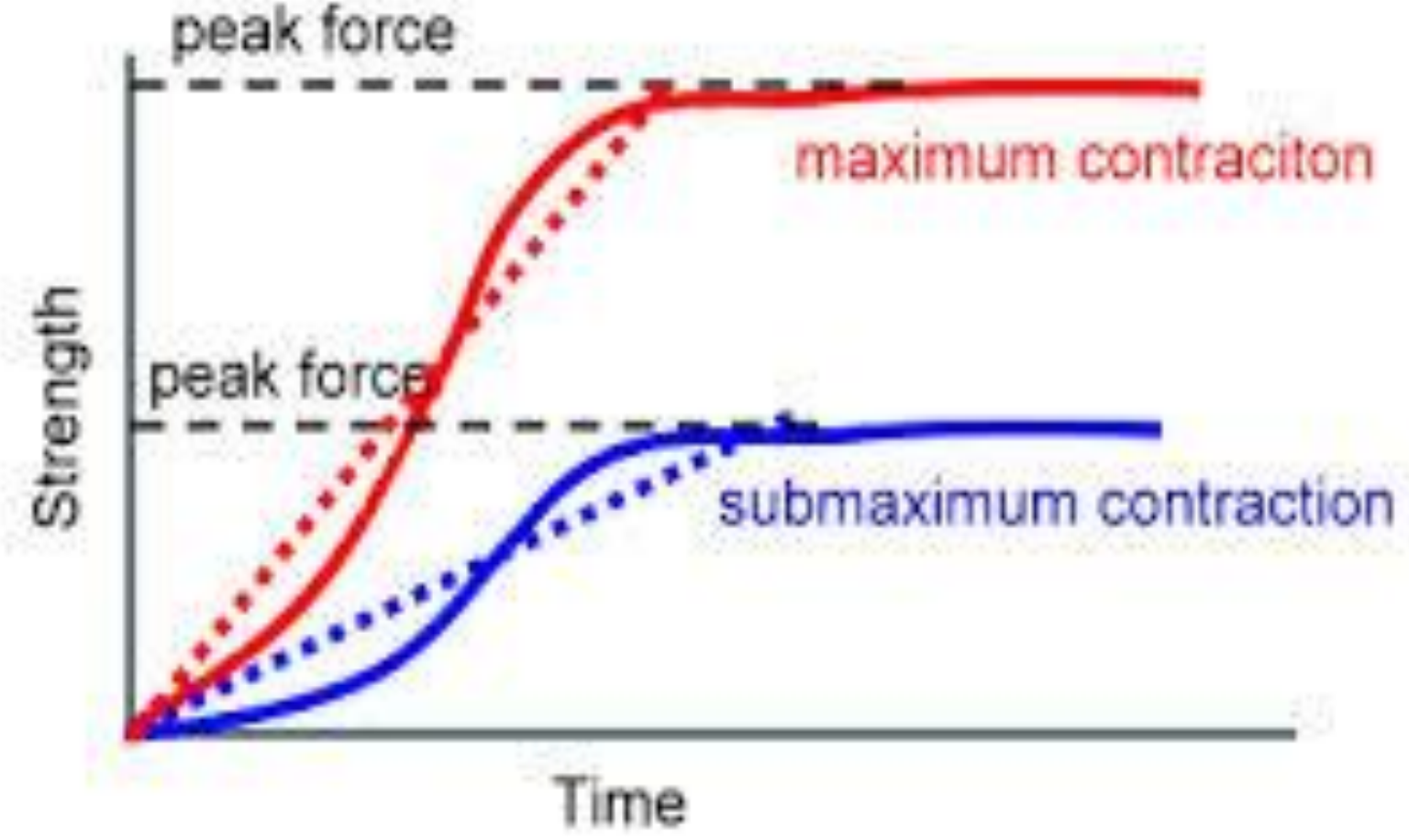
- Shortening is slow with increasing load in **concentric contraction** **(vice versa with decreasing load)**
- Lengthening is more rapid with increasing load in **eccentric contractions**.
- Tension inverse of velocity



Force-Velocity Curve of a Muscle

Force-time Relationship

- The **longer the contraction time**, the greater is the force developed, up to the point of maximum tension **(slow vs fast)**
- Slower contraction leads to greater force production because **time** is allowed for the tension produced
- Active contraction process is of **sufficient duration**



