AGA 2110

THE MUSCULAR SYSTEM1

INTRODUCTION - TERMINOLOGY

- **Myo** – prefix, refers to muscle generally
- Myocytes – muscle cells
- **Myology** – study of muscles
- **Sarco** – means flesh or muscle cells
- **Sarcolemma** - The plasma membrane of muscle fibers
- **Sarcoplasm** - the cytoplasm
- **Sarcoplasmic reticulum (SR)** - specialized smooth endoplasmic reticulum, which stores, releases & retrieves calcium ions (Ca++)
- **Sarcomere** - functional unit of a skeletal muscle fiber

INTRODUCTION

- Muscle cells are uniquely designed for contraction.
- The muscular system, in conjunction with the skeletal system, allows the movement of internal structures, limbs, & the body as a whole.

FUNCTIONS OF MUSCLES

i. Movement of body parts and organ contents
ii. Maintain posture
iii. Control of openings and passageways
iv. Heat production

MUSCLE TISSUE CLASSIFICATION

❑ Muscle tissue can be categorized according to;

1. Function (skeletal, visceral, or cardiac)
2. Activation method (voluntary or involuntary)
3. Physiology (smooth, striated or unstrained)

❑ There are 3 types of muscle tissue:

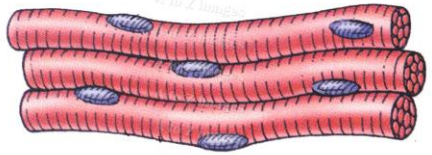
✓Skeletal muscle

✓ Smooth muscle

✓ cardiac muscle

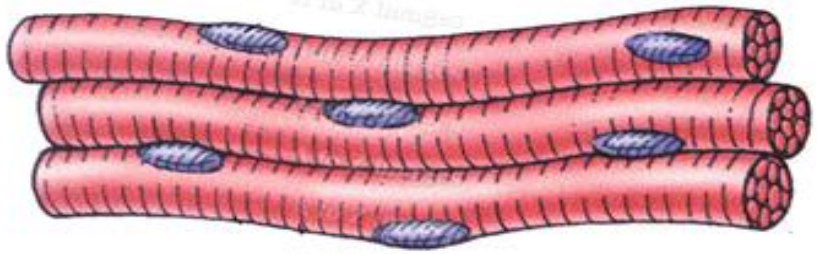
SKELETAL MUSCLE

- The cells of skeletal muscle are essentially fibres (muscle fibers) that are clustered into bundles
- Most abundant muscle in the body
- Usually attached to bones of the skeleton, hence the name
- Bundles are held together by loose connective tissue
- They are not branched & do not anastomose (no intercalated disc).
- Have Multiple, peripherally arranged nuclei in each cell in contrast to both smooth & cardiac muscle cells.
- Skeletal muscles are striated when viewed microscop
- Are under voluntary control



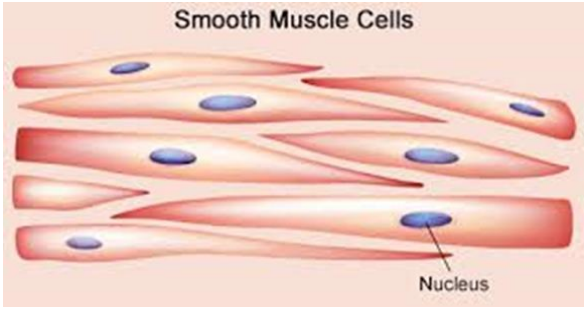
SKELETAL MUSCLE

- Skeletal muscle is responsible for producing the voluntary movements of the limbs, trunk, and head.
- It is also the muscle tissue with which we are most familiar as the meat of our domestic animals



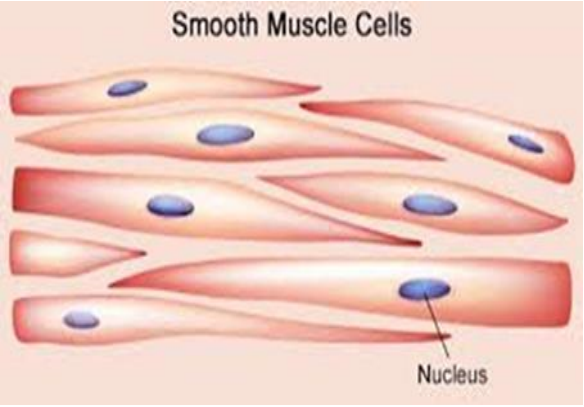
SMOOTH MUSCLE

- Individual cells/fibers are spindle shaped & have a centrally located nucleus
- So named because it has no visible striations hence appear smooth microscopically
- Smooth muscles are stimulated to contract by the action of nerves
- Unlike skeletal muscles, contractions cannot be consciously controlled. Muscles are therefore called non-striated involuntary muscles



SMOOTH MUSCLE LOCATION

- ❑Found in systems of the body with autonomic function.
- ❑ Found in the walls of following hollow organs;
- ✓ Blood vessels
- ✓ Urinary bladder
- ✓ Uterus
- ✓ Intestines
- ✓ Stomach



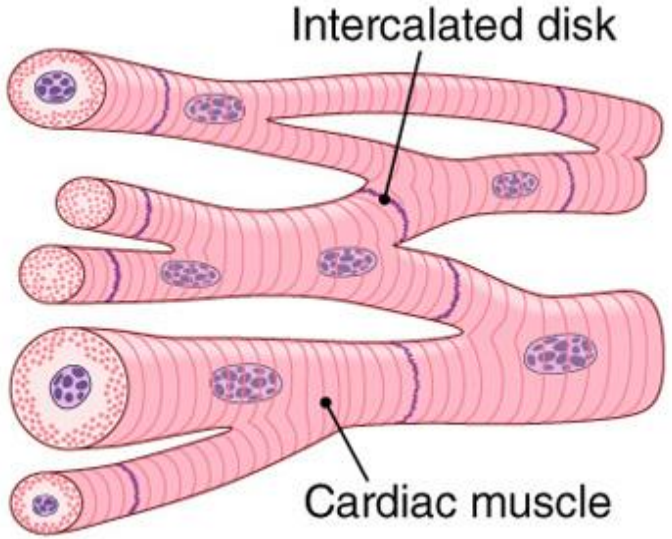
- ❑ Also found in exocrine glands & respiratory tract
- ❑ Responsible for peristalsis (GIT), constriction of blood vessels & emptying of bladder

CARDIAC MUSCLE

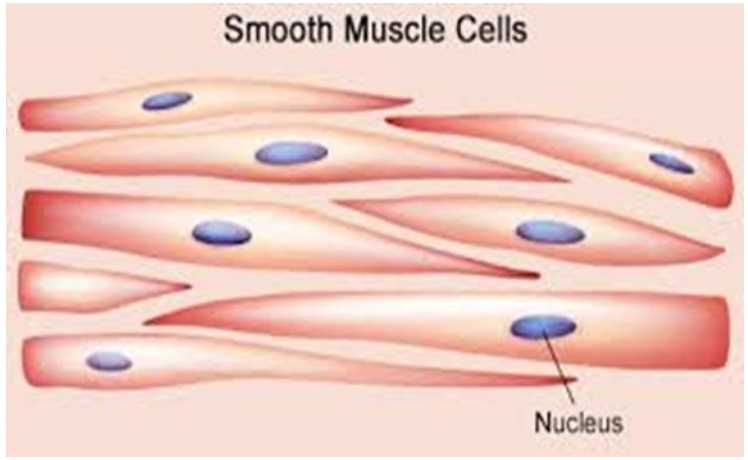
- Cardiac muscle is found only in the heart.
- Cardiac muscle is composed of elongated branching cells with irregular contours at their junctions with other cells
- The cardiac muscle cells are connected to one another at each end via specialised intercellular junctions intercalated discs
- Each cell has one nucleus (sometimes two) that is centrally located..
- Cardiac muscle shows striation & are classified as involuntary striated muscle

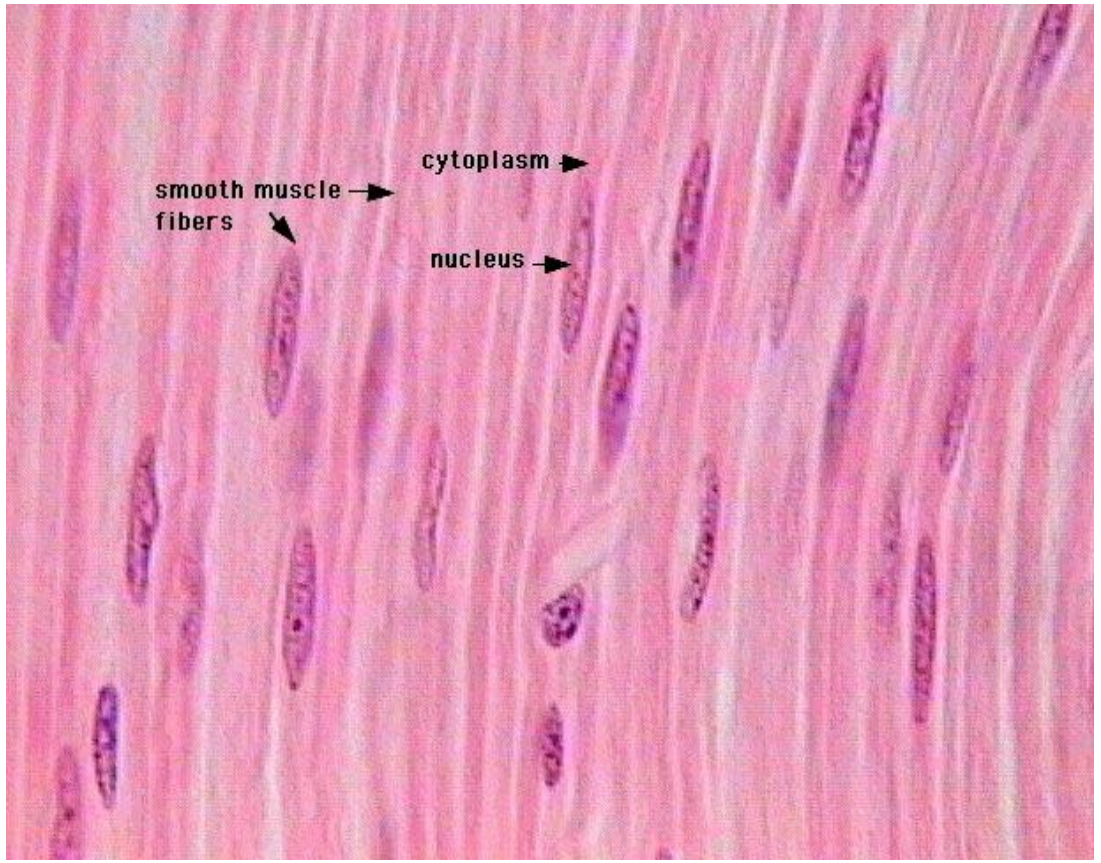
CARDIAC MUSCLE

- ❑ Has 1 or 2 nuclei
- ❑ Nuclei are centrally located
- ❑ Have intercalated discs
- ❑ Involuntary, striated



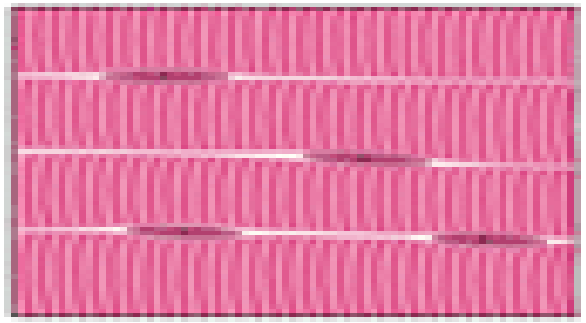
SMOOTH MUSCLE CELLS





3 TYPES OF MUSCLE TISSUE

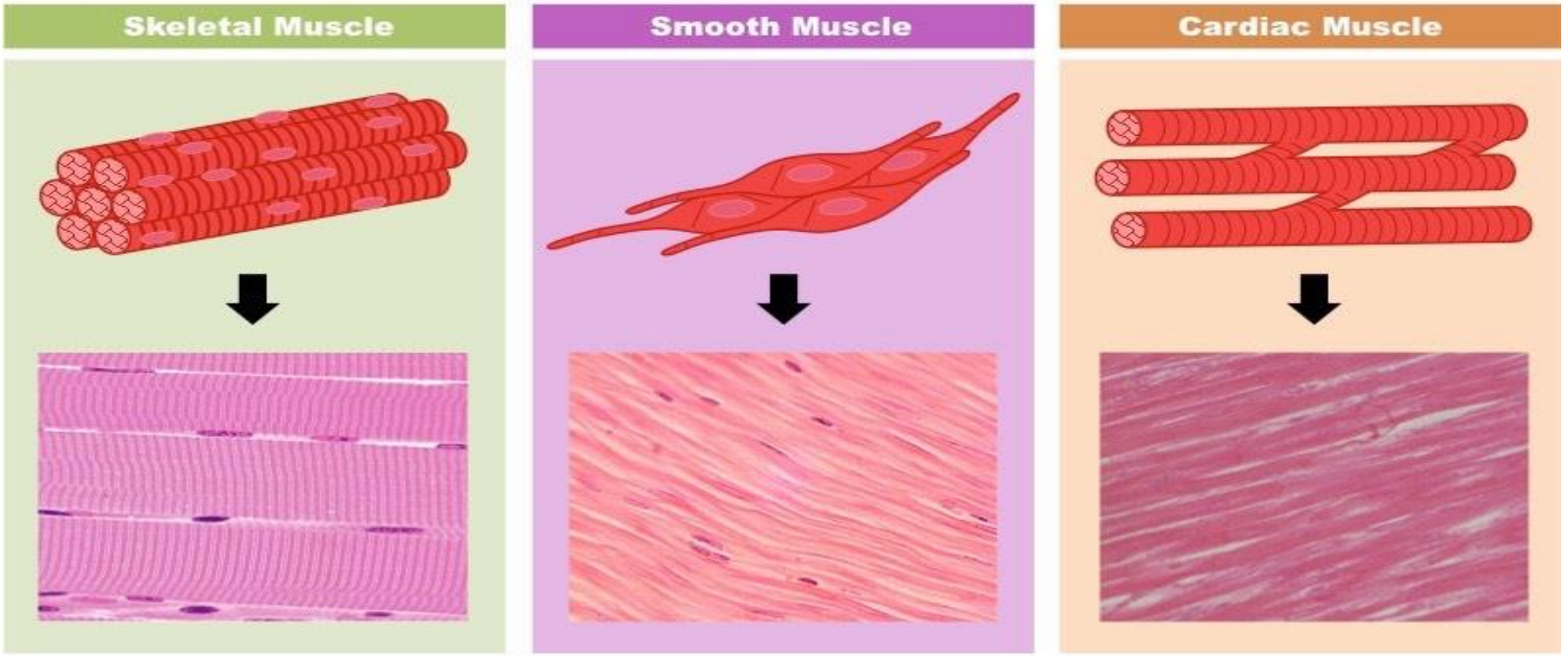
Skeletal



Smooth

Cardiac

3 TYPES OF MUSCLE TISSUE

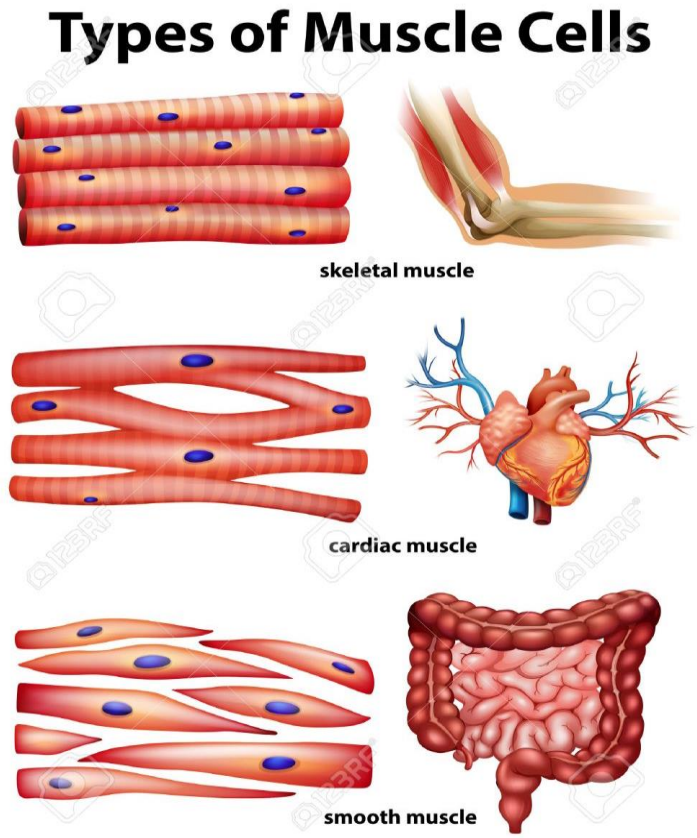


MYOCADIUM

- This is the muscular part of the heart
- It forms the walls for the compartments (chambers) of the heart.
- The muscle fibers are arranged so that, when they contract, blood is ejected from the chambers
- Heart has 4 chambers

SUMMARY - CATEGORIES OF MUSCLE TISSUE

- ✓ Skeletal (striated, voluntary)
- ✓ Cardiac (striated, involuntary)
- ✓ Smooth (non-striated, involuntary)



CONTRACTION OF MUSCLE IN GENERAL

- ❑ Role of muscle is contraction
- ❑ Relaxation is a passive process means lack of contraction
- ❑ Contraction – shortening of muscle fibers
- ❑ Contraction causes following

✓ In the skin, contraction of smooth muscles causes the hair to stand up

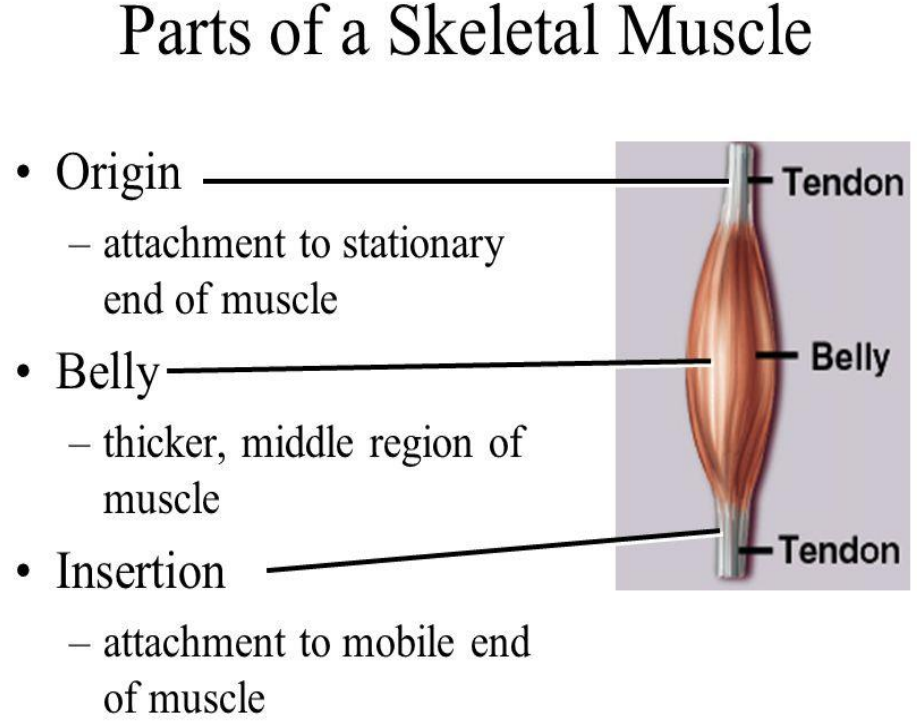
✓ Smooth muscle in walls of the GIT contract to mix & propel food along the tract

✓ Contraction of the cardiac muscle helps distribute blood to the body

PARTS OF A SKELETAL MUSCLE

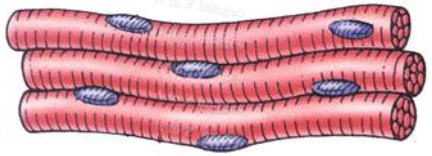
1. Origin
2. Belly
3. Insertion

❑ Most muscles attach at 2 places and cross a joint



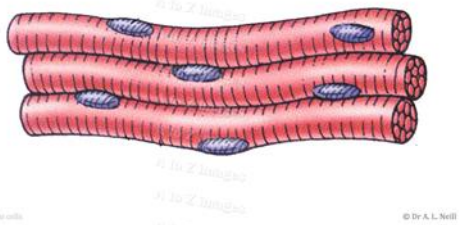
CONNECTIVE TISSUES WRAPPINGS OF SKELETAL MUSCLE

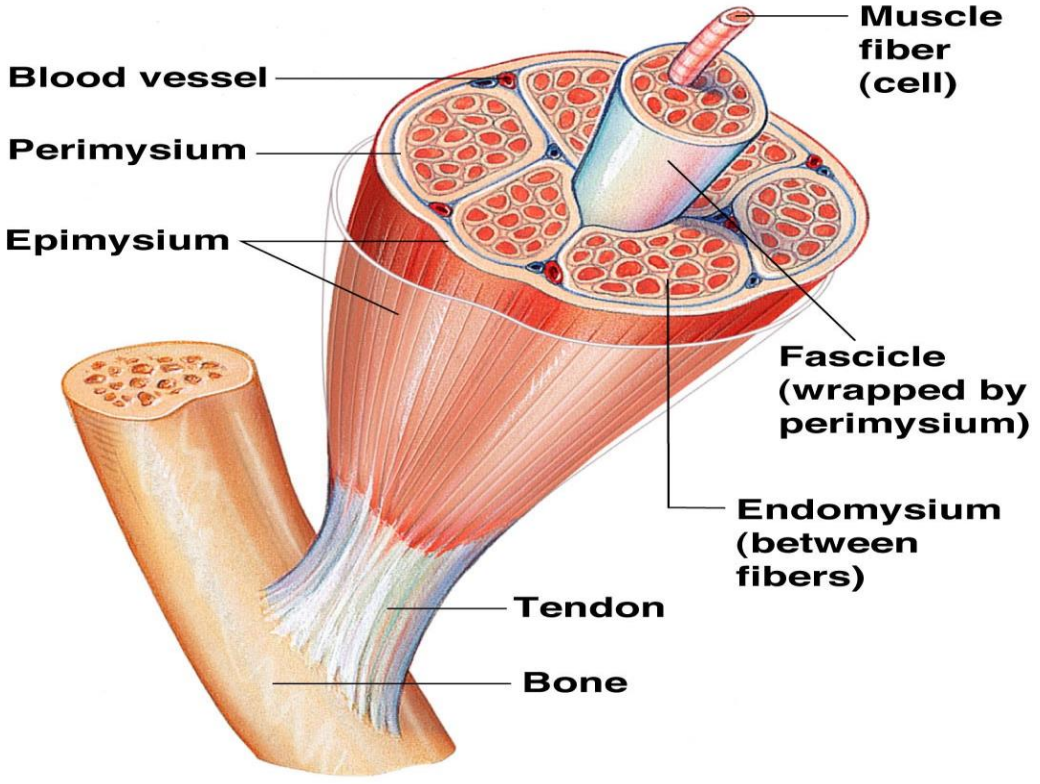
- **Endomysium** - Sheath of connective tissue that surrounds each muscle fiber.
- **Perimysium** - Sheath of connective tissue that holds fascicles together.
- **Epimysium** - Sheath of connective tissue that surrounds the entire muscle. Also known as deep fascia
- **Tendon**
- Fascicle - A bundle of muscle fibers (myoctes)



CONNECTIVE TISSUES OF A MUSCLE

- A bundle of skeletal muscle fibers is called a fascicle





CONNECTIVE TISSUE WRAPPIGS OF A MUSCLE

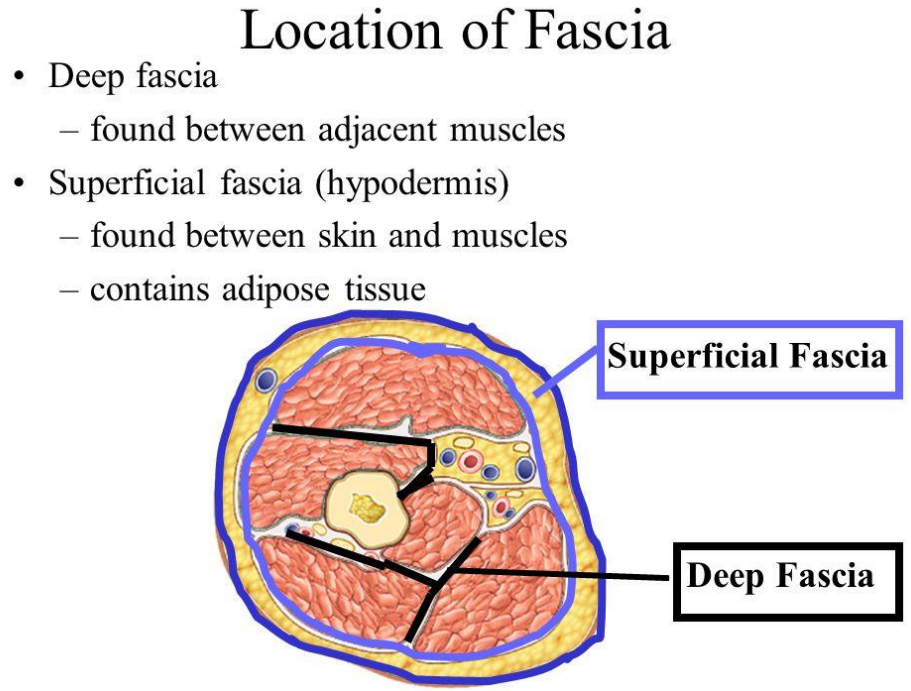
- **Endomysium** – Around a single muscle fiber ie the thin areolar tissue around each cell –allows room for capillaries and nerve fibers.
- **Perimysium** – slightly thicker layer of connective tissue which surrounds a fascicle. A fascicle is a bundle of cells (fibers)
- **Epimysium** – covers the entire skeletal muscle ie whole muscle belly blends into CT between muscles
- **Fascia** – On the outside of the epimysium

CONNECTIVE TISSUES OF A MUSCLE

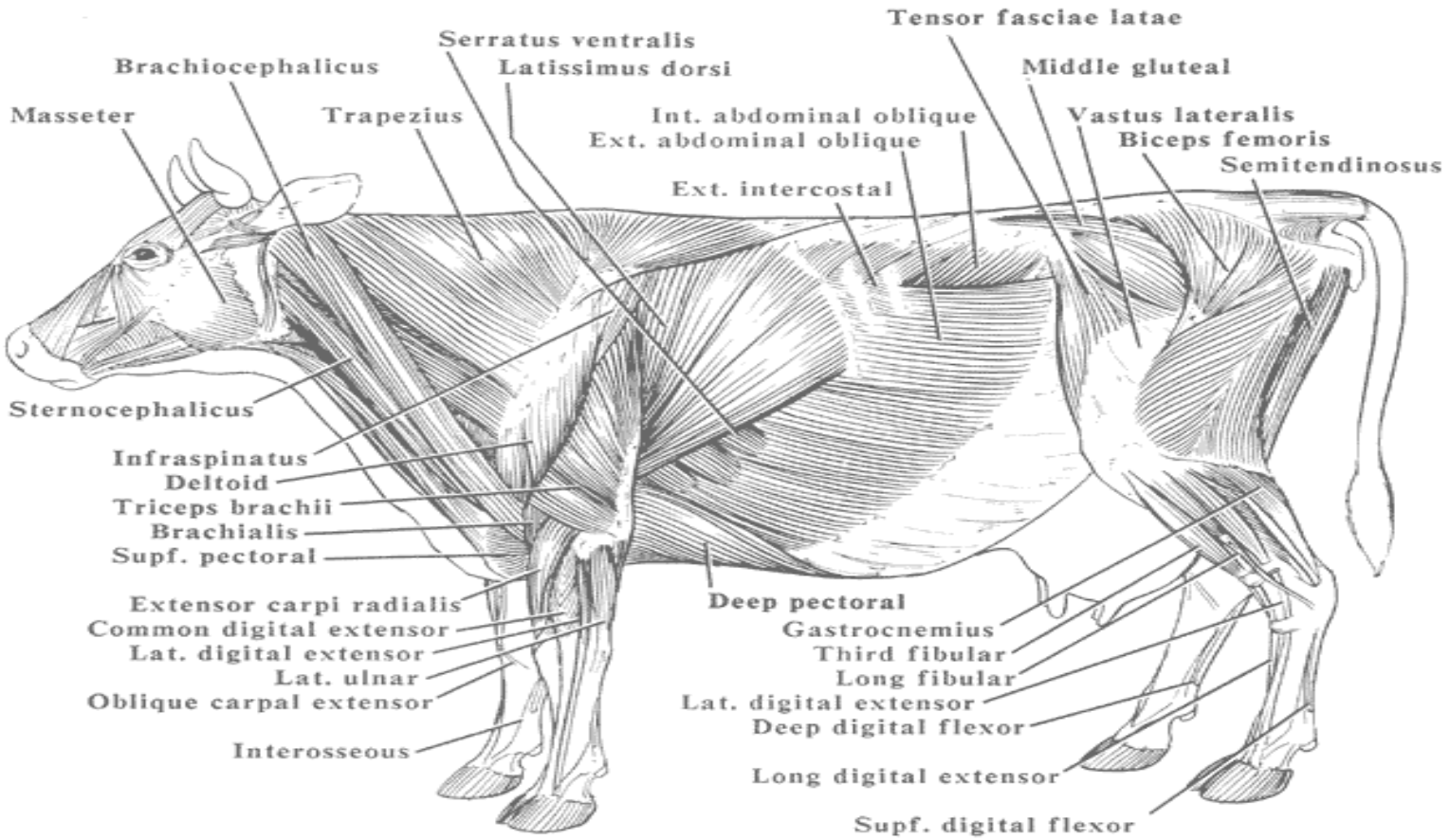
LOCATION OF FASCIA

✓Superficial Fascia (**hypodermis**) –adipose between skin and muscles

✓ Deep Fascia–found between adjacent muscles



SUPERFICIAL MUSCLES OF ANIMALS



ARRANGEMENT OF MUSCLE FIBERS (SHAPES)

❑ Muscle fibers may be arranged in different ways;

