



UNIVERSITÀ  
DEGLI STUDI  
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**DNS** DEPARTMENT OF NEUROSCIENCE

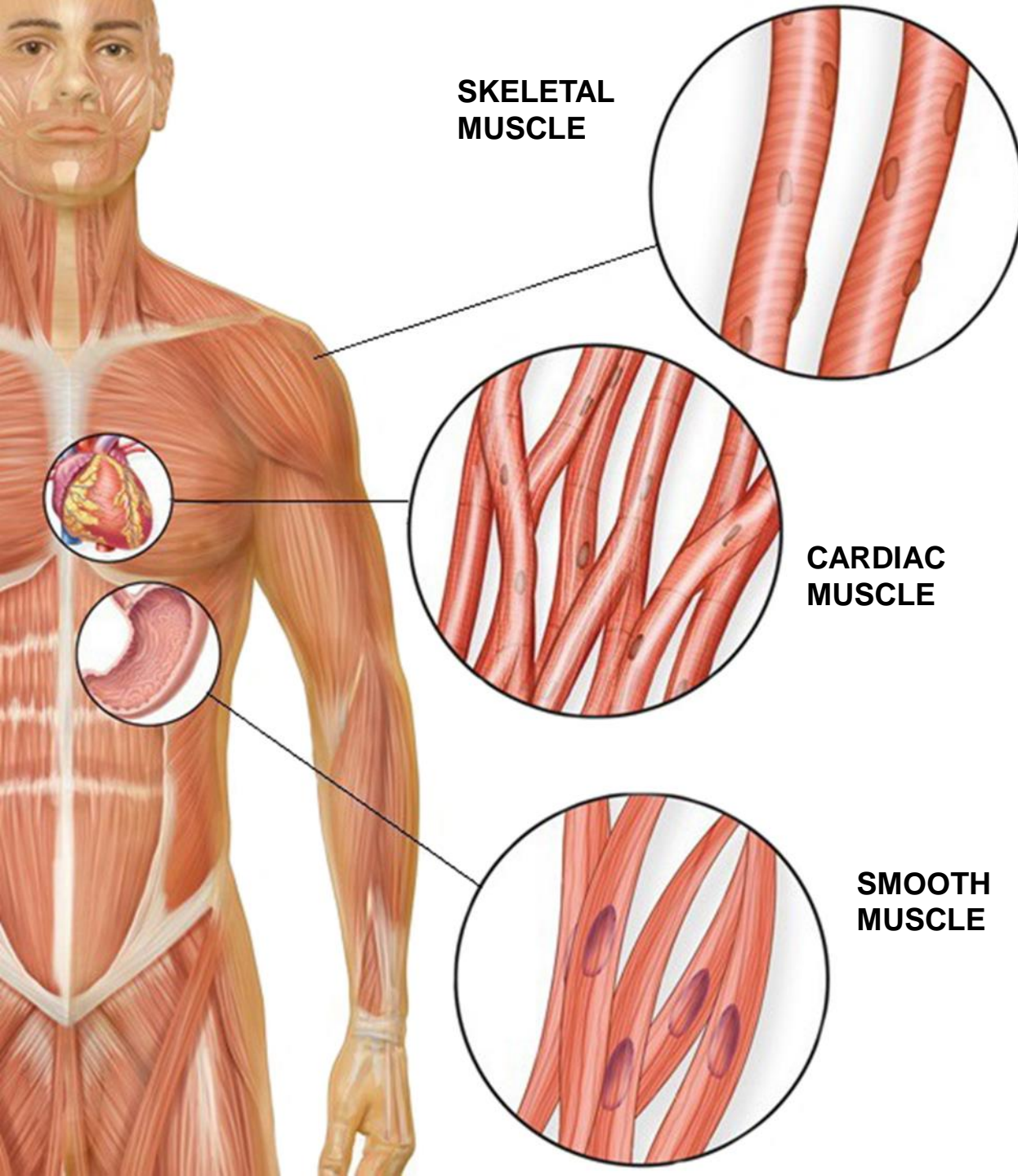


ANATOMY AND PHYSIOLOGY (C.I.)

