

Muscular System



Muscular System

- What is muscular system?
- Muscle is derived from the Latin word- **Little mouse**
- The term muscle tissue refers to all the contractile tissues of the body:
 - Skeletal muscle tissue,
 - Cardiac muscle tissue, &
 - Smooth muscle tissue
- The muscular system, however, refers to the skeletal muscle system:
 - The skeletal muscle tissue and connective tissues that make up the individual muscle organs, such as biceps brachii muscle.

FUNCTIONS OF MUSCULAR SYSTEM

1. Produce movement
 - Muscle pulls tendons to move the skeleton
2. Maintain posture and body position
 - Continuous muscle contraction
3. Support soft tissue
 - Support weight of visceral organs
4. Guard entrances and exits
 - Encircle openings to digestive and urinary tracts. Control swallowing, defecation and urination
5. Maintain body temperature
 - Energy from contraction is converted to heat.

Characteristics of Muscle Tissue

1. Excitability

- The ability to receive and respond to a stimulus

2. Contractility

- The ability to shorten forcibly when adequately stimulated
- This is the defining property of muscle tissue

3. Extensibility

- The ability to be stretched

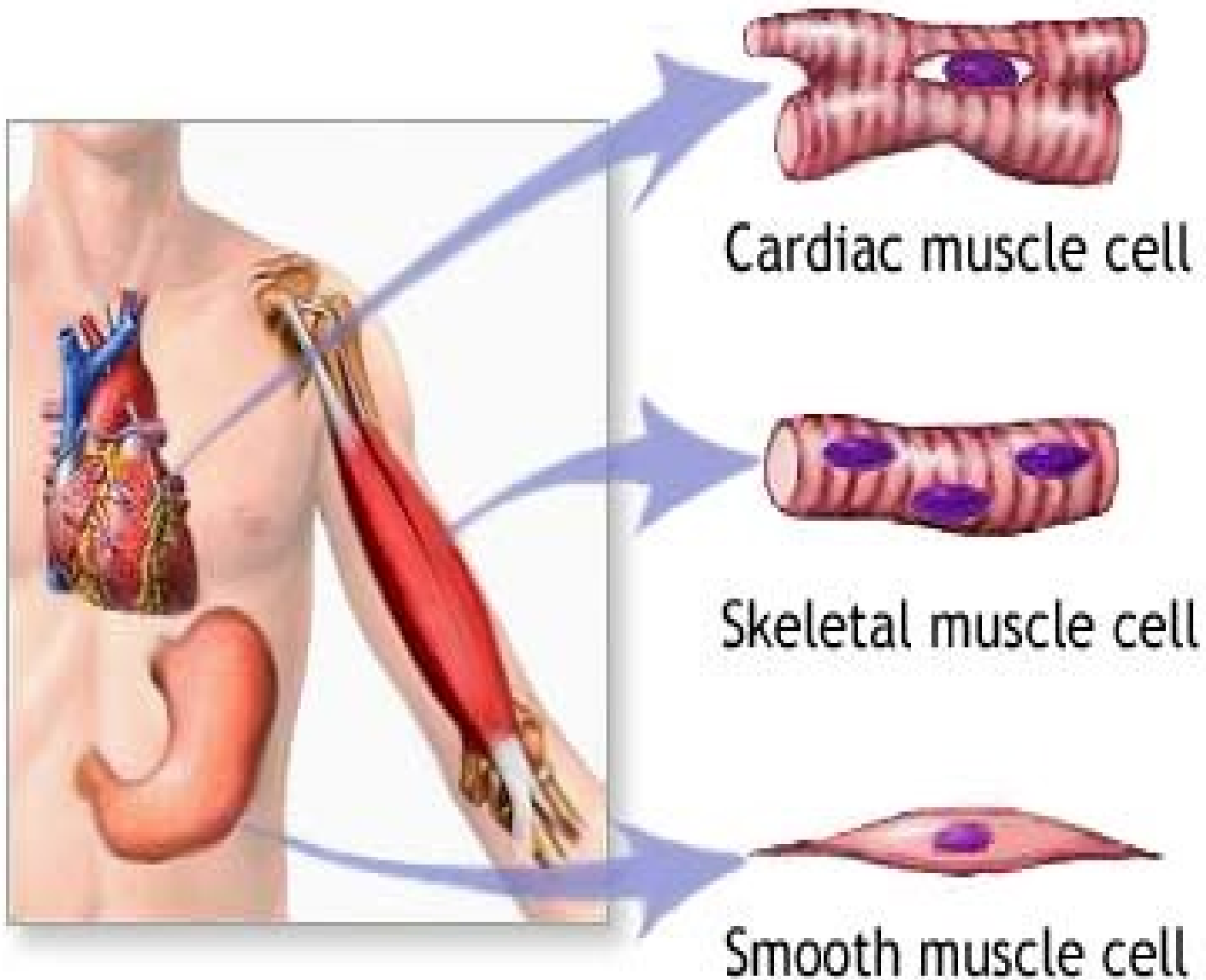
4. Elasticity

- The ability to recoil and resume original length after being stretched

TYPES OF MUSCLE TISSUE

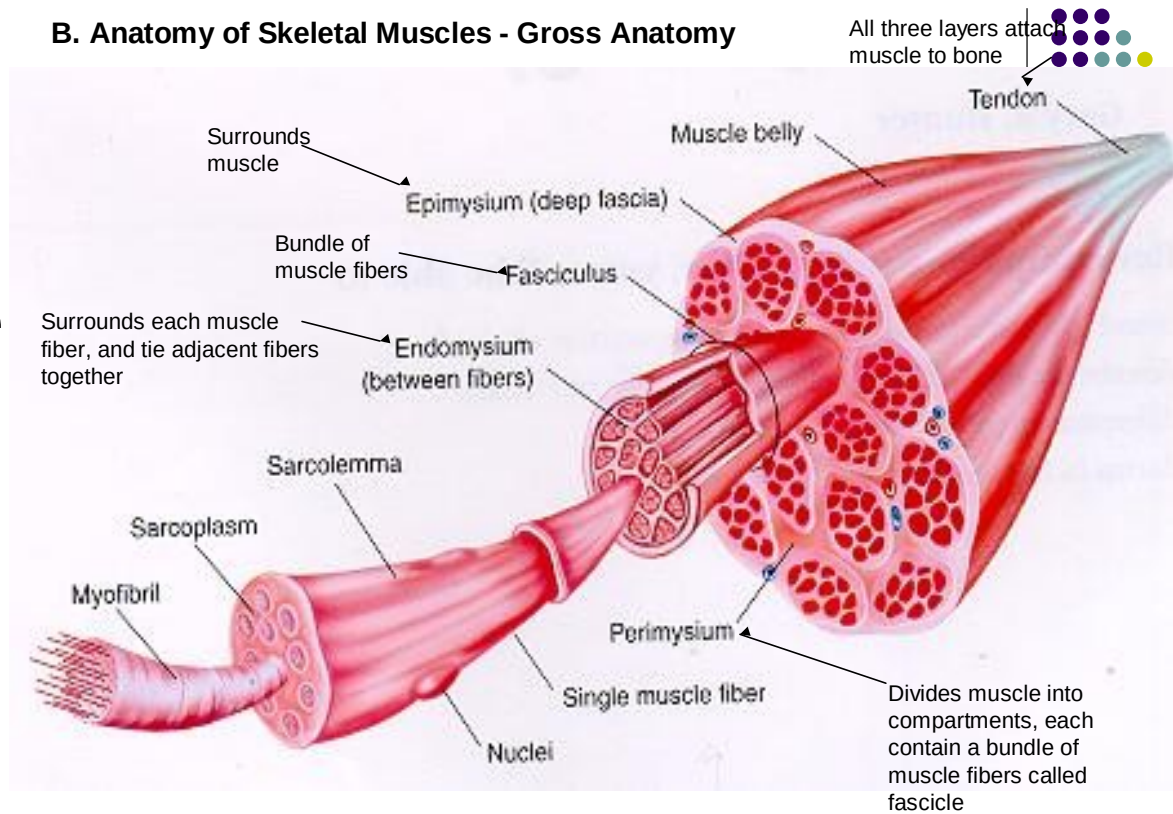
Type of tissue	Location	Type of contraction	Types of fibers	Type of striation, & No. of nucleuses in a cell	Functions
Skeletal	Skeletal Muscle	Voluntary	Long cylindrical	Striated, Multinucleated (at periphery)	Movement of skeleton. Helps maintain posture. Produces heat when contracted.
Smooth	Hollow internal organs walls of digestive, respiratory reproduc. urinary sys. Blood vessels, dermis, iris, ciliar body of the eye.	Involuntary	Spindle-shaped	Non striated, Uninucleated (at the center)	Causes movement within internal organs and vessels.
Cardiac	Heart	Involuntary	Short, branching	Striated, Multinucleated (at the center)	Causes heart to pump blood.

Three types of muscle tissue



Skeletal muscle organ & its components

- It is composed of
 1. Connective tissue coverings
 2. Skeletal muscle tissue
 3. Nerve tissue
 4. Blood tissue



I. Connective tissue covering

- Connective tissue surrounds and protects muscle tissue.
- The term fascia/fascia=bandage/ refers to a sheet of broad band of fibrous ct beneath the skin or around muscles and other organs of the body.
- There are two layers of fascia:
 - Superficial fascia &
 - Deep fascia.

A. Superficial fascia

- It is immediately deep to the skin.
- It is composed of adipose tissue and has four important functions:
 - 1.Stores fat and water; much of the fat of an over weight person is in the superficial fascia.
 - 2.It forms a layer of insulation that protects the body from heat loss.
 - 3.It provides mechanical protection against traumatic blows.
 - 4.It provides a path way for nerves and blood vessels to enter and exit muscles.

B. Deep fascia

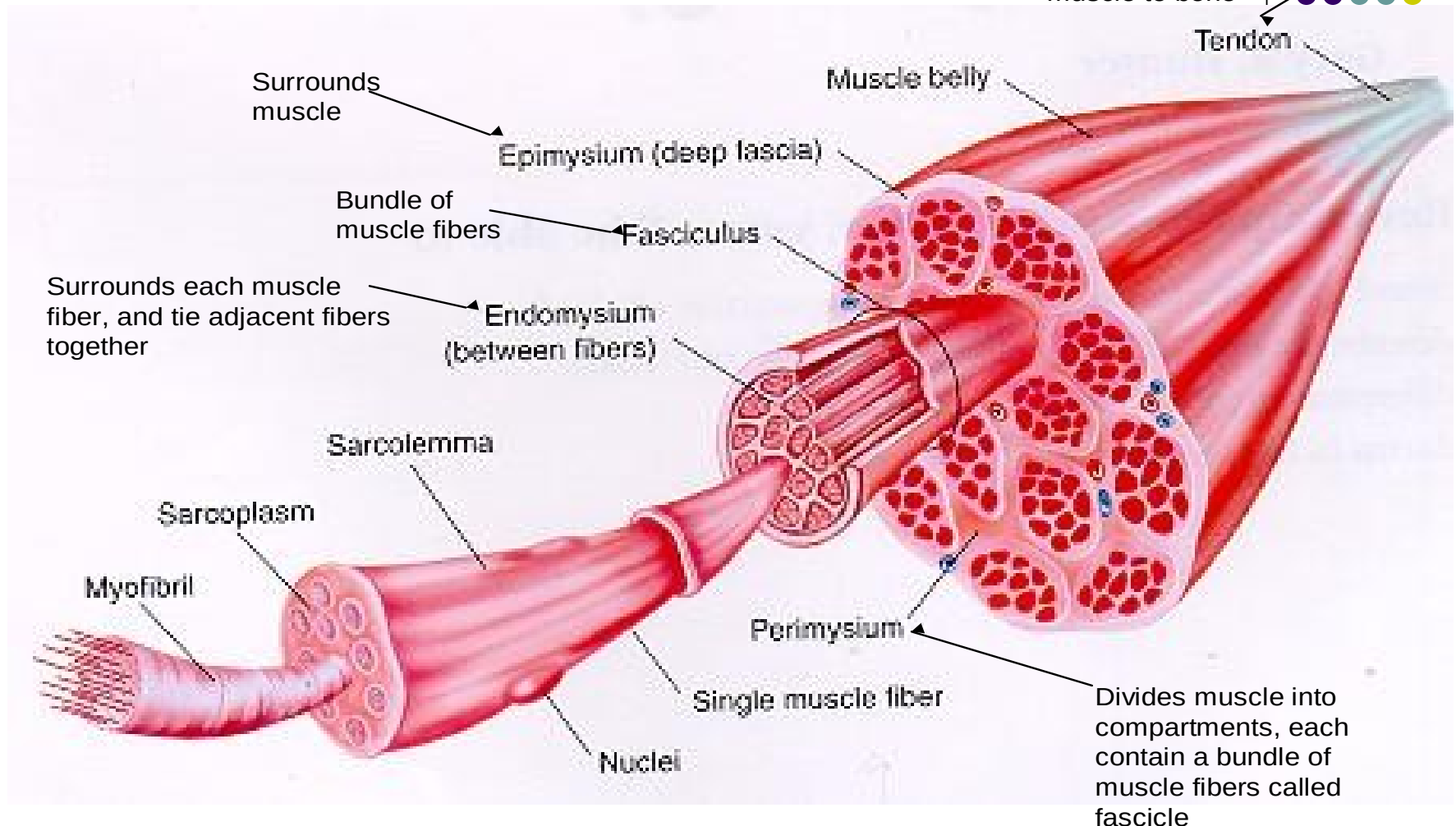
- Is dense, irregular connective tissue that lines the body wall and extremities and holds muscles together ,separating them in to functional groups .
- Allows free movement of muscles;
 - Carries nerves& blood and lymphatic vessels;&
 - Fills spaces b/n muscles.
- Three layers of dense irregular connective tissue,**epi-**,**peri-** & **endomysium** in the order of outer most to inner most , extend from the deep fascia to further protect & strengthen muscle.

Cont...

- A. Endomysium**/endo=within/-connective tissue which surround each skeletal muscle fiber and separate them from each other.
- B. Perimysium**/peri=around/-w/c bonds muscle fibers with their endomysium together such bundle of muscle fibers form **a fascicle**.
- C. Epimysium** /epi=upon/ -ct that invests the whole muscle organ .

Cont...

- All the three cts extend beyond the belly of the muscle to form a tendon/*tendrae=to stretch out/*-a cord of dense connective tissue that attaches a muscle to the periosteum of a bone. When the connective tissue element extend as a broad ,flat layer, the tendon is called an aponeurosis.
 - This structure also attaches to:
 - The coverings of a bone,
 - Another muscle, or
 - The skin



Arrangement of Fascicles in a Muscle

- Skeletal muscles – consist of fascicles
 - **Fascicles** – arranged in different patterns
 - Fascicle arrangement – tells about action of a muscle
- **Types of fascicle arrangement**
 - **Parallel** – fascicles run parallel to the long axis of the muscle
 - Strap-like – sternocleidomastoid
 - Fusiform – biceps brachii
 - **Convergent**
 - Origin of the muscle is broad
 - Fascicles converge toward the tendon of insertion
 - Example – pectoralis major

Con..

– Pennate

- **Unipennate** – fascicles insert into one side of the tendon
- **Bipennate** – fascicles insert into the tendon from both sides
- **Multipennate** – fascicles insert into one large tendon from all sides

– Circular

- Fascicles are arranged in concentric rings
 - Surround external body openings
 - Sphincter – general name for a circular muscle
 - Examples
 - » Orbicularis oris and orbicularis oculi