1. **FUSIFORM MUSCLES** –thick in middle & tapered at ends Eg *Biceps*
2. **PARALLEL (strap) MUSCLES** - have parallel muscle fibers–*Rectus abdominis*
3. **CONVERGENT MUSCLE** – broad at origin & tapering to a narrower end
4. **PENNATE MUSCLES** – fascicles insert obliquely on a tendon (feather-like)

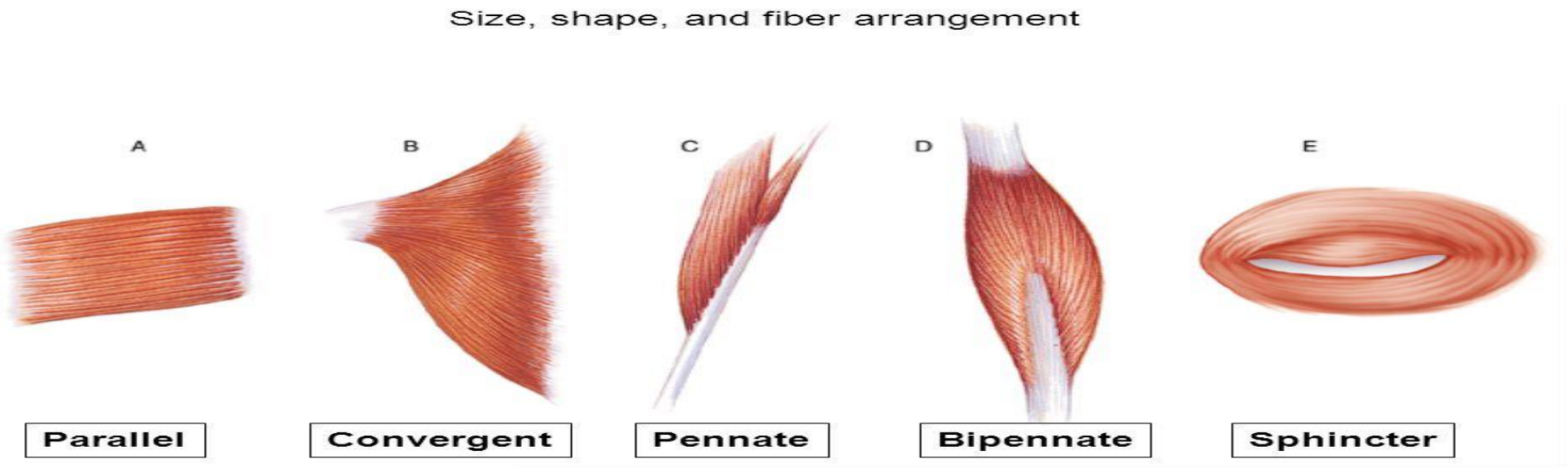
✓Unipennate – muscle fiber come from one side

✓Bipennate – from 2 sides

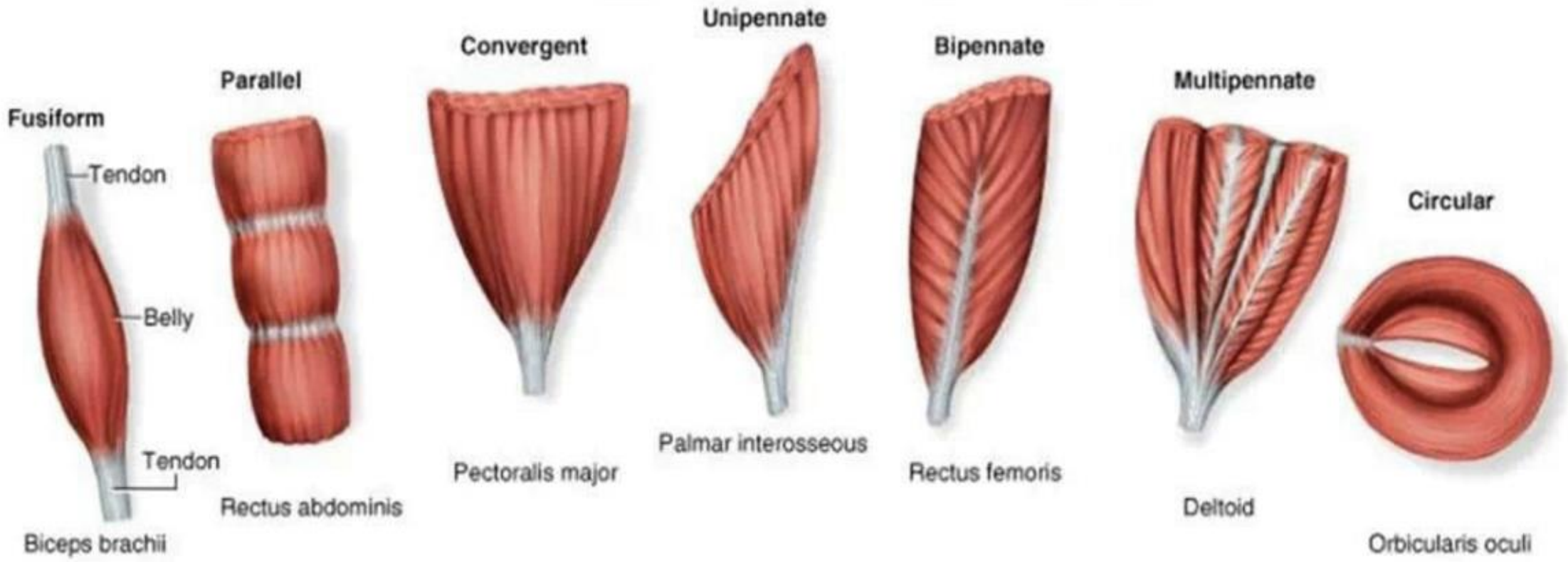
✓Multi-pennate – from 3 or more sides

5. **CIRCULAR MUSCLES** – ring around body opening

ARRANGEMENT OF MUSCLE FIBERS (SHAPES)



ARRANGEMENT OF MUSCLE FIBERS (SHAPES)



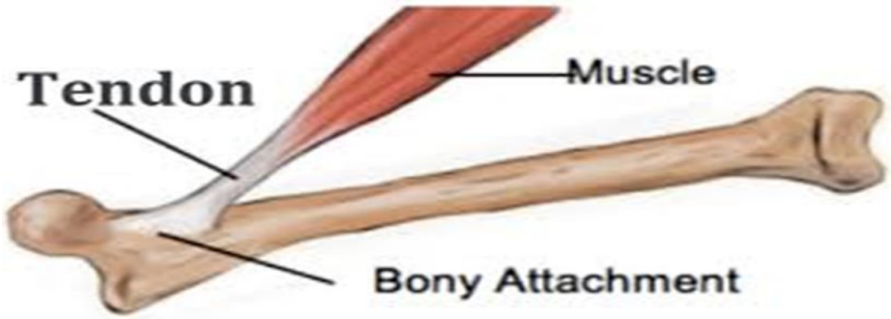
SKELETAL MUSCLE ATTACHMENTS

1. TENDONS

✓ Connect muscles to bones

✓ Tendon is a tough fibrous connective tissue that is a continuation of the epimysium

✓ Most tendons are cords or bands that attach spindle-shaped or pennate muscles to bones.

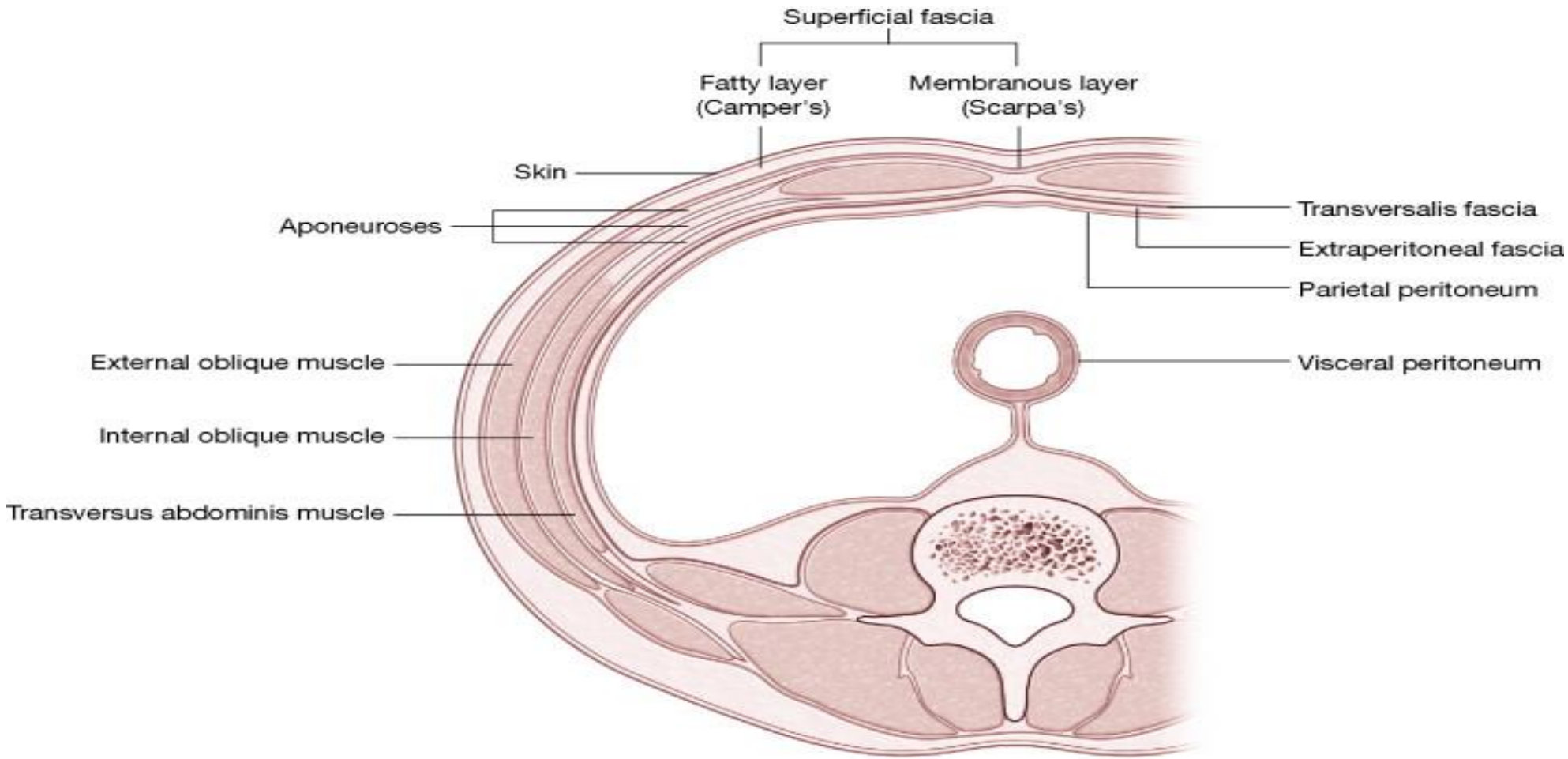


SKELETAL MUSCLE ATTACHMENTS

2. APONEUROSIS

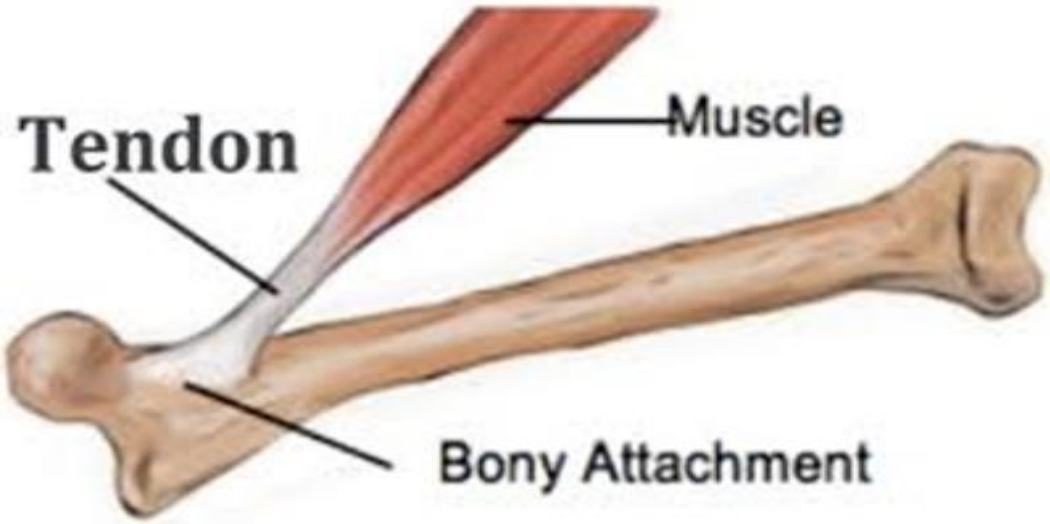
- ✓some muscles Instead of connecting to band-like tendons, are attached to bones or to other muscles by broad sheets of fibrous connective tissue called **aponeuroses**.
- ✓ The most prominent **aponeurosis** the **linea alba** (white line) that runs lengthwise between the muscles
- ✓ The linea alba is on an animal's ventral midline. It connects the abdominal muscles from each side together & is a common site for surgical entry into the abdomen.

APONEUROSIS

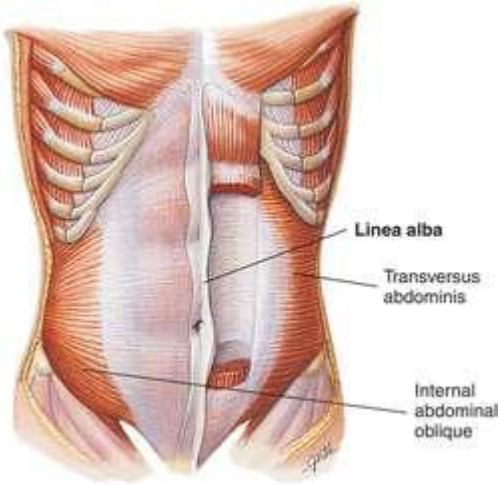


SKELETAL MUSCLE ATTACHMENTS

TENDON



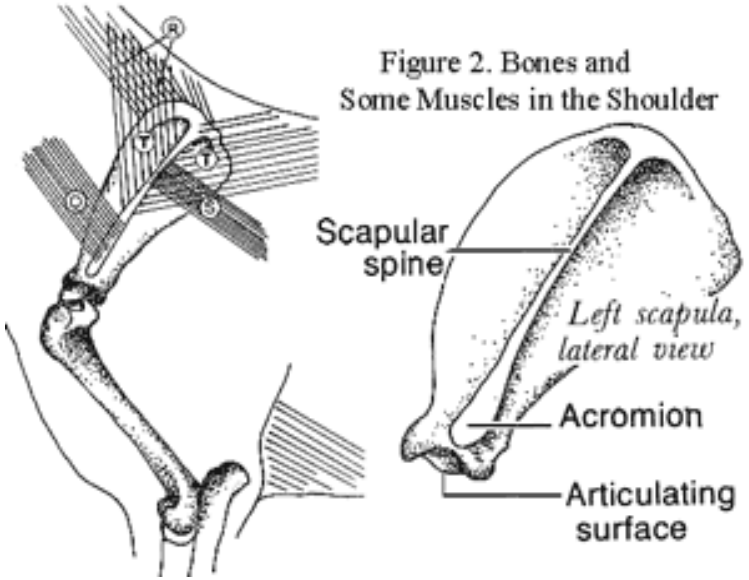
Aponeurosis



SKELETAL MUSCLE ATTACHMENTS

3. **FLESHY ATTACHMENT**

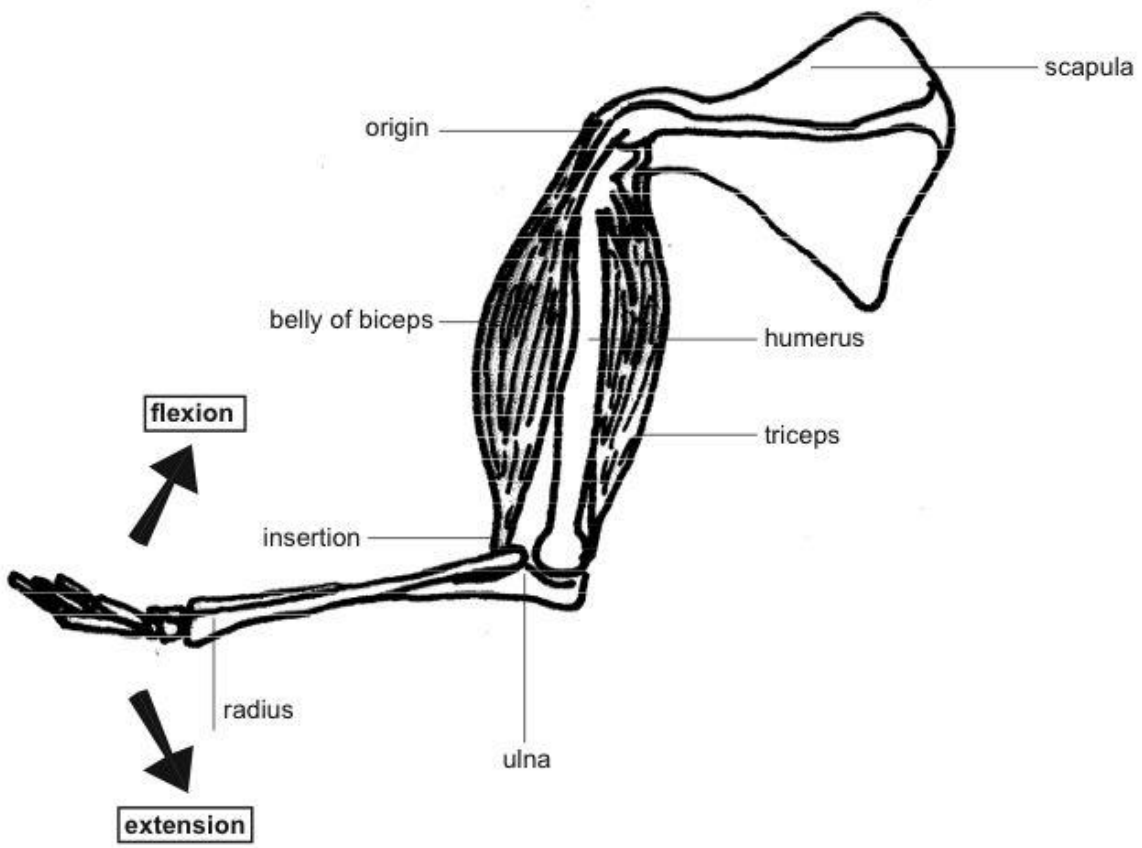
- ✓ Some muscles appears to come directly from the bone, it is said to be fleshy attachment.
- ✓ Ex. Muscles attaching to the scapula. In reality muscles attach through very short tendon



ORIGIN AND INSERTION OF MUSCLES

- ❑ One of a skeletal muscle's attachment sites is generally more stable (moves less) than the other.
- ✓Origin of a muscle - This is a more stable site muscle. It does not move much when a muscle contracts
- ✓ Insertion of a muscle - is the site that undergoes most of the movement when a muscle contracts.

ORIGIN AND INSERTION OF MUSCLES



FUNCTIONAL GROUPING OF SKELETAL MUSCLES

- Skeletal muscles can be divided into 6 functional groups:
  - ✓ Flexors
  - ✓ Extensors
  - ✓ Abductors
  - ✓ Adductors
  - ✓ Sphincters
  - ✓ Cutaneous
- Many muscles work in pairs so that when one contracts (flexes or shortens) the other one relaxes (extends or lengthens). This relationship is known as antagonism.
- Muscles that work together to perform a movement are referred to as synergists.

FUNCTIONAL GROUPING OF SKELETAL MUSCLES

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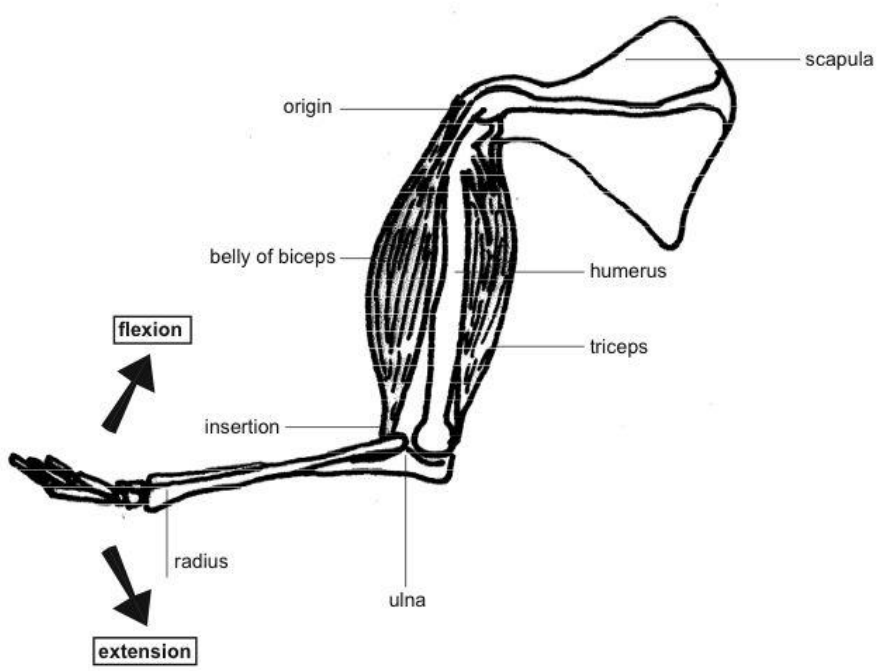
1. **FLEXOR MUSCLES**

- Flexor muscles decrease the angle between two lever bones when they contract

Or

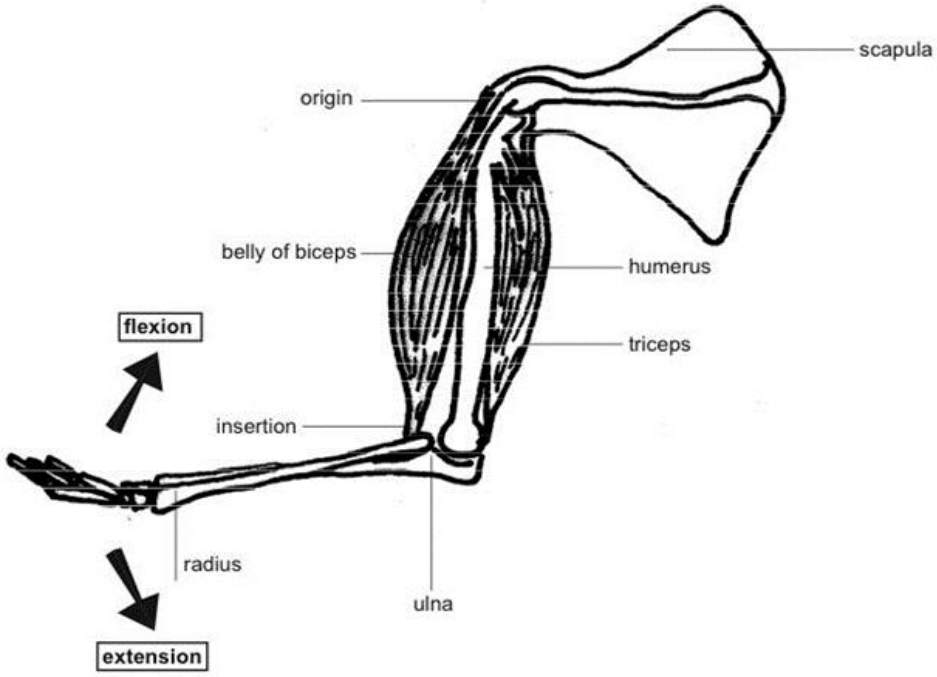
- flexor muscles reduce the angle of a joint when they contract.
- Example: Biceps



FUNCTIONAL GROUPING OF SKELETAL MUSCLES

2. EXTENSOR MUSCLES

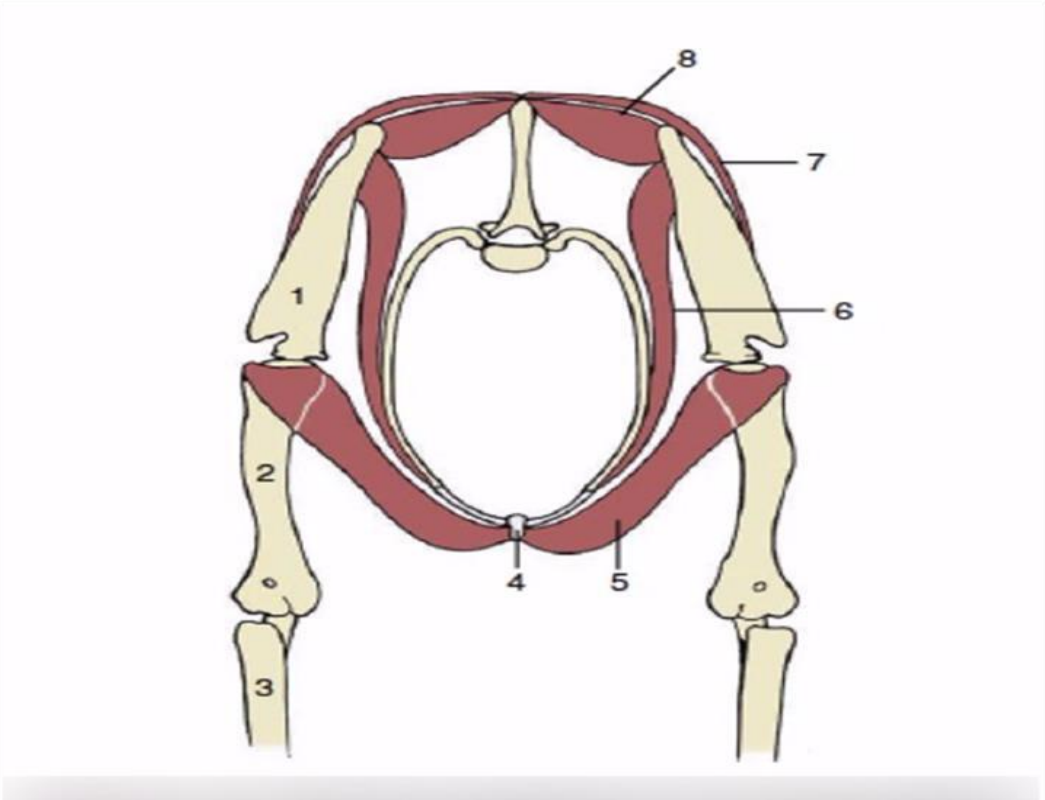
- Extensor muscles increase the angle between two lever (bones) when they contract.
- Eg triceps



FUNCTIONAL GROUPING OF SKELETAL MUSCLES

3. ABDUCTOR MUSCLES

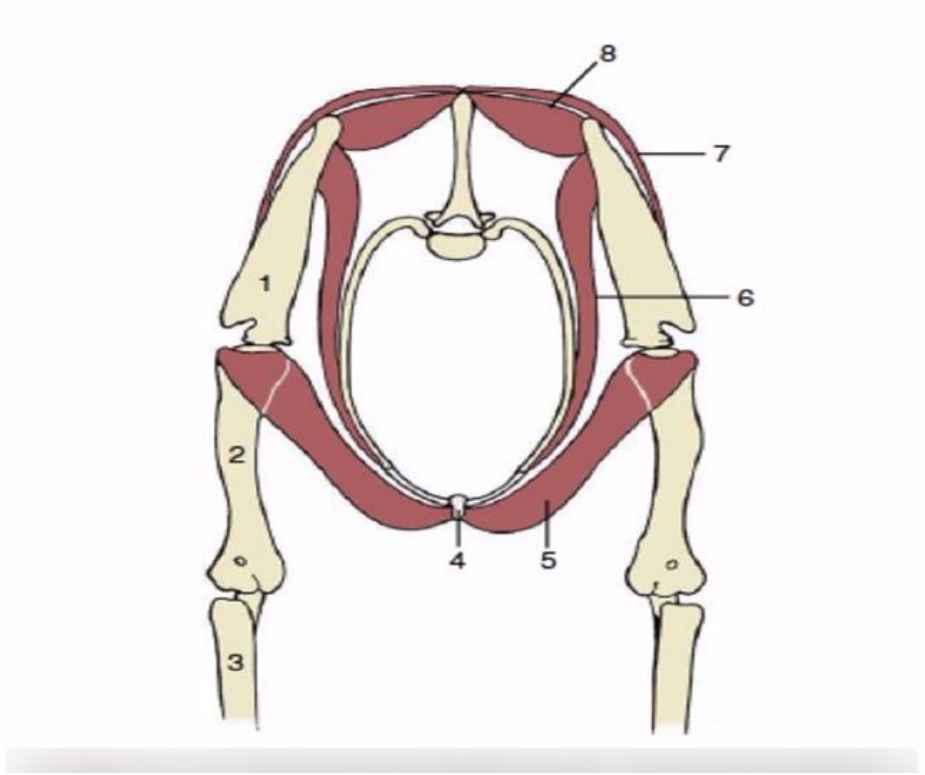
- ❑ Abductor muscles moves the limbs away from the median plane (middle part of the body)
- Example. *Trapezius muscle* (7)



FUNCTIONAL GROUPING OF SKELETAL MUSCLES

4. ADDUCTOR MUSCLES

- Adductor muscles pull the limbs towards the median plane
- Example is the *Pectoralis profundus* muscle (5 in picture)



FUNCTIONAL GROUPINGS OF MUSCLES

5. SPHINCTERS

- ✓ These are muscles that encircle an opening, whether they are striated or smooth
- ✓ muscles of Pyloric & cardiac sphincter
- ✓ *Orbicularis oculi* muscles in the eye lids – contract to cause eyelids to shut

6. CUTANEOUS MUSCLES

FUNCTIONAL GROUPINGS OF MUSCLES

6. CUTANEOUS MUSCLES

- ✓ Occur in the superficial fascia (a layer of connective tissue) between the skin and the deep fascia covering the skeletal muscles.
- ✓ The cutaneous muscles attach to the skin & are responsible for movement of the skin. Or twitching of the skin

SKELETAL MUSCLES ACTIONS

- Skeletal muscles contract
- Skeletal muscles rarely act alone. They usually work in groups, with certain muscles producing most of the desired movement.
- Named according to actions produced

INTERACTIONS OF SKELETAL MUSCLES

- **Agonist**: “prime mover”, major responsibility for producing a specific /desired movement
- **Antagonist** - is a muscle or muscle group that directly opposes the action of an agonist
- Antagonists for one movement can be agonists for another

INTERACTIONS OF SKELETAL MUSCLES

- **Synergists help prime movers** – is a skeletal muscle that contracts at the same time as an agonist and assists it in carrying out its action

- **Fixators**: muscles stabilize joints to allow other movements to take place. For example, some of the muscles that flex the digits also can flex the carpus.