HUMAN ANATOMY  
(Mod. A)

THE MUSCULAR SYSTEM

# INTRODUCTION TO THE MUSCULAR SYSTEM



*There are three kinds of muscle in the human body:*

## **1. Smooth Muscles**

Found in the hollow walls of the body organs (colon, small intestine, rectum, etc.), the blood vessels, and the respiratory ways.

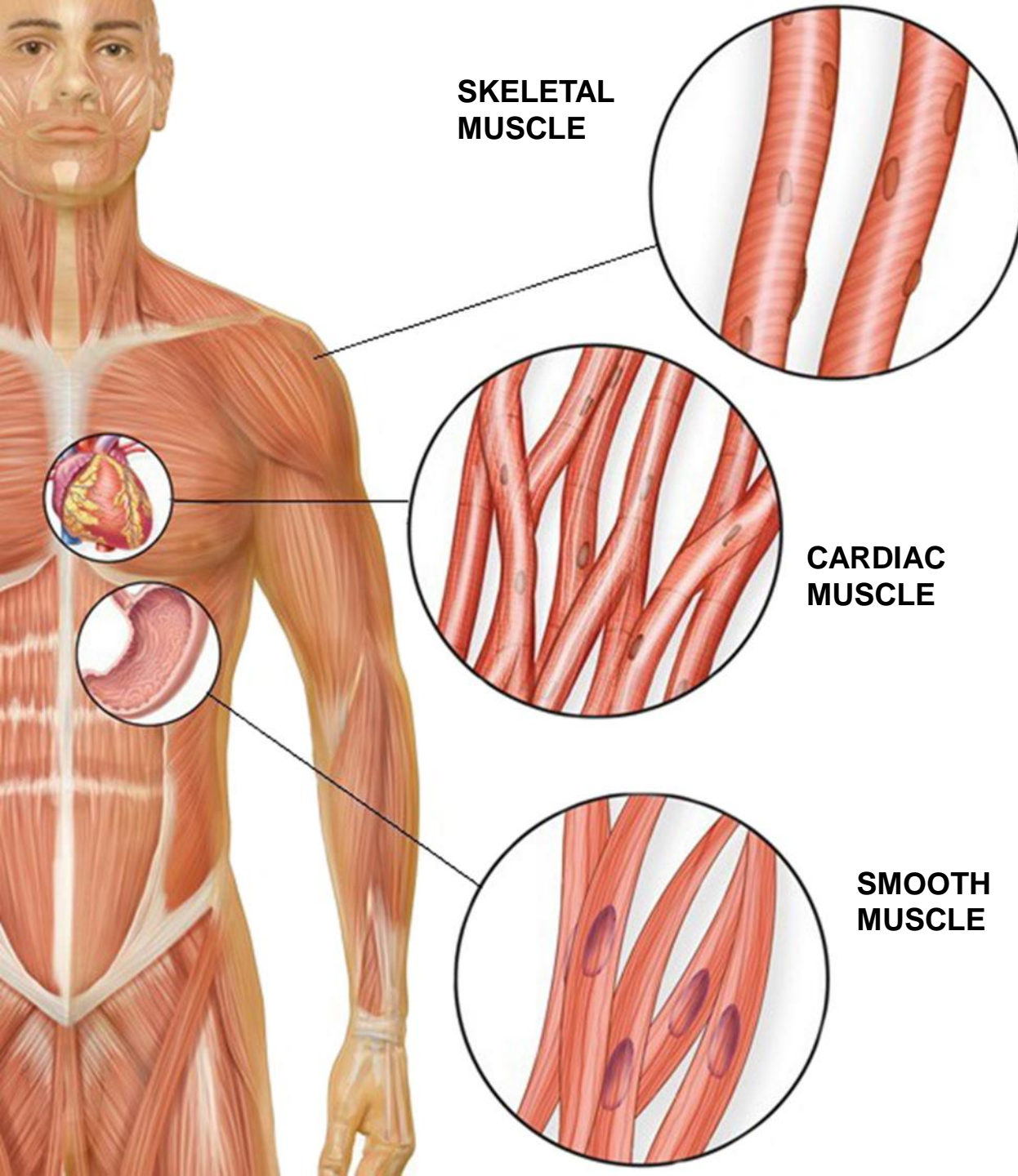
## **2. Skeletal Muscles**

These are the muscles that attach to bones and produce movement at the joints.

## **3. Cardiac Muscle**

The muscle tissue of the HEART.