Pectoralis major



(a) Convergent

Orbicularis oris



(d) Circular

Deltoid



(e) Multipennate

Biceps brachii

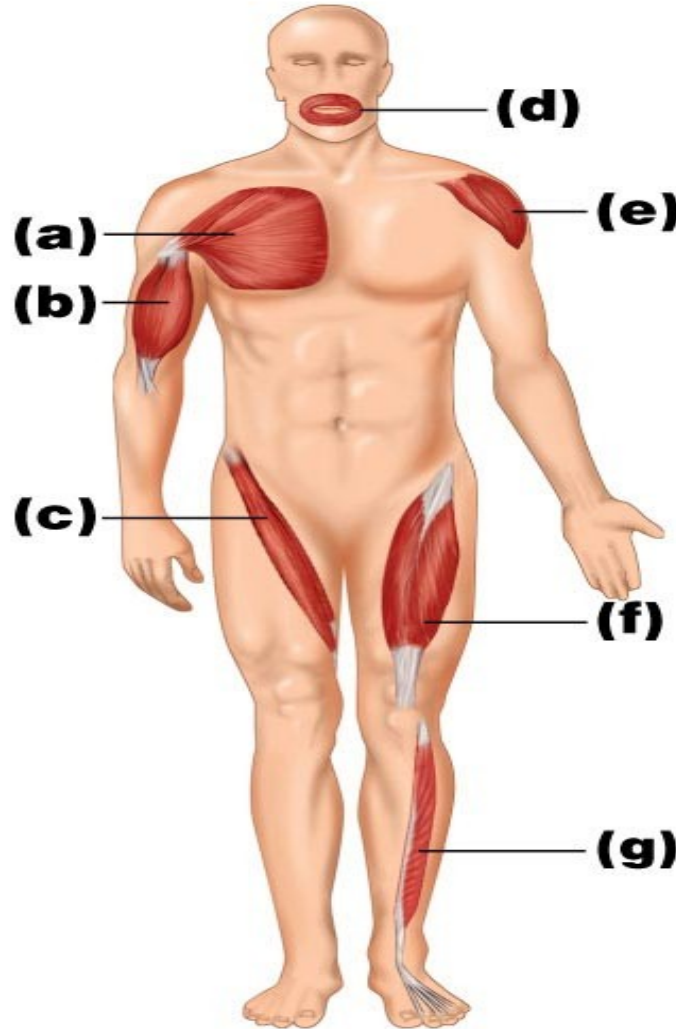


(b) Fusiform

Sartorius



(c) Parallel



Rectus femoris



(f) Bipennate

Extensor digitorum longus



(g) Unipennate

Microscopic anatomy of skeletal muscle

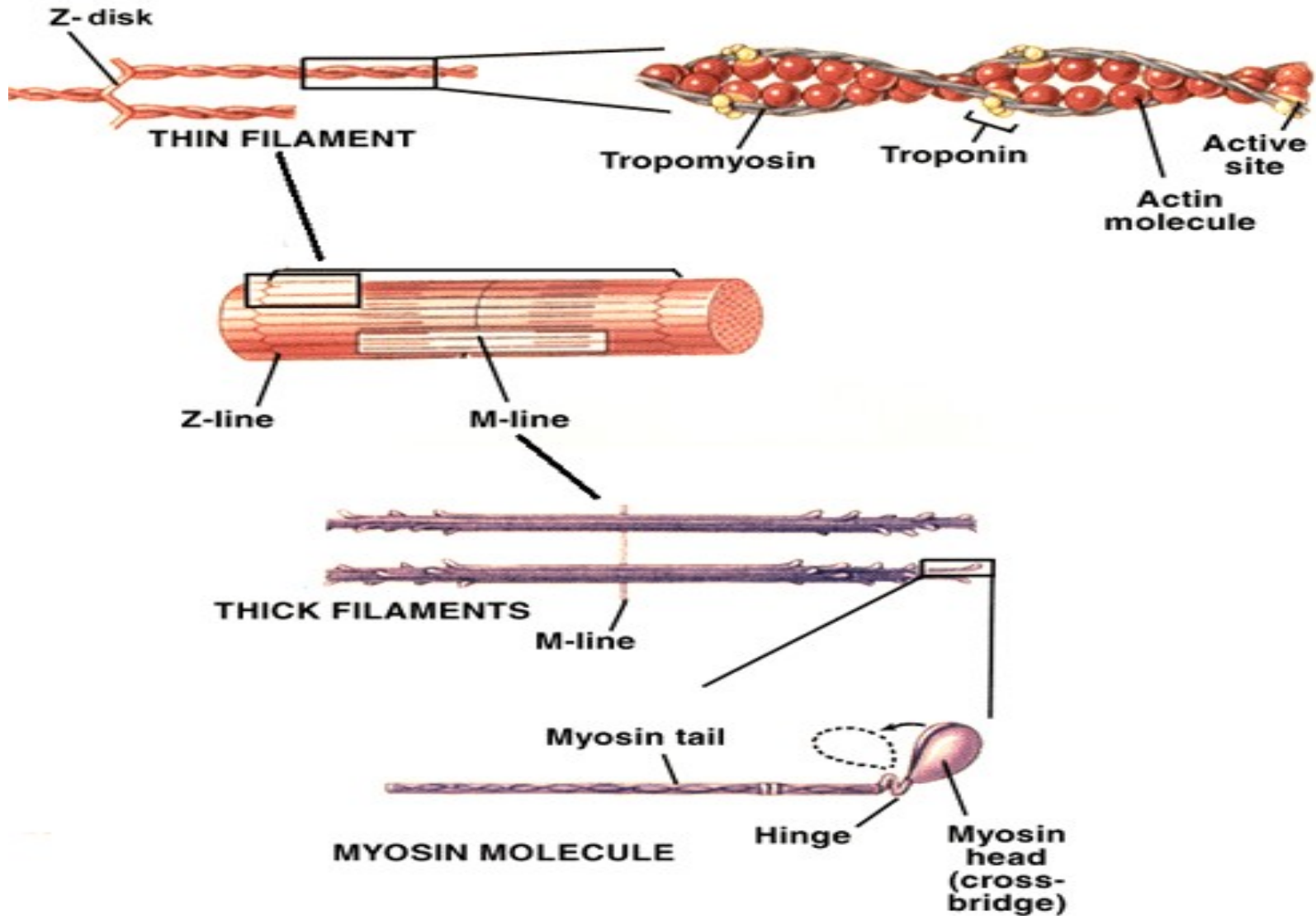
- Skeletal muscle cell-skeletal muscle fiber.
- Large b/s - fusion of hundreds of myoblasts.
- Each muscle fiber will have multiple nuclei.
- Muscle fiber PM is known as **sarcolemma**, muscle fiber cytoplasm is known as **sarcoplasm**.
- **T tubules**, invaginations of Sarcolemma that penetrate through the cell .
- **Sarcoplasm** ; lots of **mitochondria**, lots of **glycogen granules** (to provide glucose for energy needs) , **myofibrils** and **sarcoplasmic reticuli**.

- **Sarcoplasmic Reticulum**
 - smooth endoplasmic reticulum (SER).
 - calcium storage site in muscle cells.
 - Its loose network surrounds all the myofibrils in a muscle fiber.
- **Myofibrils**
 - rod like structures that extend the length of the cell.
 - long bundles of **myofilaments**.
- **Myofilaments**
 - **Thick & thin** make up myofibrils.
 - Thick myofilaments – made up of protein **myosin**.

Thin Filament

- Made up of **3 different types of proteins: actin, tropomyosin, and troponin.**
- Each thin filament consists of a long helical double strand.
- On each actin subunit, there is a **tropomyosin binding site.**
- Loosely wrapped around the actin helix and covering the myosin binding site is the filamentous protein, **tropomyosin.**
- Bound to both actin & tropomyosin is **troponin.**

Con...

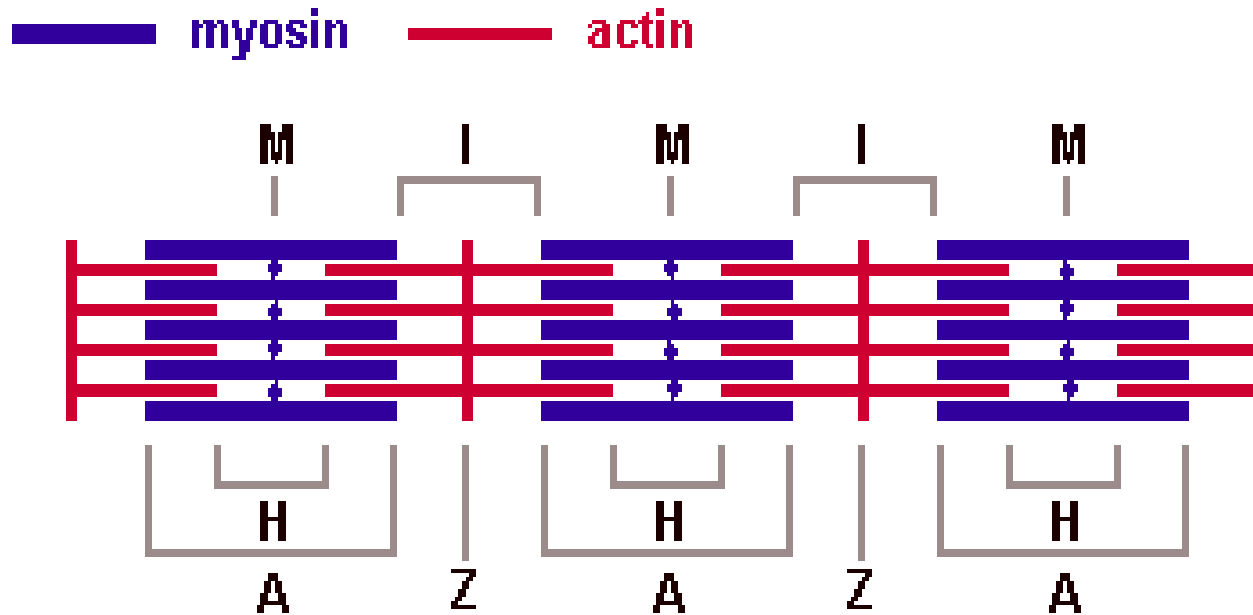


CONTRACTILE APPARATUS

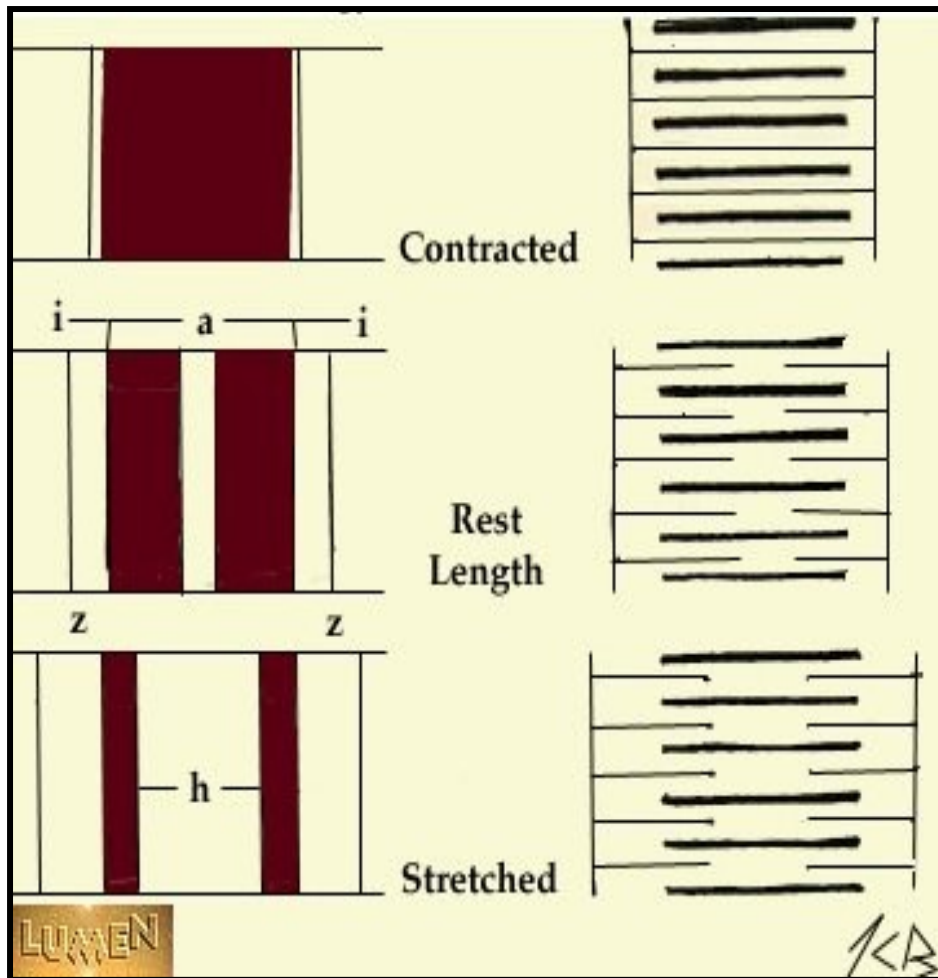
- Highly regular spatial relation b/n myofilaments
- This regular organization results cross-striation, (skeletal and cardiac muscles). Sets of individual "**stria**" within a myofibril correspond to the smallest contractile units of skeletal muscle, **the sarcomeres**
- **With in sarcomer are bands & lines**
 - **I, H & A bands and Z & M lines.**

- **I-band**-actin filaments,
- **A-band**-myosin filaments which may overlap with actin filaments
- **H-band** - zone of **myosin** filaments only, within the **A-band**
- **Z-line** - zone of apposition of actin filaments belonging to two neighboring **sarcomeres** (mediated by a protein **alpha-actinin**),
- **M-line** - band of connections between myosin filaments (mediated by proteins, e.g. myomesin, M-protein).

Contractile Apparatus



Bands and lines in the contractile apparatus of skeletal muscle



Dark (A) bands(Isotropic band):An overlapping of the thick myosin strands and the thin actin strands.

Light (I) bands (Isotropic band): The thin actin strands.

Dark Z line: Cutting across each I band.

H zone (Hensen's zone): Within the A band is a somewhat lighter zone, which consists only of myosin strands.

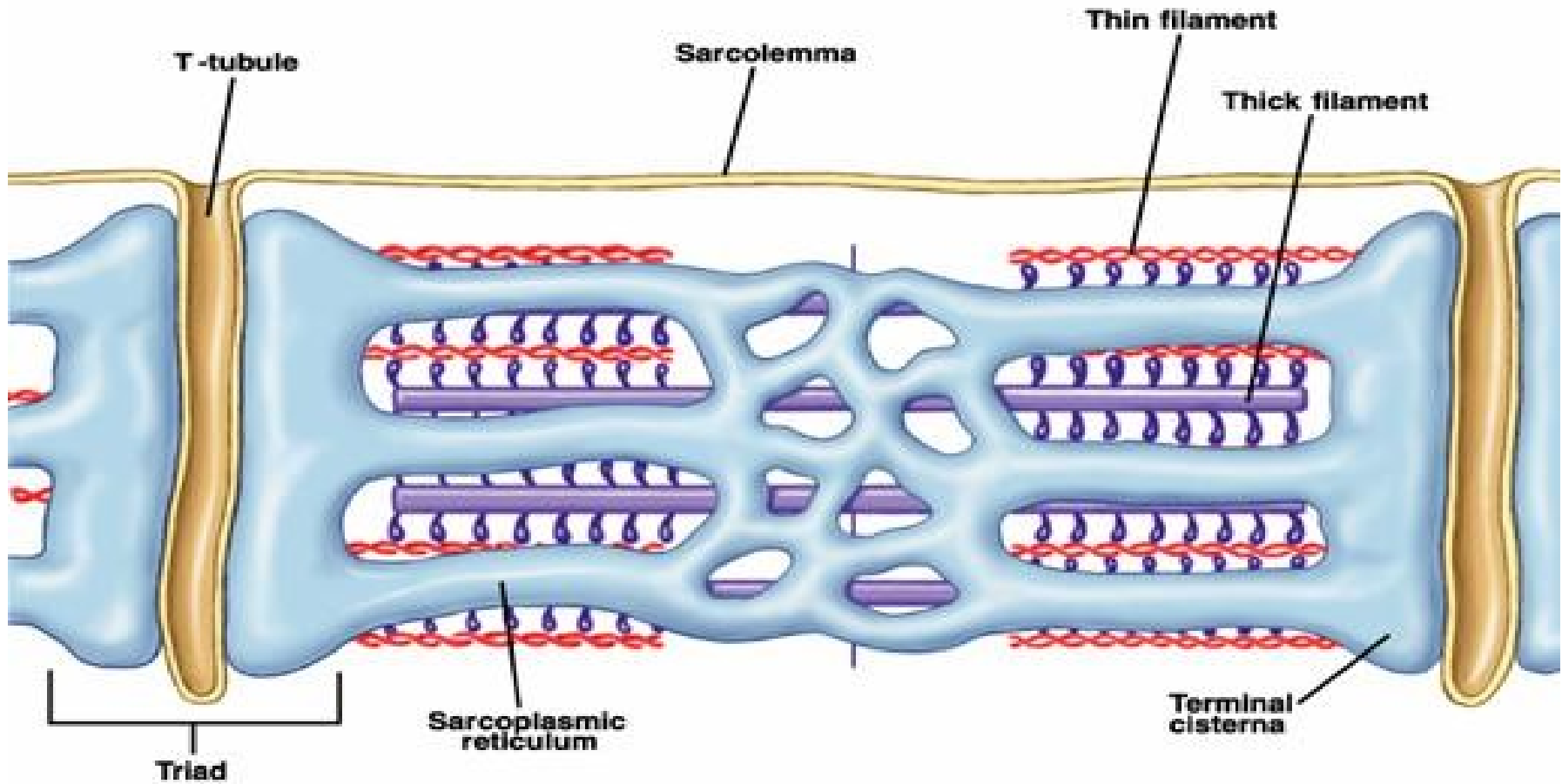
M line (Middle line): Extending across the H zone is a delicate line, which connects adjacent myosin strand.

Sarcomere: The fundamental unit of muscle contraction, which is made up of a section of the muscle fiber that extends from one Z line to the next.

T-Tubules and the Sarcoplasmic Reticulum

- Each muscle fiber has many T-tubules
- Typically each myofibril has a branch of T-tubule encircling it at each A-I junction.
- At each A-I junction, the SR will expand and form a dilated sac (terminal cisterna). Each T-tubule will be flanked by a terminal cisterna. This forms a so-called triad consisting of two terminal cisternae and one T-tubule branch.

Con...



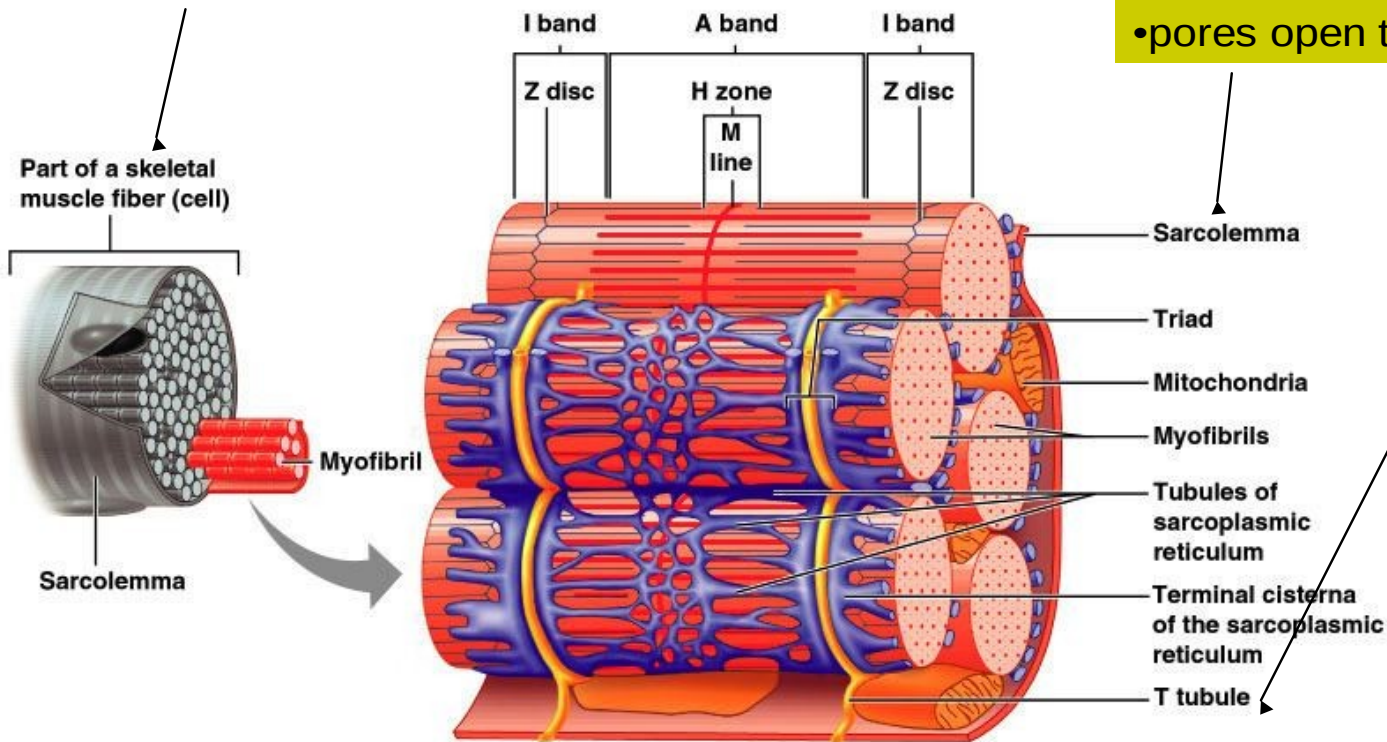
Con...