Eg If a muscle that extends the carpus contracts at the same time as a digital flexor muscle, it fixes the carpus in place (prevents it from moving) while the digits are pulled into a flexed position.

MUSCLE NAMING

❑ Muscles are named according to the physical characteristics; eg

i. Action

✓Muscles that flex a joint are often called flexor muscles. Eg the *superficial digital flexor* muscle. Flexes digits when it contracts

ii. Shape

✓A muscle's name can reflect its distinctive shape, such as with the *deltoid* muscle. ''*Deltoid*" or *trapezius* means triangular.

iii. **Location**

✓A muscle's name can indicate its physical location in the body. For example, the *biceps brachii* muscle is located in the *brachial* (upper "arm") region.

MUSCLE NAMING

iv. Direction of fibers

✓ The term "r*ectus*" means straight. The *rectus abdominis* muscles on the ventral abdomen

v. **Number of heads or divisions**

✓ The number of heads refers to the number of attachment sites that a muscle has to its origin. Eg *Biceps brachii*, *Triceps brachii*

SELECTED SKELETAL MUSCLES

- We will discuss only muscles that are of clinical importance or those that can be used as reference points or landmarks on an animal's body.
- **.** The general arrangement of muscles in different animal species is similar.

GIRDLES

GIRDLE – set of bones in the appendicular skeleton which connect the limbs to the axial skeleton

- ❑ PECTORAL (SHOULDER) GIRDLE - Scapula
- ❑ PELVIC GIRDLE – (paired hipbones) sacrum – ilium, ischium, pubic

THE PECTORAL GIRDLE –MUSCLES ACTING ON THE SHOULDER GIRDLE

- In domestic animals the chief movement of the proximal part of the thoracic limb is a pendulous swing forward and backward.
- Muscles that hold the scapula in place contribute to swinging movement.
- These muscles are also critical in allowing the weight of the thorax to be supported between the two thoracic limbs
- Superficial muscles of the scapula that link it to the bony thorax include the;

i. *m. trapezius*
ii. *m. omotransversarius*
iii. *m. rhomboideus*
iv. *m. serratus ventralis* are deep.

ATTACHMENT OF FORELIMB TO THE TRUNK

1 - Scapula

2 – Humerus

3 – Radius & ulna

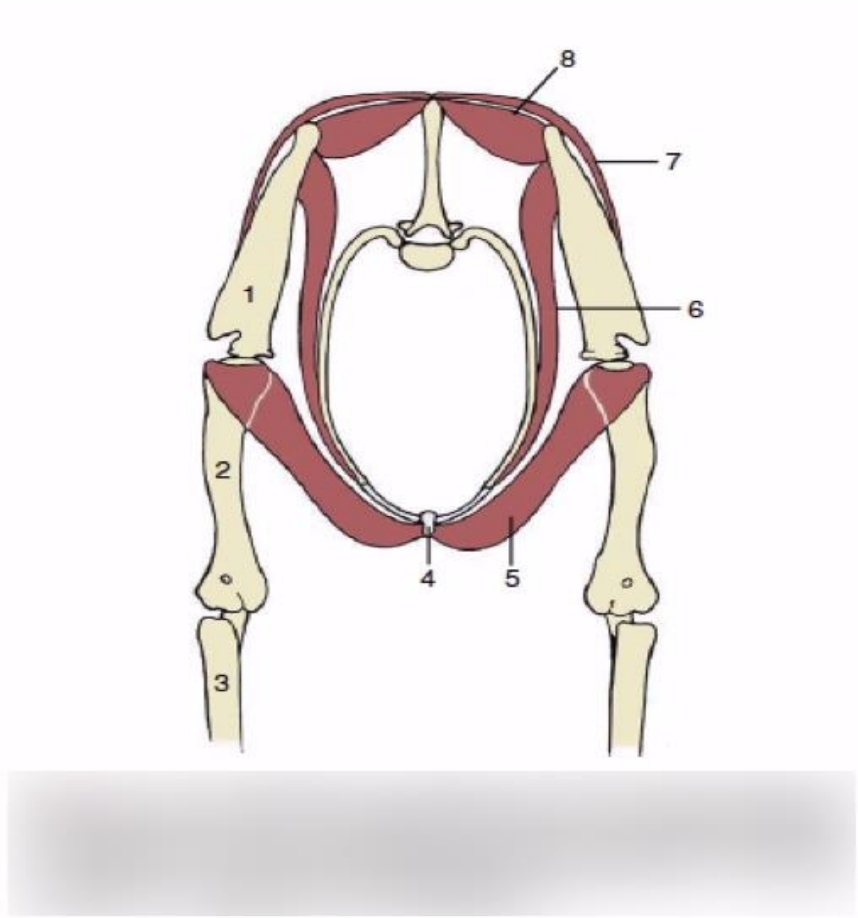
4 – Sternum

5 - *Pectoris muscle*

6 – *Serratus ventralis*

7- *Trapezius*

8 - *Rhomboideus*



MUSCLES ACTING ON THE SHOULDER GIRDLE

THE *TRAPEZIUS Muscle*

- ✓is a triangular flat muscle
- ✓ that takes origin along the dorsal midline from the head to the lumbar vertebrae.
- ✓ The *m. trapezius*
- ✓ inserts chiefly on the spine of the scapula
- ✓ Has 2 parts

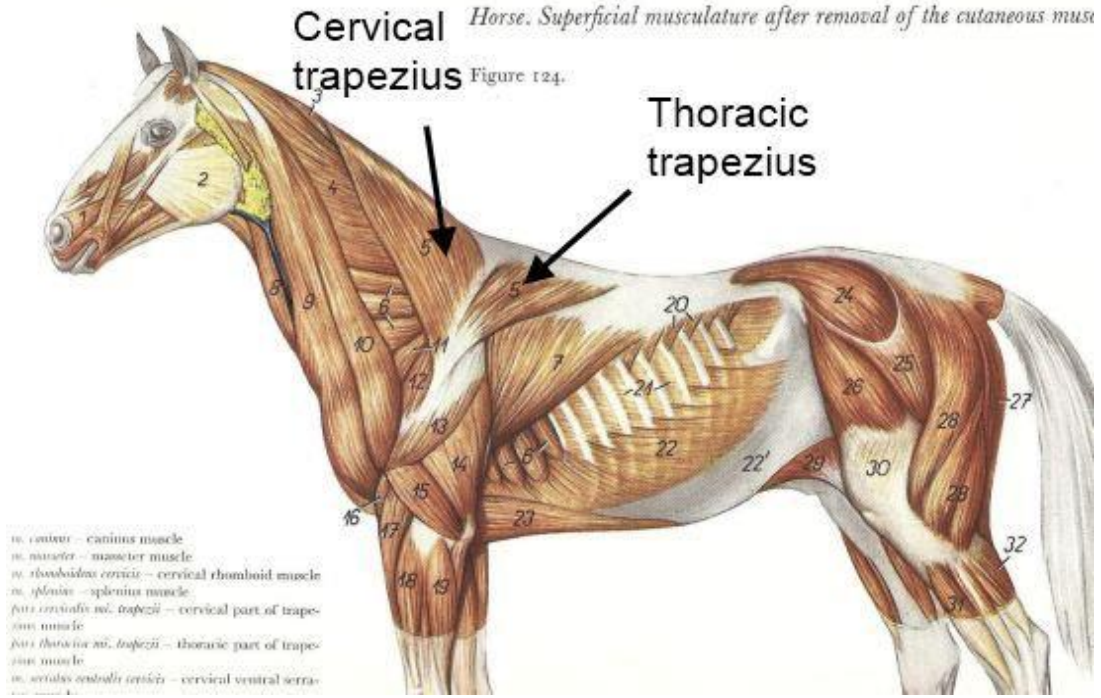
i. The portion originating cranial to the scapula helps swing the scapula forward;

ii. the one attaching behind draws it back.

MUSCLES ACTING ON THE SHOULDER GIRDLE

TRAPEZIUS MUSCLE

✓



MUSCLES ACTING ON THE SHOULDER GIRDLE

THE *M. RHOMBOIDEUS*

- ✓is a heavier muscle just deep to the trapezius.
- ✓ originates from the dorsal midline both cranial and caudal to the scapula.
- ✓The *m. rhomboideus* inserts on the deep (medial) face of the scapular cartilage
- ✓ Role: Retract (adduction) limb and raise limb

MUSCLES ACTING ON THE SHOULDER GIRDLE

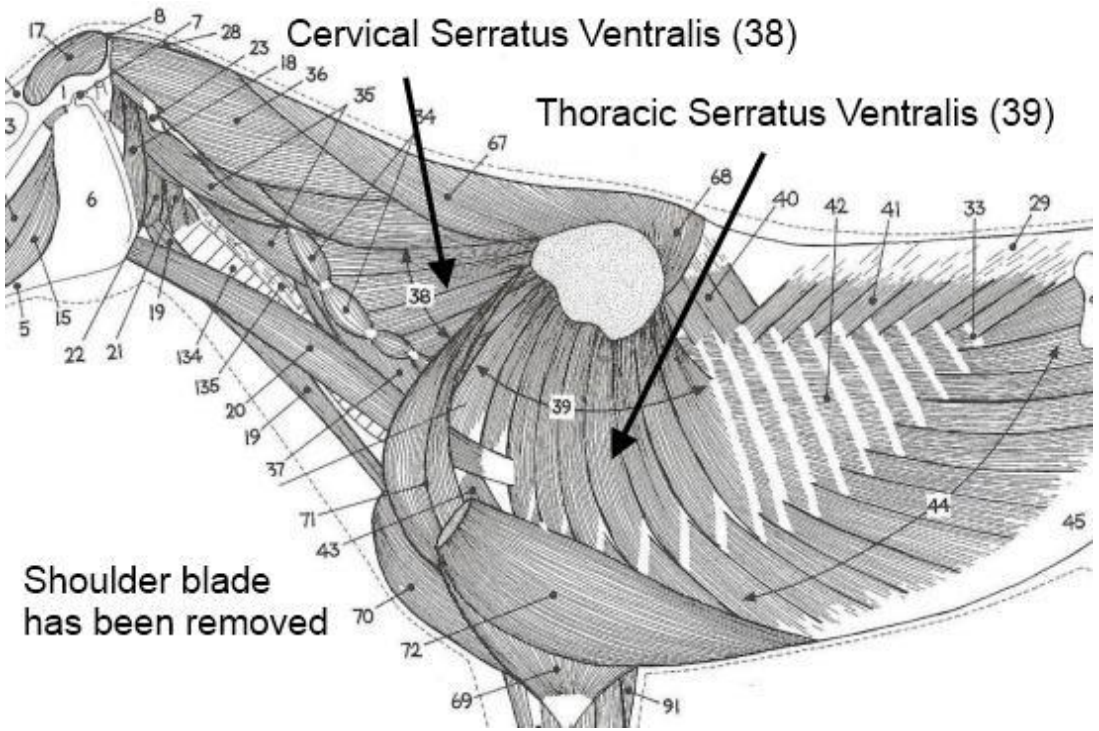
SERRATUS VENTRALIS MUSCLE

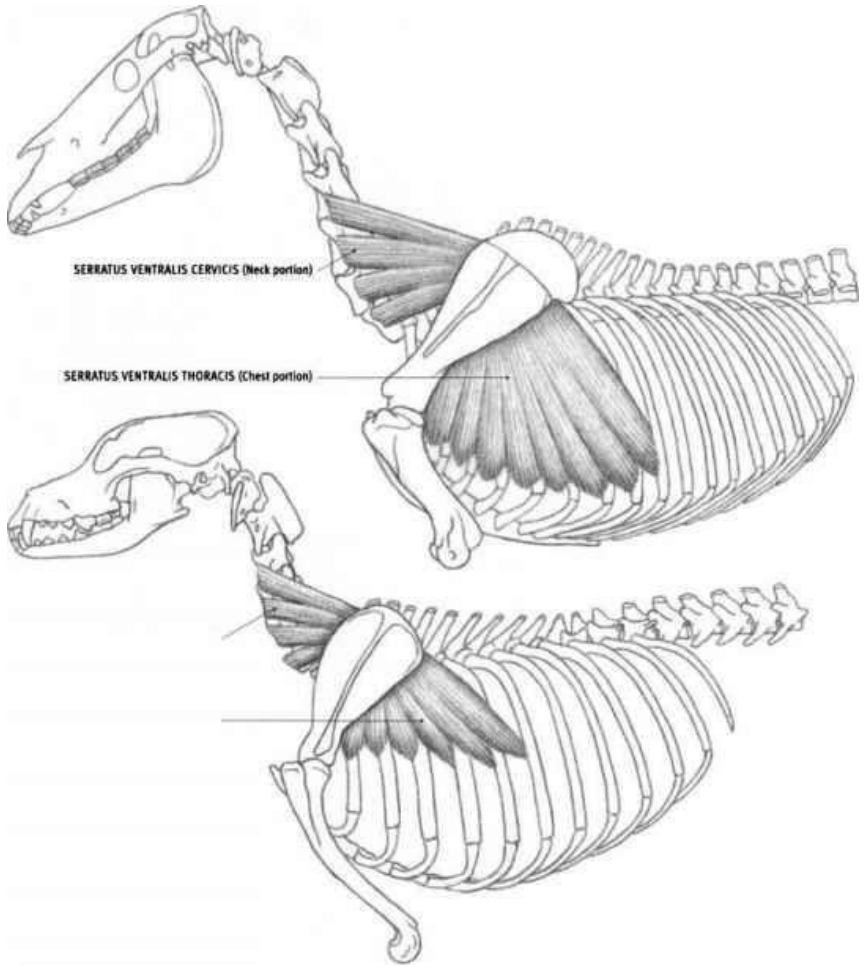
- ✓ The largest & most important muscle attaches thoracic limb to the trunk.
- ✓ It is a large, fan-shaped muscle.

ORIGIN

- ✓extends from the transverse processes of the cervical & thoracic vertebrae & from the ribs along a curved line just above the sternum as far back as the 10th costal cartilage.
- ✓INSERTION; the medial side of the dorsal portion of the scapula
- ✓ The muscle on each side together form a sling that supports the trunk between the thoracic limbs.

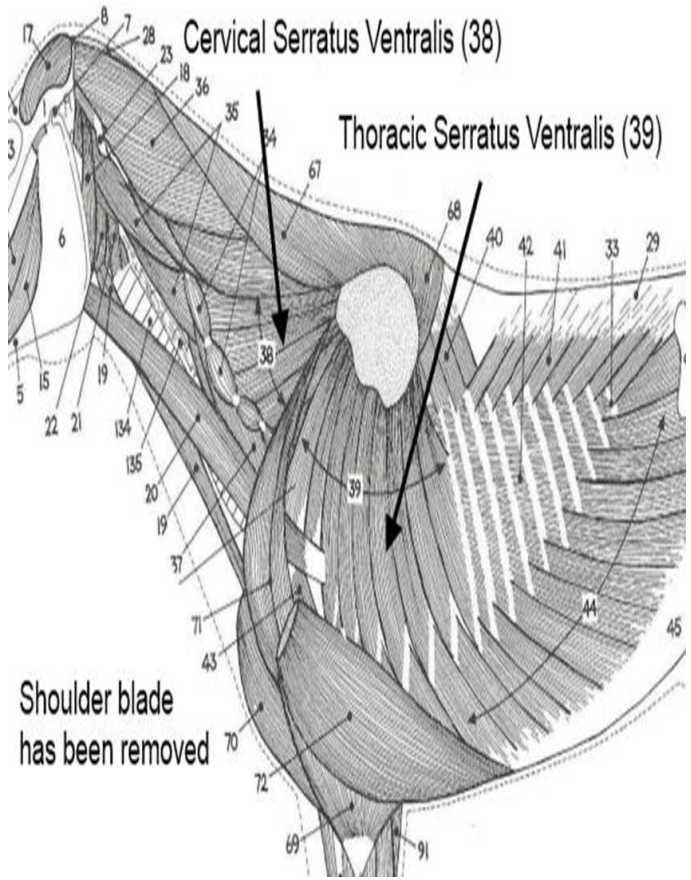
MUSCLES ACTING ON THE SHOULDER GIRDLE





SERRATUS VENTRALIS

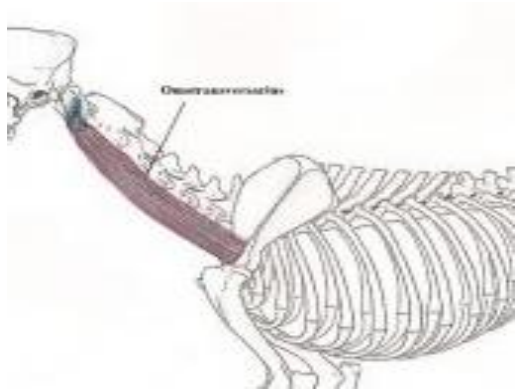
- CERVICAL part – originates from then final 4-5 cervical vertebrae and inserts on the scapular
- Thoracic part – originate from the lateral side of the 8-9 ribs & inserts on the scapular
- The 2 muscles are antagonists to each other the cervical part pulls the scapular towards the neck & the thoracic part pull the scapular away from the neck



MUSCLES ACTING ON THE SHOULDER GIRDLE

THE *M. OMOTRANSVERSARIUS*

- ✓ is a separate muscle of the shoulder region in most domestic species.
- ✓ It takes origin from the transverse processes of the more cranial cervical vertebrae & inserts on the distal part of the spine of the scapula
- ✓ Action: Pulls distal end of scapular forward
- ✓Also help in lateral flexion of the neck



HEAD AND NECK MUSCLES

- ❑ The muscles of the head have many roles.

i. They control facial expression

ii. Enable chewing *(mastication)*

iii. Move sensory structures such as the eyes and ears

- The large *masseter* muscle in the cheek area of the skull is the most powerful of the chewing muscles. Its main action is to close the jaw.

MUSCLE OF THE HEAD

MASSETER MUSCLES (Cheek muscle)

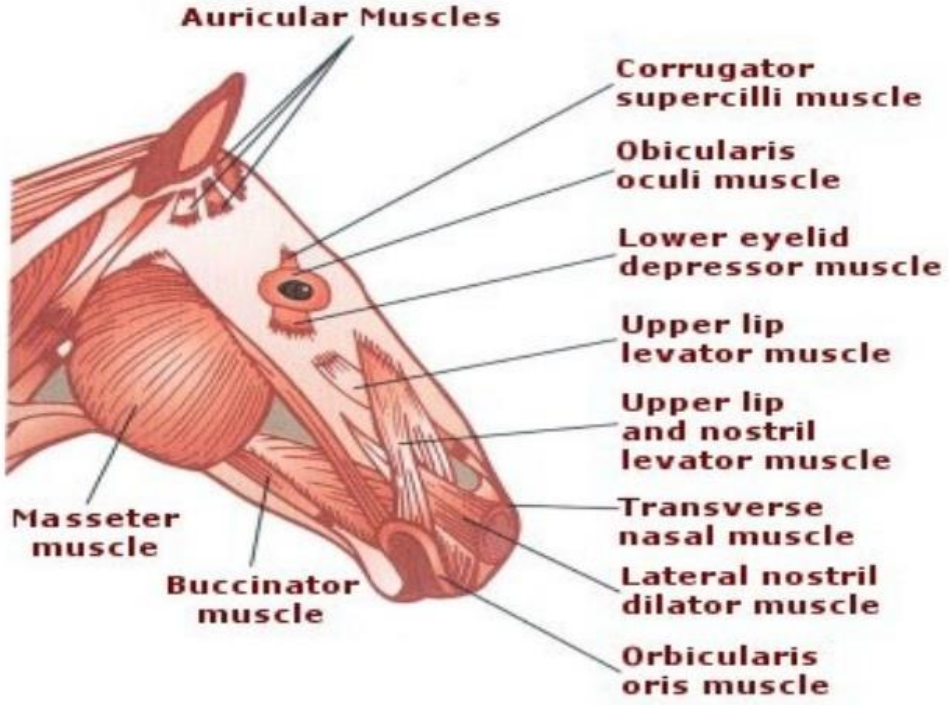
✓moves the jaws open and closed to allow chewing

ORBICULARIS OCULI MUSCLES

✓ Around the eyelids

ORBICULARIS ORIS

✓ surrounds the orifice of the mouthy



MUSCLES ACTING ON THE SHOULDER JOINT

- The shoulder, being a ball-and-socket joint
- make all types of movement.
- In the quadruped its chief actions are extension and flexion.

MUSCLES ACTING ON THE SHOULDER JOINT

EXTENSORS OF THE SHOULDER.

1. THE ***M. BRACHIOCEPHALICUS,***

✓Origin; From the occipital bone of the skull and transverse processes of 3rd and 4th cervical vertebrae

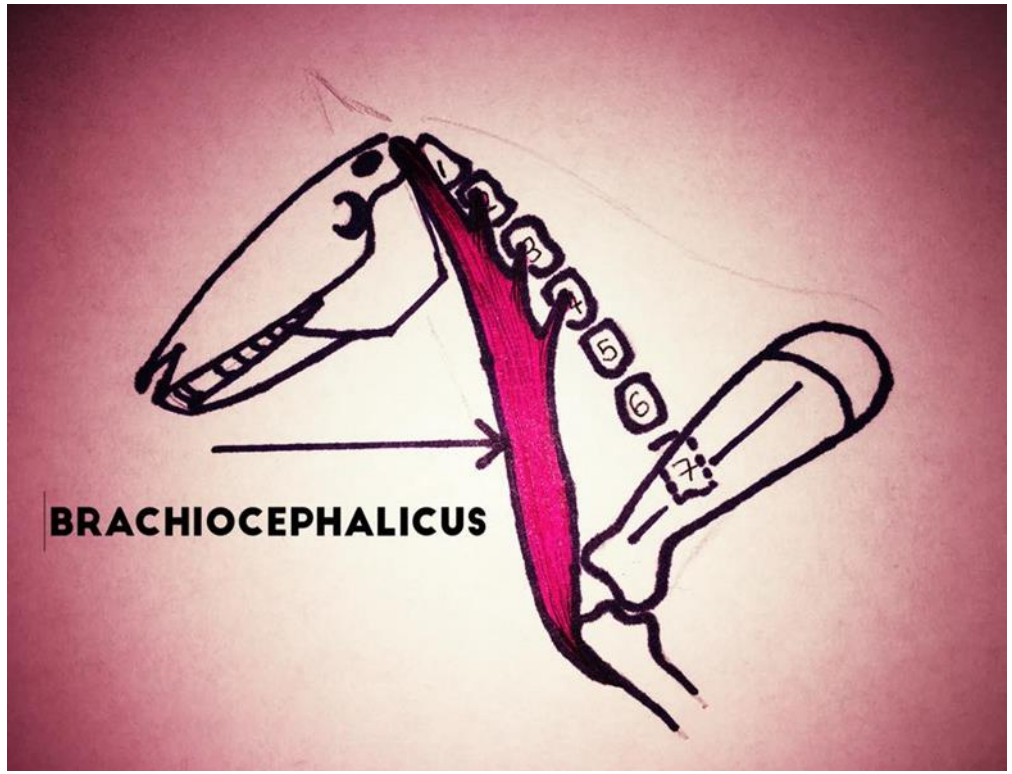
✓ It inserts on the lateral side of the proximal part of the humerus

✓ Action – Principle extensor of the shoulder: also raise & advances shoulder

MUSCLES ACTING ON THE SHOULDER JOINT

1. BRACHIOCEPHALICUS MUSCLE

- ✓Originates from occipital bone bone, atlas. 3rd and 4th cervical vertebrae
- ✓ inserts on the humerus
- ✓ Pulls the forelimb forward and raises the scapular



MUSCLES ACTING ON THE SHOULDER JOINT

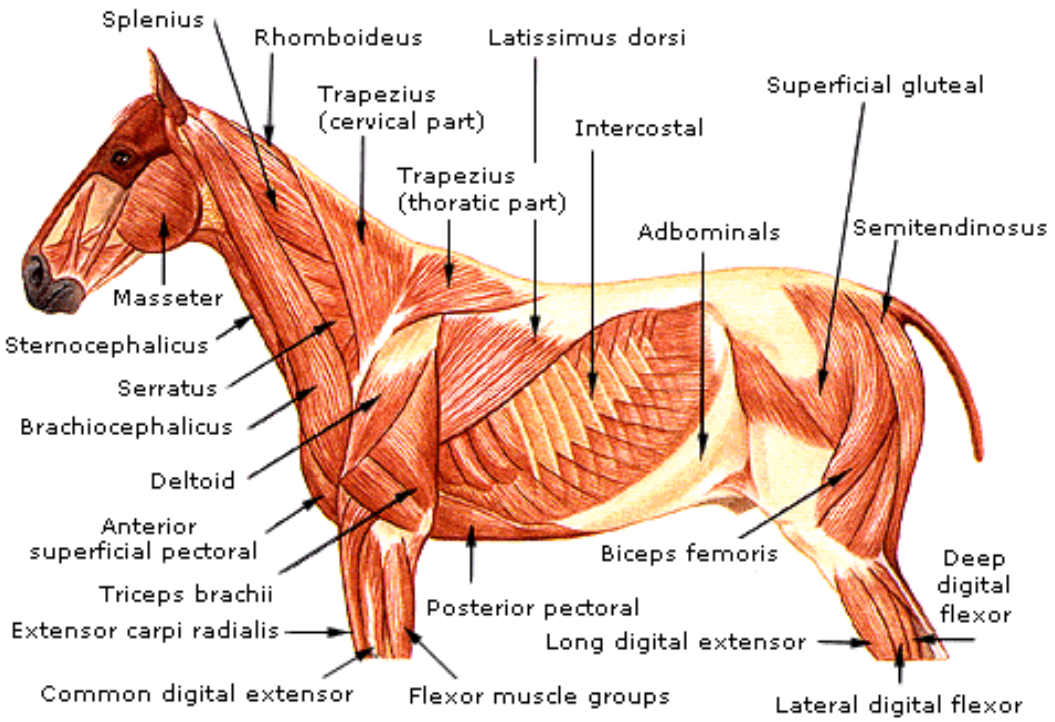
EXTENSORS OF THE SHOULDER

2. SUPRASPINATUS

- ✓originates from the supraspinous fossa of the scapula cranial to the **spine.**
- ✓ inserts on the greater tubercle of the humerus
- ✓Action - assist in extending the shoulder but acts chiefly as a stabilizing ligament of the shoulder joint

HEAD & NECK MUSCLES

- ❑ The sternocephalicus muscle is a smaller, strap-like muscle
- ❑ Originates from the sternum to the caudal side of the mandible
- ❑ Acts to flex (lower) the head and neck.



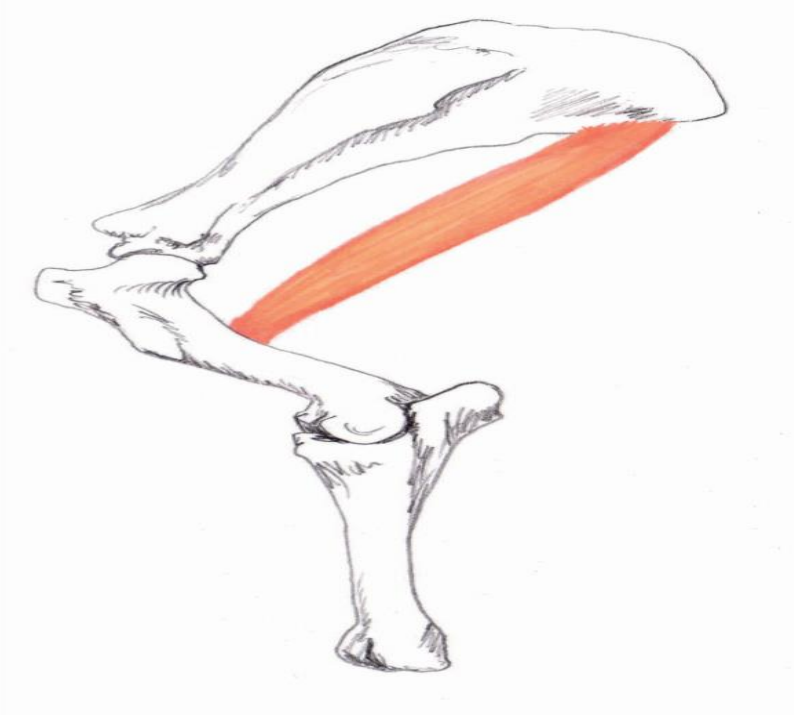
FLEXORS OF THE SHOULDER JOINT

1. THE M. TERES MAJOR

✓ originates from the dorsal part of the caudal border of the scapula

✓ inserts on the teres major tuberosity on the medial side of the shaft of the humerus.

✓ It is a strong flexor of the shoulder joint.