- ✓ There are about 600 skeletal muscles in the body.
- ✓ Skeletal muscles alone make up about 40% of body weight.



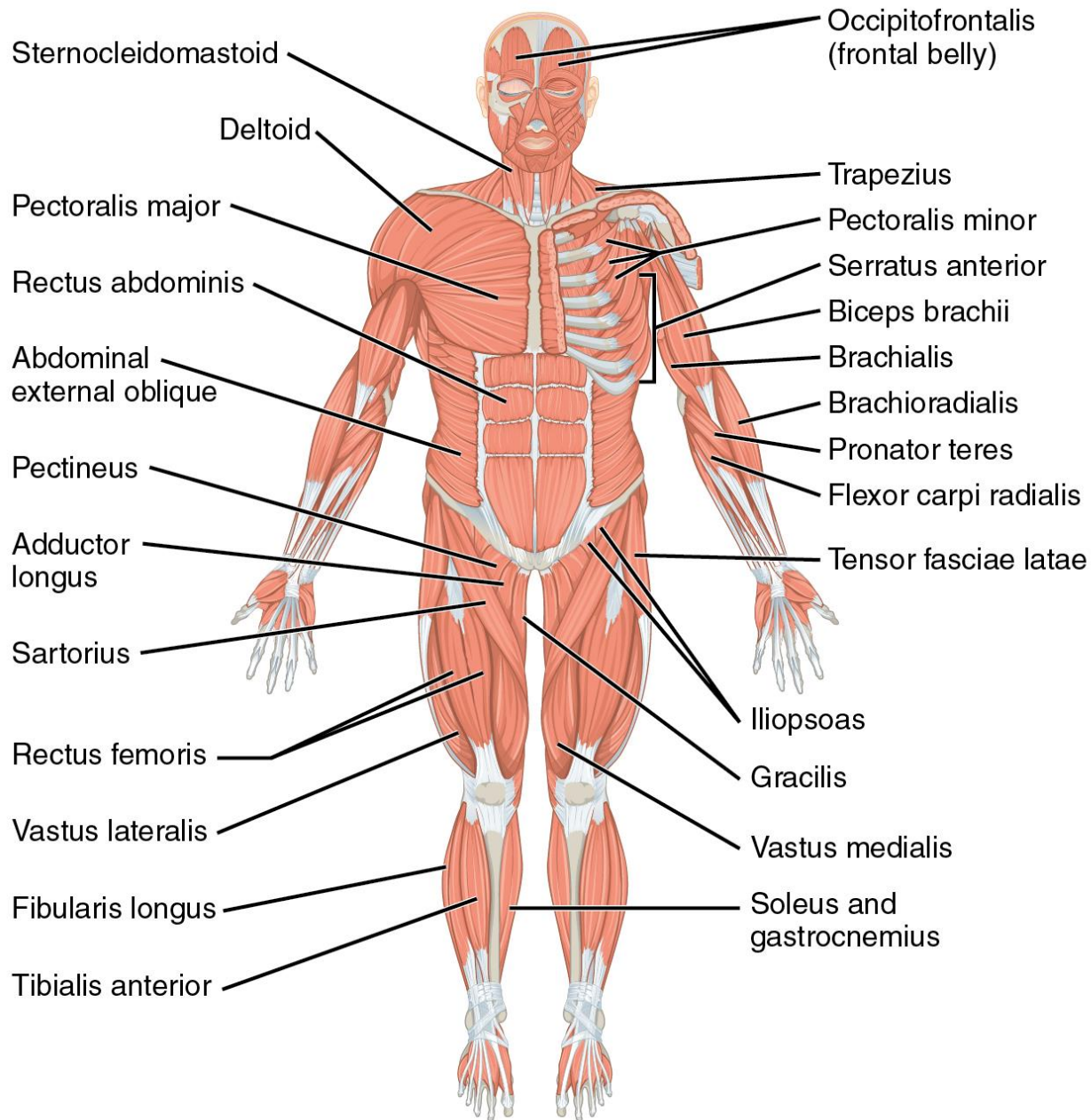
Muscular action is categorized as:

- **VOLUNTARY** → operates under conscious control
- **INVOLUNTARY** → operates automatically, without conscious decision or direction

- **Smooth muscle and cardiac muscle are INVOLUNTARY**  
These are the muscles, operating automatically, without conscious effort, that control the internal systems of the body - the digestive, circulatory, urinary, and reproductive systems. These muscles work “automatically” to keep us healthy even when we are asleep.