Force-Time Curve

Effect of skeletal muscle architecture

- The arrangement of the contractile components affects the contractile properties of the muscle
- **The more sarcomeres lie in series, the longer is myofibril.** The velocity and the excursion **(working range)** that the muscle can produce are proportional to the **length of myofibril**
- **The more sarcomeres lie parallel the larger the cross-sectional area of the myofibril will be & More force** produced by muscles as force is proportional to the **cross-section** of the myofibril

- Muscles with shorter fibers and a Larger cross sectional area are designed to produce force e.g. **quadriceps muscle**
- Muscles with long fibers are designed for excursion and velocity. The **Sartorius muscle** has longer fibers and a smaller cross-sectional area and is better suited for high excursion

Effect Of Pre-stretching

- **VARIED RESULTS**
- Some evidence shows that muscle perform more work when it shortens in a concentrically contracted state immediately after being light stretched ….than when it shortened from state of pre-stretched or isometric contraction.
- Strong evidences that **stretching (Static)** may reduce the performance or force production in the muscles.? (GTO)

Effect Of Temperature

- A **rise in muscle temperature** causes an increase in conduction velocity across the sarcolemma ----→Increasing **the frequency of stimulation ---→ Increase** production of muscle force
- Rising of the muscle temperature from **6 to 34C** results in an almost linear increase of the tension ratio

- ↑ed temperature= **↑ed enzymatic activity** of muscle metabolism, ↑ed efficiency of muscle contraction
- **Increased elasticity** of the collagen in the series and parallel elastic components causes Increased **extensibility** of the muscle-tendon unit.
- increases the force production of the muscle

- At **low temperature 10C**, it has been shown that the maximum shortening velocity and the isometric tension are inhibited significantly ----→due to **Decreased pH** (acidosis) in the muscle.
- **NOTE:**
- **At physiological PH 7.35-7.45 muscle work best**.

Effect Of Fatigue

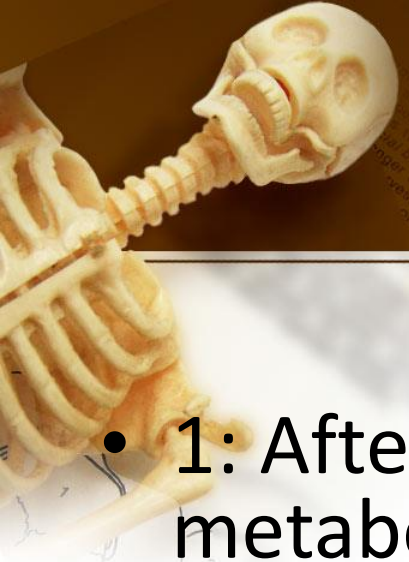
- Physical fatigue, or muscle fatigue, is the temporary physical inability of a muscle to perform optimally.
- The ability of a muscle to contract and relax depend on availability of adenosine triphosphate **ATP**
- ATP breakdown balance ATP Synthesis
- **Imbalance ----→ fatigue**
- Drop in tension after prolonged stimulation/function is muscle fatigue
- Chances of Fatigue are even greater in tetanic phase
- Rest interval recovers ATP improves efficiency of muscle/force production of muscle

Sources of ATP in muscle

1. **Creatine phosphate**
2. Substrate Phosphorylation during **anaerobic glycolysis**.
3. **Oxidative Phosphorylation** in the mitochondria.

- Three energy system depend on intensity & duration determine which and to what extent energy systems used

- When contraction begins **myosin ATPase** rapidly breaks down ATP.
- The increase in adenosine diphosphate (ADP) and phosphate (Pi) concentrations resulting from this breakdown ultimately leads to increased rates of **oxidative Phosphorylation and glycolysis**.



- 1: After a **short lapse(a short duration activity)** metabolic pathways begin to deliver ATP at a high rate**.(aerobic)**
- During this duration the energy for ATP formation is provided by **Creatine phosphate**, which offers the most rapid means of forming ATP in the muscle cell
- 2: At **moderate rates (long duration activity) of muscle activity**, most of the required ATP = oxidative Phosphorylation

- **3: During intense exercise=** ATP is broken down rapidly= limited cell's ability to replace ATP by oxidative Phosphorylation lack of circulatory oxygen.
- The **glycolytic pathway=** much smaller amounts of ATP from the breakdown of glucose operates at a much faster rate proceed in the **absence of oxygen= ATP &lactic acid** end product.
- (During **intense exercise**, anaerobic glycolysis becomes an additional source for rapidly supplying the muscle with ATP)

- The **glycolytic pathway** has the disadvantage of requiring large amounts of glucose for the production of small amounts of ATP **BUT** **myosin ATPase** may breakdown ATP faster than glycolysis can replace it & fatigue occur rapidly.
- After a period of intense exercise, much of the muscle glycogen may have been converted to **lactic acid.**
- **For muscle to be returned to its original state** , creatine phosphate re-synthesized & glycogen stores replaced.