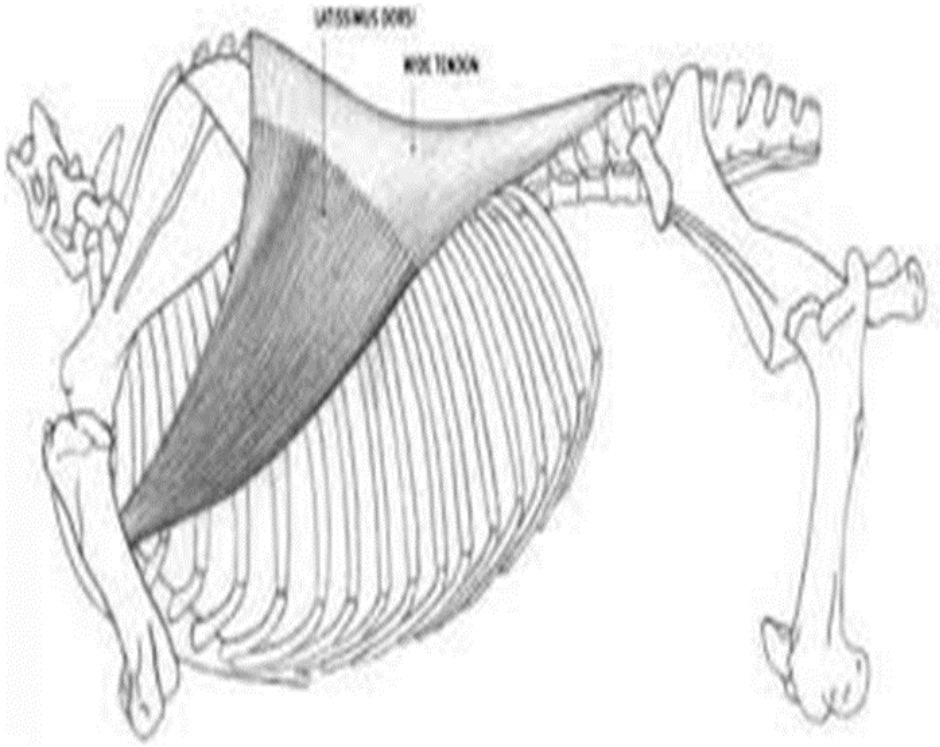


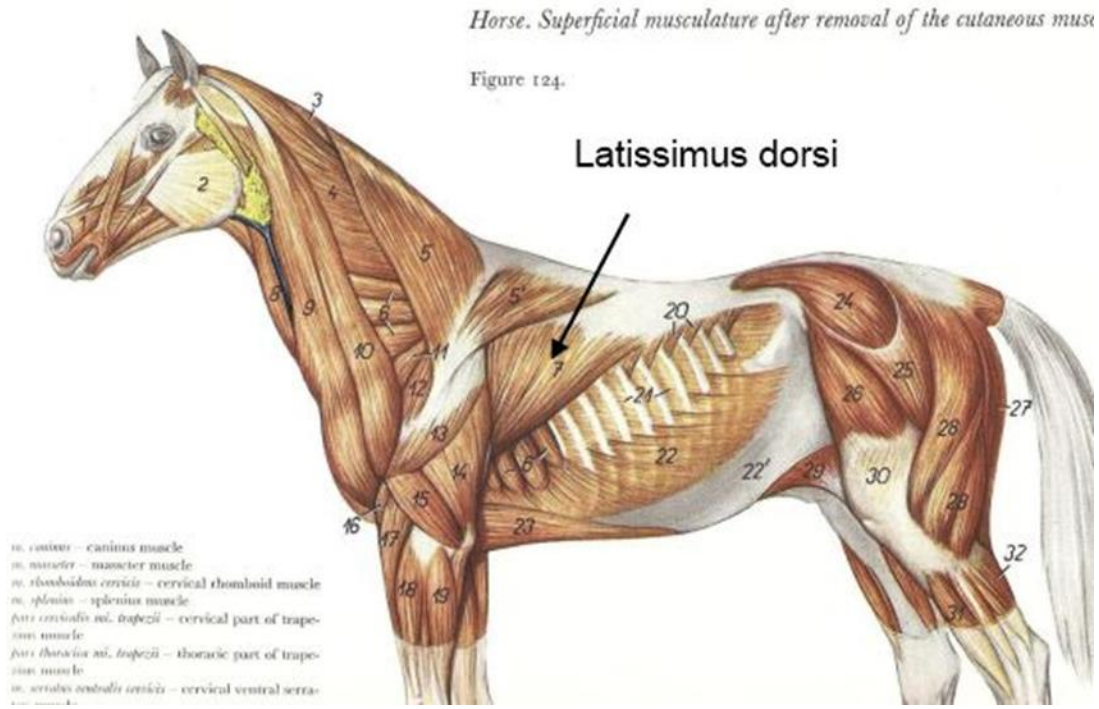
FLEXORS OF THE SHOULDER JOINT

2. **LATISSIMUS DORSI MUSCLE**

- ✓ is a wide, triangular muscle that originates from the spinous processes of the thoracic & lumbar vertebrae by means of a wide aponeurosis, the thoracolumbar fascia.
- ✓ It inserts with the teres major mon the medial side of the humerus
- ✓ it is a strong flexor of the shoulder.
- ✓ Also, it pulls the thoracic limb caudad or, if the limb is fixed, advances the trunk.

FLEXORS OF THE SHOULDER





Horse. Superficial musculature after removal of the cutaneous mus

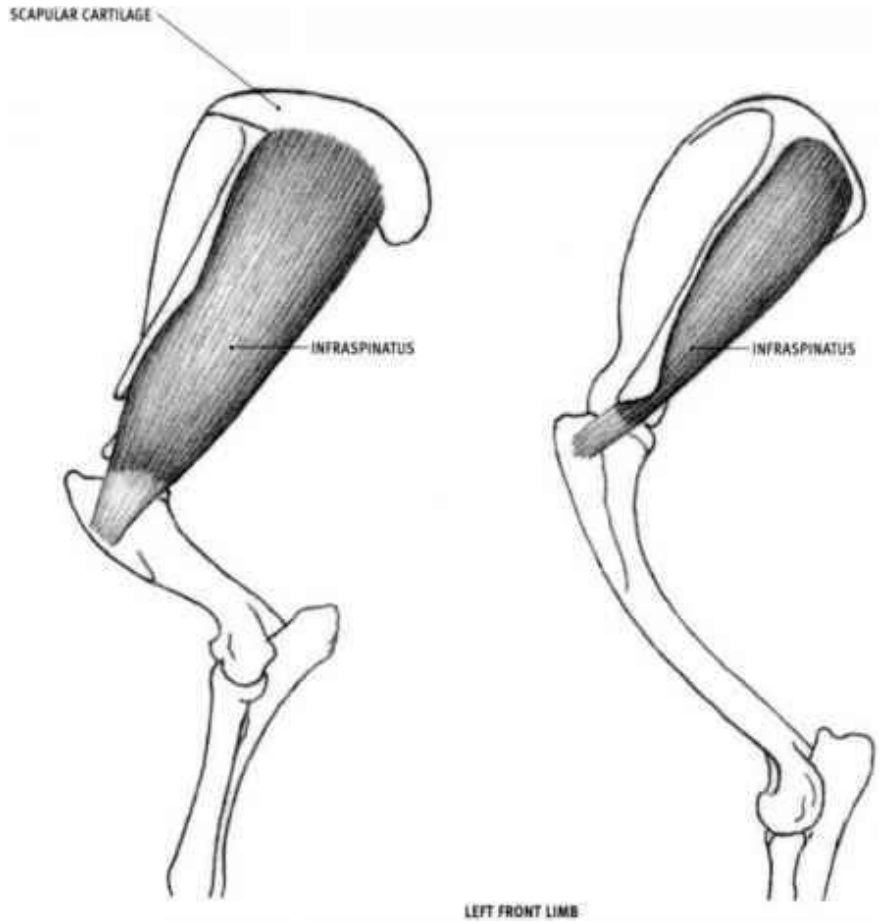
Figure 124.

m. caninus – caninus muscle
m. masseter – masseter muscle
m. rhomboideus cervicis – cervical rhomboid muscle
m. splenius – splenius muscle
pars cervicalis mi. trapezii – cervical part of trapezius muscle
pars thoracica mi. trapezii – thoracic part of trapezius muscle
m. serratus ventralis cervicis – cervical ventral serra-

FLEXORS OF THE SHOULDER

3. INFRASPINATUS MUSCLE

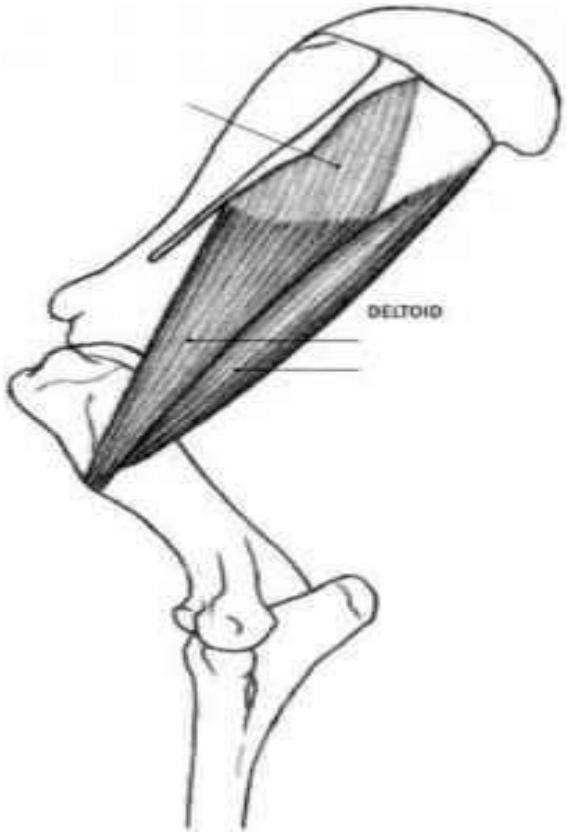
- ✓ originates from the infraspinous fossa just caudal & ventral to the spine of the scapula.
- ✓ It inserts into the caudal part of the greater tubercle of the humerus.
- ✓ also acts as a strong collateral ligament of the shoulder joint and may abduct, flex, and outwardly rotate the shoulder.



FLEXORS OF THE SHOULDER

DELTOIDEUS MUSCLE

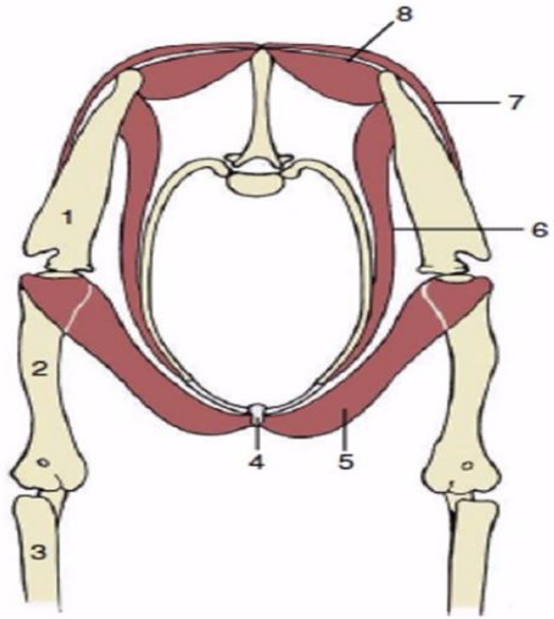
- ✓ The ***m. deltoideus*** extends from the spine of the scapula to the deltoid tuberosity of the humerus.
- ✓ It is an abductor & flexor of the shoulder joint.



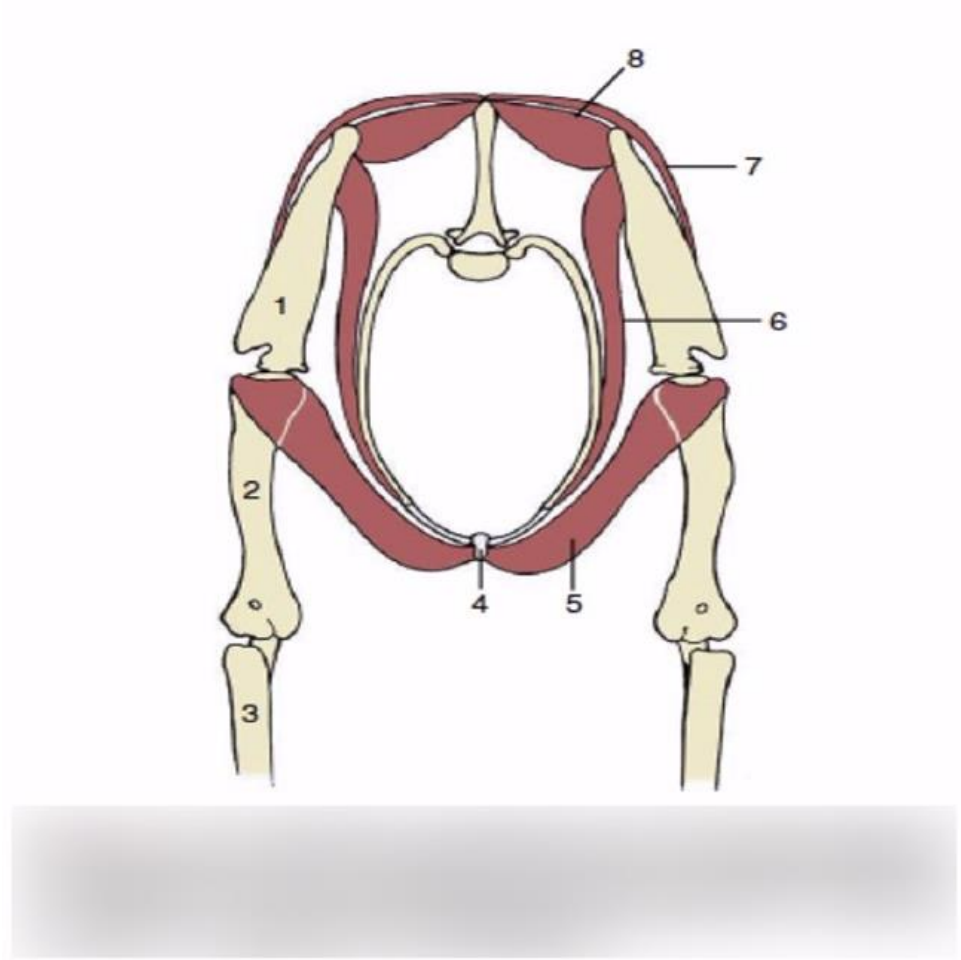
ADDUCTORS OF THE SHOULDER

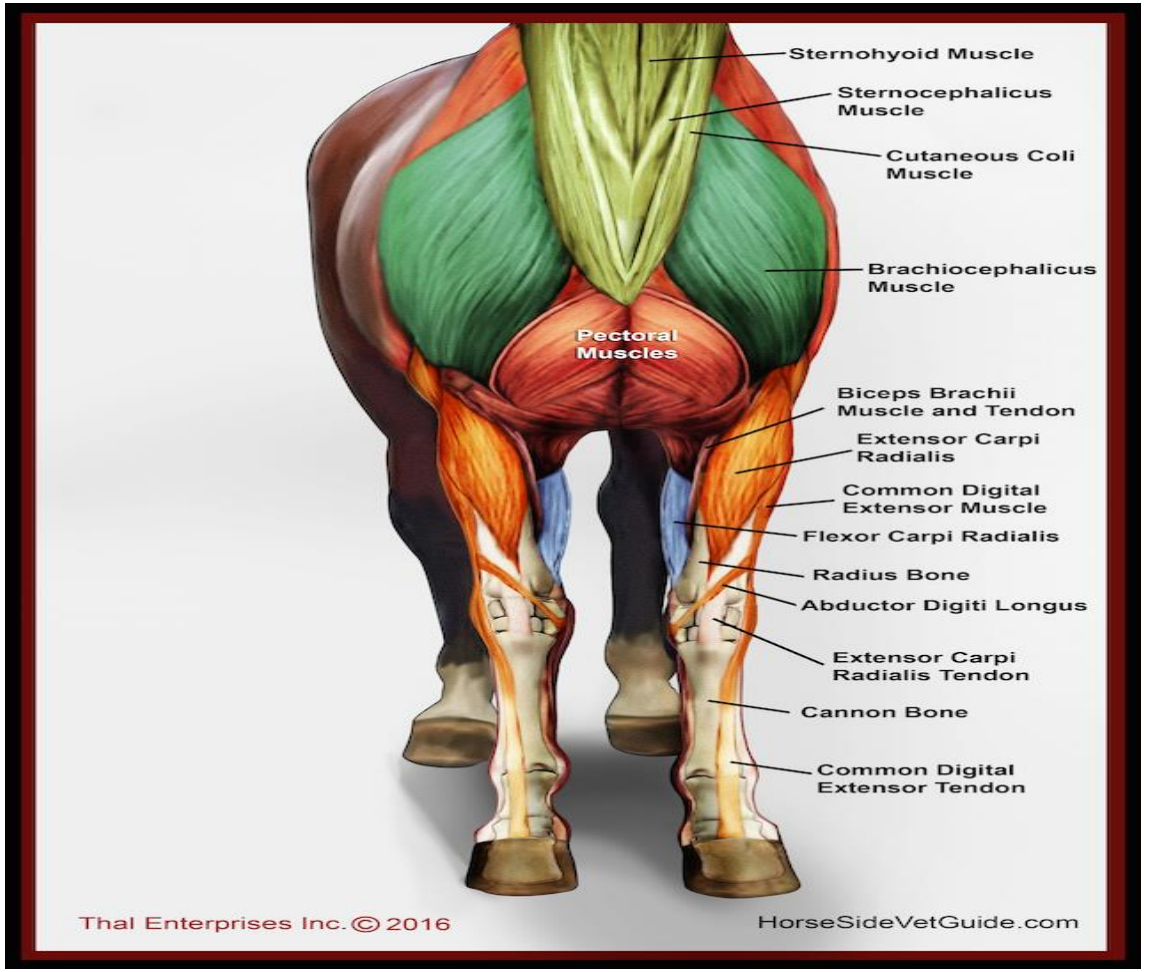
THE ***PECTORAL MUSCLES***

- ✓ Form the substance of the brisket
- ✓They originate from the sternum
- ✓ Insert mainly on the proximal part of the humerus. (5)

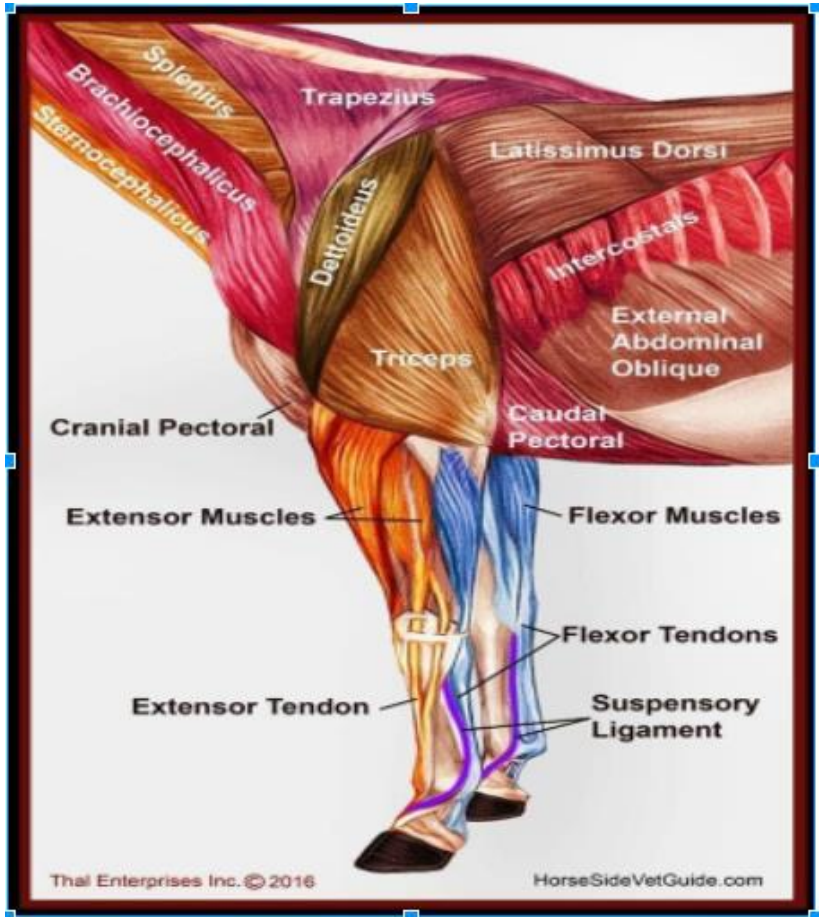


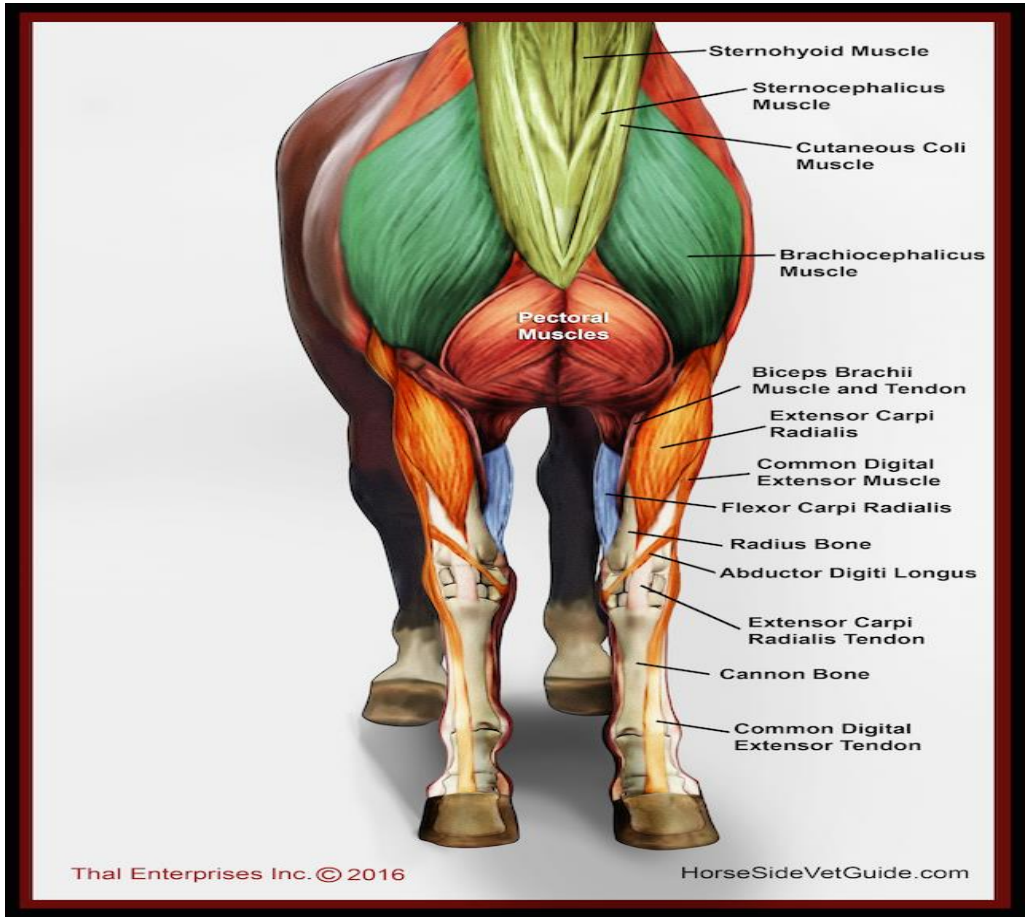
PECTORAL MUSCLES





PECTORAL MUSCLES





MUSCLES ACTING ON THE ELBOW JOINT

- The elbow is a hinge joint
- The muscles acting on it are either flexors or extensors.
- In quadrupeds, the extensors are stronger than the flexors because they support the weight of the body by maintaining the limbs in extension

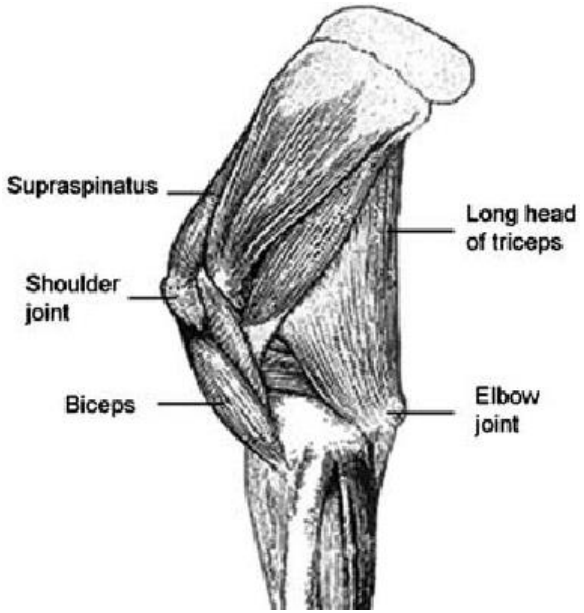
EXTENSORS OF THE ELBOW JOINT

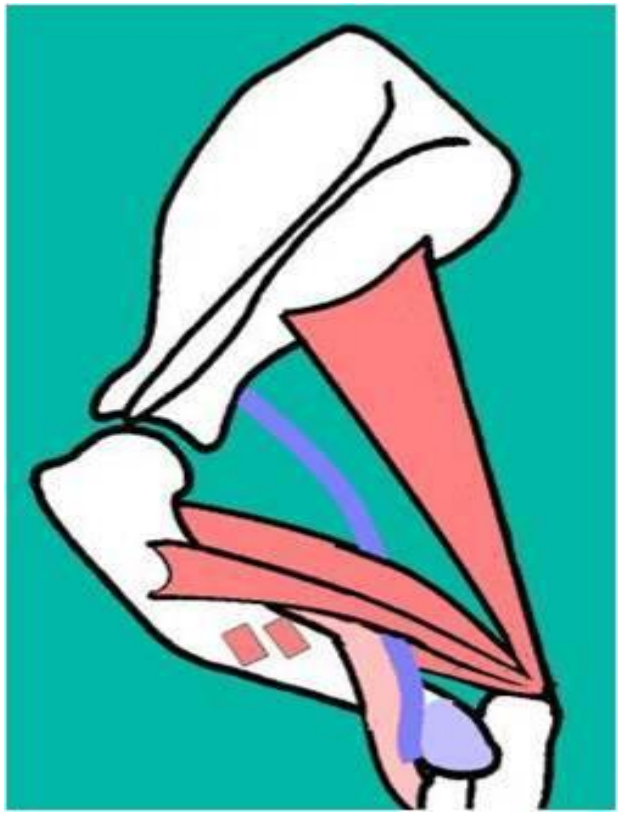
THE *M. TRICEPS BRACHII*

- ✓ Has three heads.
- ✓ The ***long head*** originates from the caudal border of the scapula & the ***medial*** and ***lateral heads*** originate from the respective sides of the humeral diaphysis.
- ✓ All heads insert on the olecranon process of the ulna.
- ✓ The triceps is the strongest extensor of the elbow
- ✓ The long head may also act to flex the shoulder.

EXTENSORS OF THE ELBOW JOINT

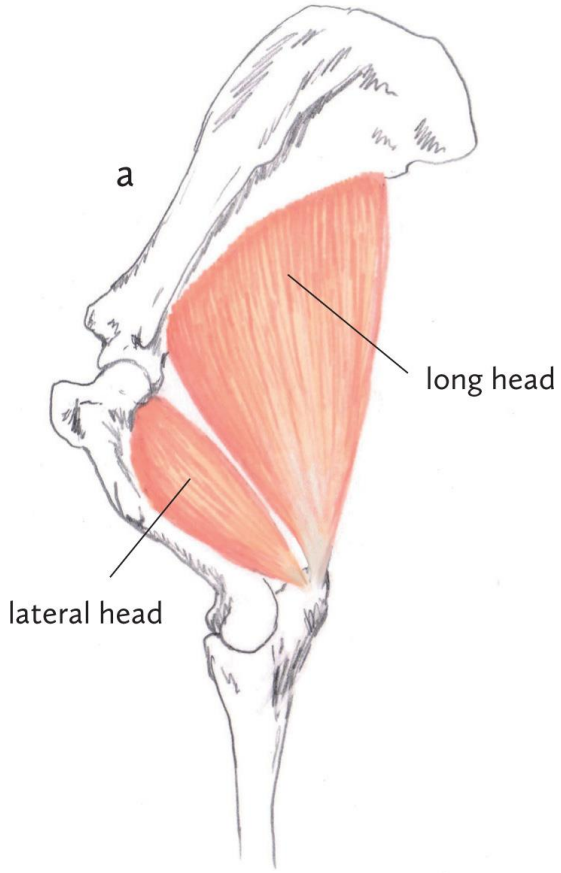
TRICEPS BRACHII





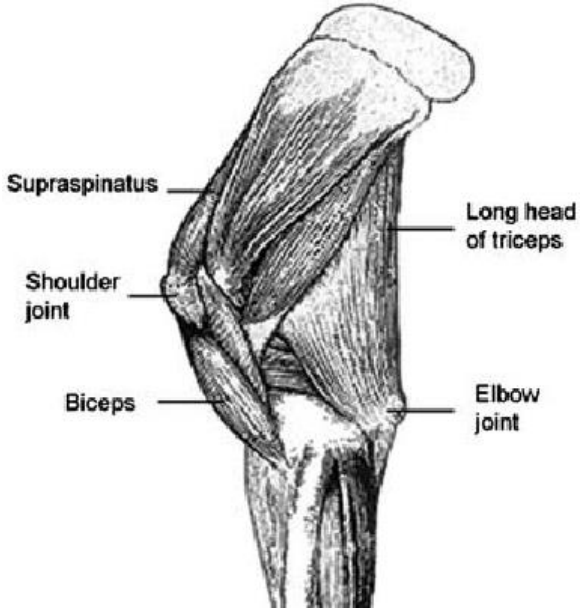
EXTENSORS OF THE ELBOW JOINT

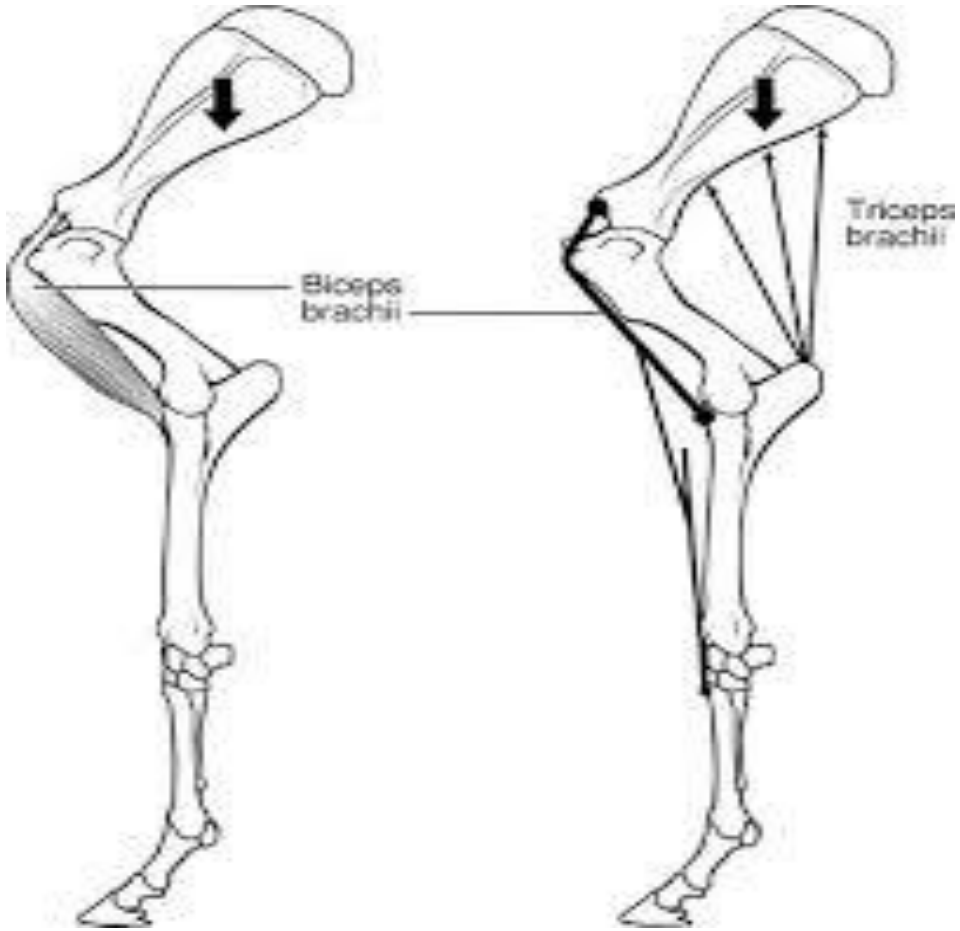
TRICEPS BRACHII



EXTENSORS OF THE ELBOW JOINT

TRICEPS BRACHII



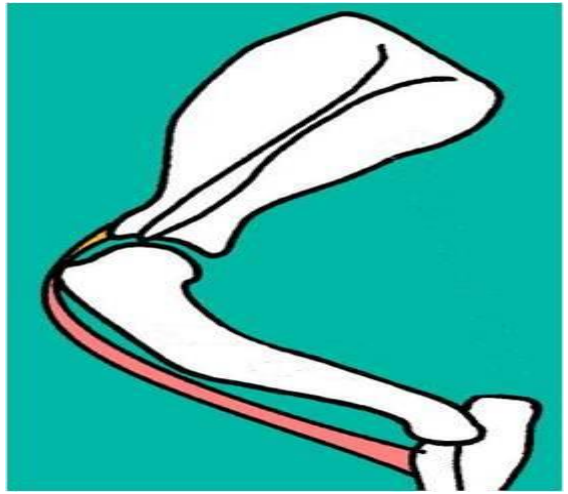


FLEXORS OF THE ELBOW

1. **M. BICEPS BRACHII**

✓ Originates on the supraglenoid tubercle just dorsal & cranial to the articular surface of the scapula.