- **Skeletal muscle is VOLUNTARY**  
because it operates under conscious control.





Major muscles of the body.  
Right side: superficial; left side:  
deep (anterior view)

The skeletal muscles have three main functions:

### 1. Movement of the skeleton:

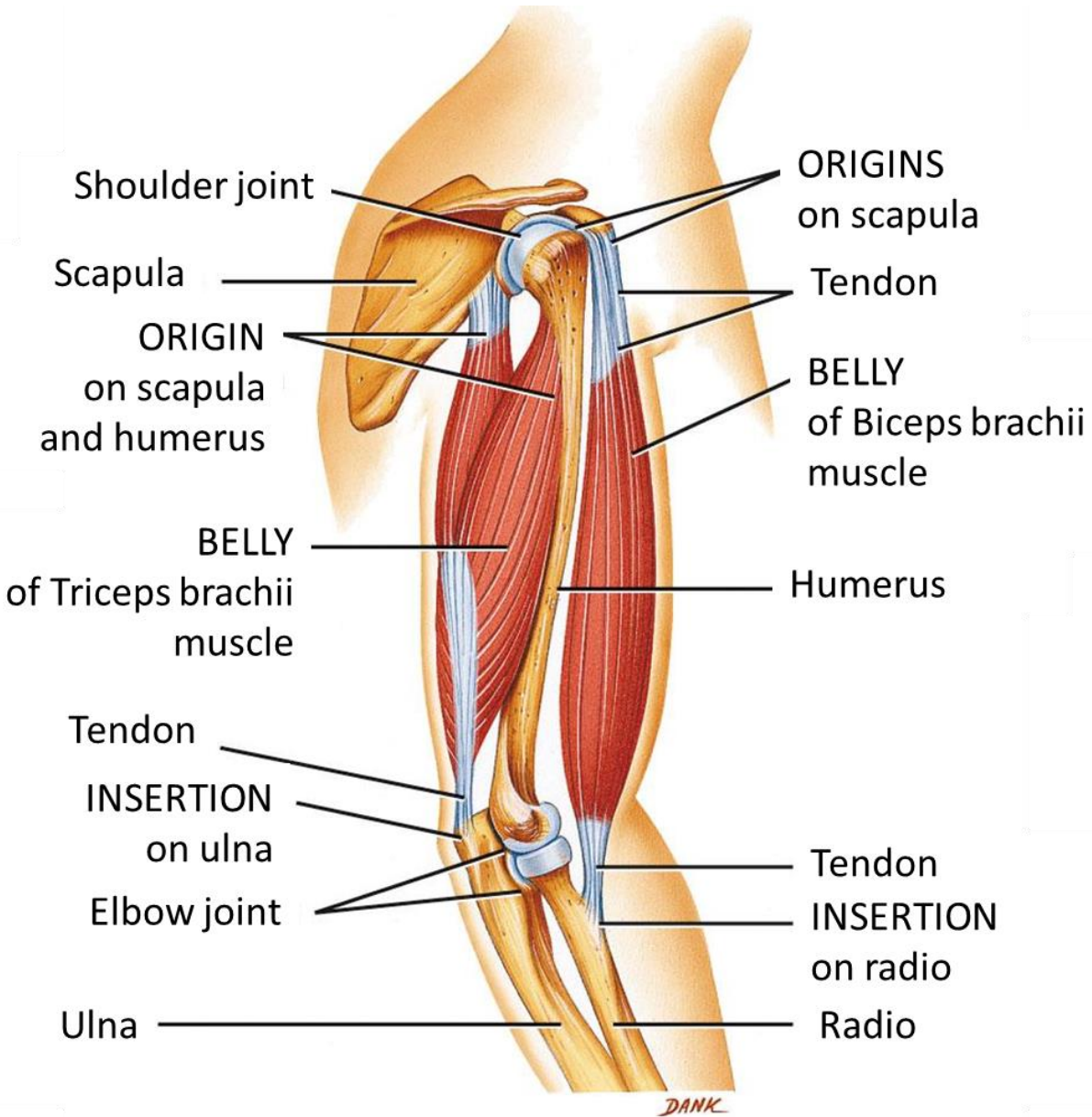
muscles are attached to two bones that make up a joint. When the muscles contract, the joint moves. Muscles act in pairs or groups. *For example, when the biceps muscle on the front of the upper arm contracts, the elbow bends. This movement is called "flexion." When the triceps muscle on the back of the upper arm contracts, the lower arm straightens. This movement is known as "extension." This is an example of how muscles work in pairs or groups to make a movement happen.*