Both process require energy, muscle continue to use oxygen at a rapid rate though it stopped contracting. This oxygen from deep breathing after strenuous exercise

- 20-25% energy used during ATP synthesis and break
- when muscle is operating in its **most efficient state**, a maximum of only approximately **45%** of the energy is used for contraction
- Dissipation energy

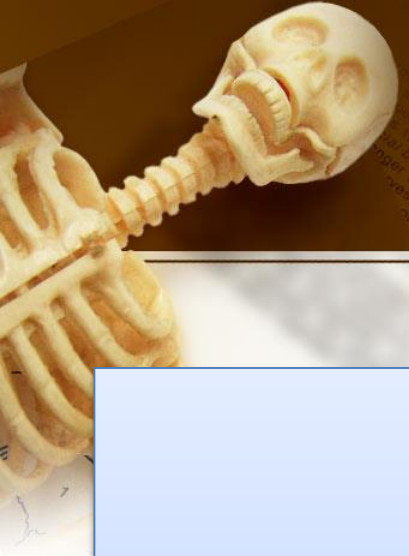
Consequences of fatigue

- Muscle fatigue results in **lack of coordination** of movement
- **Skill** of person performing a given action is affected
- Reduction in **accuracy, control and speed** of contraction which may predispose an individual to **injury**
- Natural fatigue depend on presence of type of muscle fibers(red & white)

- In the average population, approximately 50 to 55% of muscle fibers are **type I**
- Approx. 30 to 35 percent are **type II A**, and approx. are 15 percent **type II B**, but these percentages vary greatly among individuals.
- **Genetically determined**
- **Type of training**