Microanatomy – Sarcolemma and T-Tubules



- Very large cells
- 100's of nuclei

- Cell membrane
- pores open to T-tubules



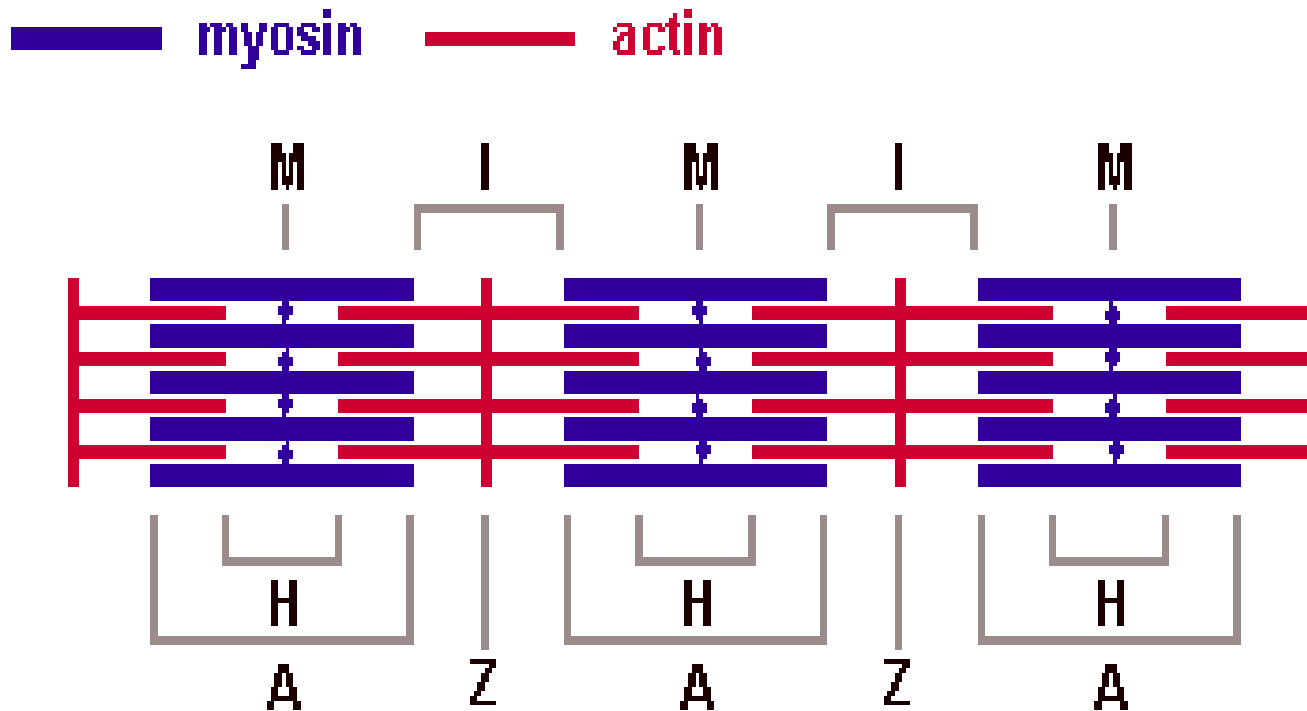
- Network of narrow tubules
- filled with extracellular fluid
- form passageways through muscle fiber

Muscle Contraction

In the process of contraction

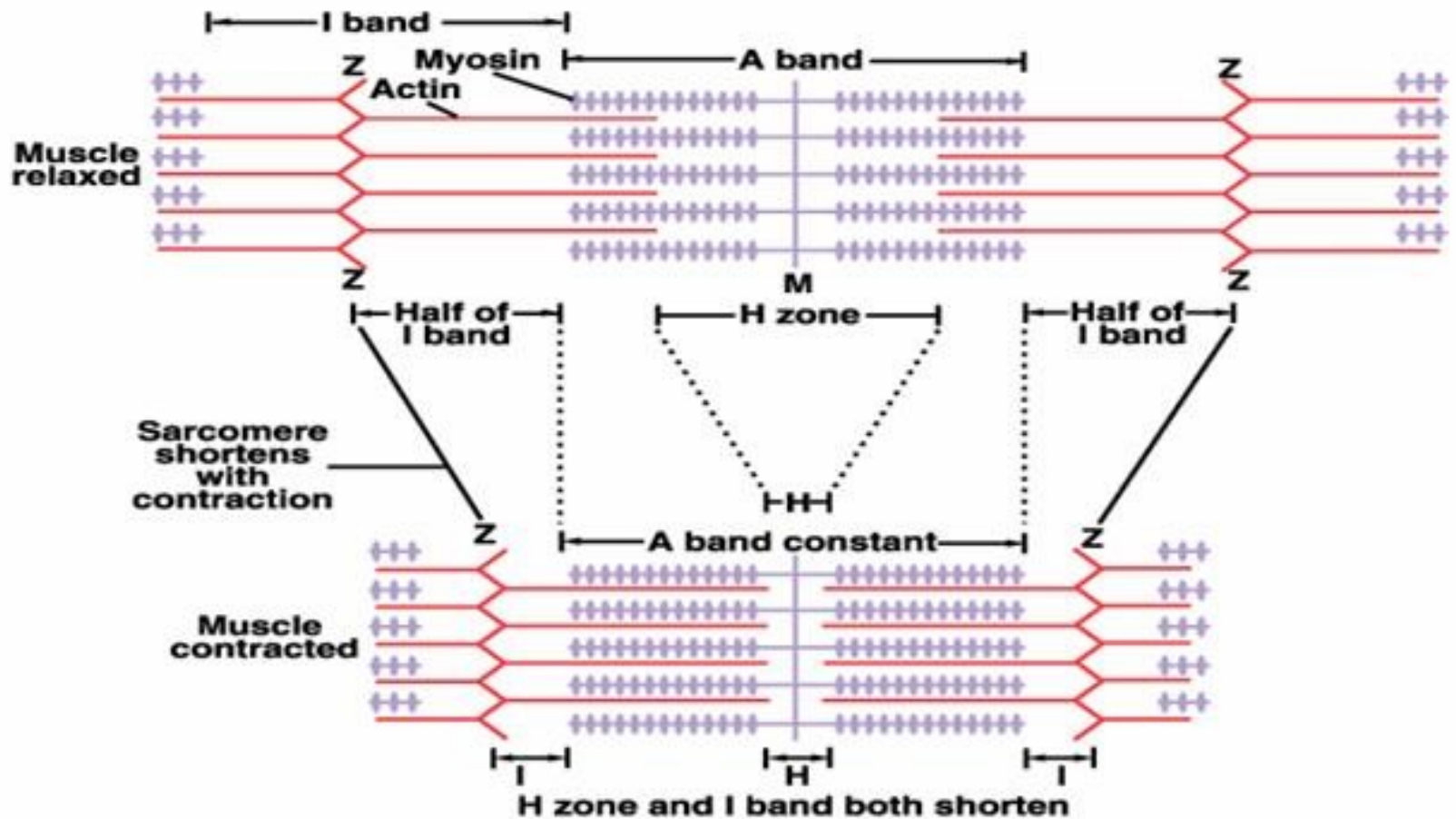
- Distance between Z discs decreases
- Length of the A band remains constant
- Length of the H zone decreases
- Length of the I band decreases
- The length of the sarcomere decreases and shortens.

Con...



Bands and lines in the contractile apparatus of skeletal muscle

Con...



Skeletal muscle form & structure

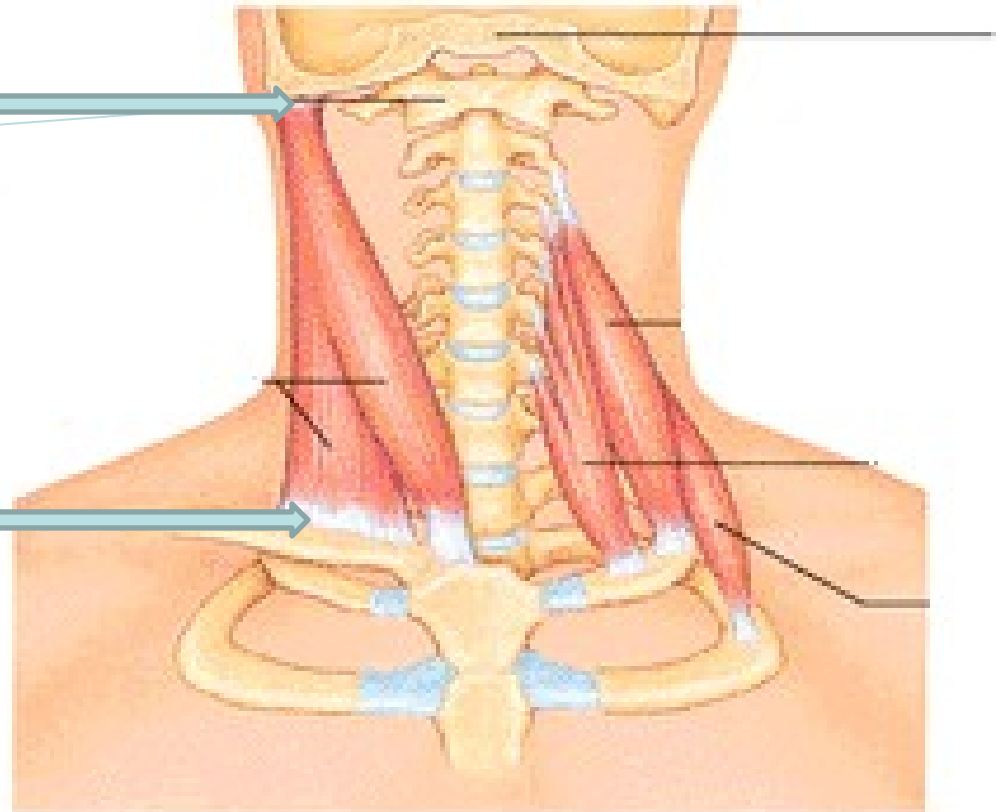
- ✓ constituting about 40% of the body weight
- ✓ are innervated by voluntary or somatic nerves which arise either from cranial or spinal nerves
- ✓ have three parts where they are attached to bones or any other tissue & they are :
 1. **Origin** – fixed part where there is no or little movement
 2. **Insertion** – movable part , muscles usually pull from their point of insertion
 3. **Belly** –part between origin & insertion

Movable end

Origin: 

Immovable

end



Nomenclature of Muscles

- Muscles can be named as follows by using different criteria.

1. According to their function:

E.g. 1. Flexors

2. Extensors

3. Abductors

4. Adductors

5. Rotators

6. Levators

7. Supinators

8. Pronators

2. According to their attachments:

- when naming muscles by attachments the origin is named first followed by its insertion. E.g. :-
 - **Sternocleidomastoid**
 - **Sternohyoid**
 - **Stylohyoid**
 - **Brachioradialis**

3. According to their shape

- **Quadratus, Trapezius**

4. According to their location

- **Pectoralis major** – large muscle of the chest
- **Brachialis** – muscle in the brachium or arm

5. According to the relative size of the muscle :

1. Flexor digitorum longus (long)
2. Flexor digitorum brevis (short)

6. According to the direction of their fibers:

1. Transverse – transverse abdominis
2. Oblique – internal & external oblique

7. Naming with a combination of criteria:

1. Flexor carpi radialis longus
2. flexor digitorum superficialis

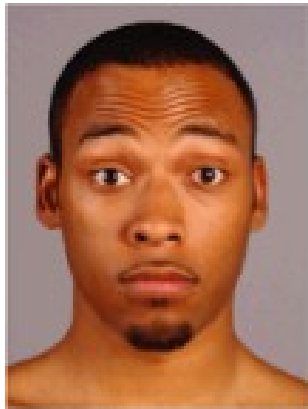
Nerves & blood vessels of skeletal muscles

- Due to the high energy & oxygen demand, skeletal muscles are rich in blood vessels, the flow of blood through these vessels is raised during muscular activity by dilatation of these vessels
- The change in the flow of blood through these vessels is regulated by the autonomic motor nerves that innervate the smooth muscle cells in the wall of these blood vessels

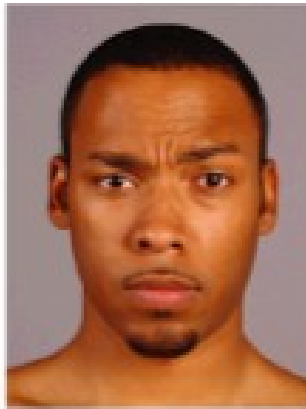
- They are also innervated by motor (efferent) & sensory (afferent) nerve fibers.
- Nerves & vessels enter a muscle at its hilum that lies at or near the middle of a muscle
- When muscles are used extensively E.g. by sports men their bulk increases, this is known as functional or activity **hypertrophy**
- On the contrary if they are under used their bulk decreases, this is known as functional or inactive **atrophy (hypotrophy)**

Muscles of the face

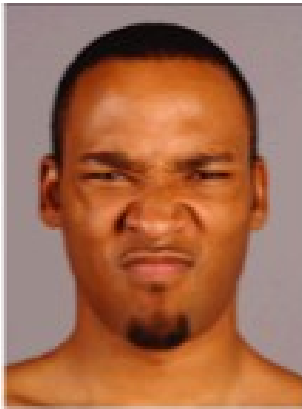
- Lie in subcutaneous tissue
- Inserted in to the skin
- Named as muscles of **facial expression**
- Arranged in groups around the
 - orbit,
 - nose,
 - mouth and
 - auricles
 - functionally considered as regulators of openings
- Supplied from branches of **facial nerve**



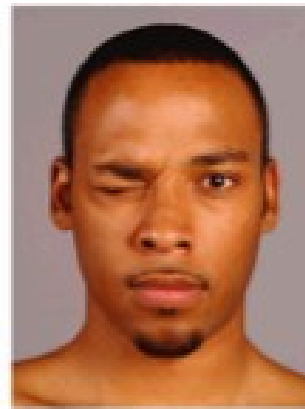
Occipitofrontalis



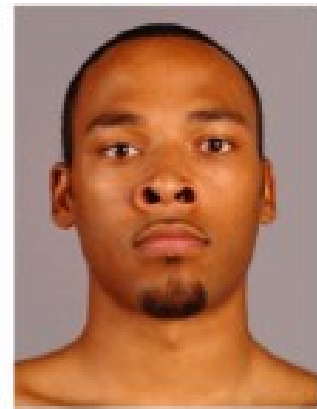
Corrugator supercilii



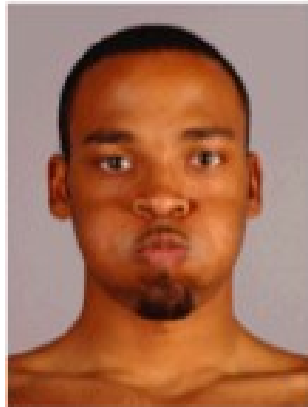
Procerus + transverse
part of nasalis



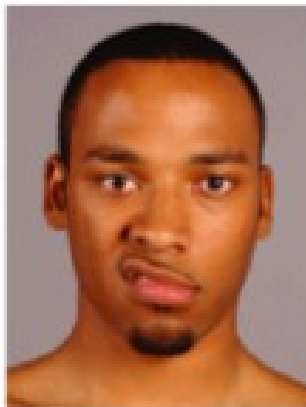
Orbicularis oculi



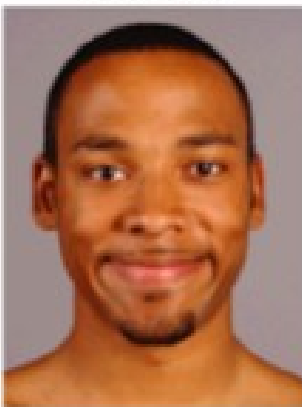
Lev. labii sup. alaeque nasi +
alar part of nasalis



Buccinator + orbicularis oris



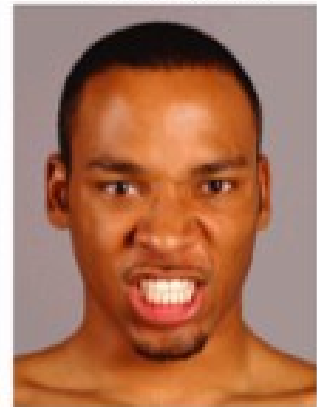
Zygomaticus major + minor



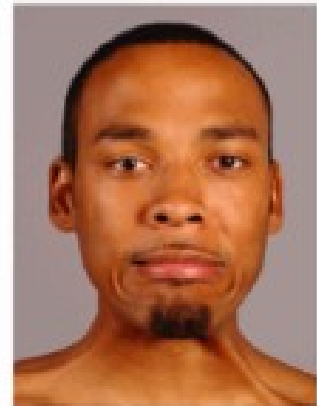
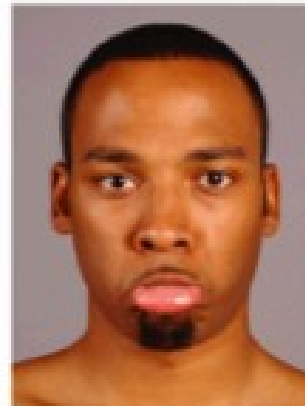
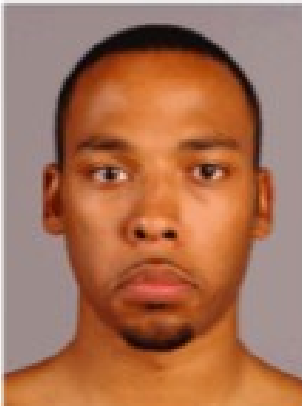
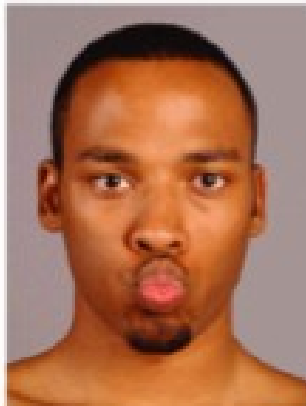
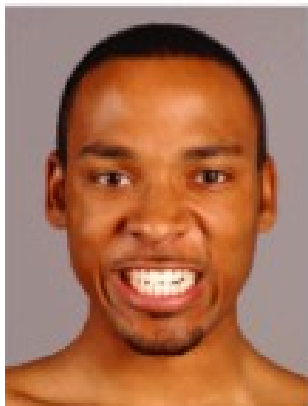
Risorius