### 2. Maintenance of posture and support:

muscles maintain the body upright in varying positions. Muscle tone, a consistent, slight contraction of muscle, maintains posture and position. The back, neck, and abdominal muscles are some of the muscles involved in maintaining posture.

### 3. Generation of heat:

this is an important function. Heat is a natural byproduct of muscle cell metabolism resulting from muscle movement. Muscles create most of the heat necessary to keep the physiological body temperature.



To move the skeleton, the tension created by the contraction of the fibers in most skeletal muscles is transferred to **the tendons**.

The tendons are strong bands of dense, regular connective tissue that connect muscles to bones.

*The bone connection is why this muscle tissue is called skeletal muscle.*

## MUSCLE ORIGIN AND INSERTION

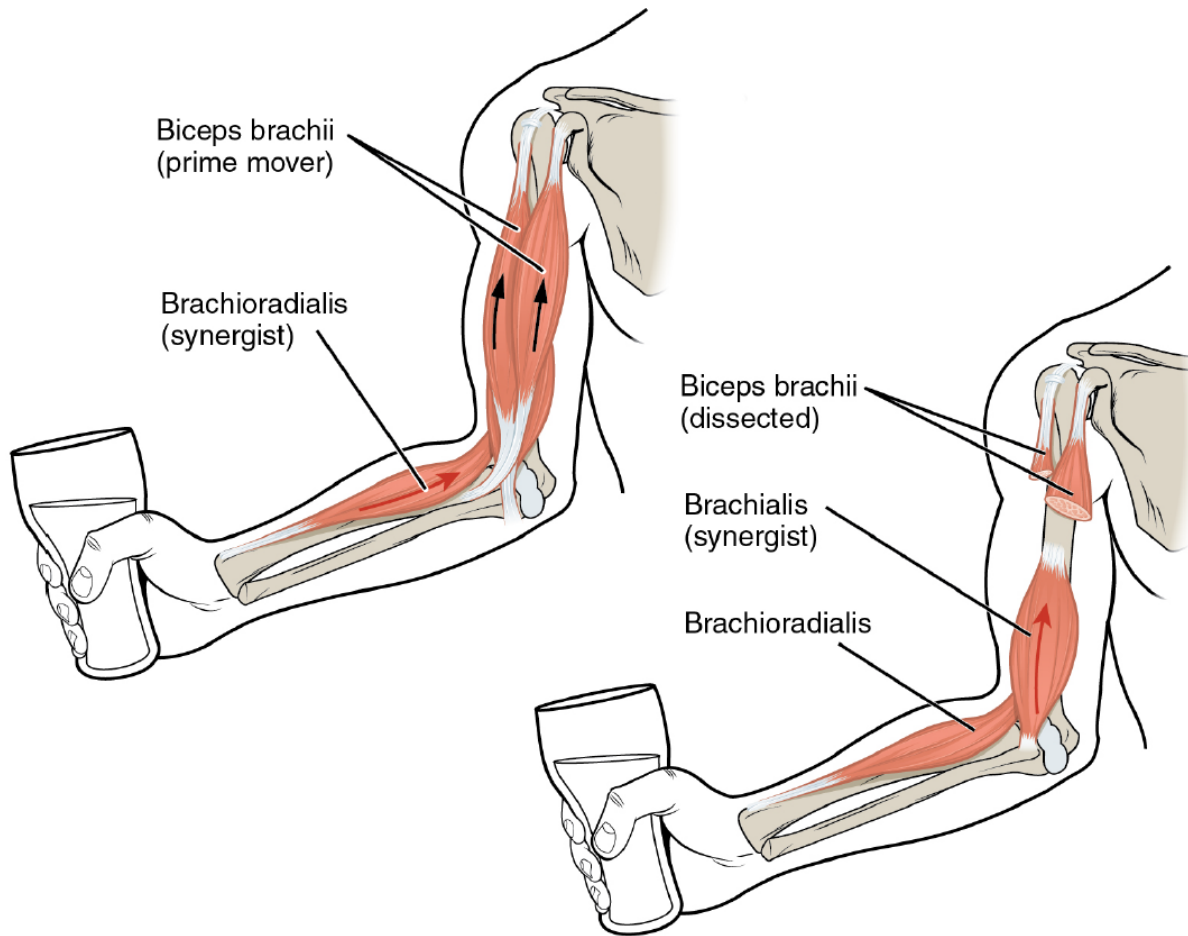
**ORIGIN (FIXED point):** it is the tendon end of the muscle which is connected to a fixed (or stabilized) bone *(or the point closest to the trunk)*.