Endurance athletes have type I fibers in abundance e.g. Marathon Runners

Sprinters have Type II fibers in abundance

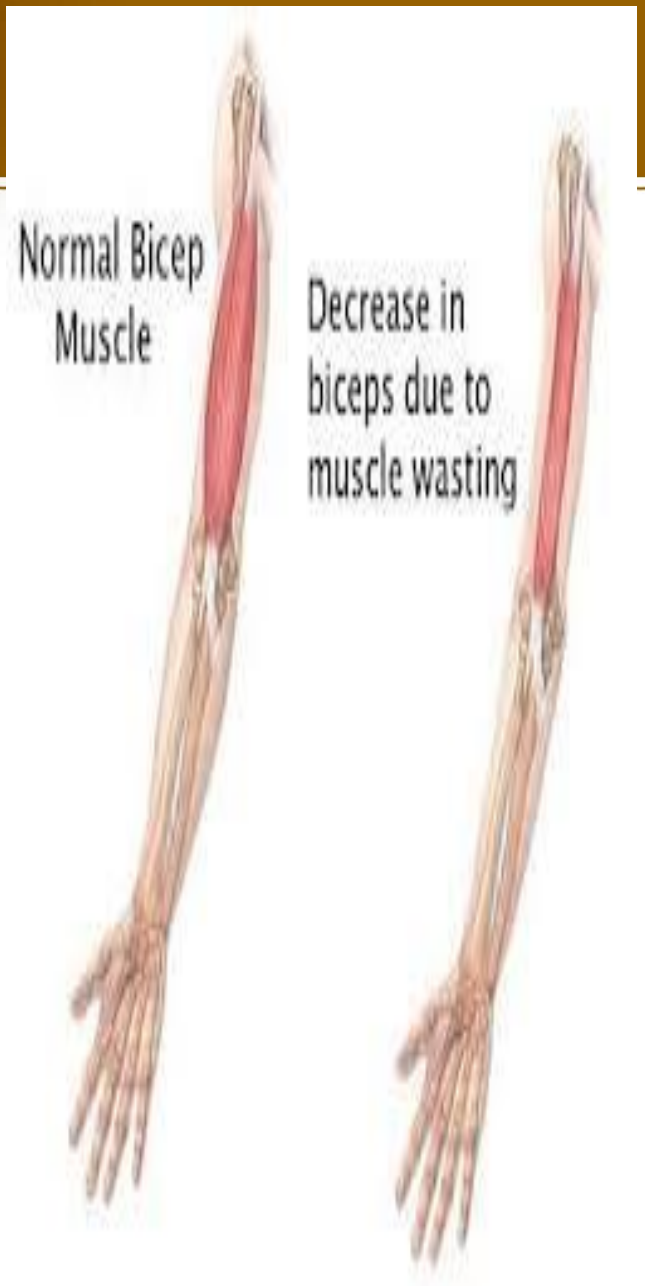


- **MUSCLE REMODELING**

1: Effects of disuse and immobilization

- Both has Detrimental effects
- Muscle **atrophies** on a microstructural and macrostructural level, such as decreased numbers and size of fiber
- **Biochemical** changes occur and affect aerobic and anaerobic energy production.
- Immobilization in a **lengthened position** has a less deleterious effect **as compare to shortened**


Active
Inactive
A.D.A.M.


Normal Bicep Muscle
Decrease in biceps due to muscle wasting

- **immediate or early motion** may prevent muscle atrophy after injury or surgery
- Cannot be reversed through the use of only **isometric exercises** in case of applied plasters, so require
- 1:::dynamic resistance exercises rehabilitation or
- 2:: Partly **mobile casts** should used

- **Human muscle biopsy** : type I fibers that atrophy with immobilization; their cross-sectional area decreases and their potential for oxidative enzyme activity is reduced
- **Early motion**
- **When muscle is placed under tension** :afferent (sensory) impulses from the intrafusal muscle spindles will increase, leading to increased stimulation of the type I fiber(by stimulation of extrafusal fibers)

- Although **intermittent isometric exercise** may be sufficient to maintain the metabolic capacity of the type II fiber
- Type I fiber (the postural fiber) requires a more **continuous impulse**.
- **Electric stimulation** may prevent the decrease in type I fiber size…
- **Fibers affected may be in accordance with the sports involved**