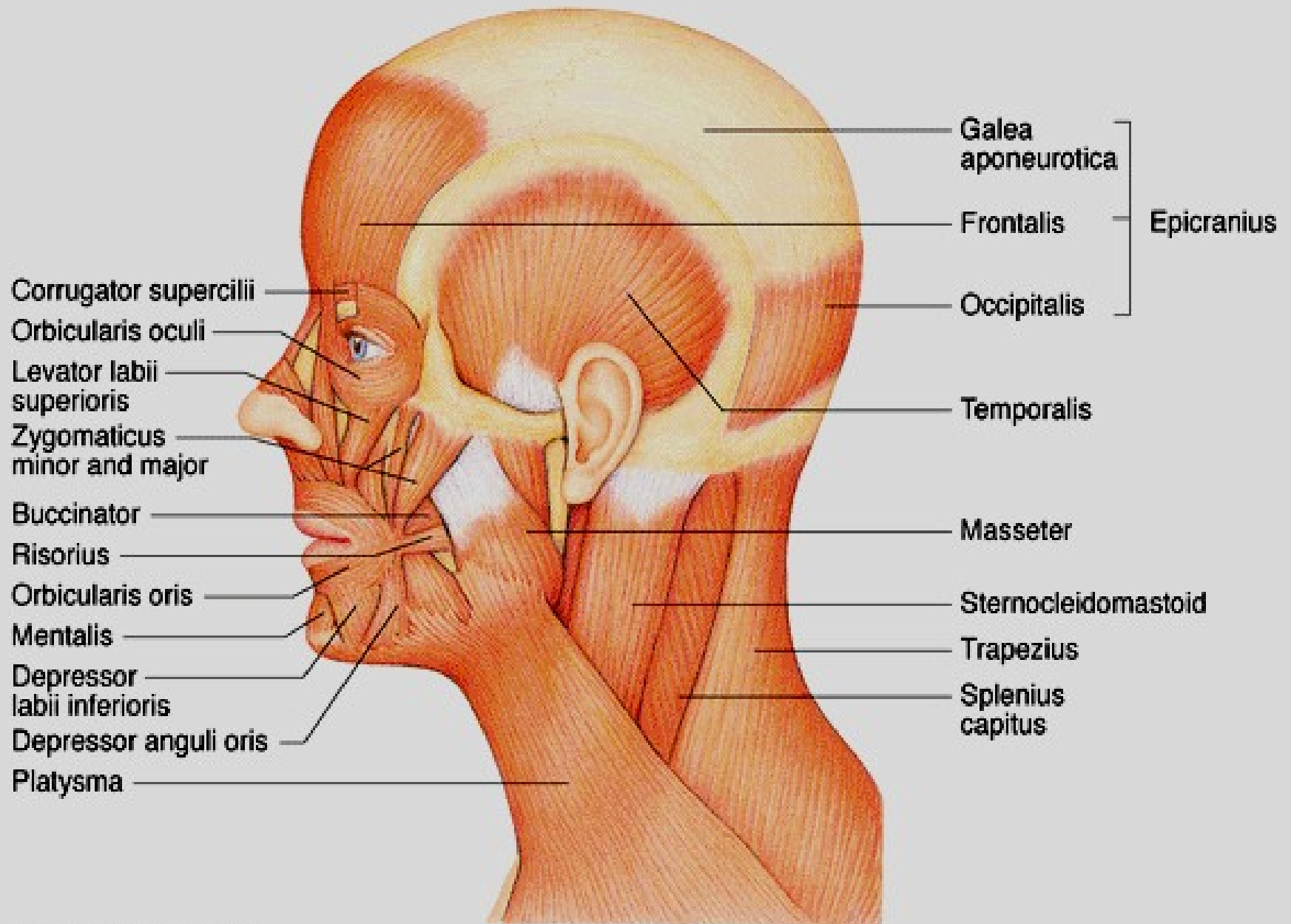


Risorius + depressor
labii inferioris



Levator labii superioris +
depressor labii





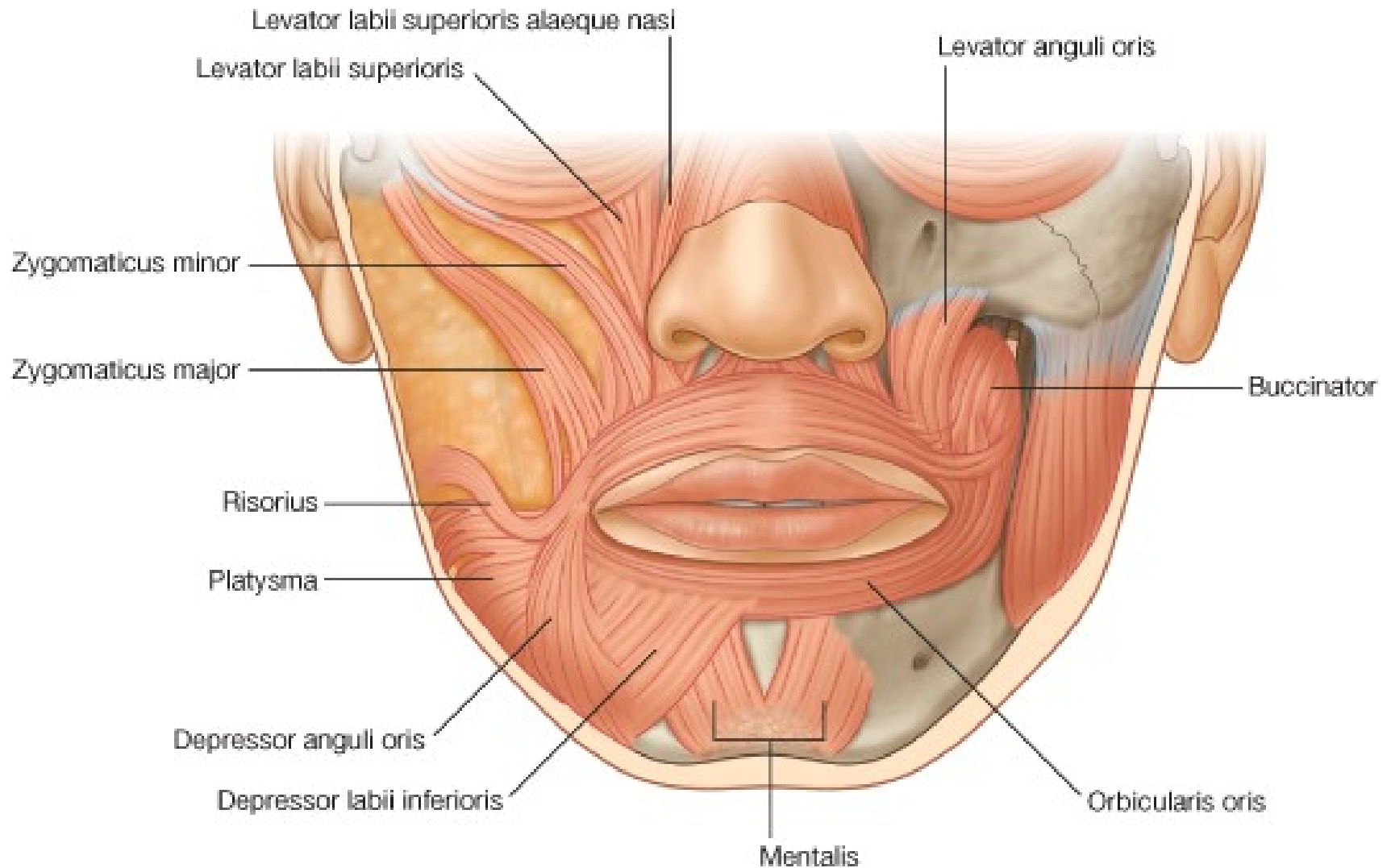
Muscles of the Face

- ✓ Develop from the second pharyngeal arch
- ✓ Innervated by branches of the facial nerve [VII].
- ✓ Are in the superficial fascia

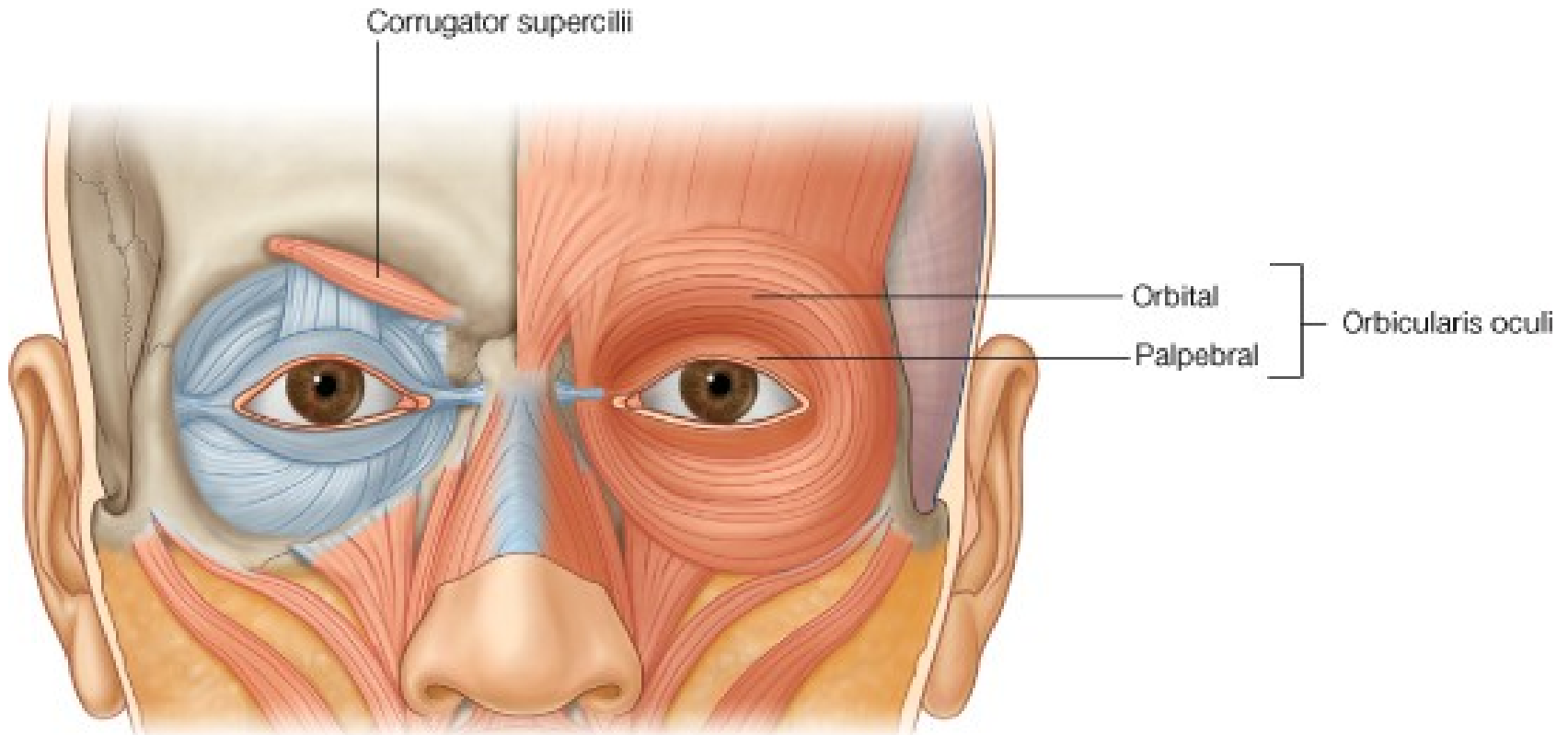
Oral group

- The muscles in the oral group move the lips and cheek
- They include the orbicularis oris and buccinator muscles, and a lower and upper group of muscles
- Lower group includes :- the depressor anguli oris
 - depressor labii inferioris
 - mentalis
- Upper group of oral muscles includes :
 - risorius
 - zygomaticus major
 - zygomaticus minor
 - levator labii superioris
 - levator labii superioris alaeque nasi, and levator anguli oris

Oral Group



Orbital group



© Elsevier. Drake et al: Gray's Anatomy for Students - www.studentconsult.com

- Two muscles are associated with the orbital group - the orbicularis oculi and - the corrugator supercilii.

Nasal group



- ✓ Three muscles are associated with the nasal group
 - the nasalis,
 - the procerus, and
 - the depressor septi nasi

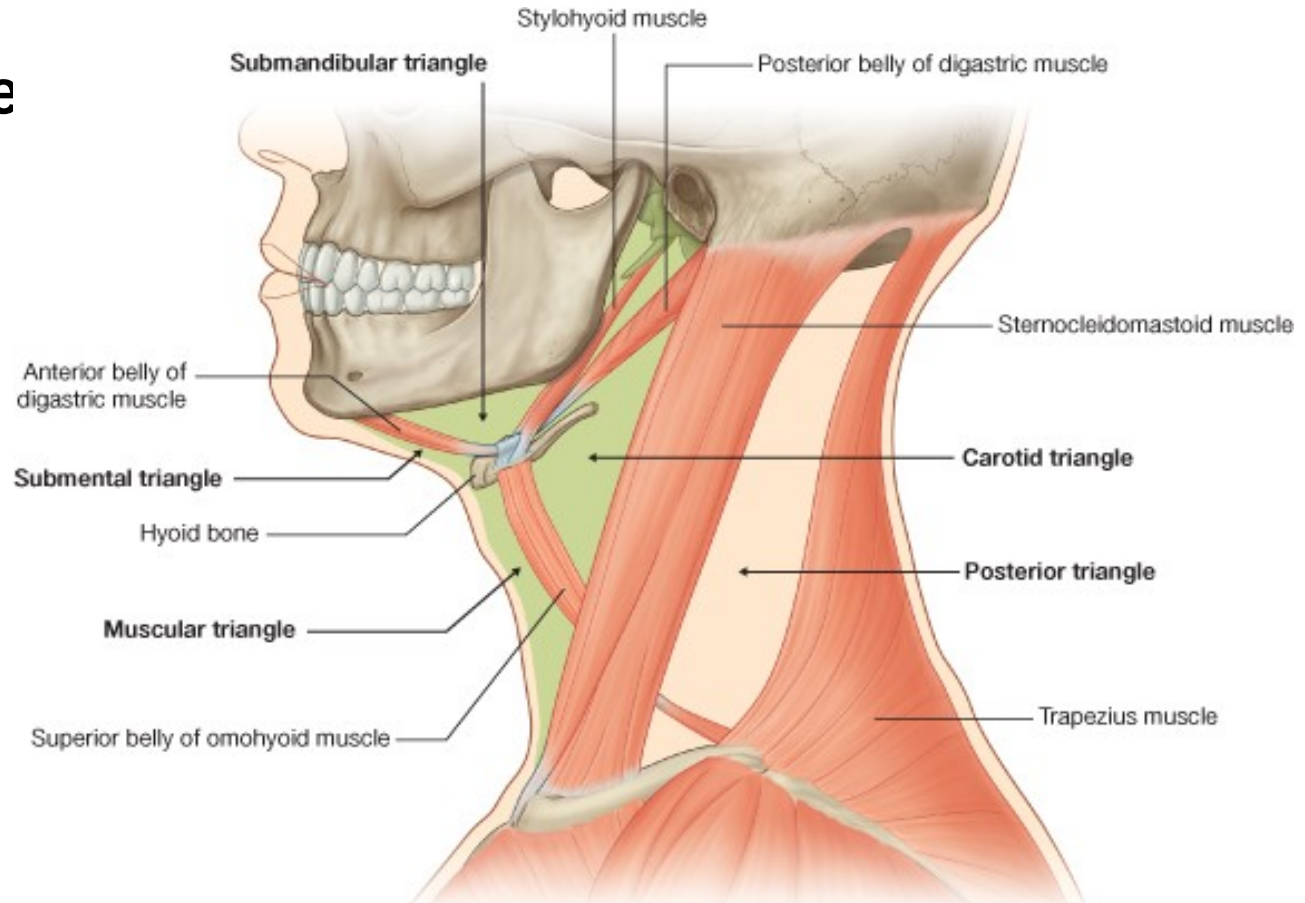
TRIANGLE OF THE NECK

- Divisions of the triangle of the neck:

A. Anterior triangle of the neck

- Submandibular
- Submental
- Muscular
- Carotid

B. Posterior triangle of the neck



© Elsevier, Drake et al: Gray's Anatomy for Students - www.studentconsult.com

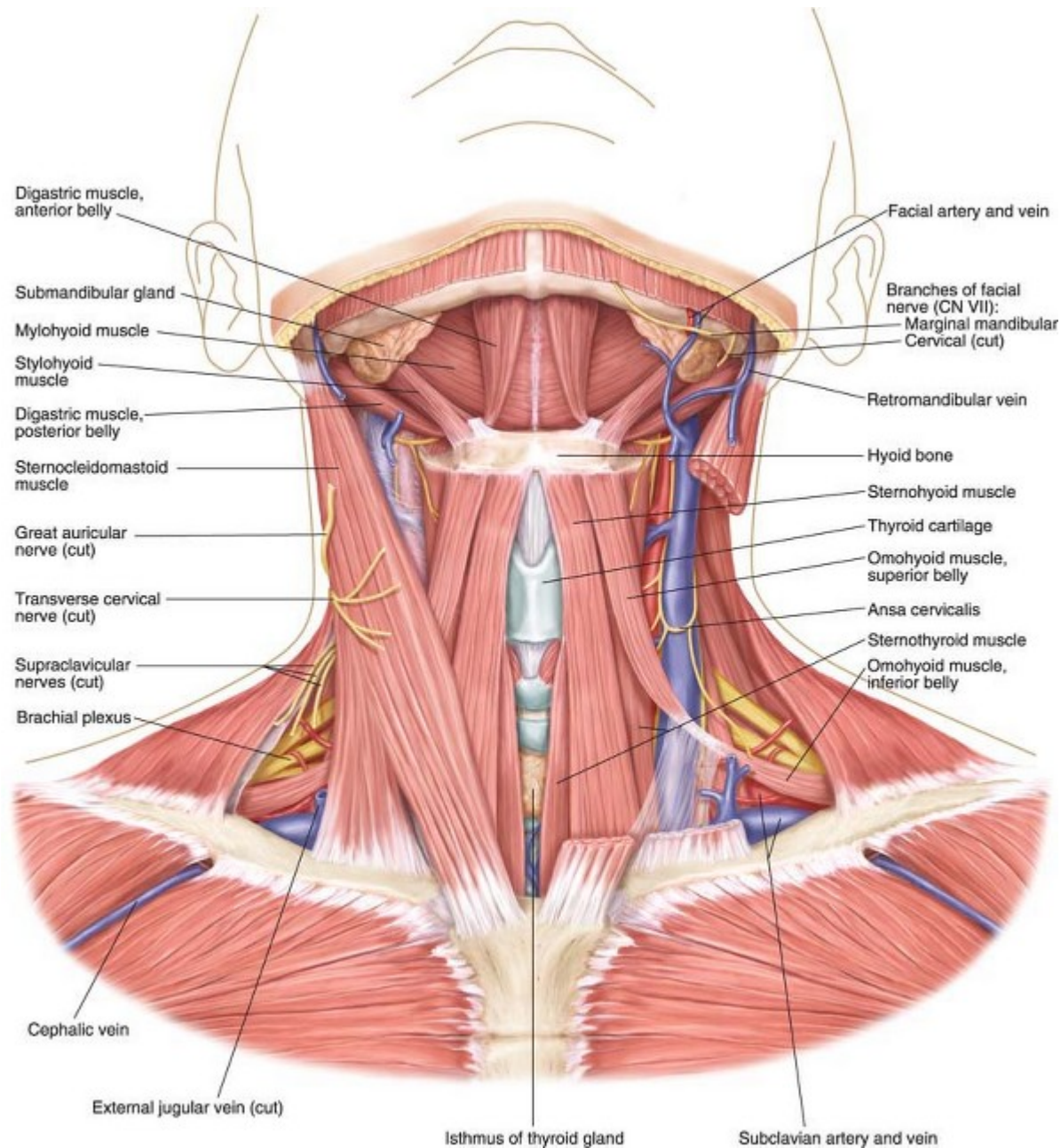
floor: pharynx, larynx & thyroid gland

Roof: deep fascia

Use for approaching many important structures Like larynx, trachea and thyroid glands

CONTENTS;

Msls, arteries, veins, nerves, L.nds



MUSCLES;