✓ It inserts on (1) the radial tuberosity on the cranial aspect of the proximal radius the medial collateral ligament of the elbow, & (3) the antebrachial fascia.



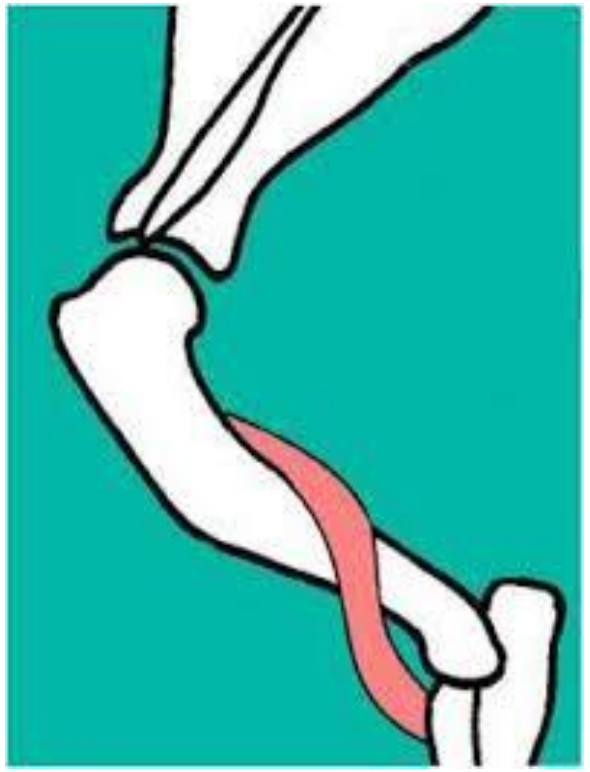
FLEXORS OF THE ELBOW

2. THE *BRACHIALIS MUSCLE*

✓ is strictly a flexor of the elbow

✓Originates on the humerus

✓Inserts on the cranial aspect of the radius



MUSCLES OF INSPIRATION & MECHANISMS OF INHALATION & EXHALATION

❑ The main inspiratory muscles are;

i. The diaphragm and

ii. The external intercostal muscles

THE DIAPHRAGM

✓ is a sheet of skeletal muscle that separates the thoracic cavity from the abdominal cavity

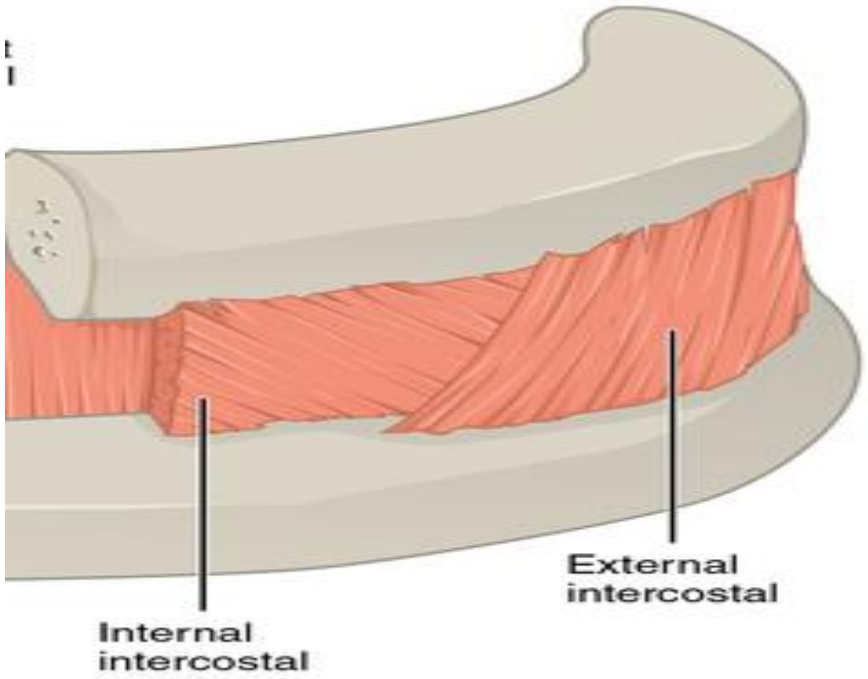
✓ When the diaphragm contracts, it flattens out. This pushes the abdominal organs caudally. It also increases the size of the thoracic cavity, causing air to be drawn into the lungs

MUSCLES OF INSPIRATION(INHALATION)

THE EXTERNAL INTERCOSTAL MUSCLES

- Fibers of the external intercostal muscles are directed in an oblique direction
- Responsible for inhalation
- when they contract they rotate the ribs upward and forward.
- This increases the size of the thoracic cavity and causes air to be drawn into the lungs.(inspiration)

INTERNAL & EXTERNAL INTERCOSTAL MUSCLES



MECHANISM OF EXPIRATION

- Expiation is pushing air out of the lungs
- Does not require much effort like inspiration
- 2 sets of expiratory muscles aid the process of expiration

i. Internal intercostal muscles

ii. Abdominal muscles

MECHANISM OF EXPIRATION

INTERNAL INTERCOSTAL MUSCLES

- ✓ Fibers run at right angles to those of the ext. intercostal muscles
- ✓ When they contract, they rotate the ribs backwards which decreases the size of the thorax & pushes air out of the lungs

ABDOMINAL MUSCLES

- ✓ When they contract, they push abdominal organs against the caudal side of the diaphragm.
- ✓This pushes the diaphragm back into its dome shape & decreases the size of the thorax

ABDOMINAL MUSCLES

- ❑ The muscles that form the bulk of the abdominal wall
- ❑ They support organs of digestion & reproductive
- ❑ The abdominal muscles are arranged in layers with the muscle fibers running in different directions.
- ❑ Most of these muscles have broad aponeurotic insertions that meet at the midventral line known as the linea alba (white line).
- ❑ 4 layers

✓External abdominal oblique muscle

✓ Internal abdominal oblique muscle

LAYERS OF THE ABDOMINAL MUSCLES

❑ From outside in, they are;

✓ the *external abdominal oblique* muscle,

✓ the *internal abdominal oblique* muscle

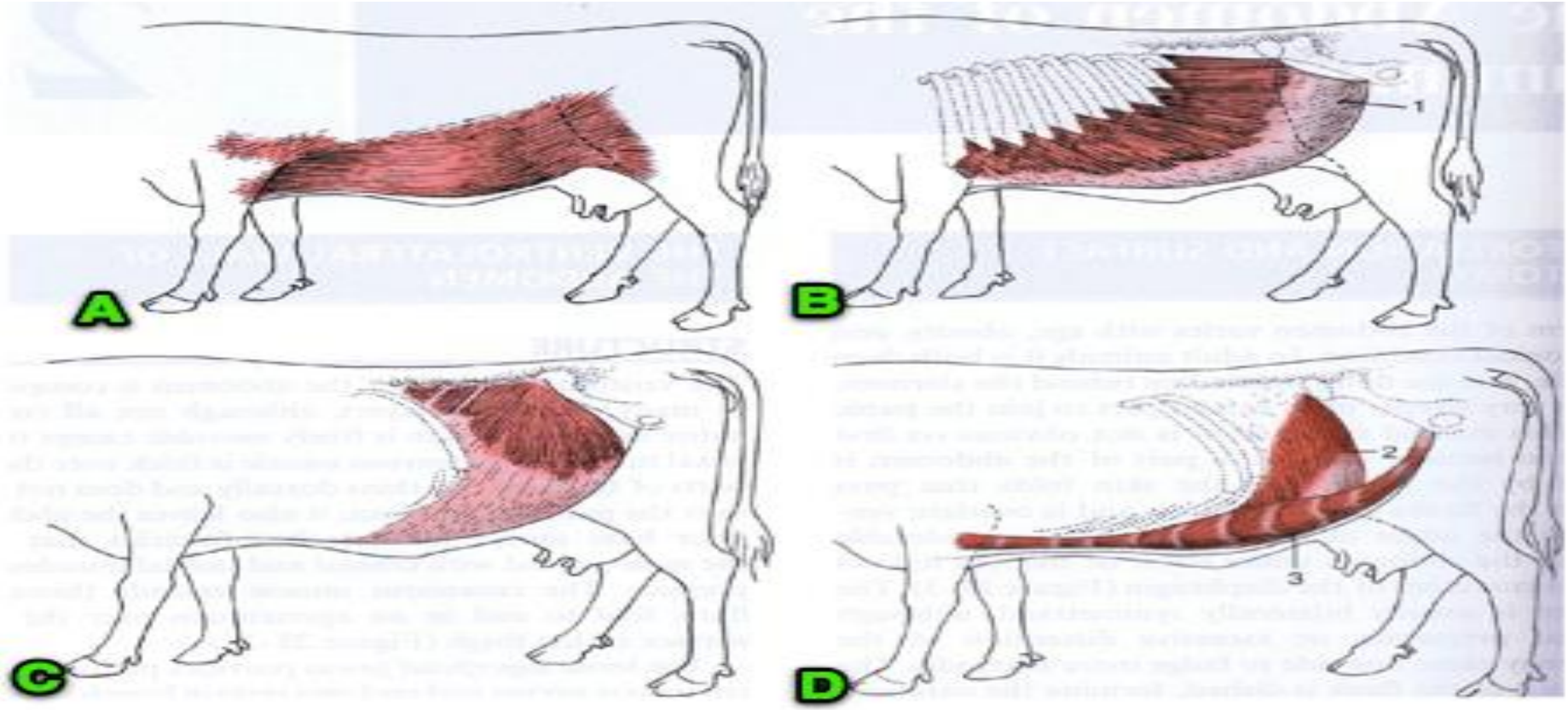
✓ the *rectus abdominis muscle*,

✓the *transversus abdominis* muscle

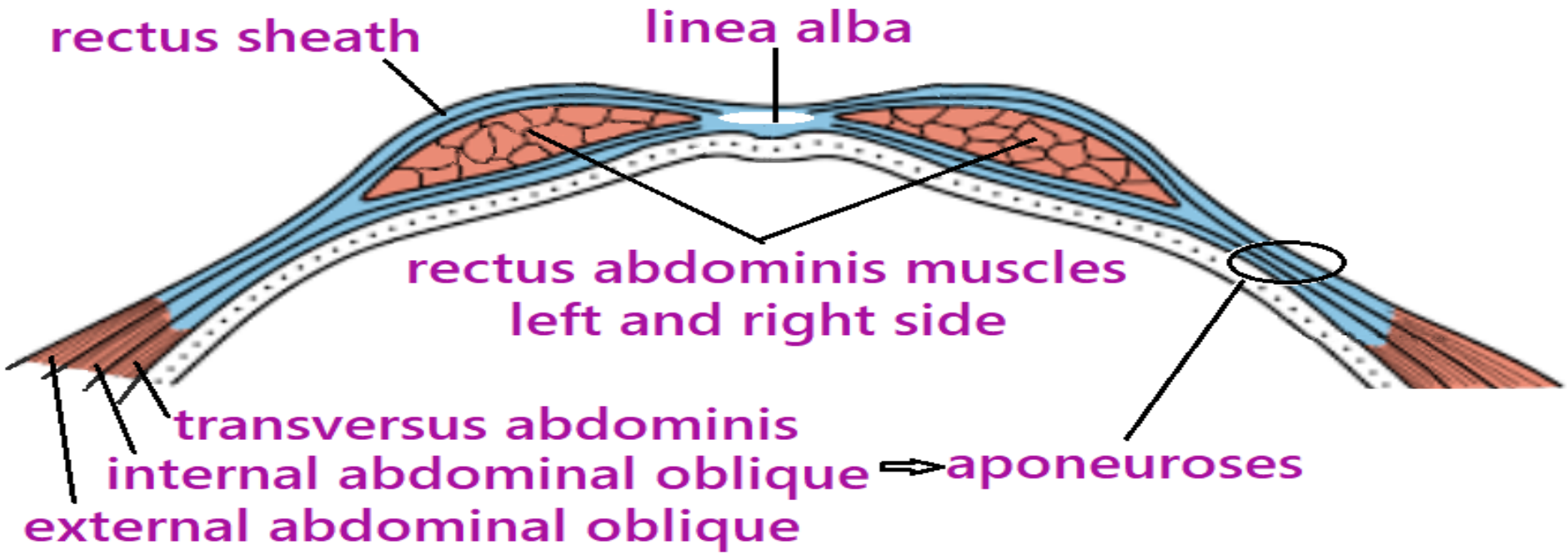
❑ The left & right parts of each muscle come together on the ventral midline at the linea alba (the aponeurosis that extends from the xiphoid process [caudal end] of the sternum to the cranial brim of the pubis).

LAYERS OF THE ABDOMINAL MUSCLES

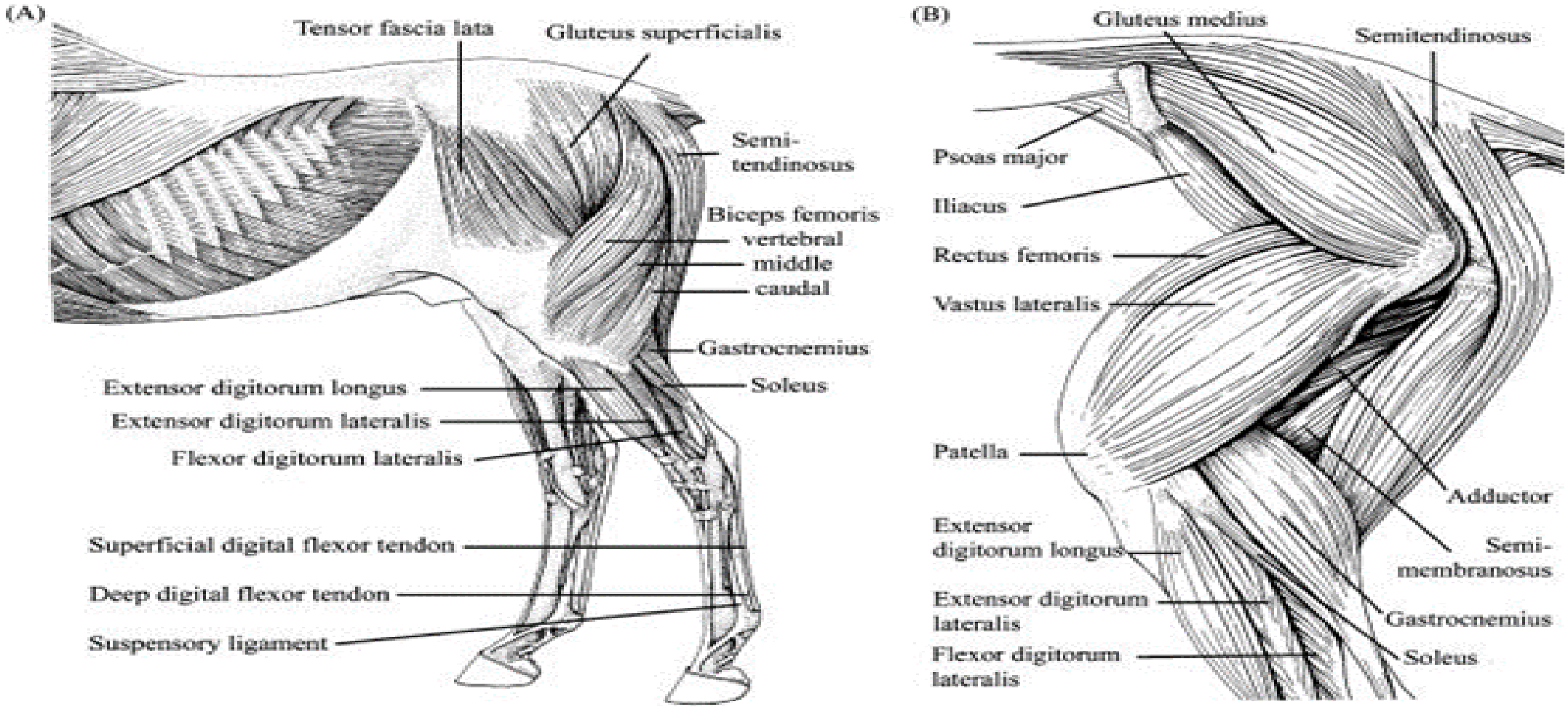
A = Cutaeous trunci m, B = Ext.abd. Obliq. C= Int. abd. Oblique. D= Trans. Abd & rectus abd. mm



LINEA ALBA


rectus sheath
linea alba
rectus abdominis muscles
left and right side
transversus abdominis
internal abdominal oblique
external abdominal oblique
aponeuroses

MUSCLES OF THE HINDLEG



PELVIC LIMB SKELETAL MUSCLES

❑ The pelvic limb muscles are also involved mainly in locomotion.

EXTENSORS OF THE HIP JOINT

i. THE GLUTEAL MUSCLES

✓Origin – bones of the pelvis

✓ Insert – on the femur

ii. THE HAMSTRING MUSCLE

✓ Located on the caudal part of the thigh region

✓ Composed of 3 muscles; the *biceps femoris* muscle, the semimembranosus muscle & the semitendinosus muscle

✓ Also the main flexors of the stifle joint

PELVIC LIMB SKELETAL MUSCLES

EXTENSORS OF THE STIFLE JOINT

✓ *Quadriceps femoris* muscle

✓ Location – cranial part of the thigh region

MAIN EXTENSOR OF THE HOCK JOINT

The *gastrocnemius* muscle

✓ Origin: distal end of the femur

✓ Inserts; on the calcaneal tuberosity of the fibular tarsalbone

MUSCLE PHYSIOLOGY

- Muscle tissue has basic physiologic properties other than contractility or the ability to shorten.

These include;

i. Excitability
ii. Extensibility
iii. elasticity.
iv. Conductibility
v. contractibity

MUSCLE PHYSIOLOGY

1. CONTRACTIBILITY

✓ Ability to shorten when stimulated

2. EXCITABILITY (also called irritability)

✓ is the ability to receive and respond to a stimulus.

3. **EXTENSIBILITY**

✓ is the ability to be stretched or extended

4. ELASTICITY

✓ is the ability to return to the original shape after contraction or after being stretched.

5. CONDUCTIBILITY – Ability to receive a stimulus & transmit a wave of excitation (electrochemical activity)

All 5 of these properties are related to the ability of muscle to produce movement.

STRUCTURE OF A SKELETAL MUSCLE FIBER

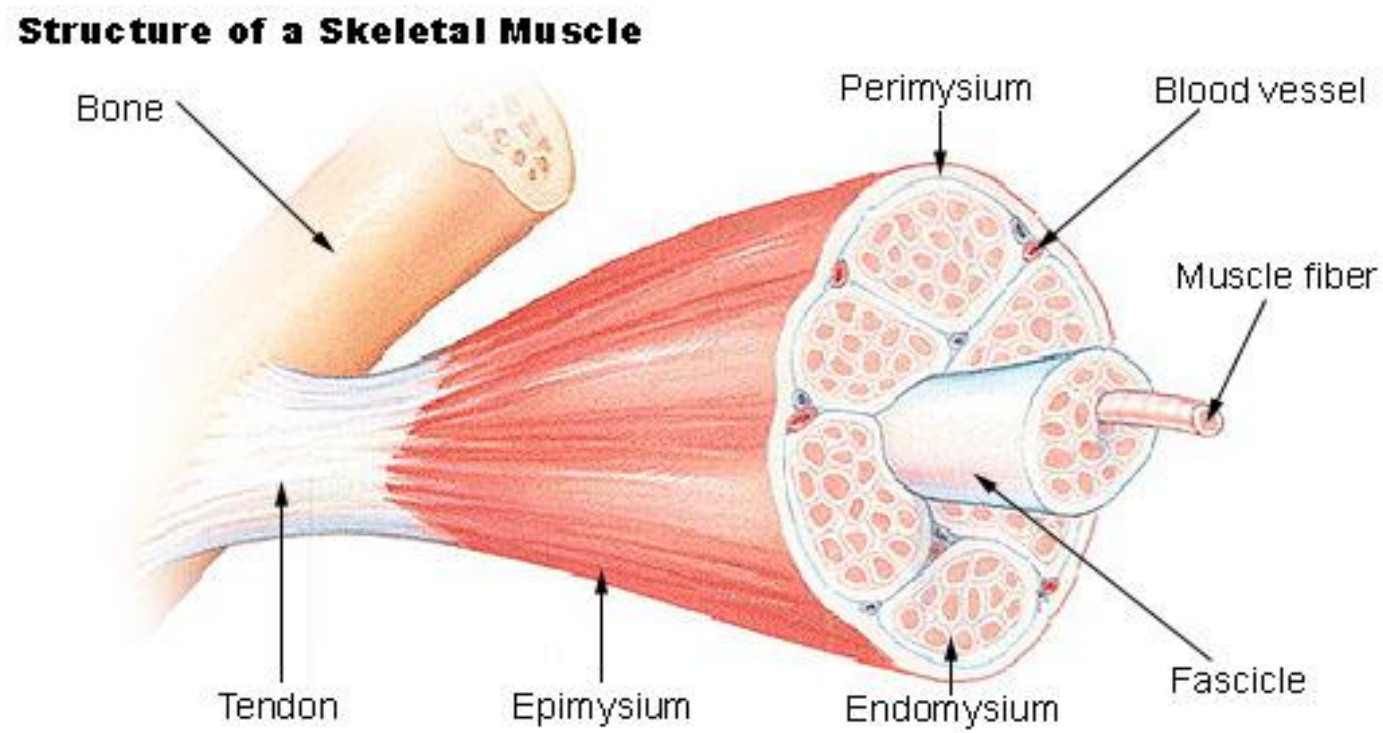
- ❑ The interior of a muscle fiber is interesting
- ❑ Each skeletal muscle fiber is made up of 100s or 1000s of smaller myofibrils packed together lengthwise which are themselves composed of thousands of even tinier protein filaments.
- ❑ Prominent organelles between the myofibrils in a muscle fiber include;

✓Mitochondria,

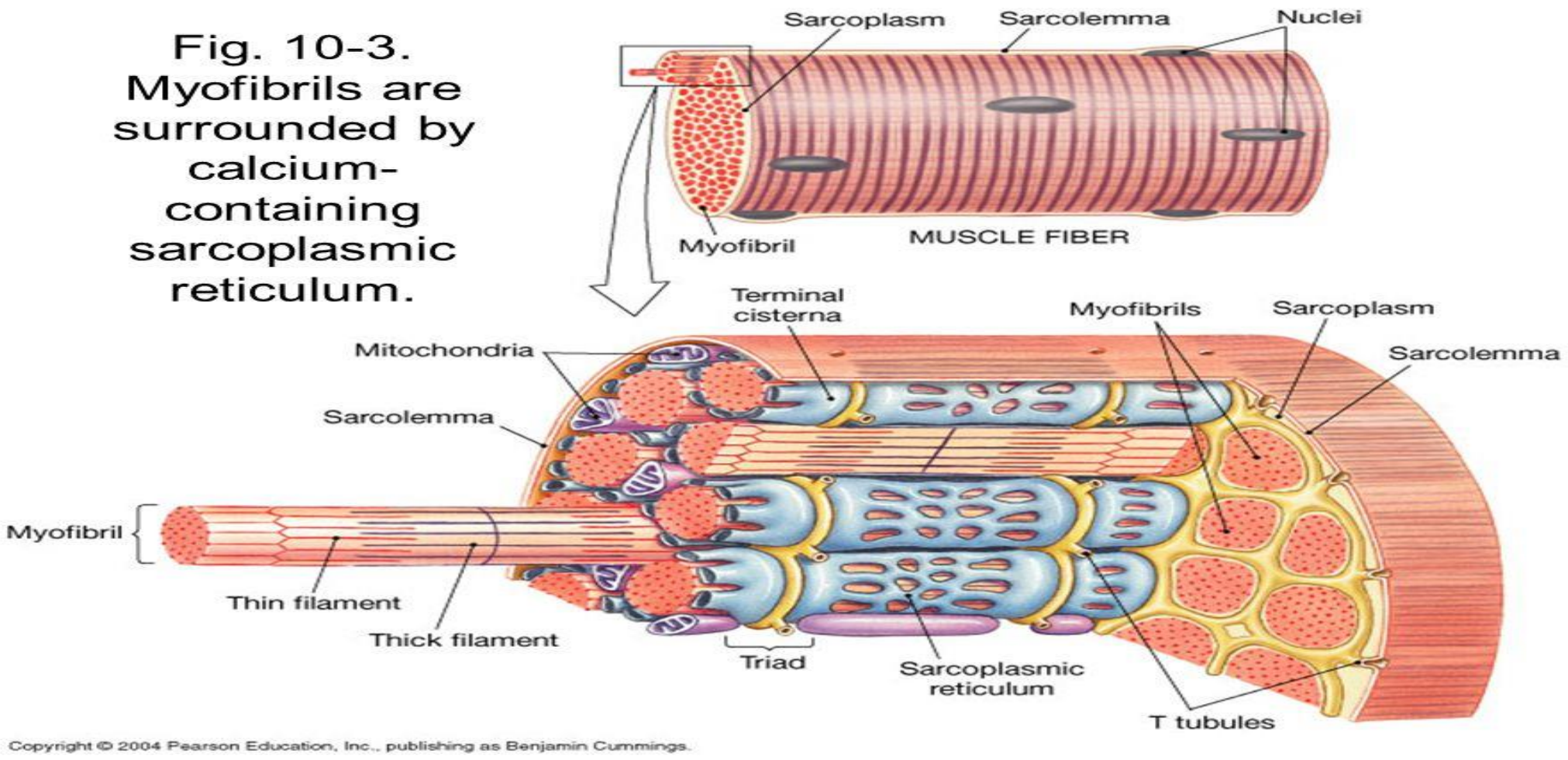
✓Sarcoplasmic Reticulum (storage organelle for calcium ions),

✓System of tubules called transverse tubules (T-tubules) that extend in from the sarcolemma (cell membrane)

STRUCTURE OF SKELETAL MUSCLE (REVISION)



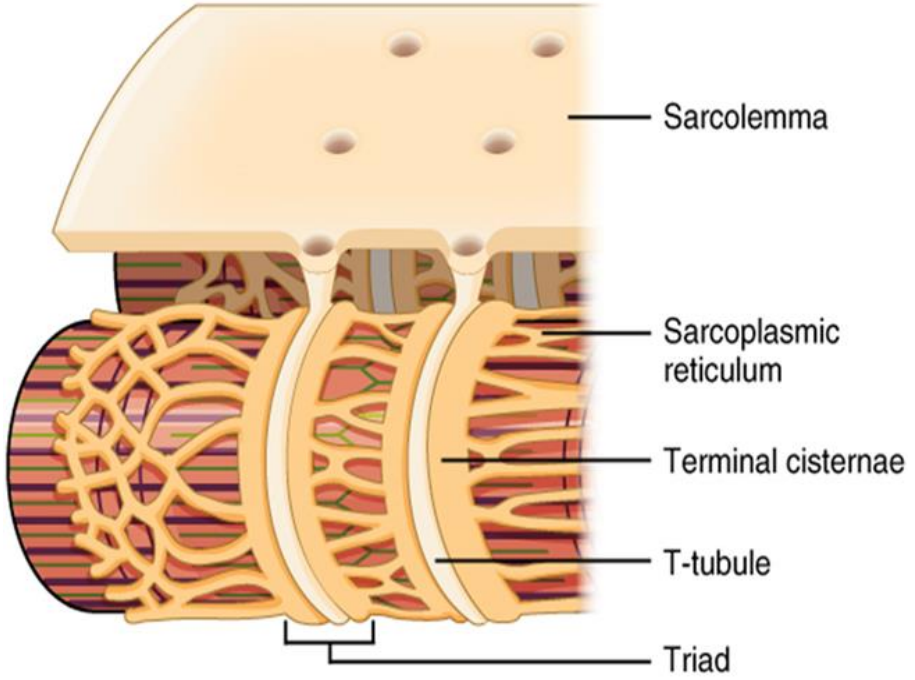
MYOFIBRIL & SURROUNDING STRUCTURES



MYOFIBRIL & SURROUNDING STRUCTURES

SARCOPLASMIC RETICULUM (SR)