**INSERTION (MOBILE point):** it is the tendon end of the muscle which is connected to the most mobile bone *(or the bone furthest from the trunk)*.

*In muscle mechanics, the origin usually corresponds to the fixed point and the insertion to the mobile point.*

The largest or thickest portion is called the **“belly” of the muscle** and it is composed of muscle fibers bundled together.

# INTERACTIONS OF SKELETAL MUSCLES IN THE BODY



Although a number of muscles may be involved in an action:

- the principal muscle involved is called the **prime mover**, or **AGONIST**
- a muscle that aid the prime mover in its motion is called **SYNERGIST**

*A synergist can also be a fixator that stabilizes the bone that is the attachment for the prime mover's origin*

→ To lift a cup, the biceps brachii muscle is actually the *prime mover*; The brachioradialis, in the forearm, and brachialis, located deep to the biceps in the arm, are both *synergists* that aid in this motion.

- a muscle with the opposite action of the prime mover is called an **ANTAGONIST**.

→ For example, to extend the knee, a group of four muscles called the quadriceps femoris in the anterior compartment of the thigh are activated (and would be called the agonists of knee extension). However, to flex the knee joint, an opposite or antagonistic set of muscles called the hamstrings is activated.

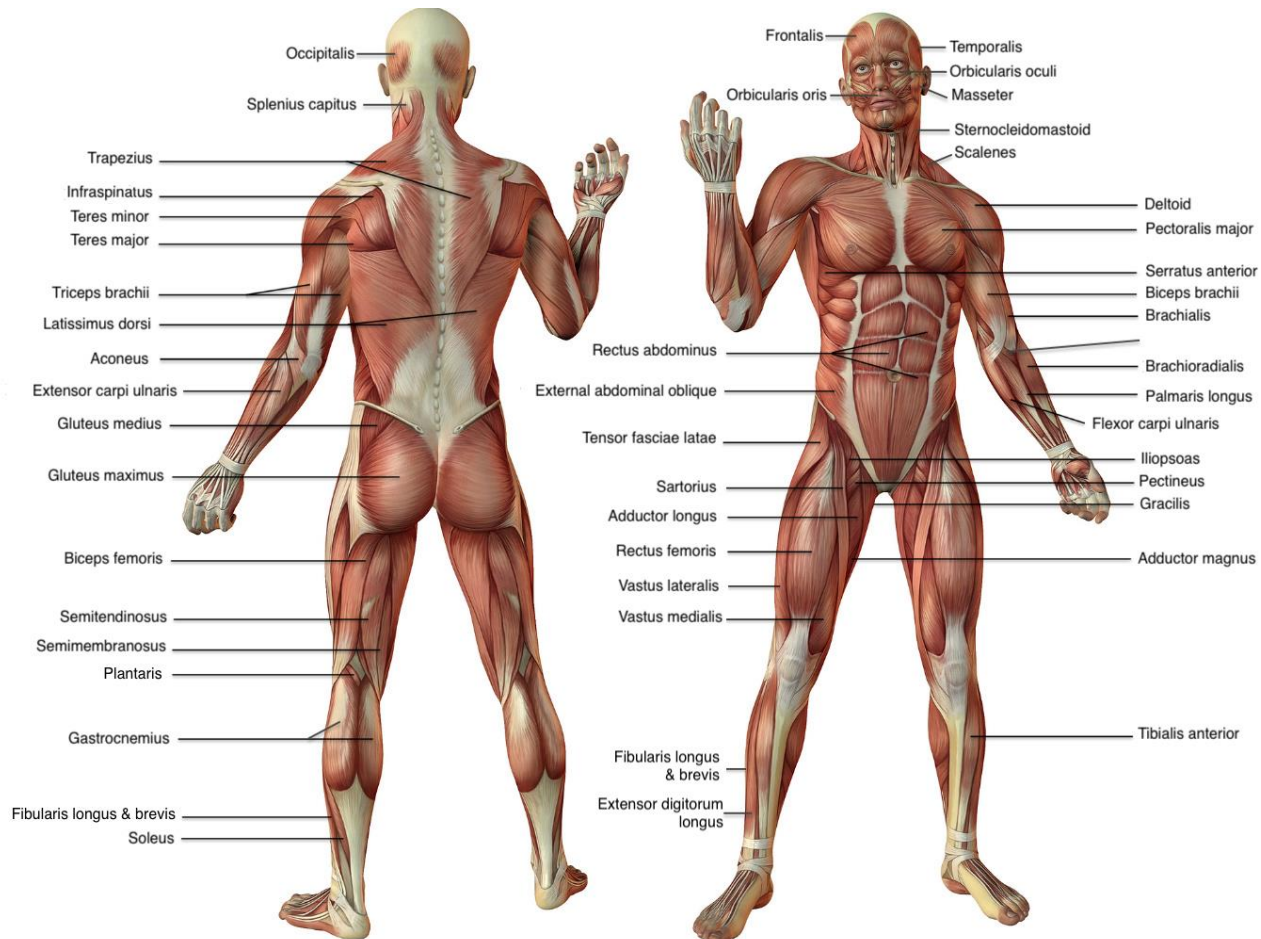
## Agonist and Antagonist Skeletal Muscle Pairs