Concerned with steadying or moving the hyoid bone

Divided in to supra& infra hyoid muscles

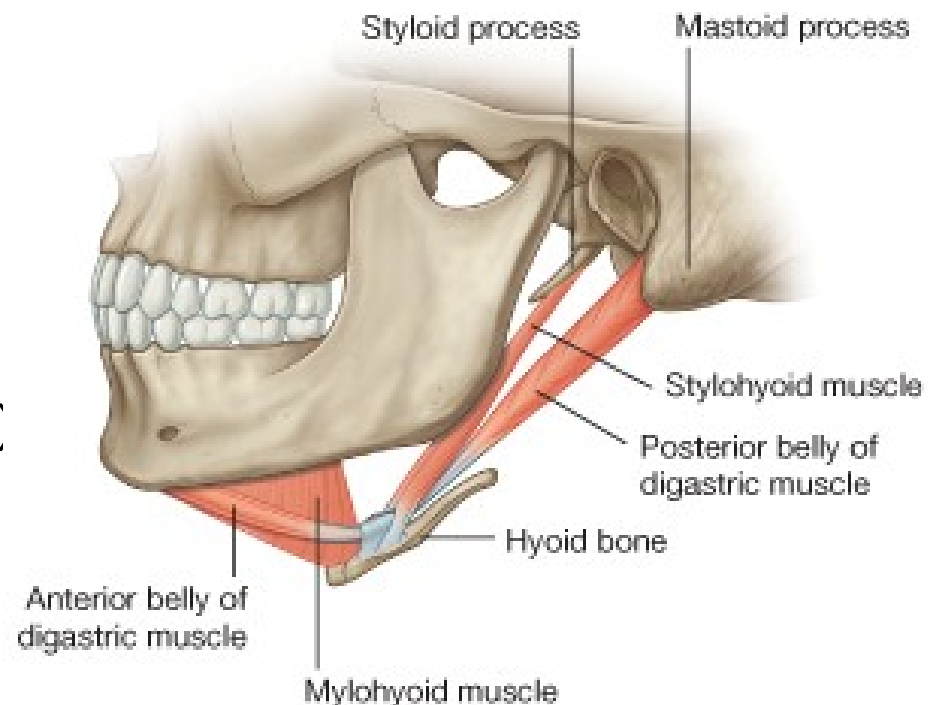
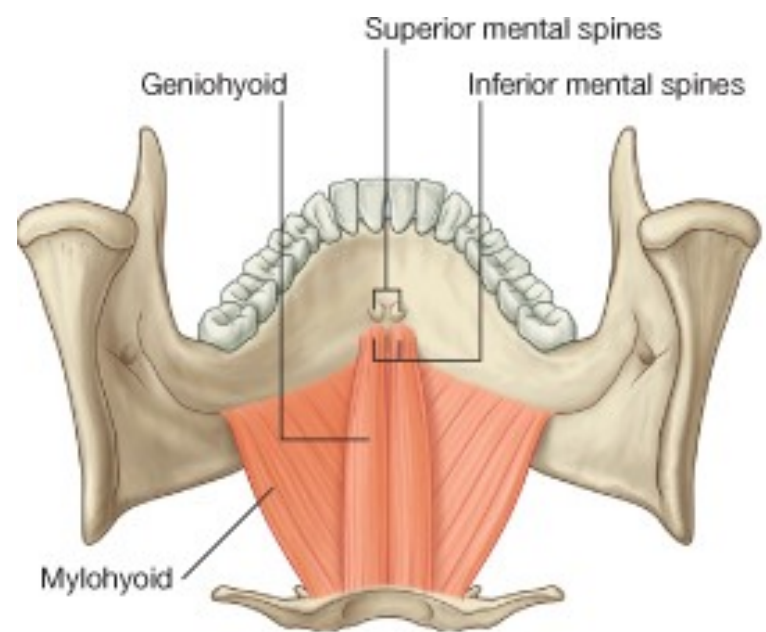
This muscles hold the hyoid bone in place by attaching it with the mandible, skull, thyroid cartilage, manubrium, and to the medial end of the scapula.

The supra hyoid msls:

Connect this bone to the skull

1. The mylohyoid
2. The geniohyoid
3. Stylohyoid
4. Digastric

Has two bellies (anterior and posterior)



Infrahyoid msls

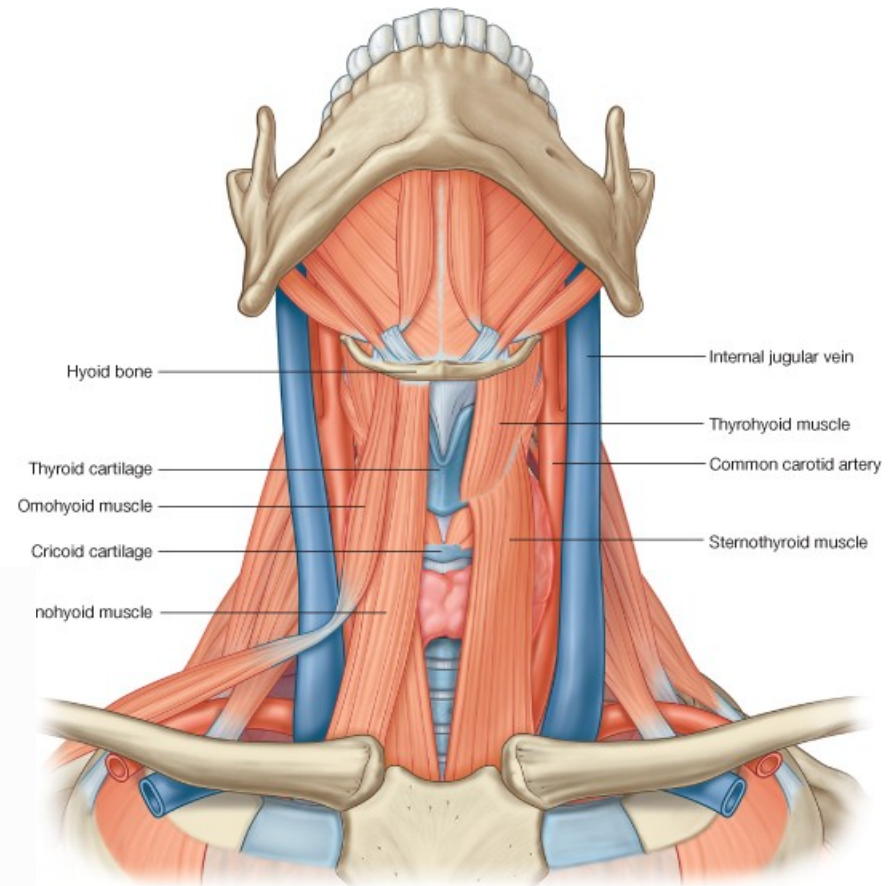
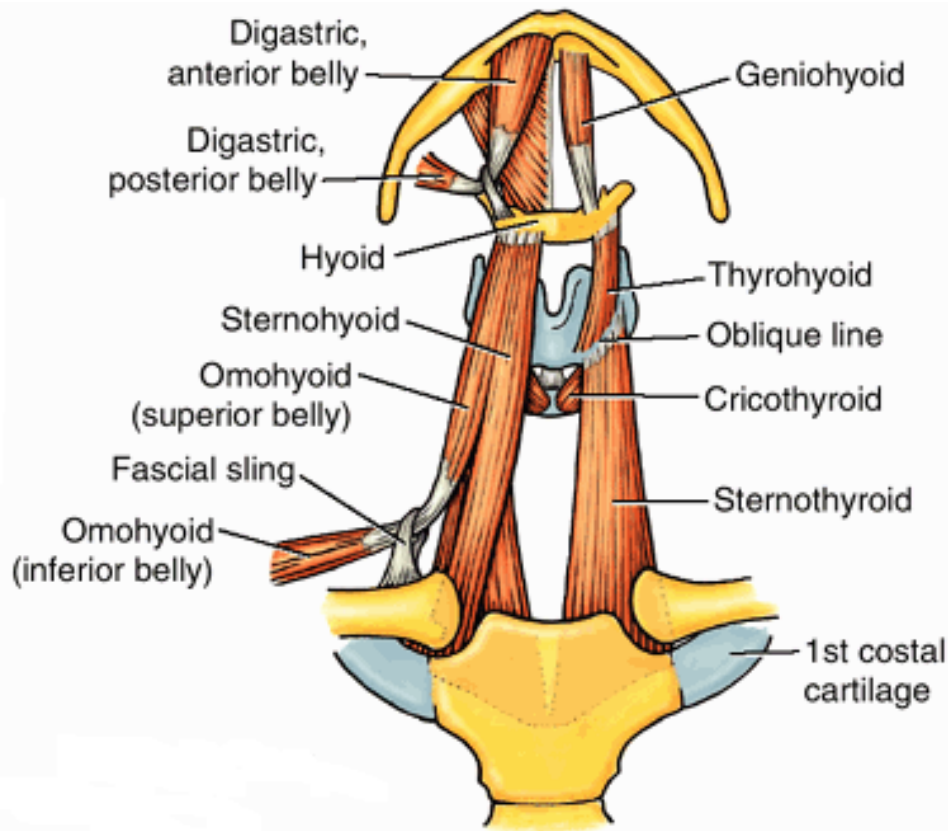
Anchor the hyoid bone &
depress the hyoid and
larynx during swallowing
and speaking

1. Sternohyoid

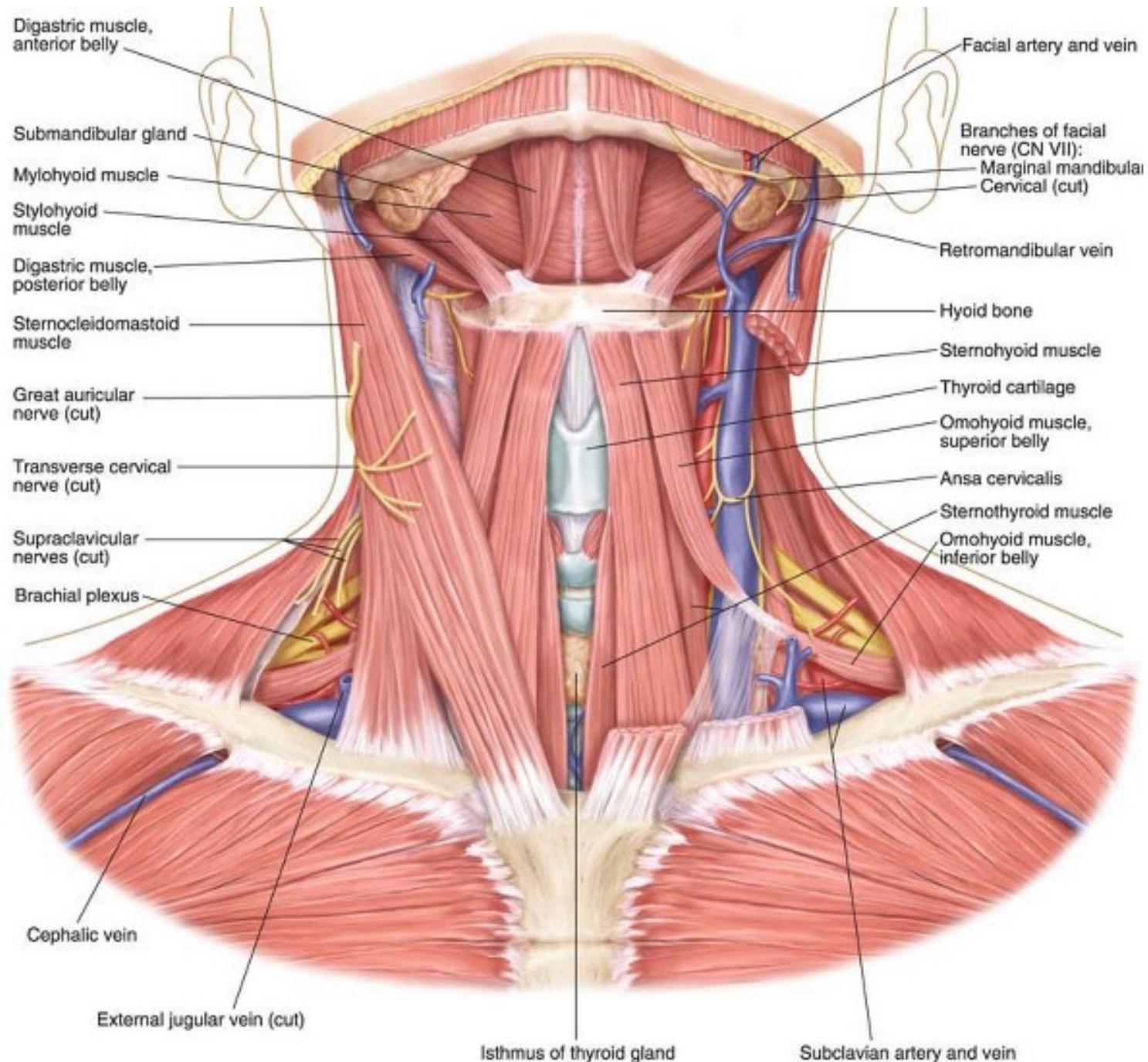
2. Sternotyroid

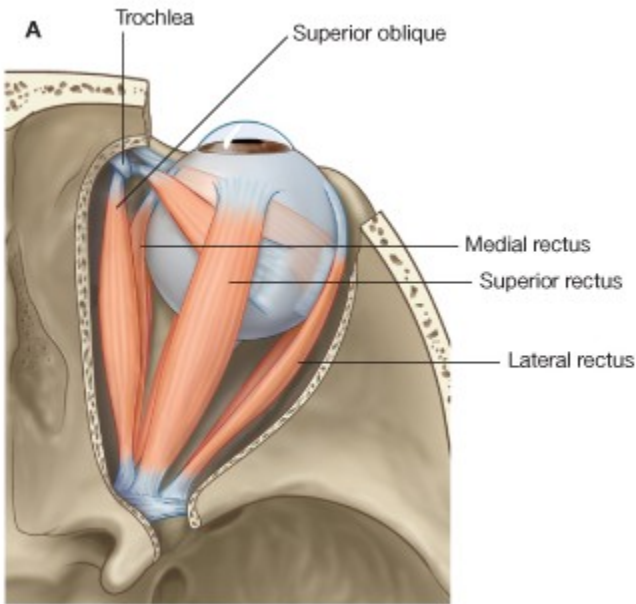
3. Thyrohyoid

4. Omohyoid

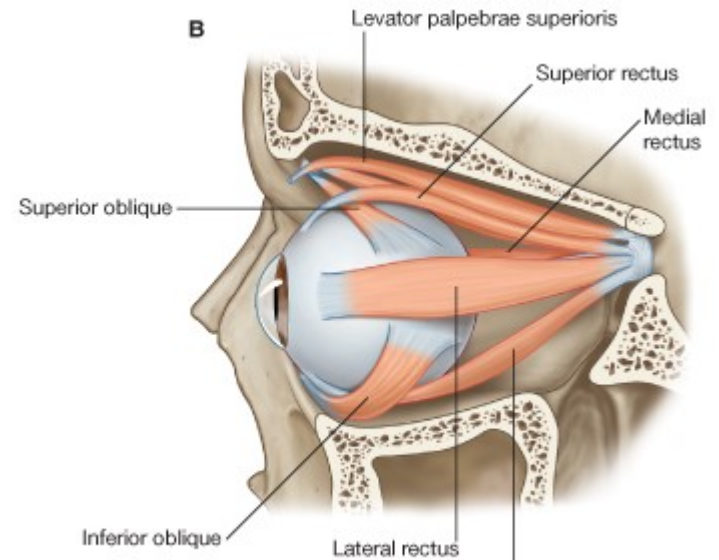


© Elsevier. Drake et al: Gray's Anatomy for Students - www.studentconsult.com





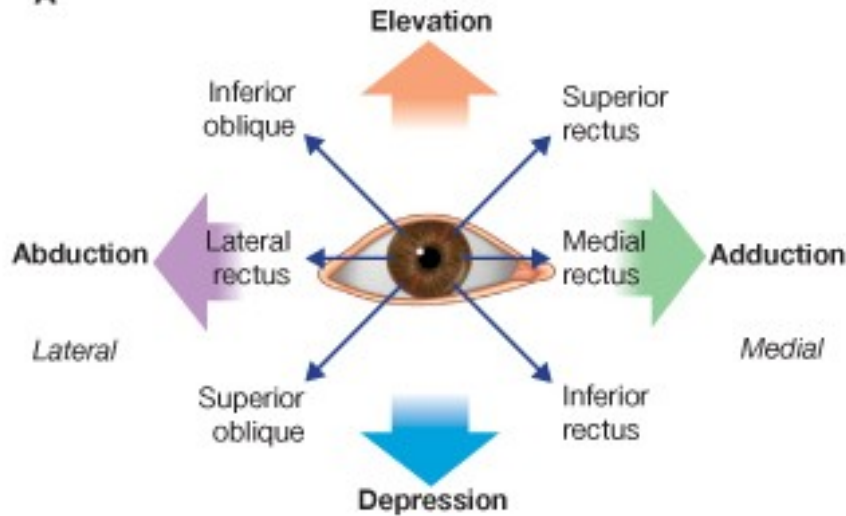
Extrinsic (extra-ocular muscles



Muscle	Origin	Insertion	Innervation	Function
Levator palpebrae superioris	Lesser wing of sphenoid anterior to optic canal	Anterior surface of tarsal plate; a few fibers to skin and superior conjunctival fornix	Oculomotor nerve [III]-superior branch	Elevation of upper eyelid
Superior rectus	Superior part of common tendinous ring	Anterior half of eyeball superiorly	Oculomotor nerve [III]-superior branch	Elevation, adduction, medial rotation of eyeball
Inferior rectus	Inferior part of common tendinous ring	Anterior half of eyeball inferiorly	Oculomotor nerve [III]-inferior branch	Depression, adduction, lateral rotation of eyeball
Medial rectus	Medial part of common tendinous ring	Anterior half of eyeball medially	Oculomotor nerve [III]-inferior branch	Adduction of eyeball
Lateral rectus	Lateral part of common tendinous ring	Anterior half of eyeball laterally	Abducent nerve [VI]	Abduction of eyeball
Superior oblique	Body of sphenoid, superior and medial to optic canal	Outer posterior quadrant of eyeball	Trochlear nerve [IV]	Depression, abduction, medial rotation of eyeball
Inferior oblique	Medial floor of orbit posterior to rim; maxilla lateral to nasolacrimal groove	Outer posterior quadrant of eyeball	Oculomotor nerve [III]-inferior branch	Elevation, abduction, lateral rotation of eyeball