THANK YOU

بسم اللہ الرحمن الرحیم

حضور نبی کریم ﷺ نے فرمایا:-

مجھے بچوں کی پانچ عادتیں بہت پسند ہیں۔

☆ وہ رو کر مانگتے ہیں اور اپنی بات منوا لیتے ہیں۔

☆ وہ مٹی سے کھیلتے ہیں اور غرور تکبر خاک میں ملا دیتے ہیں۔

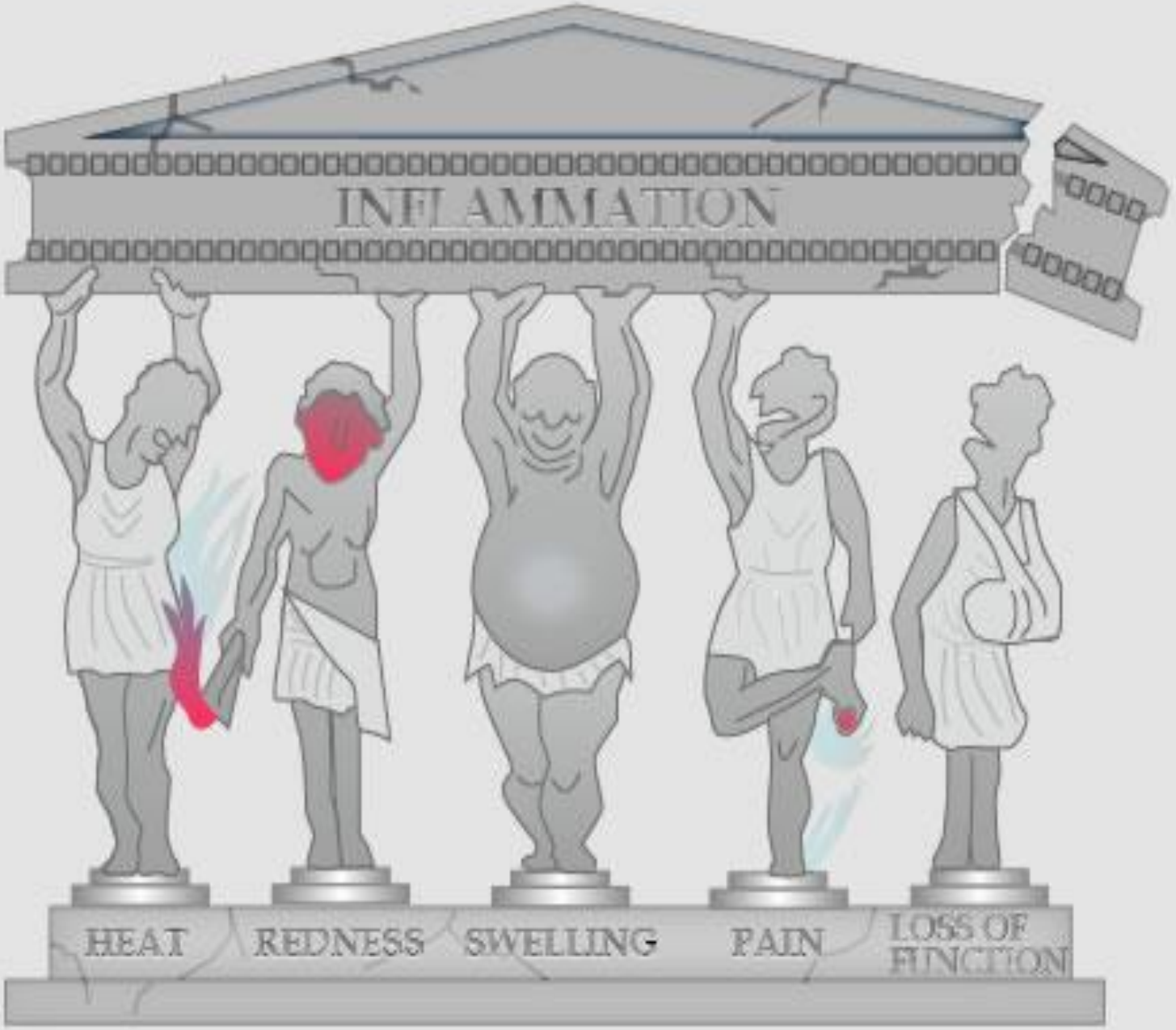
☆ جو مل جائے کھا لیتے ہیں زیادہ جمع یا ذخیرہ کرنے کی ہوس نہیں رکھتے۔

☆ لڑتے ہیں جھگڑتے ہیں اور پھر صلح کر لیتے ہیں یعنی دل میں حسد بغض اور کینہ نہیں رکھتے۔

☆ مٹی کے گھر بناتے ہیں۔ کھیل کر گرا دیتے ہیں یعنی وہ بتاتے ہیں کہ یہ دنیا باقی رہنے والی نہیں بلکہ ختم ہو جانے والی ہے۔

Muscle Injuries

- Muscle injuries comprise contusion, laceration, **ruptures**, ischemia, compartment syndromes, and **denervation**
- These injuries weaken the muscles, decreased ROM,cause muscle wasting, and **significant disability**.



Contusions

Contusions are a direct injury resulting from a blow of an object to a part of the body, damaging muscle tissue and internal bleeding occurs.

Example:

Two soccer players knee collides with the others thigh area

resulting in a contusion (corked thigh)