- ✓Is a membrane bound structure found within the muscle cells
- ✓ It is closely associated with myofibril
- ✓ Similar to ER of other cells
- ✓ Main function is to store Ca2+



MYOFIBRIL & SURROUNDING STRUCTURES

TRANSVERSE TUBULES (T- TUBULES)

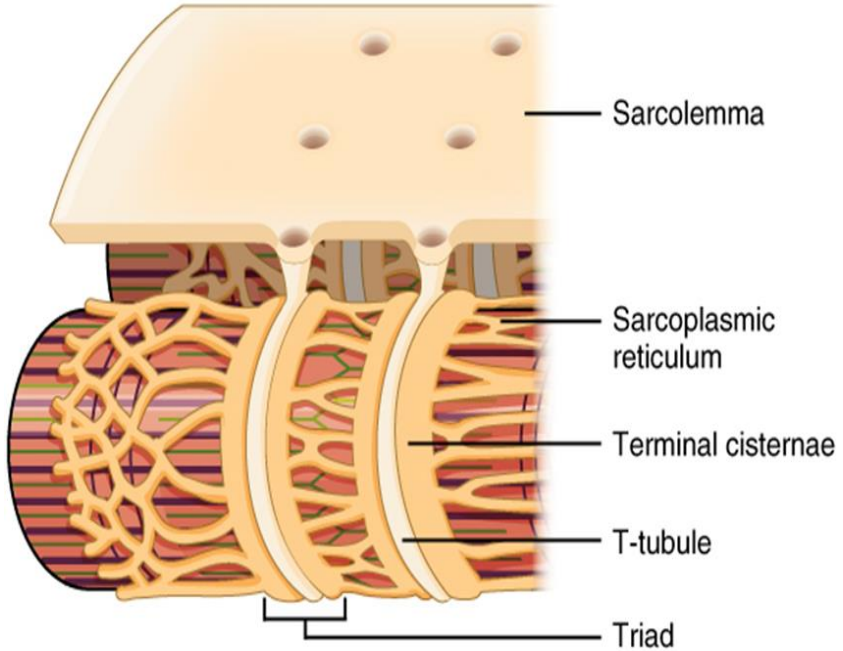
- ✓ Continuous with cell membrane & penetrates into the center of skeletal & cardiac muscle cells
- ✓ Function:

spreads (propagates) impulses (action potential) from the sarcolemma into the interior of the cell to initiate contraction of the muscle fiber

Or to conduct impulses from the surface of the cell (sarcolemma) down into the cell to the sarcoplasmic reticulum

T – TUBULES

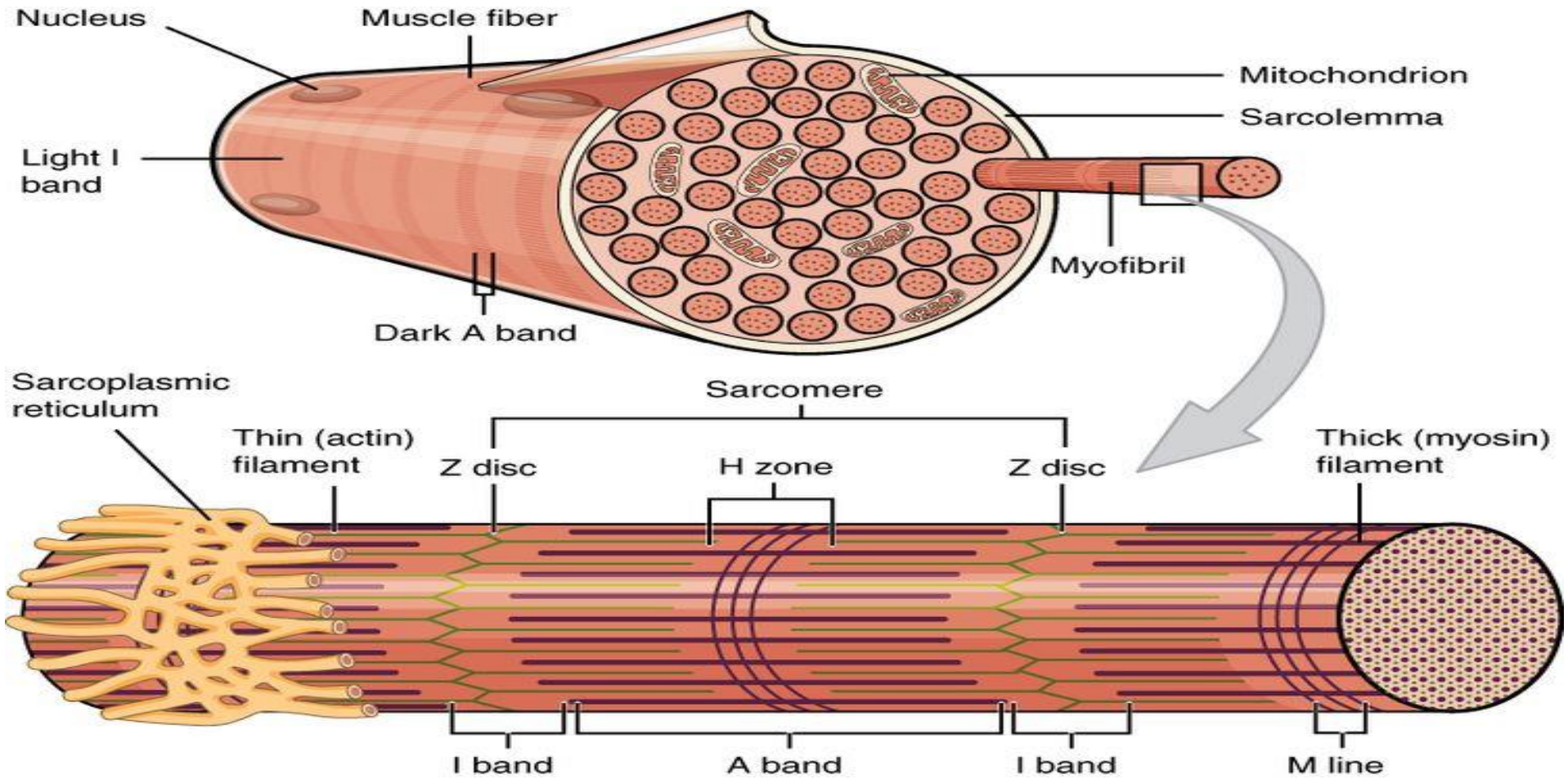
- Continuous with the plasma membrane
- Propagates action potentials



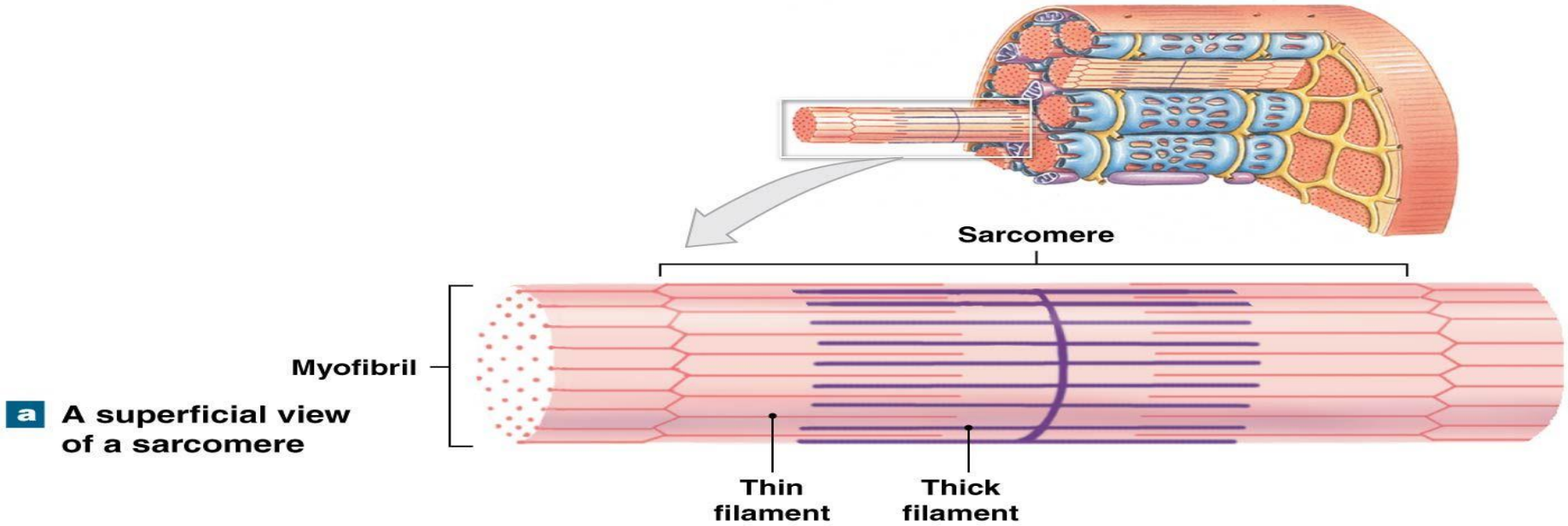
MYOFIBRIL

- Each myofibril is madeup of a series of protein filaments
- These filaments form the contractile units of a myofibril
- Each one of these contractile units is called a sarcomere
- A sarcomere is the basic contracting unit of skeletal muscle
- There are many sarcomeres laid end to end in one myofibril.
- Each sarcomere has a disc on each end called the **Z line** or Z disc

MYOFIBRIL & SARCOMERE

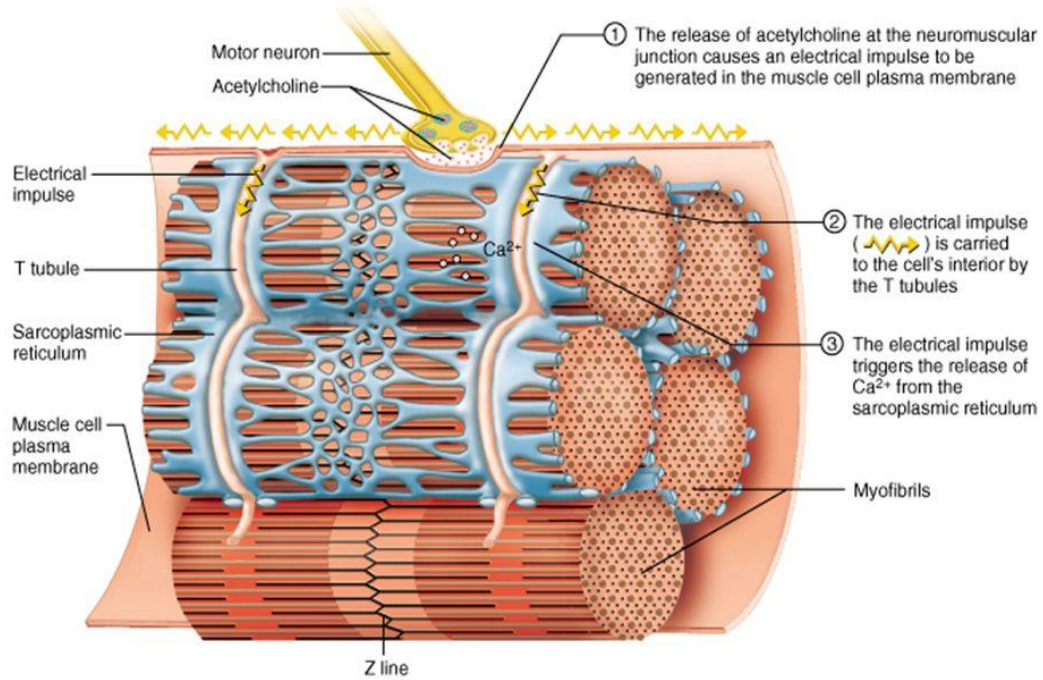


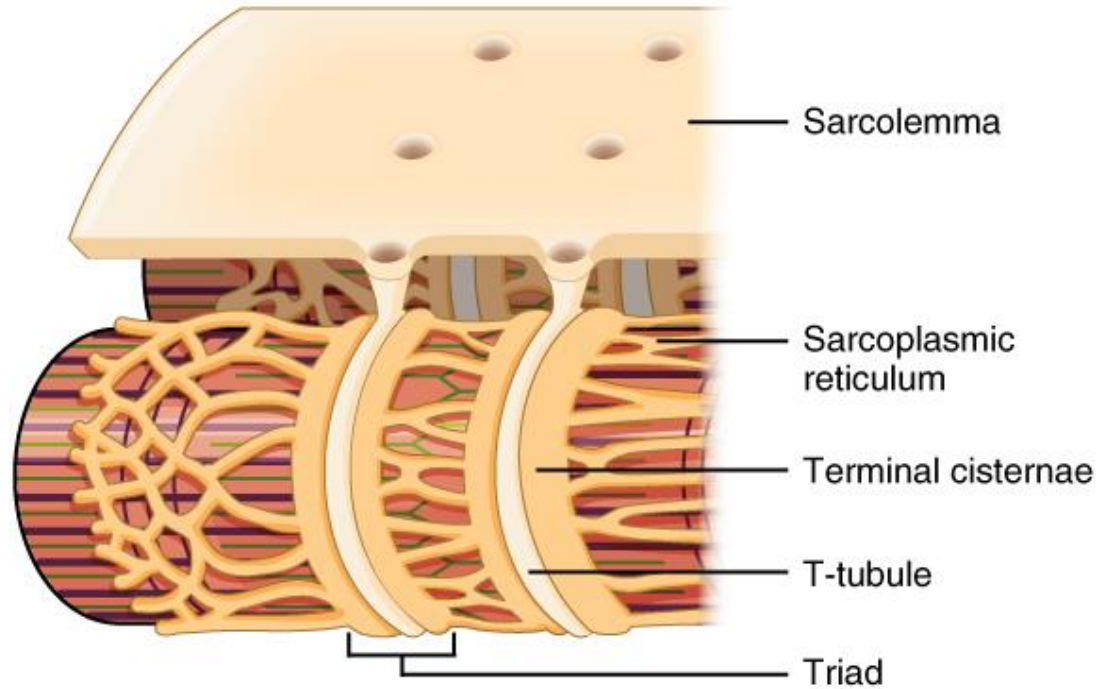
SARCOMERE STRUCTURE



a A superficial view of a sarcomere

Initiation of Contraction, Ca^{2+} release:





STRUCTURE OF A SARCOMERE

❑ Within a sarcomere there are 2 primary protein filaments that are responsible for contraction.

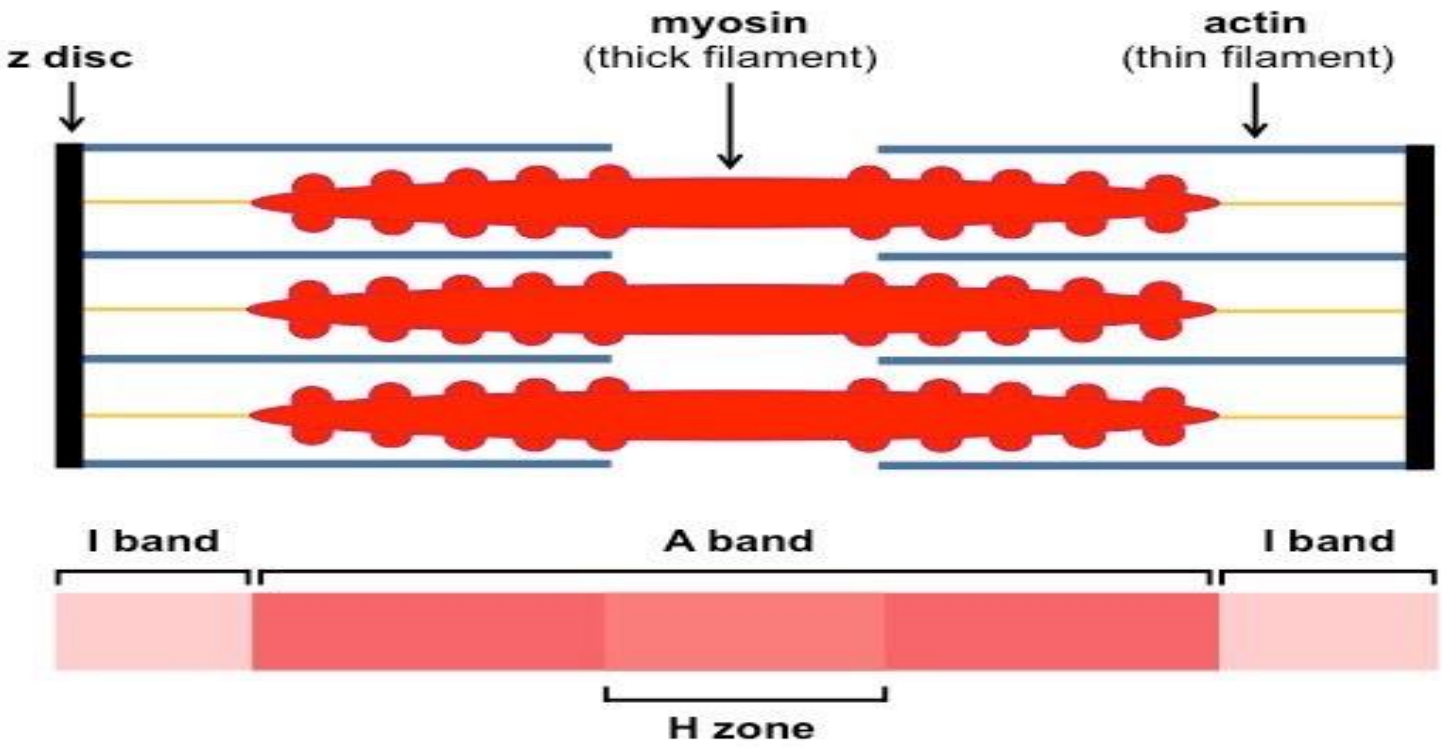
1. Actin
2. Myosin

ACTIN FILAMENTS

✓ These are thin protein filaments

✓ They attach to the Z lines & extend towards the center of the sarcomere but don't meet

STRUCTURE OF A SARCOMERE



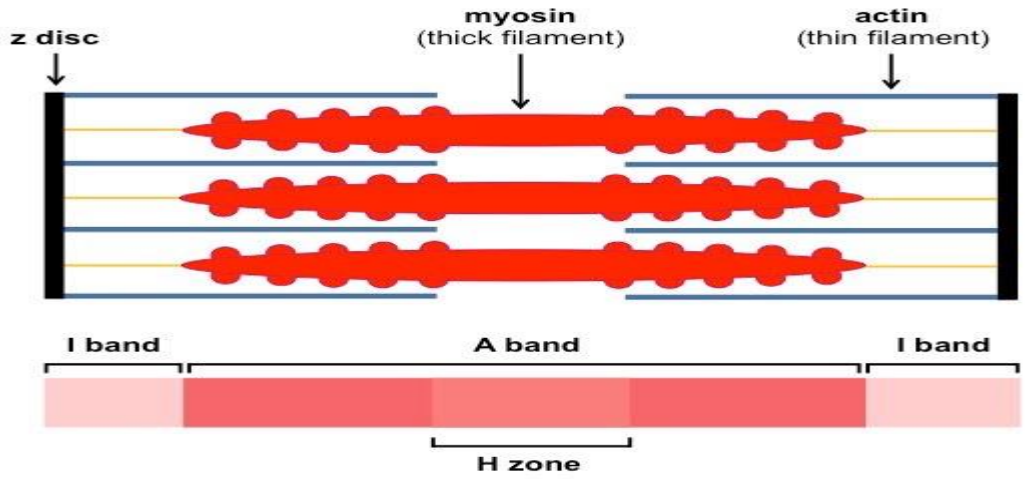
STRUCTURE OF A SARCOMERE

MYOSIN FILAMENTS

✓These are thick protein filaments

✓ They appear to float in the middle of the sarcomere between parallel actin fibers

✓They don’t connect to the Z lines



STRUCTURE OF A SARCOMERE

I BANDS

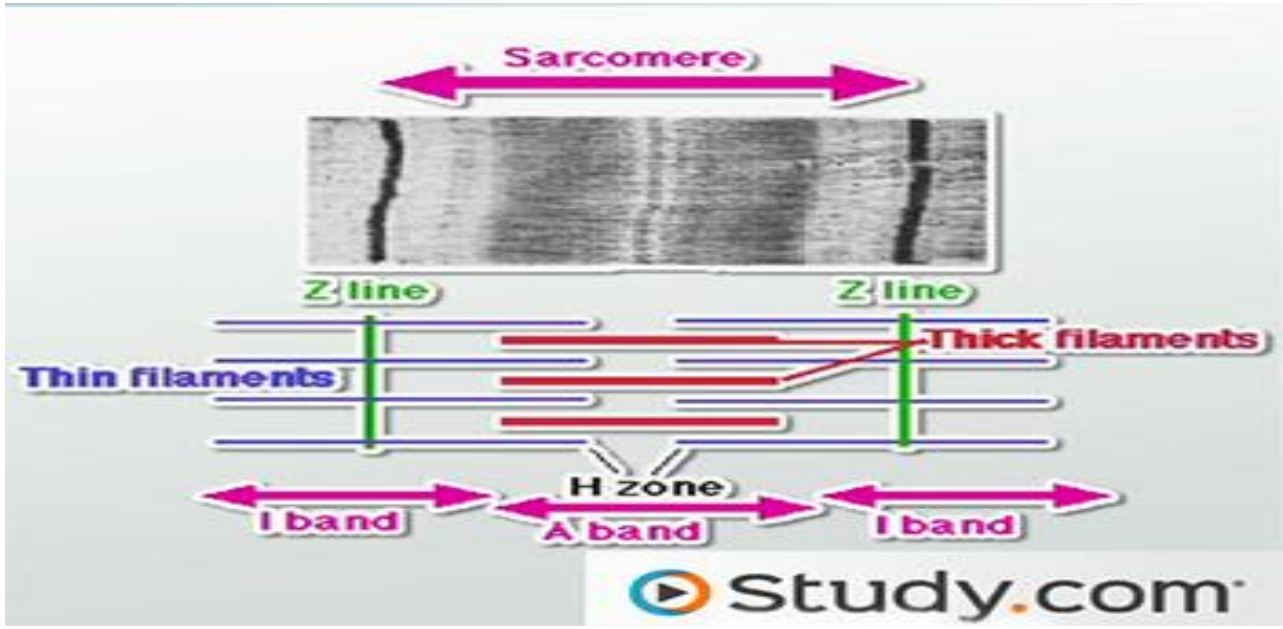
- Looking at a myofibril at a higher magnification we can see large light-colored bands. These are called I bands
- I bands are made up of the thin actin filaments.
- Each I band extends from one end of the thick myosin filaments in one sarcomere across the Z line to the beginning of the myosin fibers in the next sarcomere.
- In the center of the I band is the dark Z disc or line that is the attachment site for the actin filaments

STRUCTURE OF A SARCOMERE

A BAND

✓ Between the light I bands are darker bands called A bands.

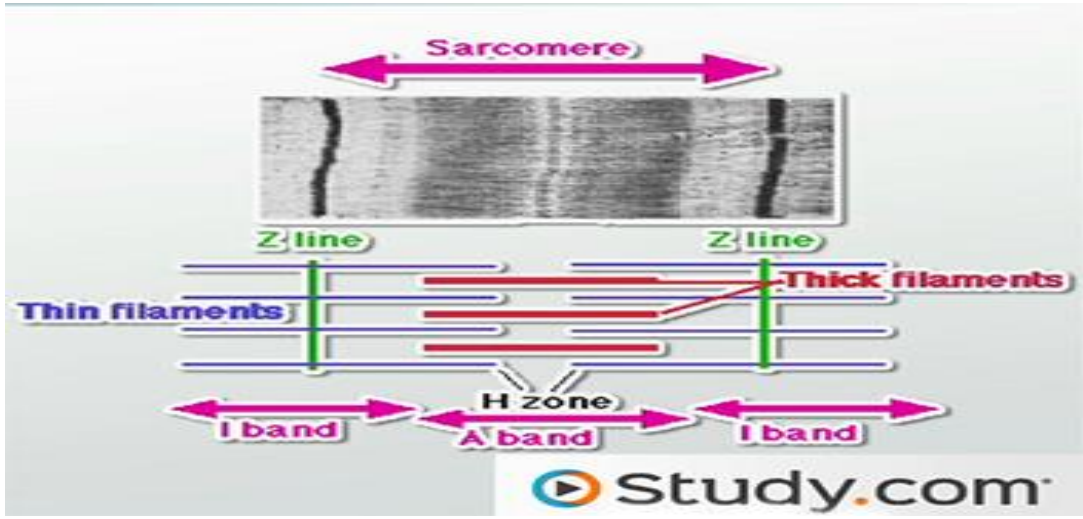
✓Theses are areas where the thick myosin filaments & thin actin filaments overlap.



STRUCTURE OF A SARCOMERE

H BAND

- ✓ is the light colored area located in the middle of the A band.
- ✓ It is made up of myosin filaments only with no overlapping actin filaments.
- ✓ the H band doesn't cover the entire width of the myosin filament

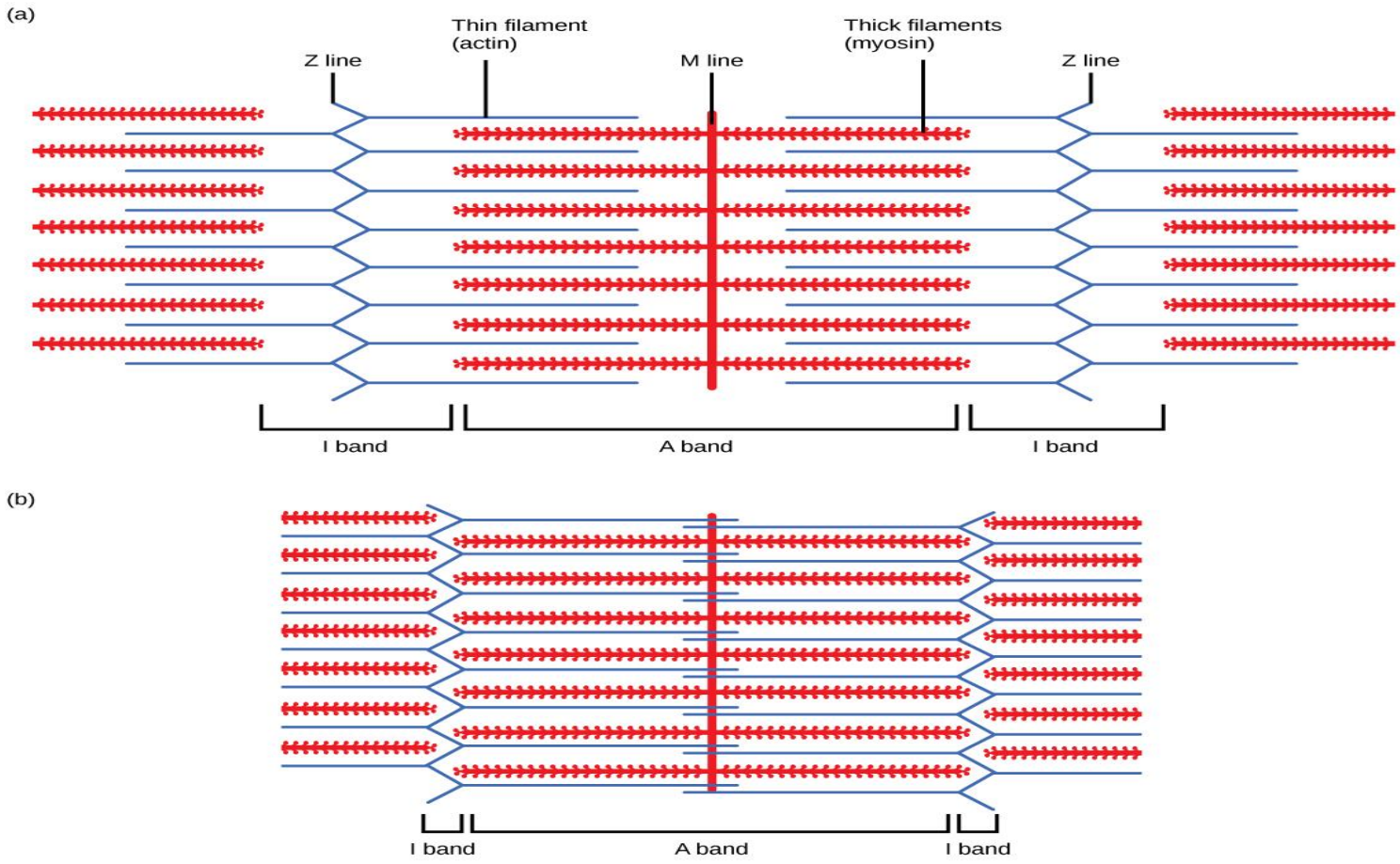


STRUCTURE OF A SARCOMERE

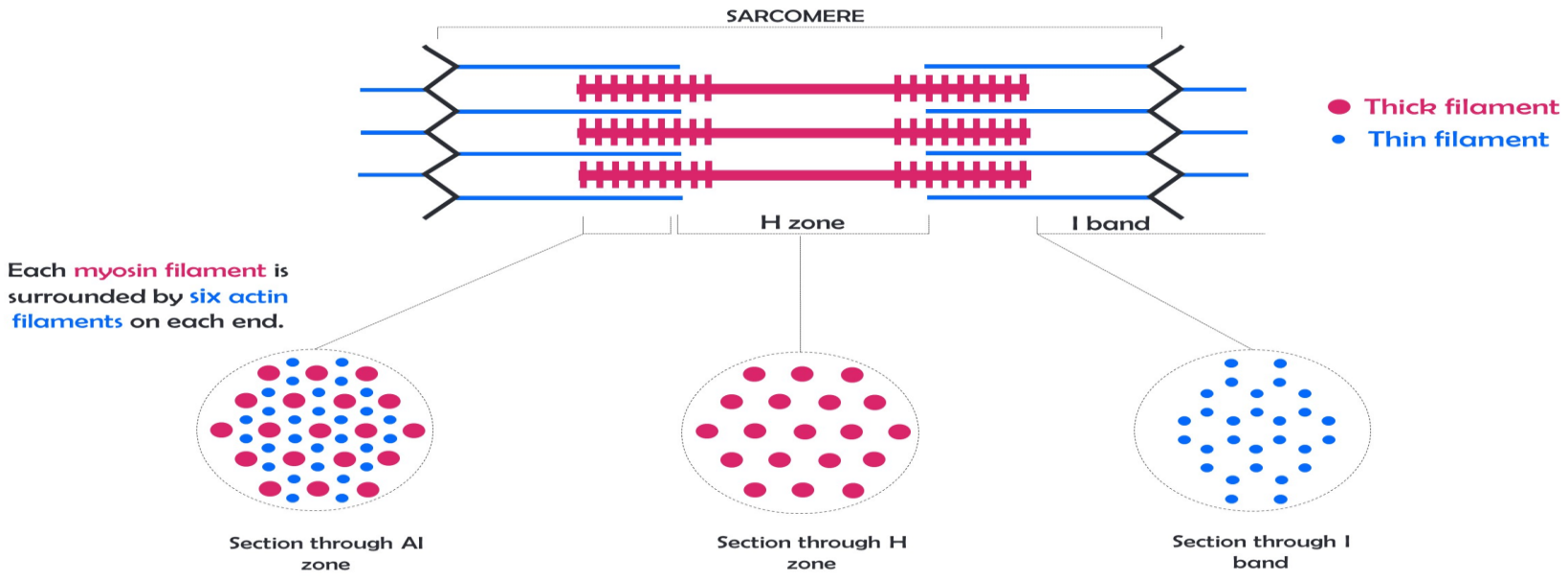
M LINE

- ✓ The center of the A band
- ✓ Considered to be the attachment site for thick filaments

SARCOMERE STRUCTURE SHOWING THE VARIOUS REGIONS



TRANSVERSE SECTION THROUGH A MYOFIBRIL



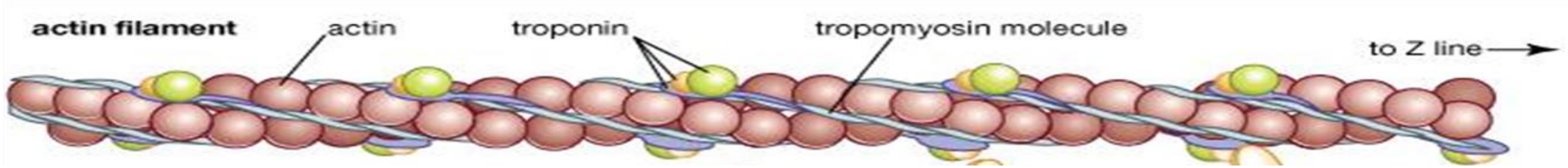
ACTIN

- ❑ Actin fibers are actually 2 strands of protein twisted together to form a helical structure similar in appearance to a DNA molecule
- ❑ Each actin molecule is made of 3 proteins;
- ✓ actin
- ✓ tropomyosin
- ✓ troponin

- ❑ Tropomyosin molecules are also joined in a strand that spirals around the strands of actin.