Actions of extrinsic muscles of the

A



B

Muscle tested

Direction to move eye when testing muscle

Superior rectus



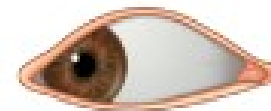
Look laterally and upward

Inferior rectus



Look laterally and downward

Lateral rectus



Look laterally

Medial rectus



Look medially

Inferior oblique

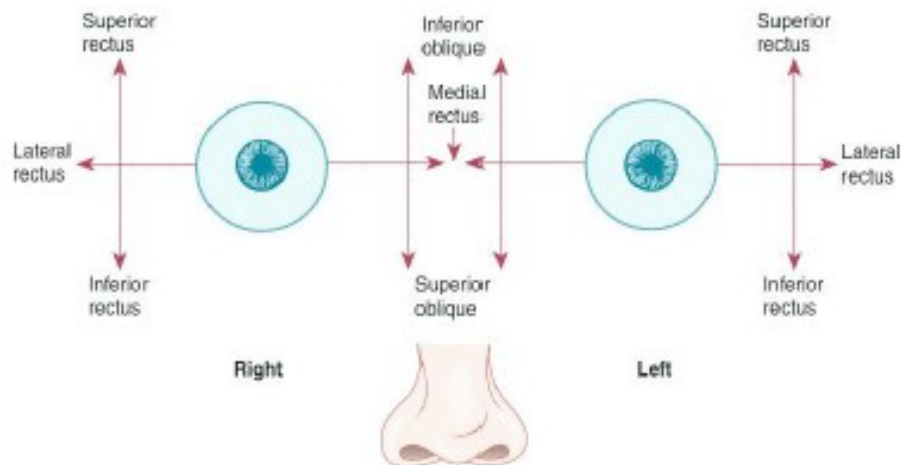


Look medially and upward

Superior oblique



Look medially and downward

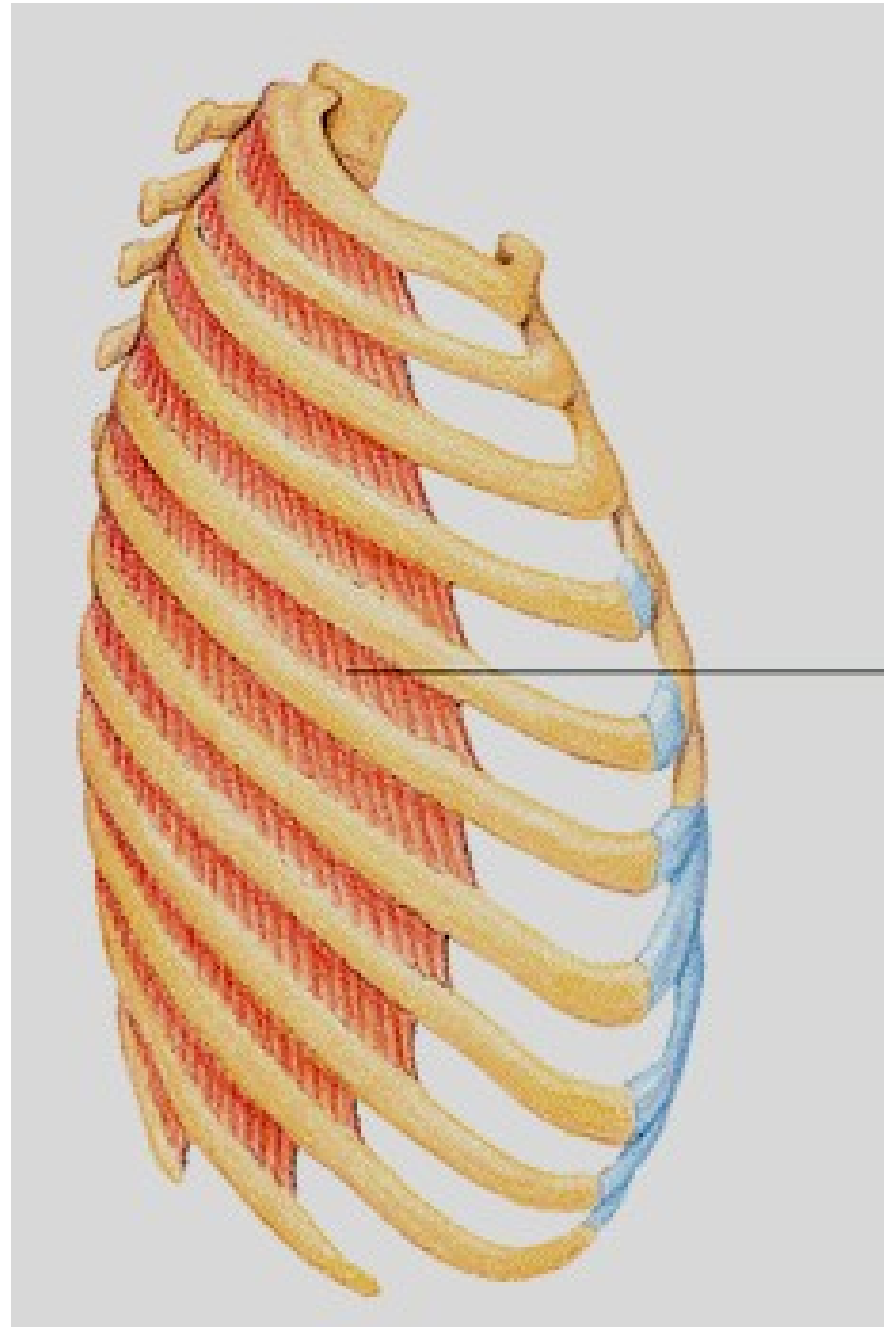


Muscles of thorax proper: Intercostal muscles

- Intercostal spaces contain 3 layers of muscles:
 - External intercostal muscles
 - Internal intercostal muscles
 - Innermost intercostal muscles

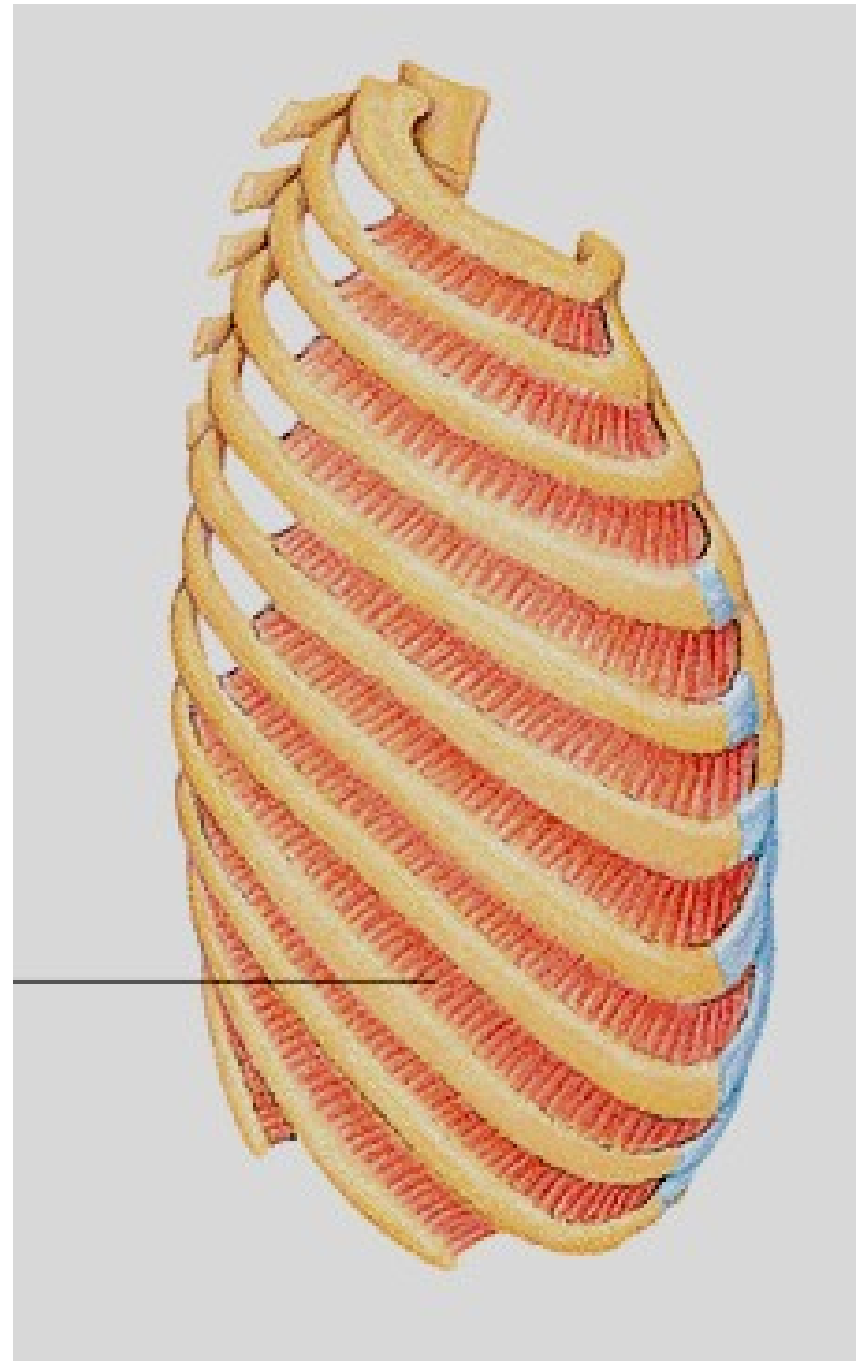
External Intercostals

- **Origin** - inferior border of rib above
- **Insertion** - superior border of rib below
- Occupy intercostal spaces from tubercles of ribs to costochondral junction
- Anteriorly replaced by external intercostal membranes
- **Action** - pulls ribs upward to aid in respiration
- Muscle fibers project inferiorly in a posterior to anterior direction



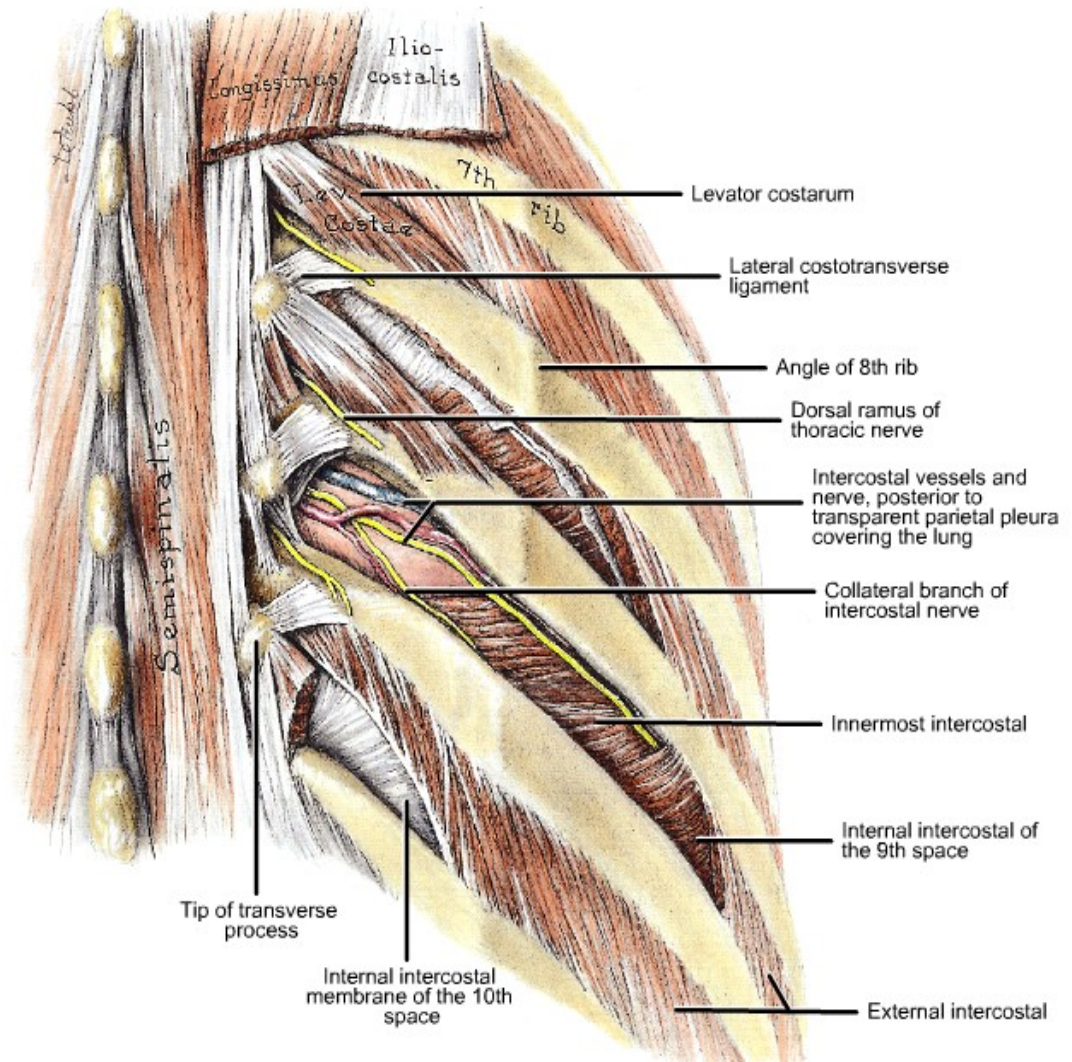
Internal intercostals

- **Origin** - superior border of rib below
- **Insertion** - inferior border of rib above
- Occupy intercostal spaces from sternum to angles of ribs
- posteriorly replaced by internal intercostal membranes
- **Action** - draws ribs together; aids in respiration
- Muscle fibers project superiorly in a posterior to anterior direction (perpendicular to fibers of external intercostals)



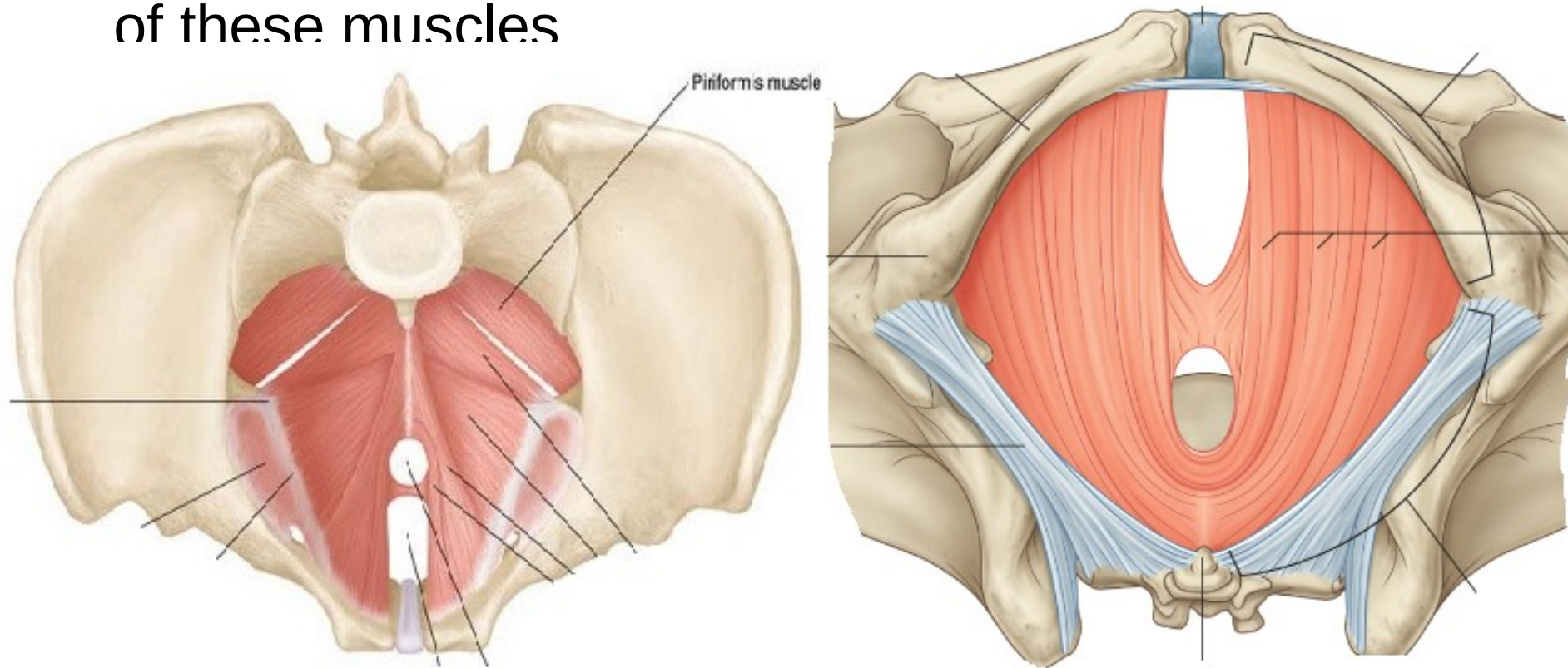
Innermost intercostal

- Similar to internal intercostal; deep portions of them
- Separated from internal intercostals by intercostal nerves and vessels



Muscles of the Pelvic Floor

- Formed by the funnel-shaped **pelvic diaphragm**
- which consists of the **levator ani and coccygeus muscles** and
- **the fascias** covering the superior and inferior aspects of these muscles



1. The levator ani muscle

- Broad muscular sheet attached to:
 - the **pubic bones** anteriorly
 - to the **ischial spines** posteriorly
- An anterior gap between the medial borders of the levator ani muscles of each side (**the urogenital hiatus**)
 - gives passage to the urethra and, in females, the vagina

2. The coccygeus muscles

- extend:
 - from the ischial spines **to**
 - the inferior sacrum and coccyx

Action of pelvic diaphragm

- **support** pelvic viscera
- acting together, raise the pelvic floor, following its descent when relaxed to allow **defecation** and **urination**, restoring its normal position
- **resist** the increased **intra-abdominal pressure** during forced expiration, coughing, sneezing, & vomiting.