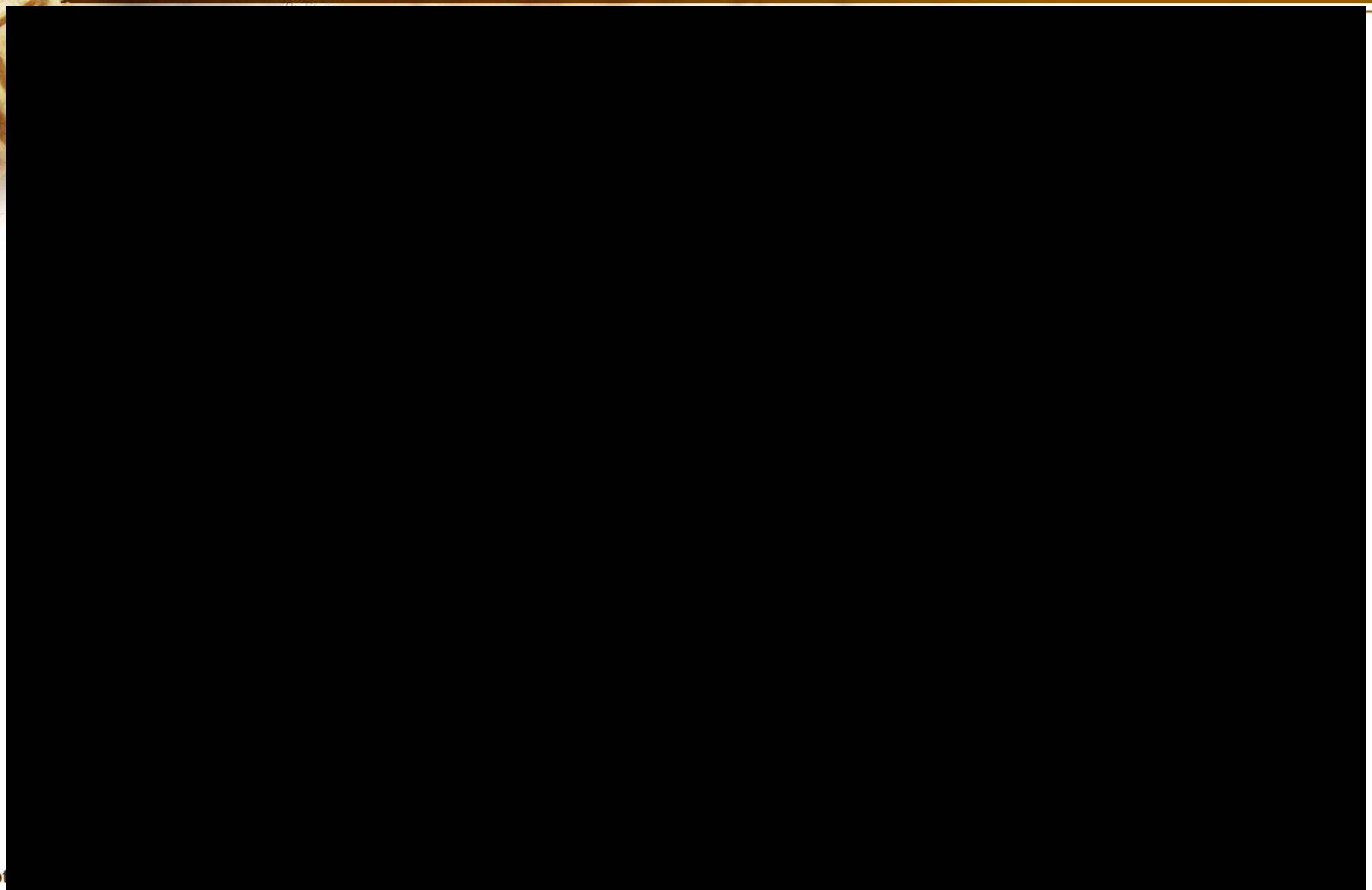
Laceration

A laceration is a tearing or ripping of the skin that result in a significant blood loss.

The repair of a laceration may require stitching and result in a permanent scar.

- A significant risk of infection as dirt and other particles can enter the blood stream.

Compartment syndrome



Compartment syndrome

- Compartment syndrome is a painful condition that occurs when pressure within the muscles builds to dangerous levels. This pressure can decrease blood flow, which prevents nourishment and oxygen to nerve and muscle cells.
- Compartment syndrome can be either acute or chronic.
- Acute compartment syndrome is a medical emergency. It is usually caused by a severe injury. Without treatment, it can lead to permanent muscle damage.
- Chronic compartment syndrome, also known as exertional compartment syndrome, is usually not a medical emergency. It is most often caused by athletic exertion.

Volkmann's contracture

- A permanent flexion contracture of the hand at the wrist, resulting in a claw-like deformity of the hand and fingers. Passive extension of fingers is restricted and painful.
- Volkmann's contracture results from acute ischaemia and necrosis of the muscle fibers of the flexor group of muscles of the forearm, especially the flexor digitorum profundus and flexor pollicis longus. The muscles become fibrotic and shortened.
- The condition is caused by obstruction on the brachial artery near the elbow, possibly from improper use of a tourniquet, improper use of a plaster cast, or compartment syndrome.
- It is also caused by fractures of the forearm bones if they cause bleeding from the major blood vessels of the forearm

Figure 2 – Close-up dorsolateral view of left hand highlights hyperextension constituting grotesque deviation from ordinary position of the metacarpophalangeal joints. Fifth finger metacarpophalangeal is by contrast only slightly hyperextended.

THANK YOU