ACTIN THIN FILAMENT

- The 3rd protein, troponin, is found attached to tropomyosin at specific sites along the strand.
- Together they are called the troponin–tropomyosin complex
- Actin molecules are the most prominent & are arranged in two long strands wound around each other in a spiral



MYOSIN STRUCTURE

- ❑ Each thick filament is a bundle of myosin filament
- ❑ Myosin molecule has 2 parts

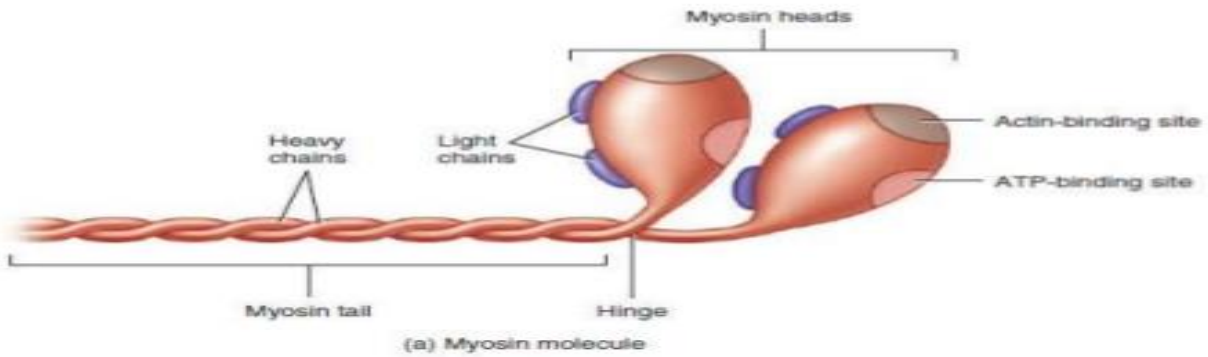
a. Filament part

b. Part that projects outwards with an enlargement at the end called myosin head

- ❑ Myosin heads protrudes from all around the thick filament.
- ❑ The heads extend away from the center in both directions, toward the surrounding thin filaments.

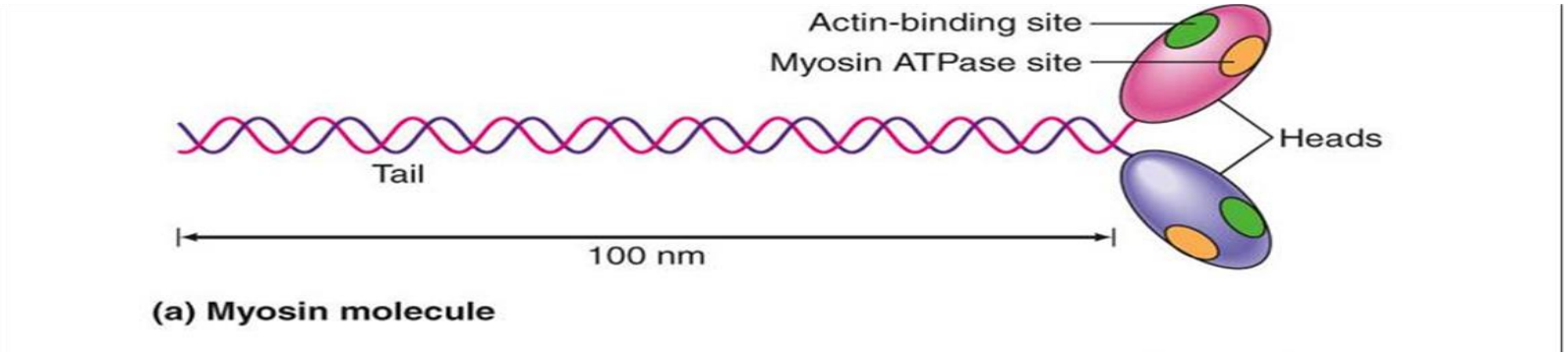
MYOSIN FILAMENT STRUCTURE

- The myosin molecule has a twisted tail attached to two globular heads that form cross-bridges to actin & interact with the actin to shorten the sarcomere during muscle contraction.

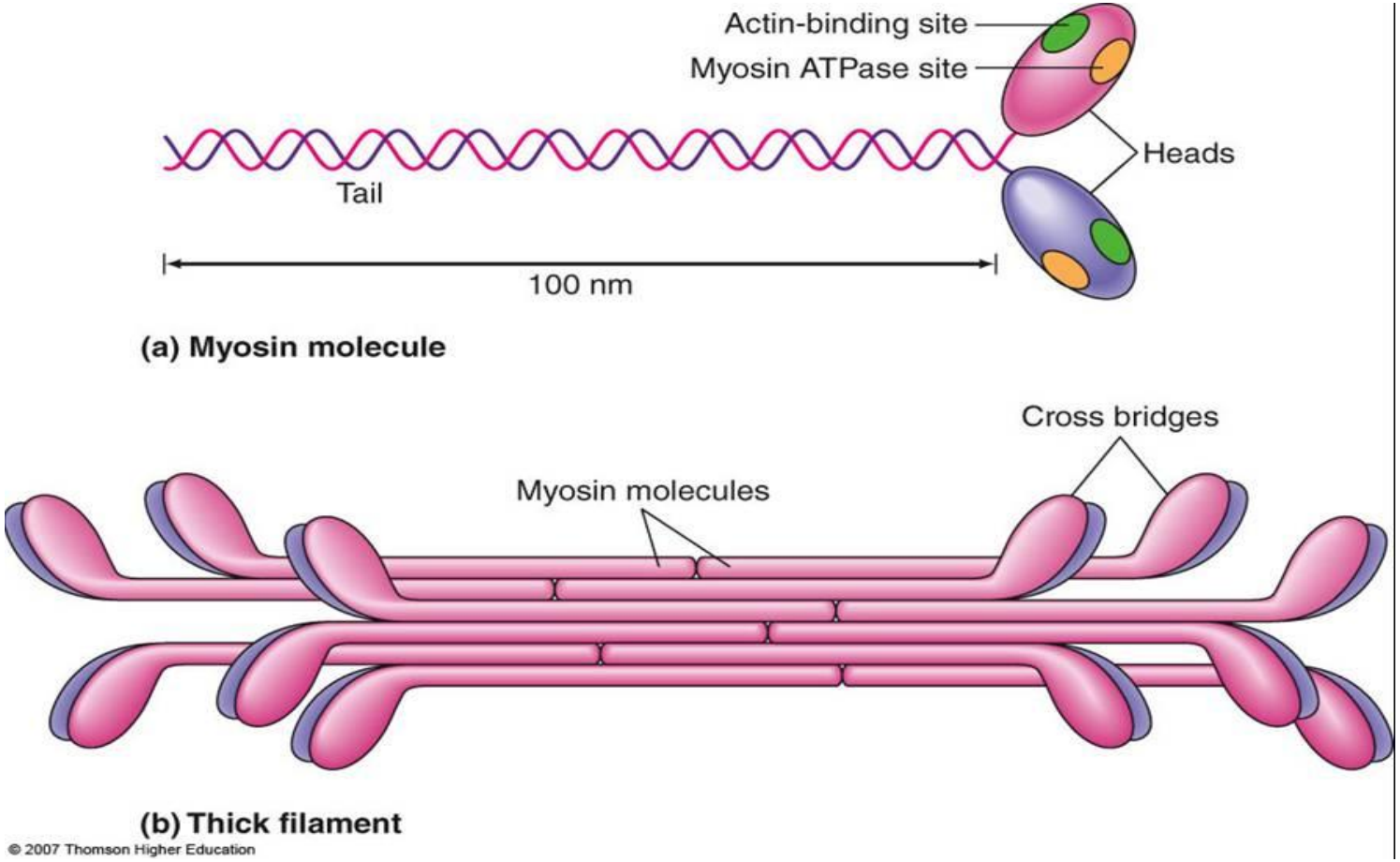


BINDING SITES ON MYOSIN HEAD

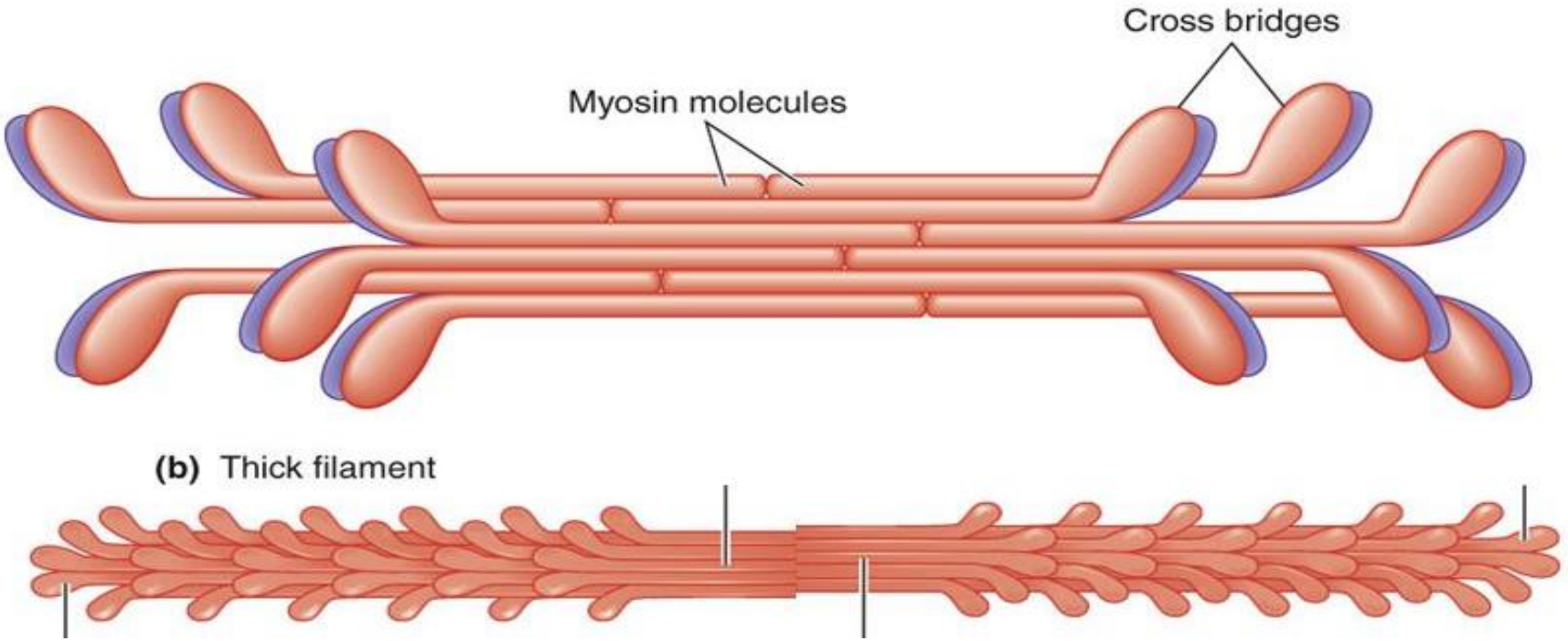
- ❑ Has 2 binding sites
- ✓ Actin binding site
- ✓ ATPase site – where ATP binds



MYOSIN STRUCTURE



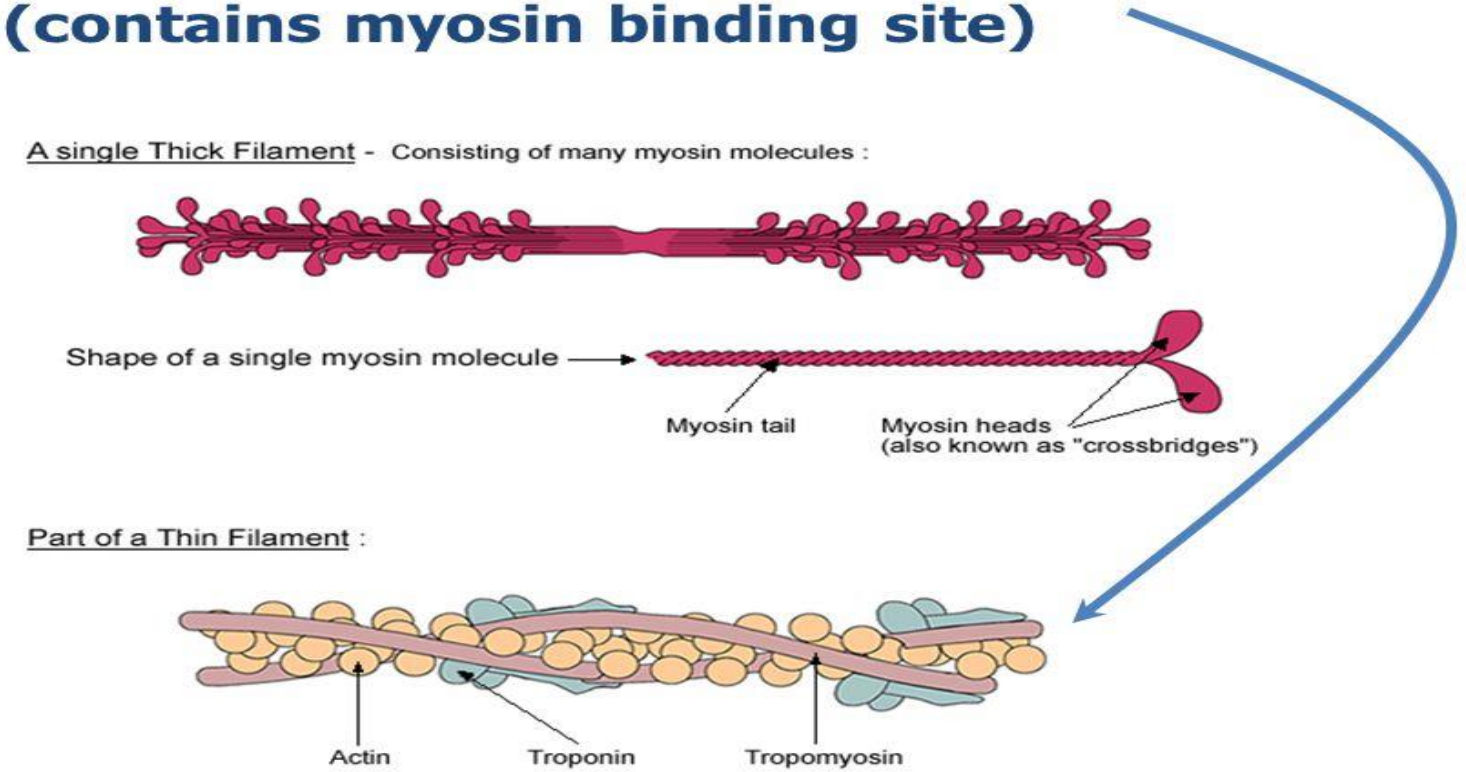
MYOSIN FILAMENT



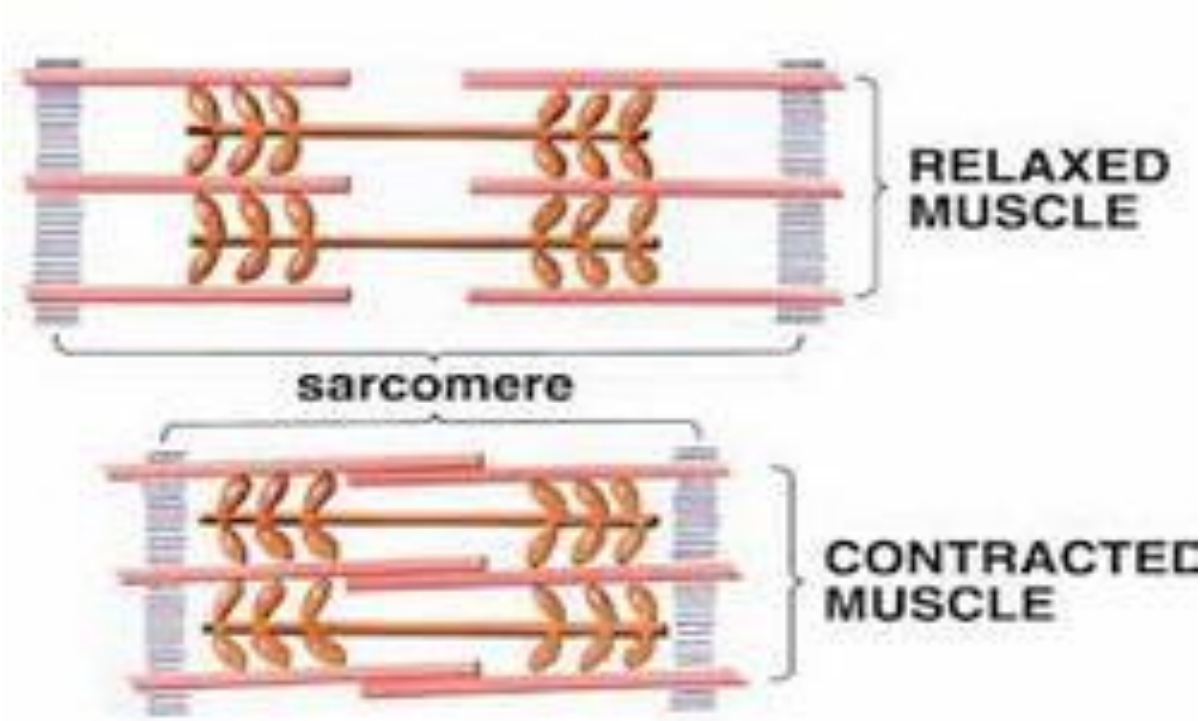
ACTIN & MYOSIN FILAMENTS

thin filaments

*** 2 twisted strands of protein *actin***
(contains myosin binding site)



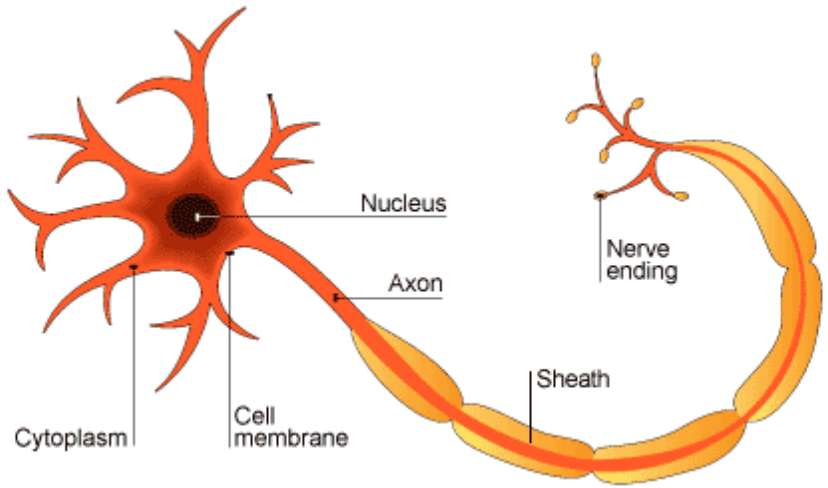
SARCOMERE DURING CONTRACTION & RELAXATION



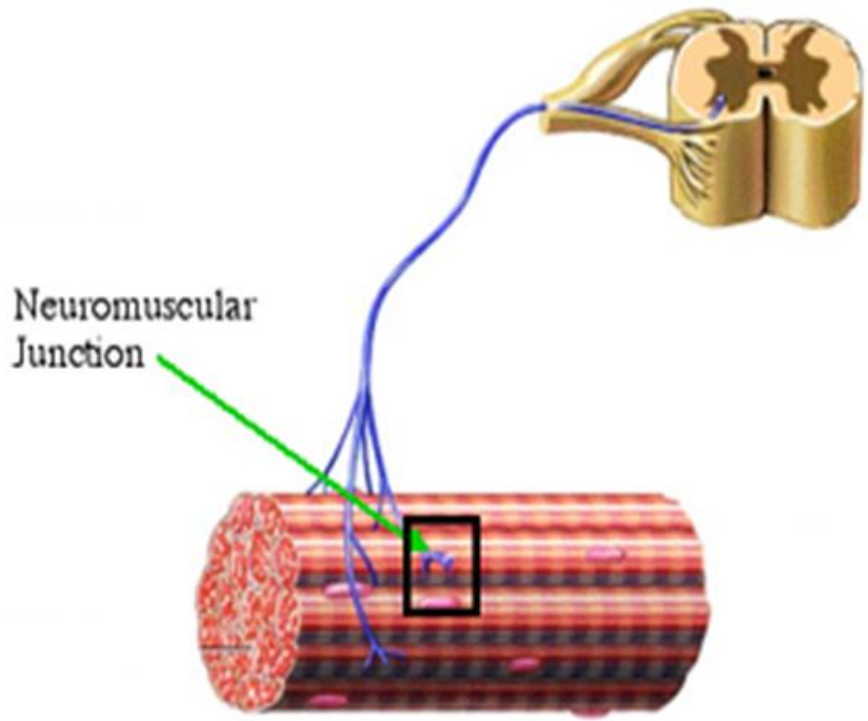
NEUROMUSCULAR JUNCTION

- Sites where the ends of motor nerve fibers connect to muscle fibers are called neuromuscular junctions.
- Skeletal muscle is under conscious, voluntary control.
- Unless it receives nerve impulses, it does not do anything.
- If a skeletal muscle's nerve supply is interrupted for a lengthy period as a result of injury, the muscle will not only lack the ability to function, it will shrink down through a process called atrophy.

NERVE CELL



- One motor nerve innervates many muscle fibers



NEUROMUSCULAR JUNCTION

SYNAPTIC SPACE

✓ the space between the ends of a a nerve fiber and a sarcolemma (cell membrane) of muscle fiber

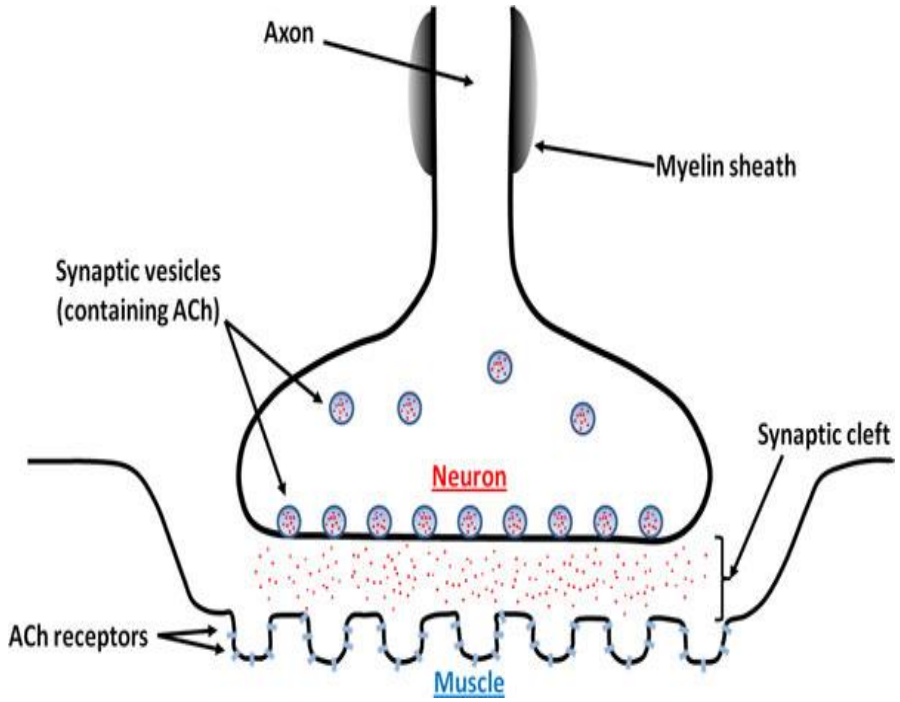
SYNAPTIC VESICLES

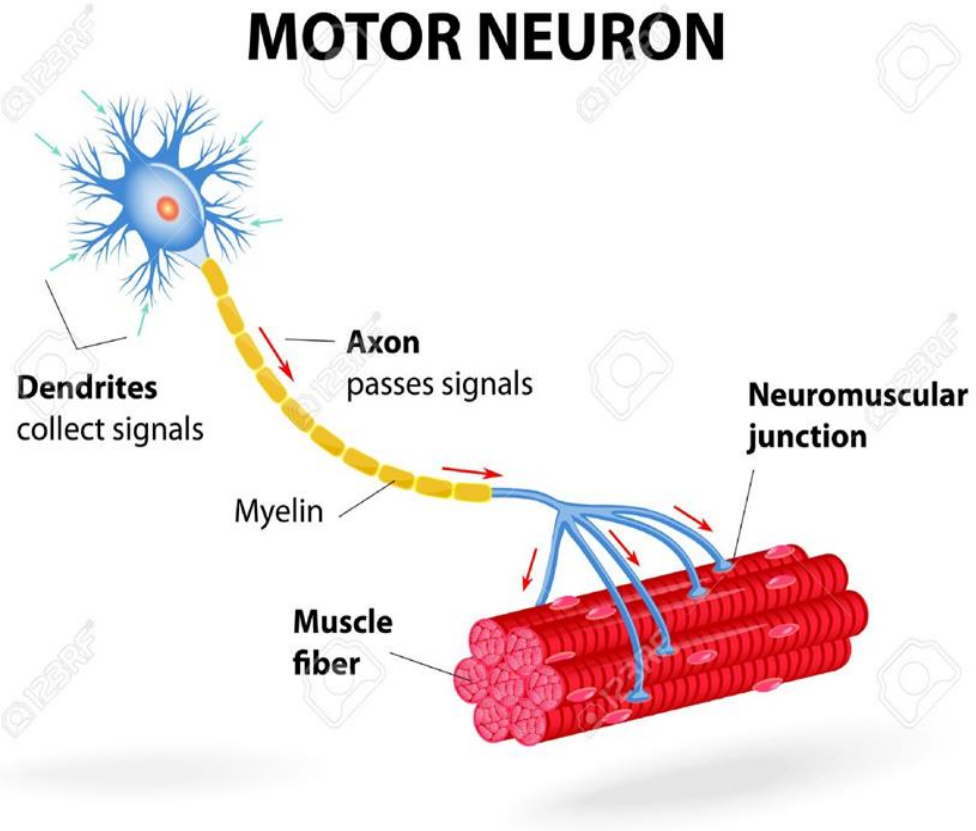
✓Tiny sacs within the end of a nerve fiber in a neuromuscular junction

✓ contain the chemical neurotransmitter *acetylcholine*

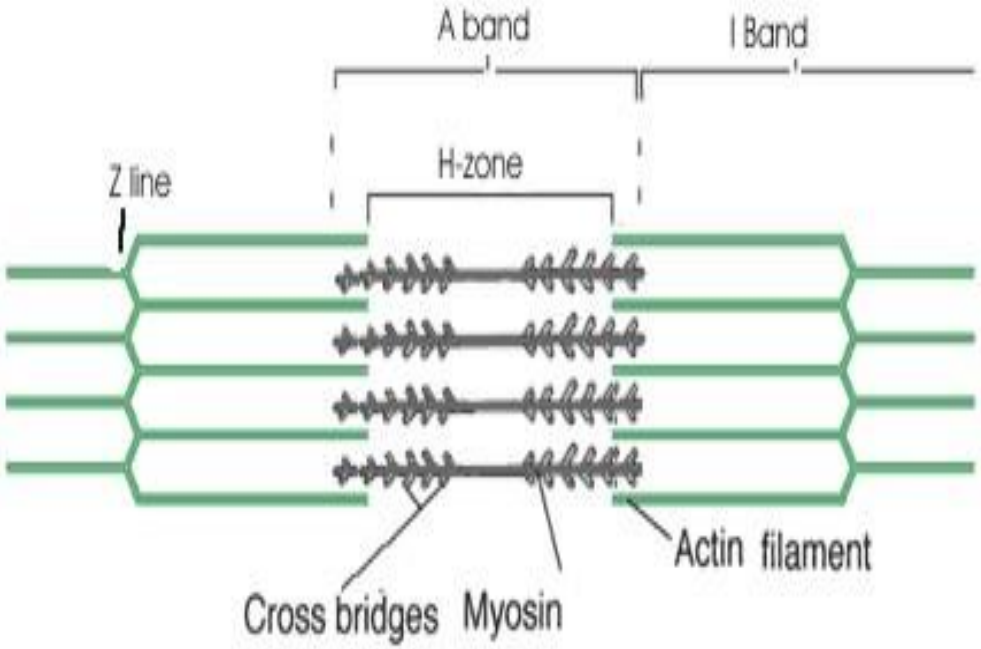
When a nerve impulse comes down a nerve fiber, it cause the release of acetylcholine which quickly diffuses across the synaptic space and binds to receptors on the sarcolemma