Injury to pelvic floor

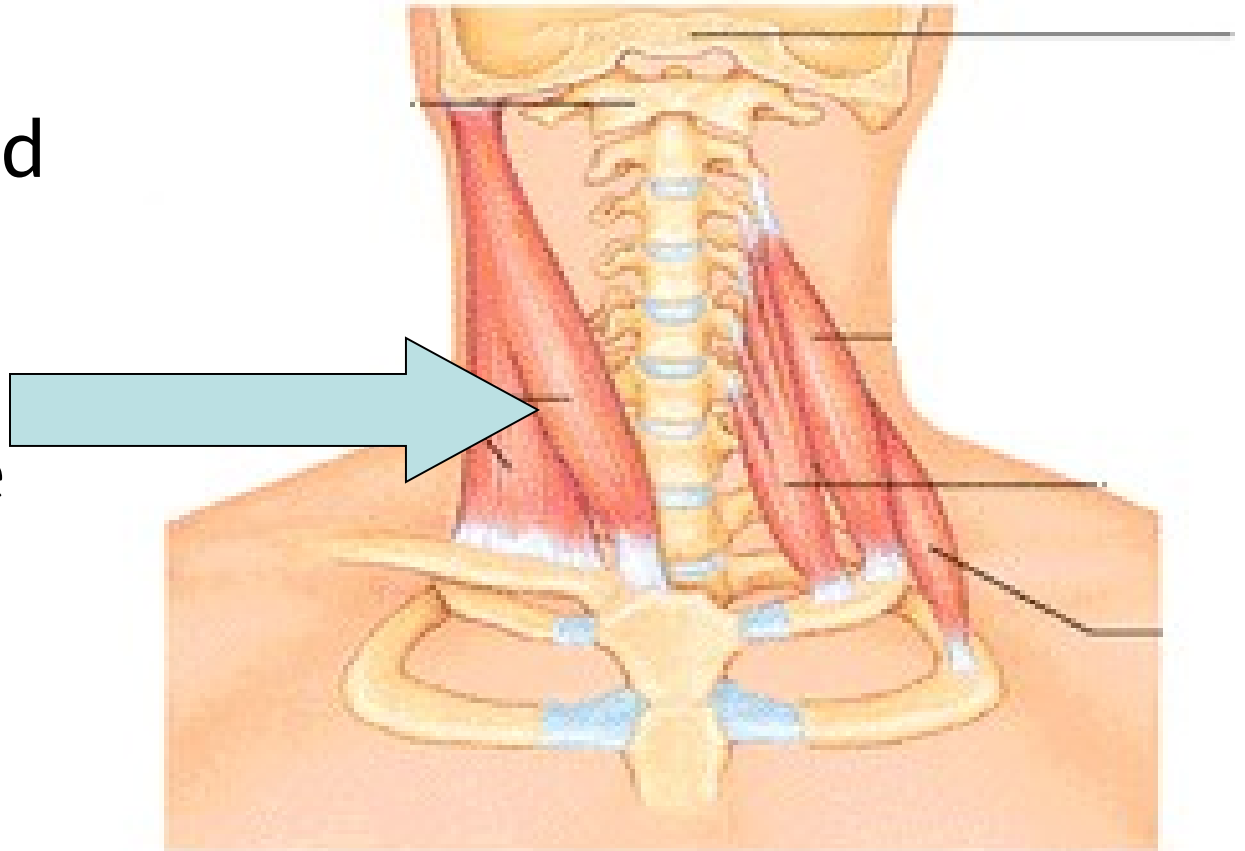
- Levator ani, and pelvic fascia may be injured during childbirth (**usually the most medial part**)
 - This part of the muscle is important because it **encircles and supports** the urethra, vagina, and anal canal
- Weakening of the levator ani may alter the position of the **neck of the bladder**, urethra and others
 - cause urinary stress **incontinence**

Some Muscles

1. Sternocleidomastoid Muscle

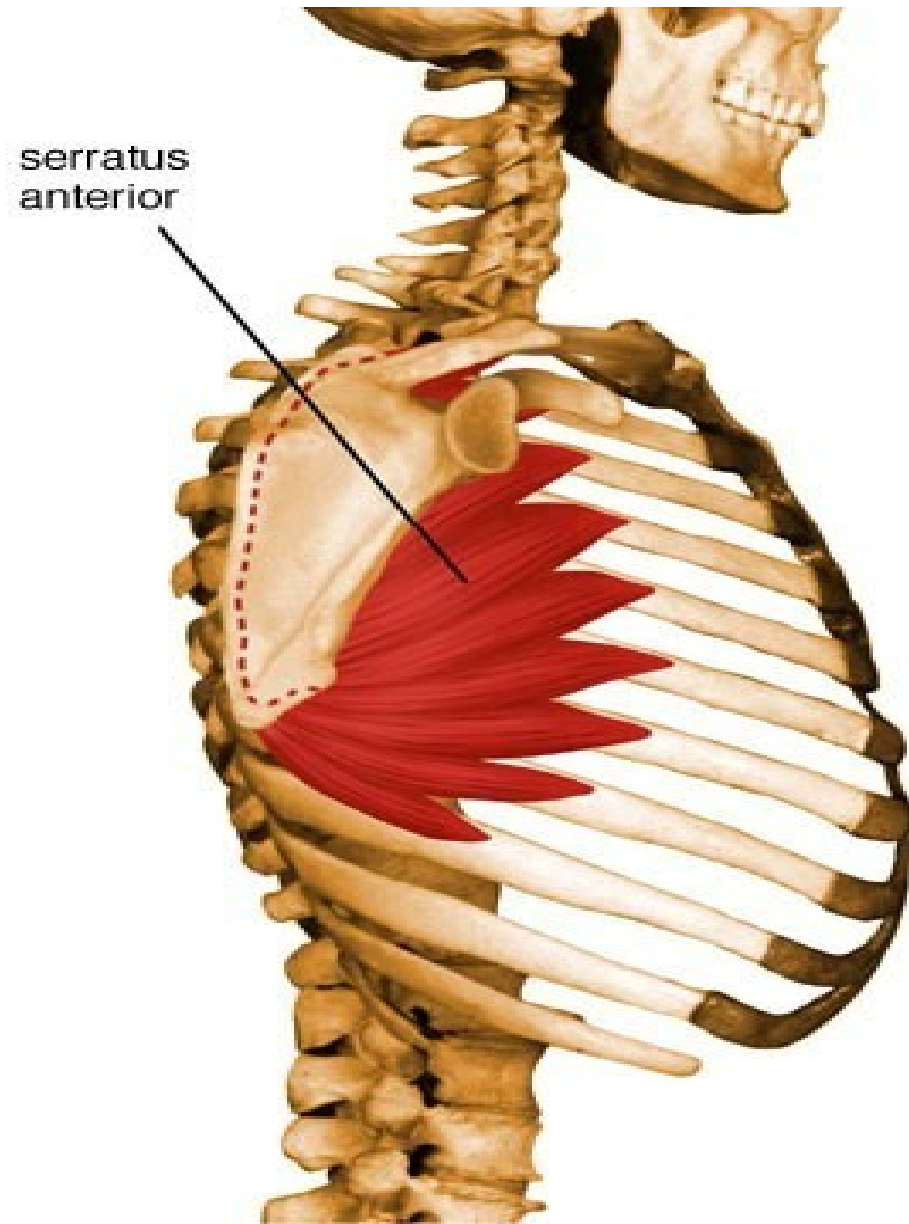
Action - flexes and rotates head

Nerve Supply -
Accessory nerve



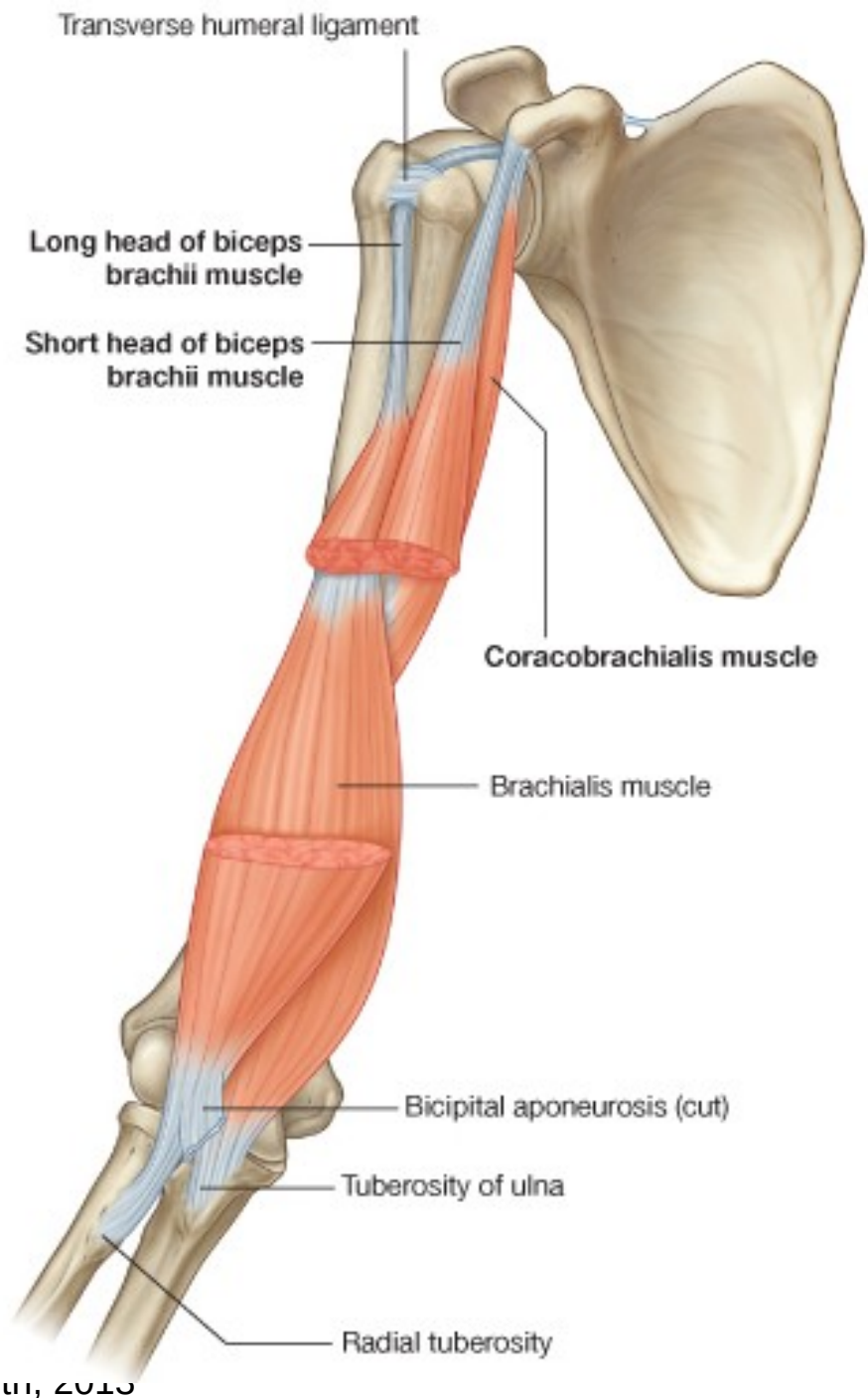
2. The serratus anterior muscle

- is innervated by the **long thoracic nerve**
- It **protracts the scapula**.
- Paralysis of this muscle results in a "**winged scapula**"



Muscles of a

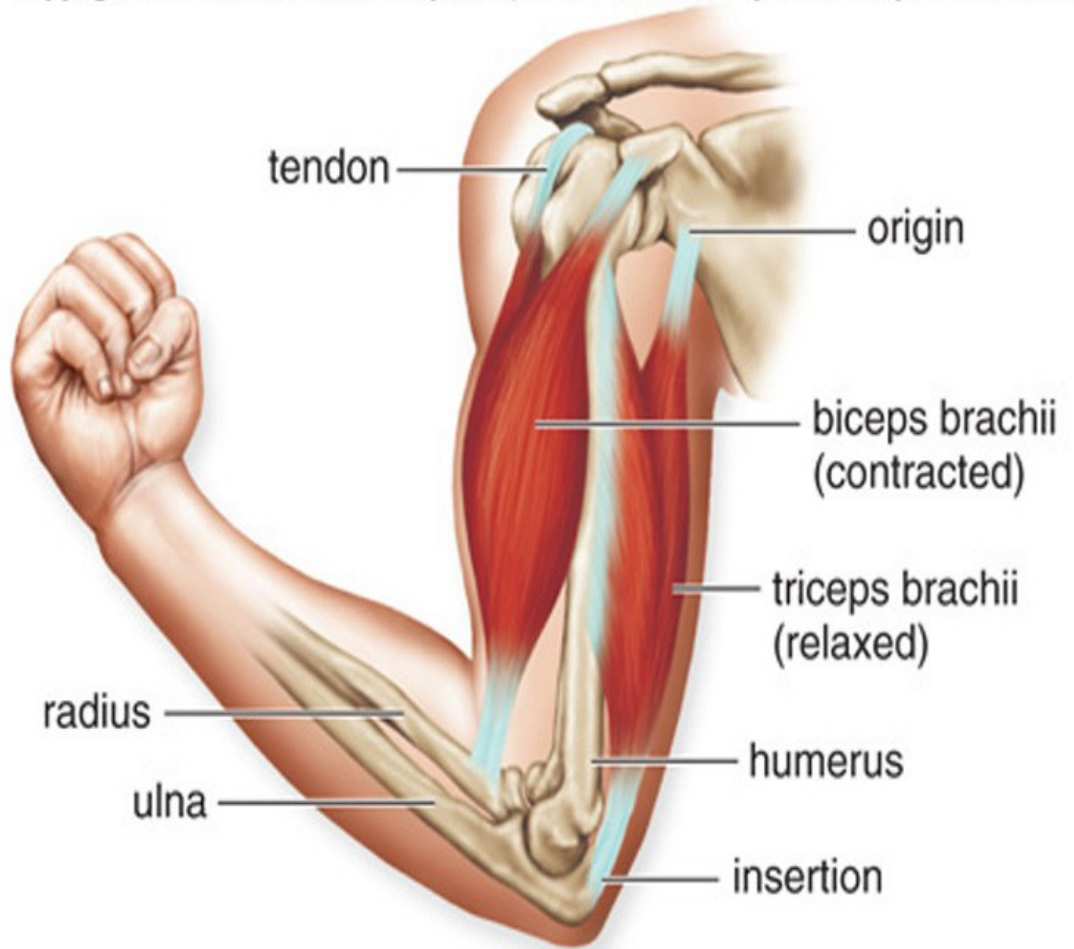
- Anterior group
 - Biceps brachii
 - Coracobrachialis
 - Brachialis



3. The anterior arm muscles

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

- are innervated by the **musculocutaneous nerve**
- **mainly flexes the elbow joint**

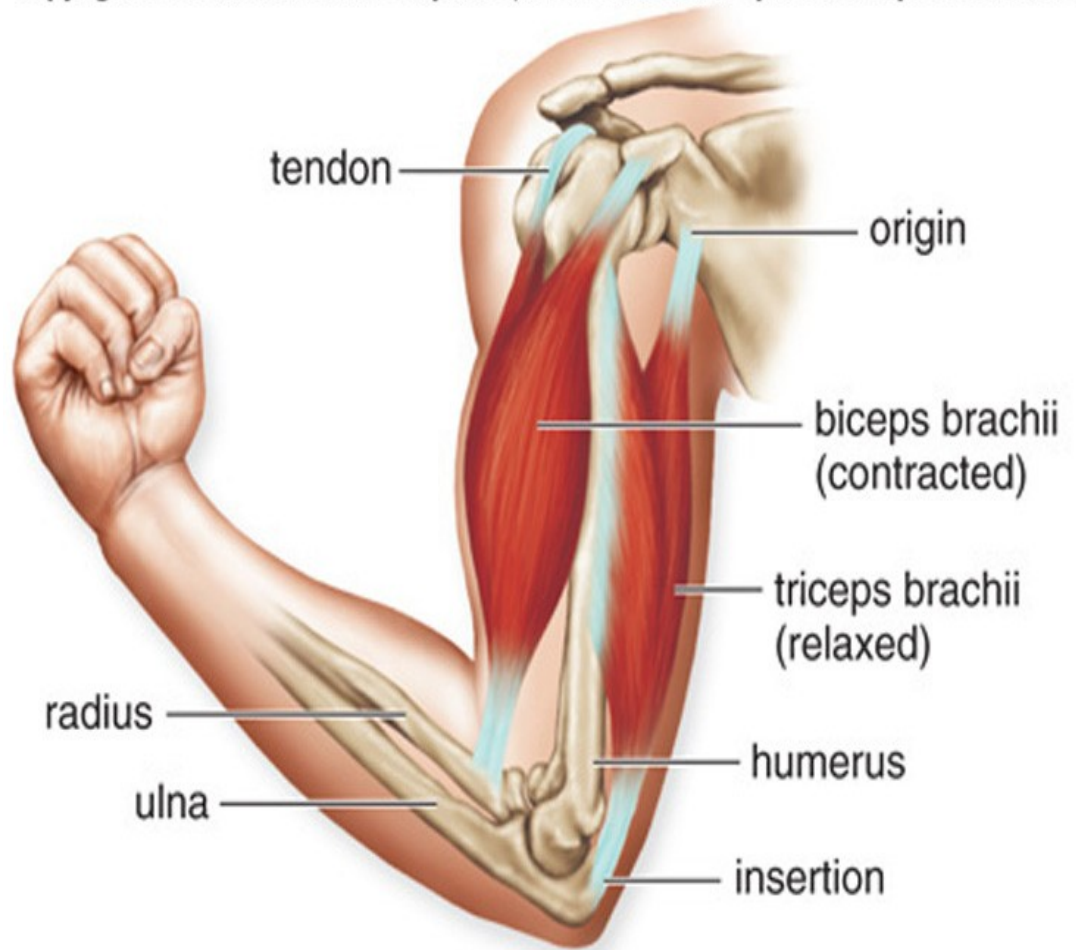


b.

4. The posterior arm muscle

- Only **triceps brachii muscle** is found in the posterior arm
- are innervated by the **radial nerve**
- **Extends the elbow joint**

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



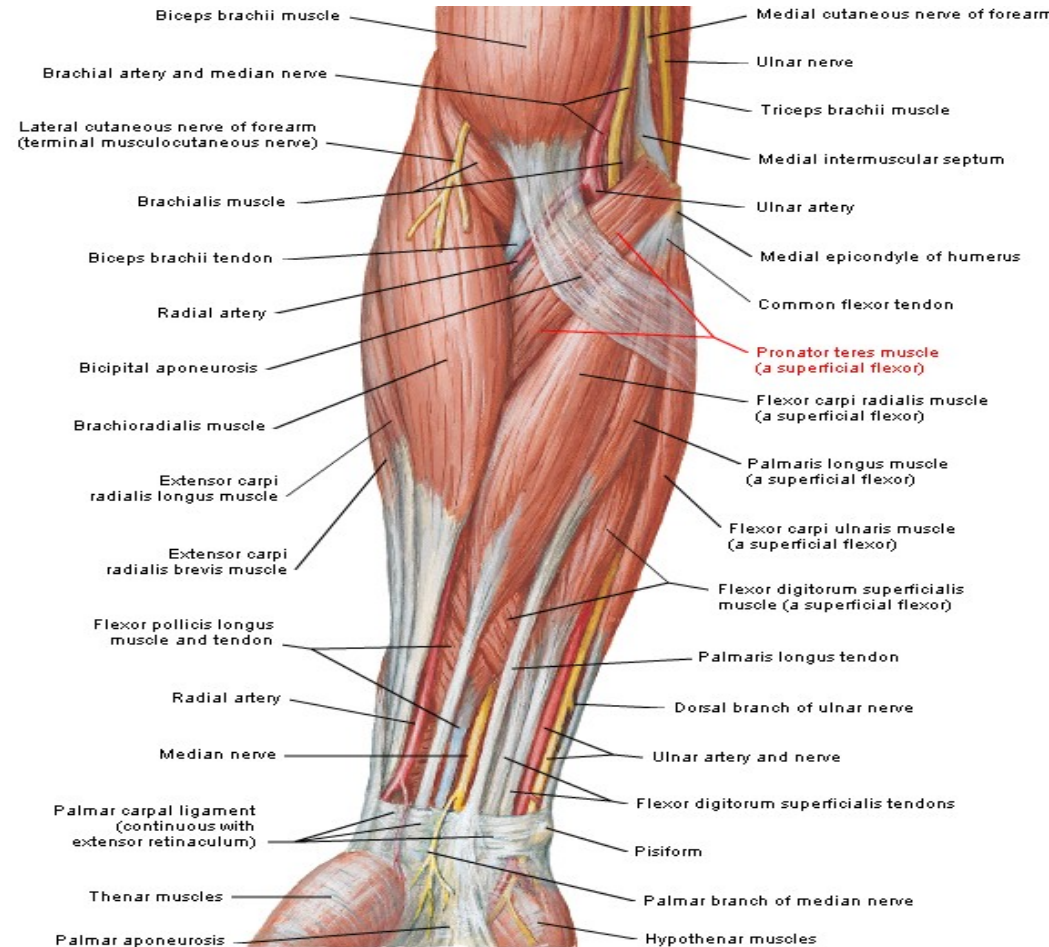
b.

Flexor-pronator muscles

Superficial layer

5. Anterior muscles of the forearm

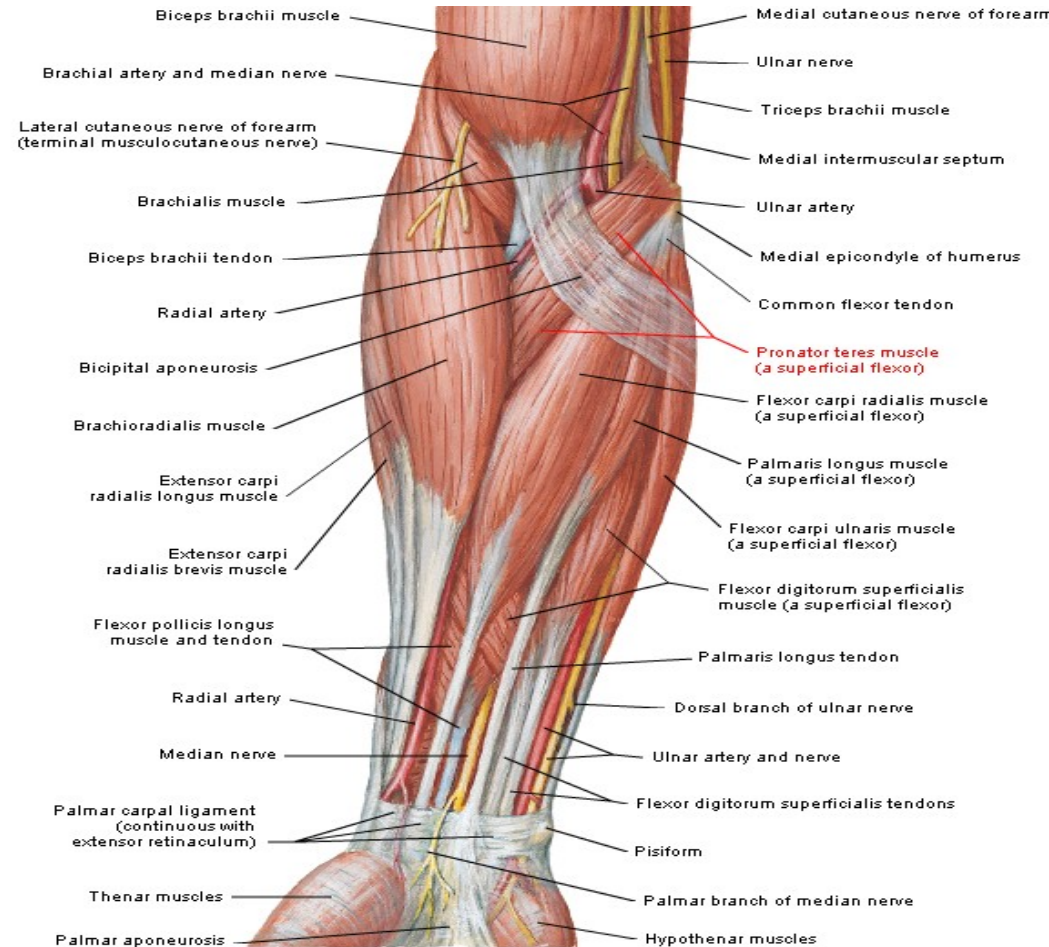
- Most are innervated by the **median nerve** and some are innervated by the **ulnar nerve**.
- **Mainly flexes the wrist joint**



Flexor-pronator muscles

6. Posterior muscles of the forearm

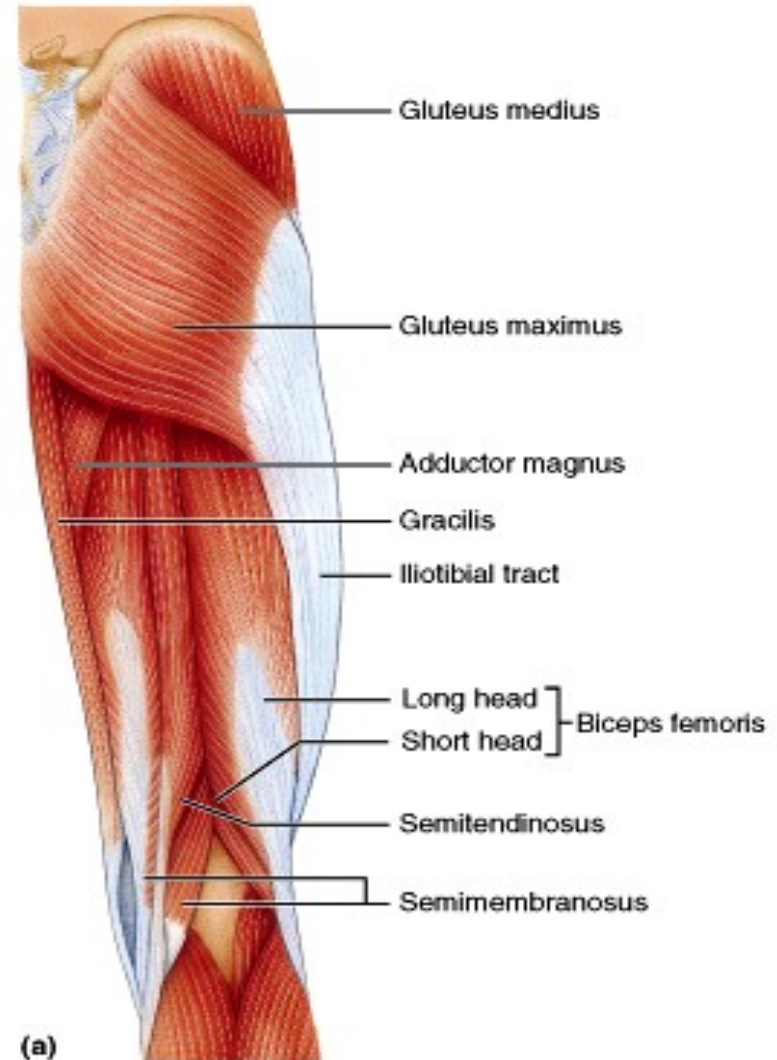
- are innervated by the **radial nerve**
- **Mainly extends the wrist joint**



7. Gluteus maximus muscle

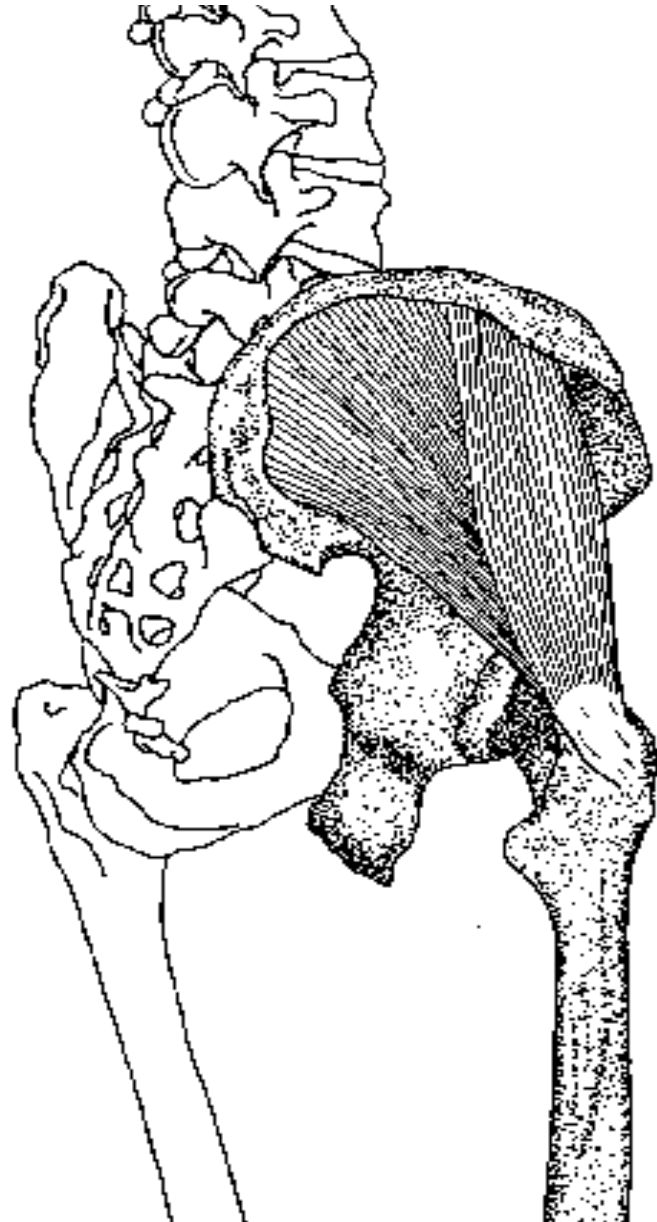
Action – Strong hip extensor; adduction, abduction, lateral rotation

Nerve Supply - inferior gluteal nerve



8. Gluteus medius muscle

- **Action** - abducts and medially rotates hip (**anterior fibers**)
lateral rotation by **posterior fibers**
 - **Stablizes pelvis**
- **Nerve Suply:** Superior gluteal nerve



Injury to Superior Gluteal Nerve

- Injury to the **superior gluteal nerve** results in weakened abduction of the thigh by the gluteus medius and minimus,
- When a person with paralysis of the right superior gluteal nerve is asked to stand on the right leg, the pelvis descends on the left side, indicating that the gluteus medius & minimus on the right side are weak or non-functional.
- When the pelvis descends on the unsupported (left) side, the lower limb becomes, too long and does not clear the ground when the foot is brought forward. To compensate, the individual leans away from the unsupported (left) side, raising the pelvis to allow adequate room for the foot to clear the ground as it swings forward. This results in a characteristic **waddling or gluteal gait** (for bilateral paralysis) or **tipping gait** (for unilateral paralysis).

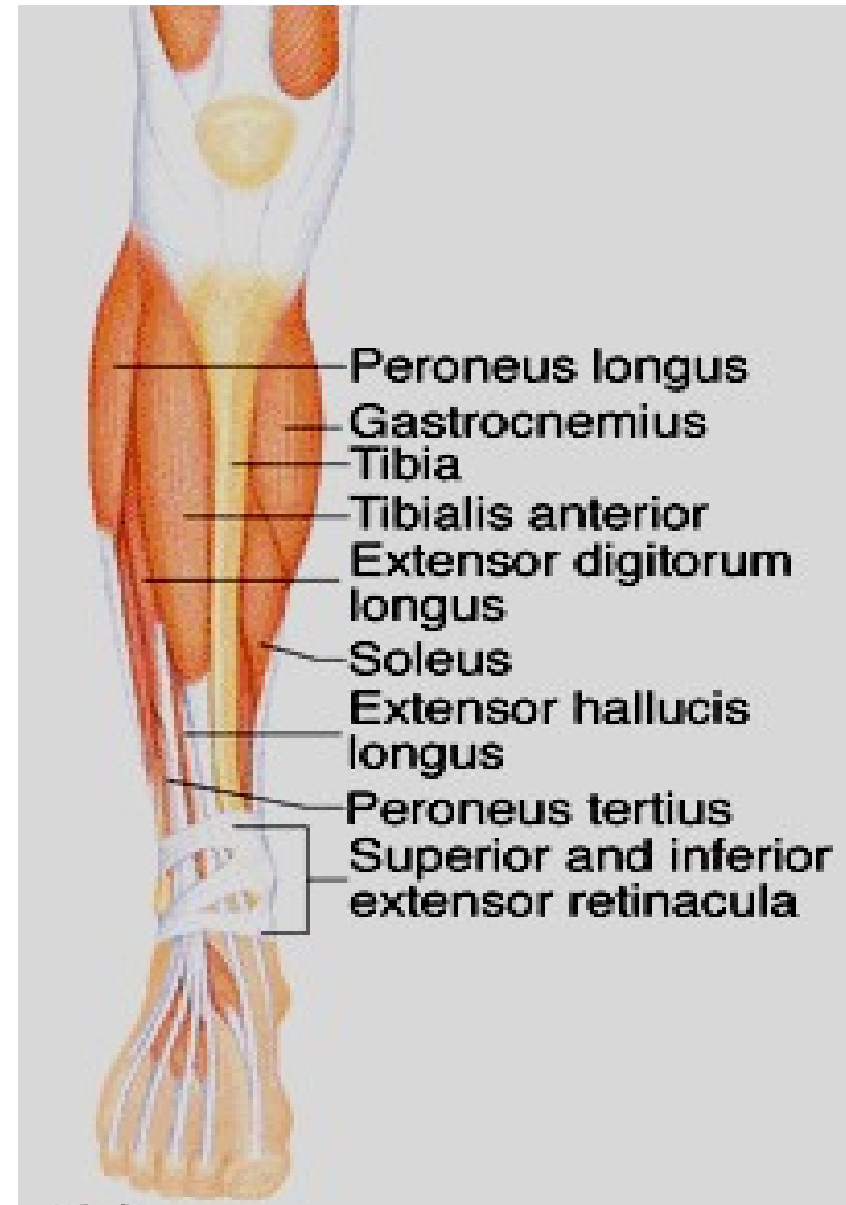
Injury to Superior Gluteal Nerve

- **Waddling or gluteal gait**
 - for bilateral paralysis or
- **Tipping gait**
 - for unilateral paralysis.



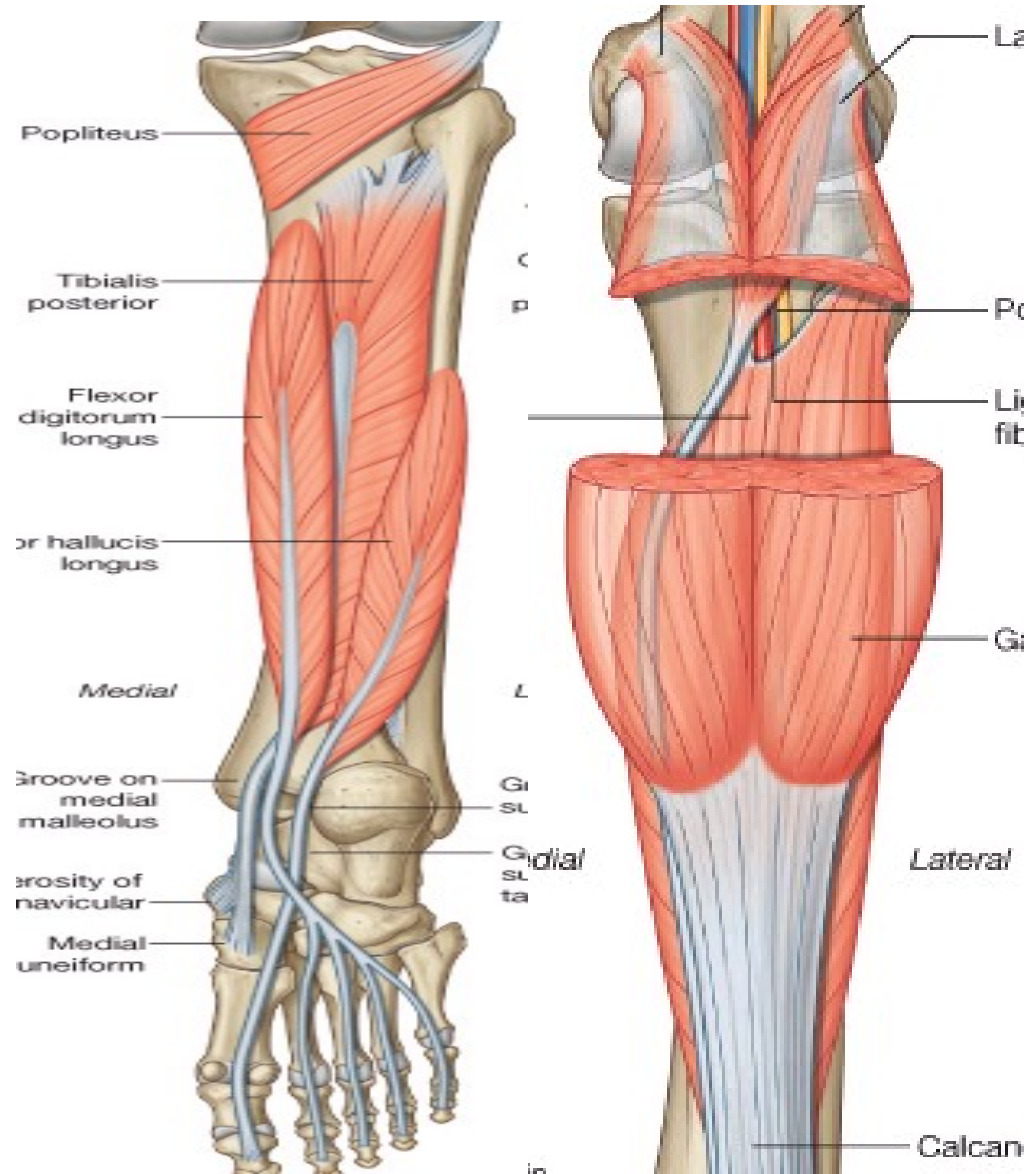
9. Muscles of the anterior compartment of the leg

- Muscles of the anterior compartment are primarily toes extensors and dorsiflexors
 1. Paralysis of these muscles resulted in impaired dorsiflexion, **difficulty of standing on heel.**
 2. **Nerve Supply** - Deep branch of common fibular (peroneal) nerve



10. Muscles of the posterior compartment of the leg

- Muscles of the posterior compartment are primarily plantar flexors and flex the toes.
- **Paralysis of these muscles results in impaired plantar flexion, difficulty of standing on toes**
- Are innervated by the **tibial nerve**



Intramuscular Injection Sites

- Sites where free from nerves and important for injection of drugs

1. The gluteal region

- The gluteal region is a common injection site because the muscles are thick and large; consequently, they provide a substantial volume for absorption of injected substances by intramuscular veins.
- It is important to be aware of the extent of the gluteal region and the safe region for giving injections

2. *Deltoid Muscle –injection for vaccination*

3. *Vastus lateralis Muscle – the inferior half*

4. *Umbilicus*

- Are the common sites for intramuscular injection

Intragluteal Injections

Injections into the buttock are safe only in the **superolateral quadrant** of the buttock.

Injury of the sciatic nerve results paralysis of posterior thigh muscles & muscles distal to the knee