NEUROMUSCULAR JUNCTION





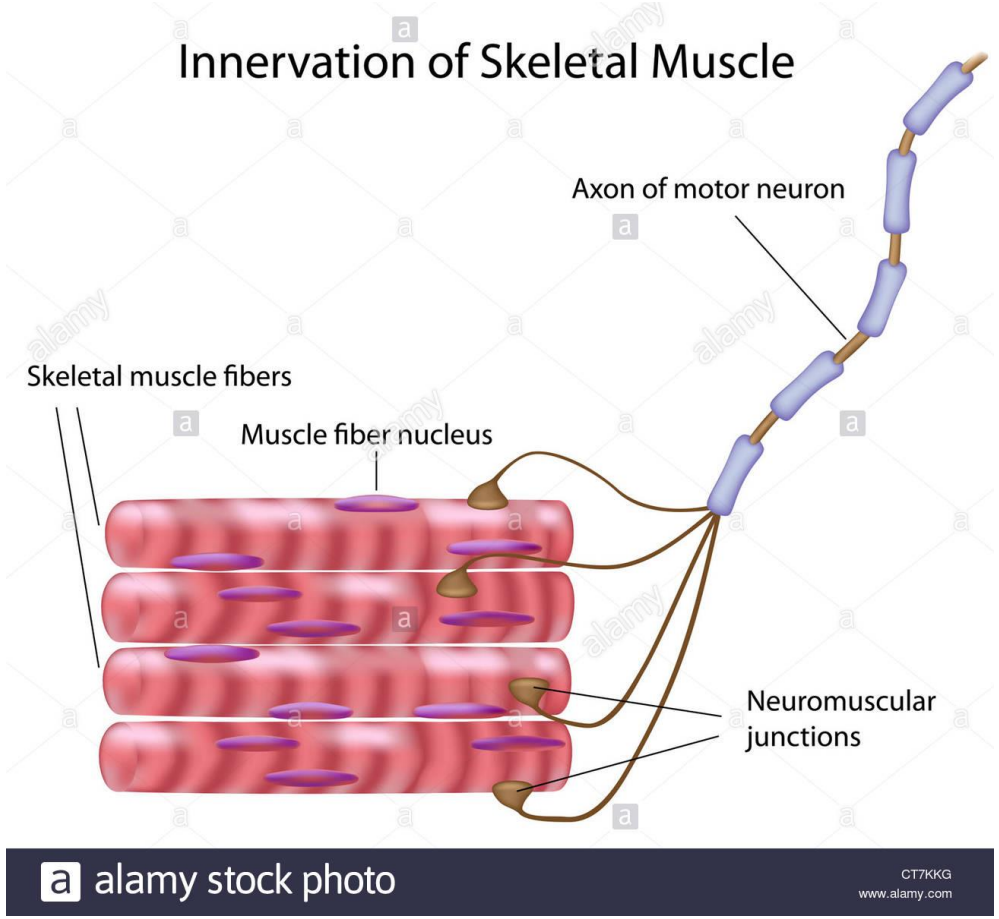
CROSS BRIDGES

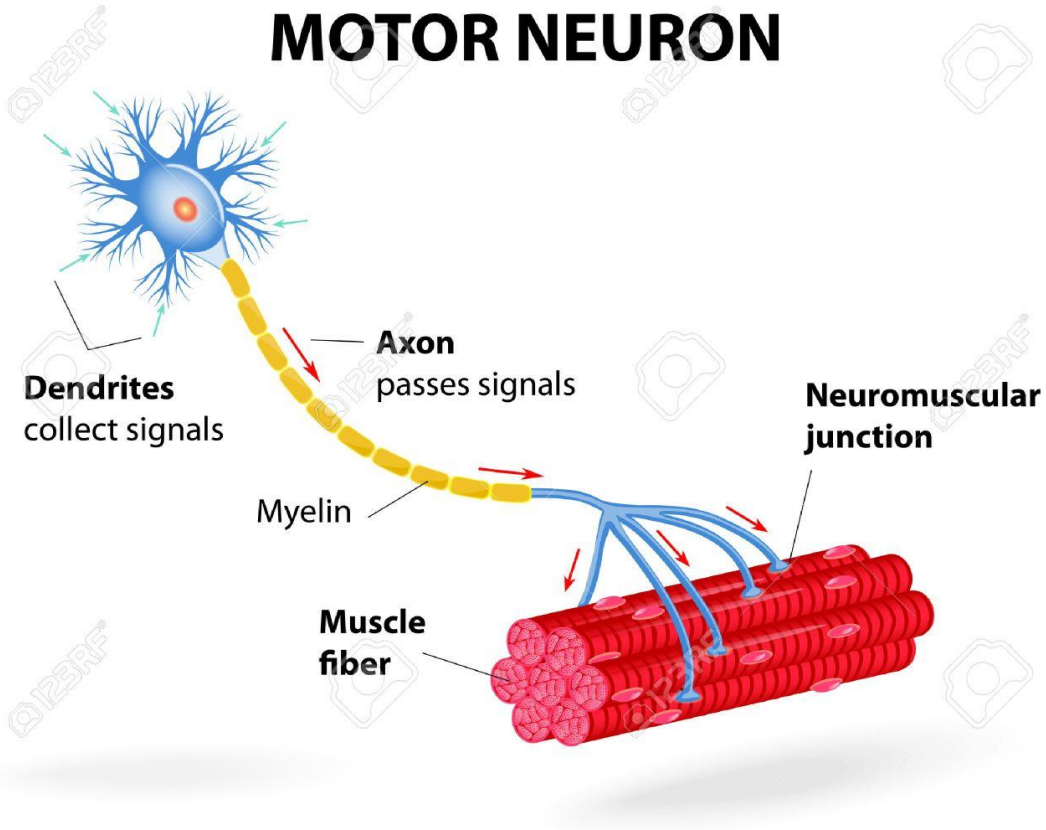


MOTOR UNIT

- The term motor unit is used to describe one nerve fiber & all the muscle fibers it innervates.
- Each nerve fiber innervates (sends impulses to) more than one muscle fiber.
- Muscles that make very small, delicate movements, such as the muscles that position the eyes, have only a few muscle fibers/nerve fiber in each motor unit.
- On the other hand, large, powerful muscles, such as leg muscles, may have 100 or more muscle fibers per motor unit. This allows the NS to control activities of the skeletal muscles in an economical manner

MOTOR UNIT


Innervation of Skeletal Muscle
Axon of motor neuron
Skeletal muscle fibers
Muscle fiber nucleus
Neuromuscular junctions
alamy stock photo
CT7KKG
www.alamy.com

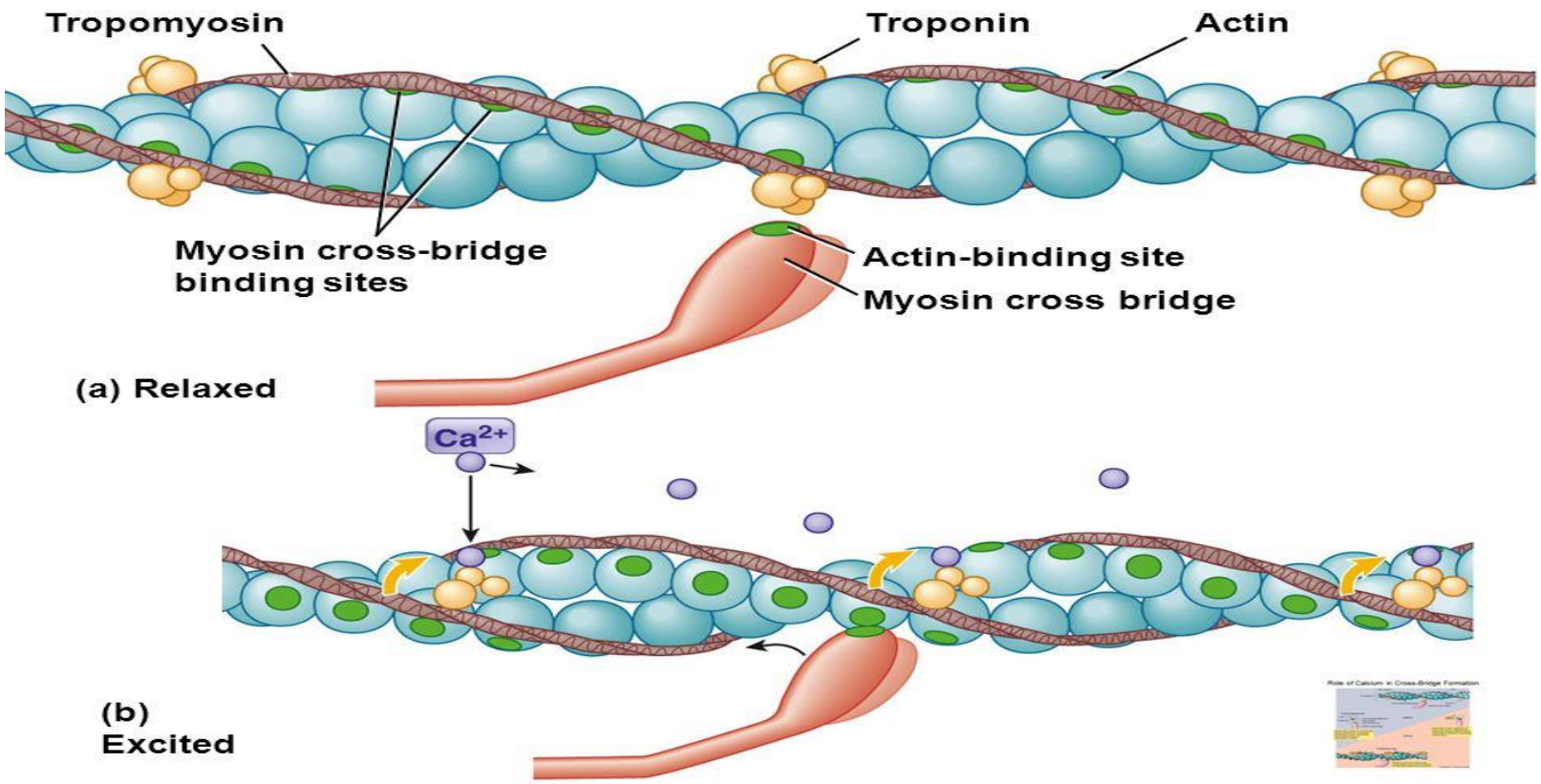

MOTOR NEURON
Dendrites
collect signals
Axon
passes signals
Myelin
Neuromuscular
junction
Muscle
fiber

SLIDING FILAMENT THEORY

also called ***sliding filament model of muscle contraction***

- ❑ The sliding filament theory describes a process used by muscles to contract.
- ❑ It is a cycle of repetitive events that cause a thin filament to slide over a thick filament and generate tension in the muscle

ACTIN BINDING SITES



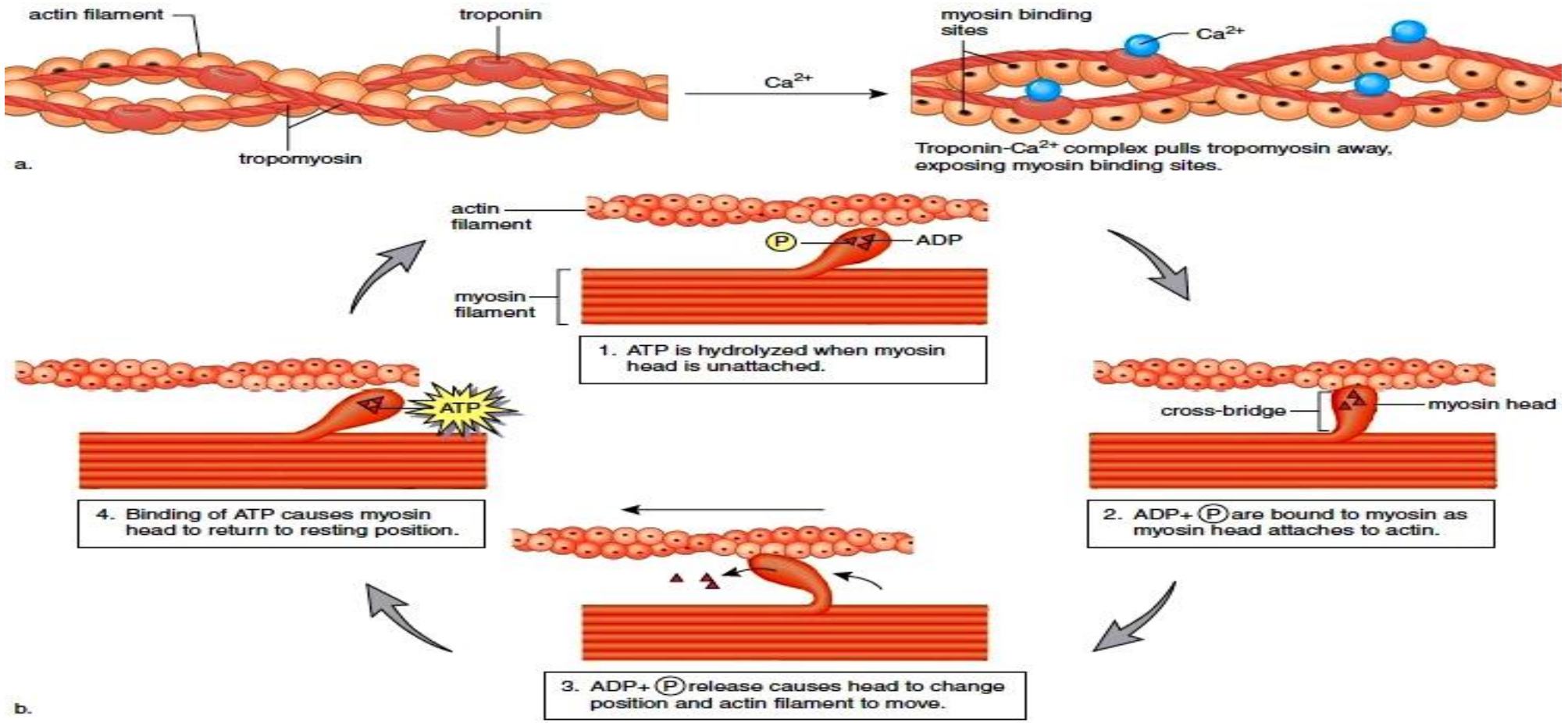
sliding filament model of muscle contraction

- Strands of tropomyosin lie over sites on the actin strand where myosin heads can bind.
- Ca^{2+} ions released from the SR binds to the troponin part of the troponin–tropomyosin complex & induce a molecular change in the tropomyosin strand.
- This change uncovers myosin binding sites on the actin strands so that the myosin head can attach.
- Binding of the myosin head to actin leads to the release of adenosine diphosphate (ADP) & phosphate, which were bound to the myosin head
- The myosin head also rotates from its resting position toward the center of the sarcomere; this movement pulls the actin chain to which it is bound past the thick filament

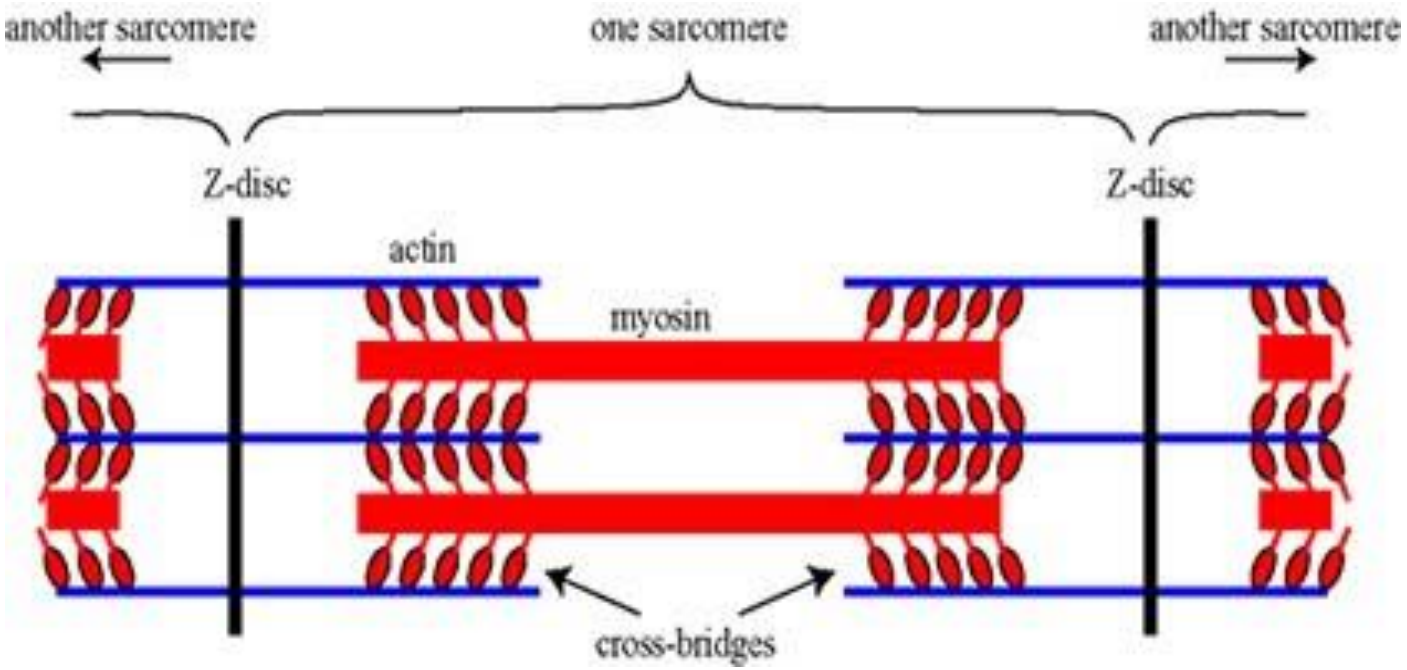
SLIDING FILAMENT MODEL OF MUSCLE CONTRACTION

- The myosin head remains at its final angle & bound to the actin of the thin filament until an intact ATP molecule binds to another site on the myosin head. (This site on the myosin head is ATPase, which also promotes the hydrolysis of ATP prior to movement of the head.)
- With the binding of a new ATP, the myosin head detaches from the actin chain and resumes its resting angle.
- It is ready to repeat the process of attaching to actin, moving from resting to final angle and pulling the attached thin filament farther toward the center of the sarcomere, detaching, then binding still another ATP molecule. The cycle of events that produces the shortening of each sarcomere, the ***sliding filament model of muscle contraction***

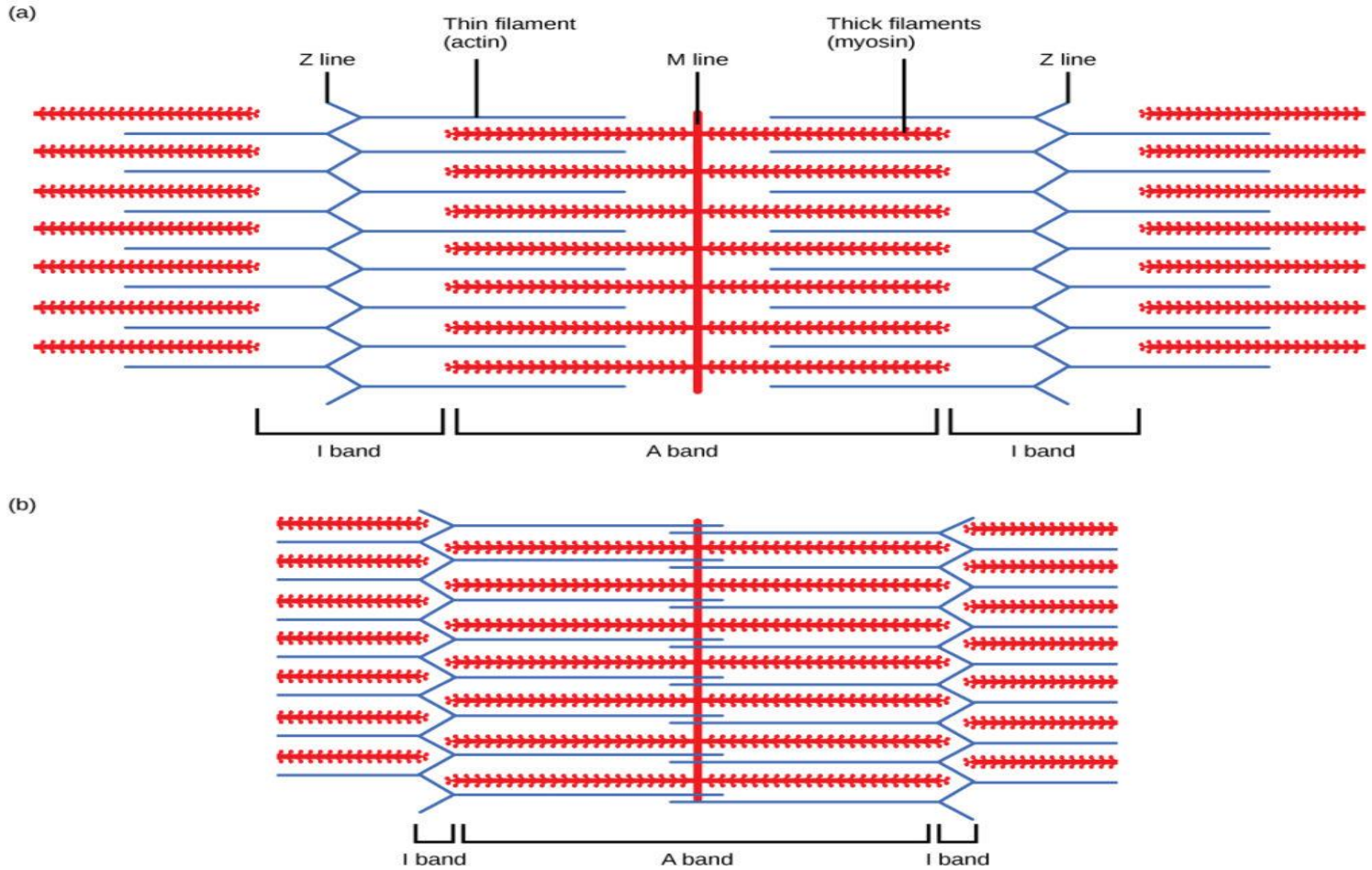
SLIDING FILAMENT MODEL OF MUSCLE CONTRACTION



CROSS BRIDGES



SARCOMERE IN CONTRACTION & RELAXATION



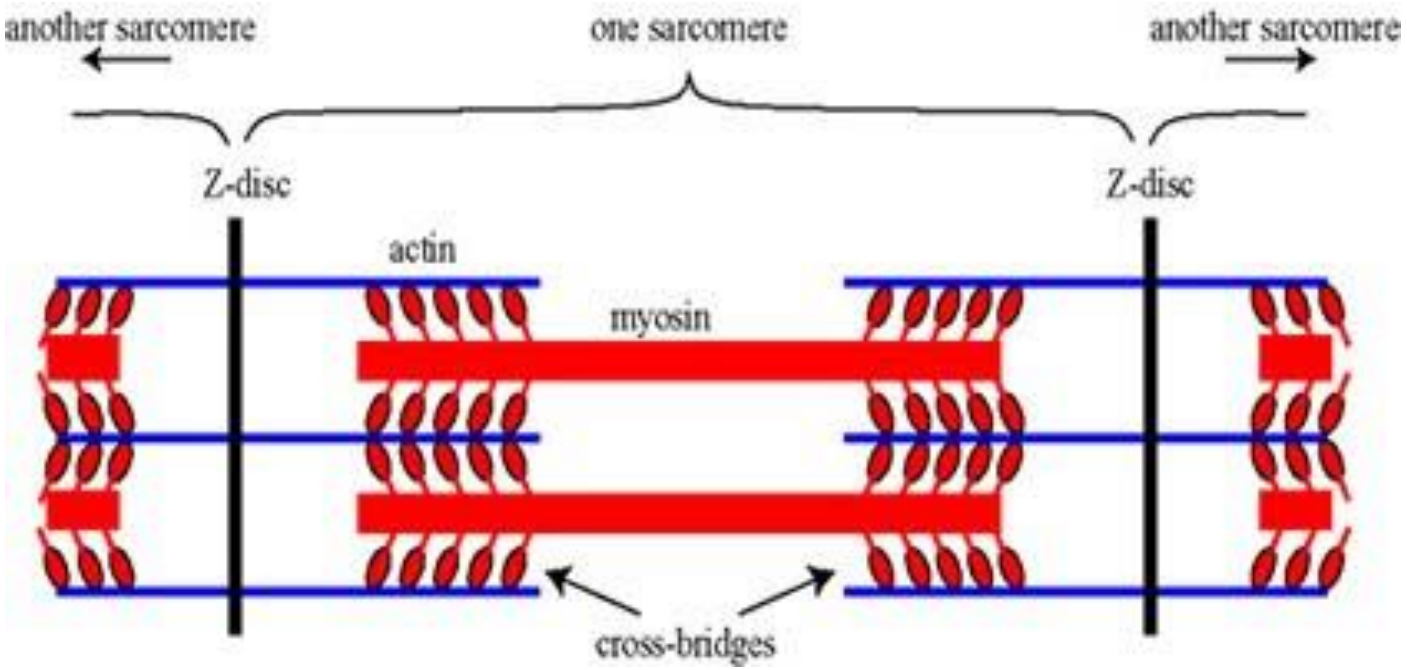
SARCOMERE IN CONTRACTION

- ❑ When a sarcomere shortens, some regions shorten whereas others stay the same length.
- ❑ A sarcomere is defined as the distance between two consecutive Z discs or Z lines;
- ❑ when a muscle contracts
- ✓ the distance between the Z discs is reduced.
- ✓ The H zone—the central region of the A zone—contains only thick filaments (myosin) & is shortened during contraction. The H zone becomes smaller & smaller due to the increasing overlap of actin and myosin filaments, and the muscle shortens.
- ✓Thus when the muscle is fully contracted, the H zone is no longer visible.
- ✓ The I band contains only thin filaments and also shortens. The A band does not shorten—it remains the same length—but A bands of different sarcomeres move closer together during contraction, eventually disappearing. Thin filaments are pulled by the thick filaments toward the centre of the sarcomere until the Z discs approach the thick filaments. The zone of overlap, in which thin filaments & thick filaments occupy the same area, increases as the thin filaments move inward.
- Note that the actin and myosin filaments themselves do not change length, but instead slide past each other.

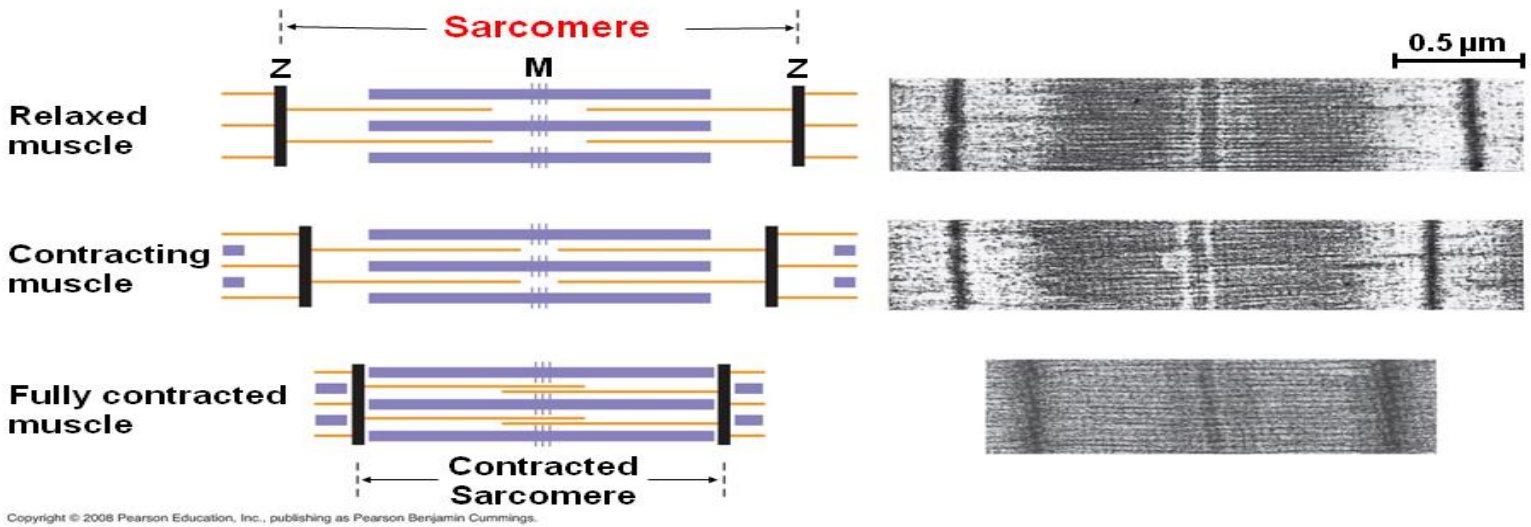
SLIDING FILAMENT THEORY EXPLAINED in summary

- ❑ Myosin heads interact and attach to the actin filament
- ❑ 2 things are needed for this interaction to occur
- ✓ ATP
- ✓ Access to actin
- ❑ Myosin is unable to interact because tropomyosin acts as a block
- ❑ To get access, myosin needs Calcium
- ❑ Calcium attaches to the troponin & this removes the block out of the way
- ❑ Once the block is removes, the mysosin head perfoms a power strock, ADP & P are released and this triggers the mysosin to pull the actin towards the center of the sarcomere

CROSS BRIDGES



The sliding-filament model of muscle contraction



SLIDING FILAMENT THEORY OVERVIEW