Agonist	Antagonist	Movement
Biceps brachii: in the anterior compartment of the arm	Triceps brachii: in the posterior compartment of the arm	The biceps brachii flexes the forearm, whereas the triceps brachii extends it.
Hamstrings: group of three muscles in the posterior compartment of the thigh	Quadriceps femoris: group of four muscles in the anterior compartment of the thigh	The hamstrings flex the leg, whereas the quadriceps femoris extend it.
Flexor digitorum superficialis and flexor digitorum profundus: in the anterior compartment of the forearm	Extensor digitorum: in the posterior compartment of the forearm	The flexor digitorum superficialis and flexor digitorum profundus flex the fingers and the hand at the wrist, whereas the extensor digitorum extends the fingers and the hand at the wrist.



# NAMING SKELETAL MUSCLES

# NAMING SKELETAL MUSCLES



Anatomists name the skeletal muscles according to a number of criteria, each of which describes the muscle in some way. These include naming the muscle after its shape, its size compared to other muscles in the area, its location in the body or the location of its attachments to the skeleton, how many origins it has, or its action.

- The skeletal muscle's **ANATOMICAL LOCATION** or its **RELATIONSHIP TO A PARTICULAR BONE** often determines its name. For example: the frontalis muscle is located on top of the frontal bone of the skull; the brachialis is in the brachial region; the tibialis anterior runs along the tibia.

- The **SHAPES** of some muscles are very distinctive and the names, such as orbicularis, reflect the shape ('orb' = circular). The deltoid is a large, triangular-shaped muscle that covers the shoulder. It is so-named because the Greek letter delta looks like a triangle.

- The **SIZE** of the muscles influences the names: gluteus **maximus** (largest), gluteus **medius** (medium), and the gluteus **minimus** (smallest).

- Names indicate **LENGTH** → **brevis** (short), **longus** (long).

- Names identify **POSITION** relative to the midline: **lateralis** (to the outside away from the midline), and **medialis** (toward the midline). **Intermedius** is inbetween medial and lateral.

Example	Word	Latin Root 1	Latin Root 2	Meaning	Translation
abductor digiti minimi	abductor	ab = away from	duct = to move	a muscle that moves away from	A muscle that moves the little finger or toe away
	digiti	digitus = digit		refers to a finger or toe	
	minimi	minimus = mini, tiny		little	
adductor digiti minimi	adductor	ad = to, toward	duct = to move	a muscle that moves towards	A muscle that moves the little finger or toe toward
	digiti	digitus = digit		refers to a finger or toe	
	minimi	minimus = mini, tiny		little	

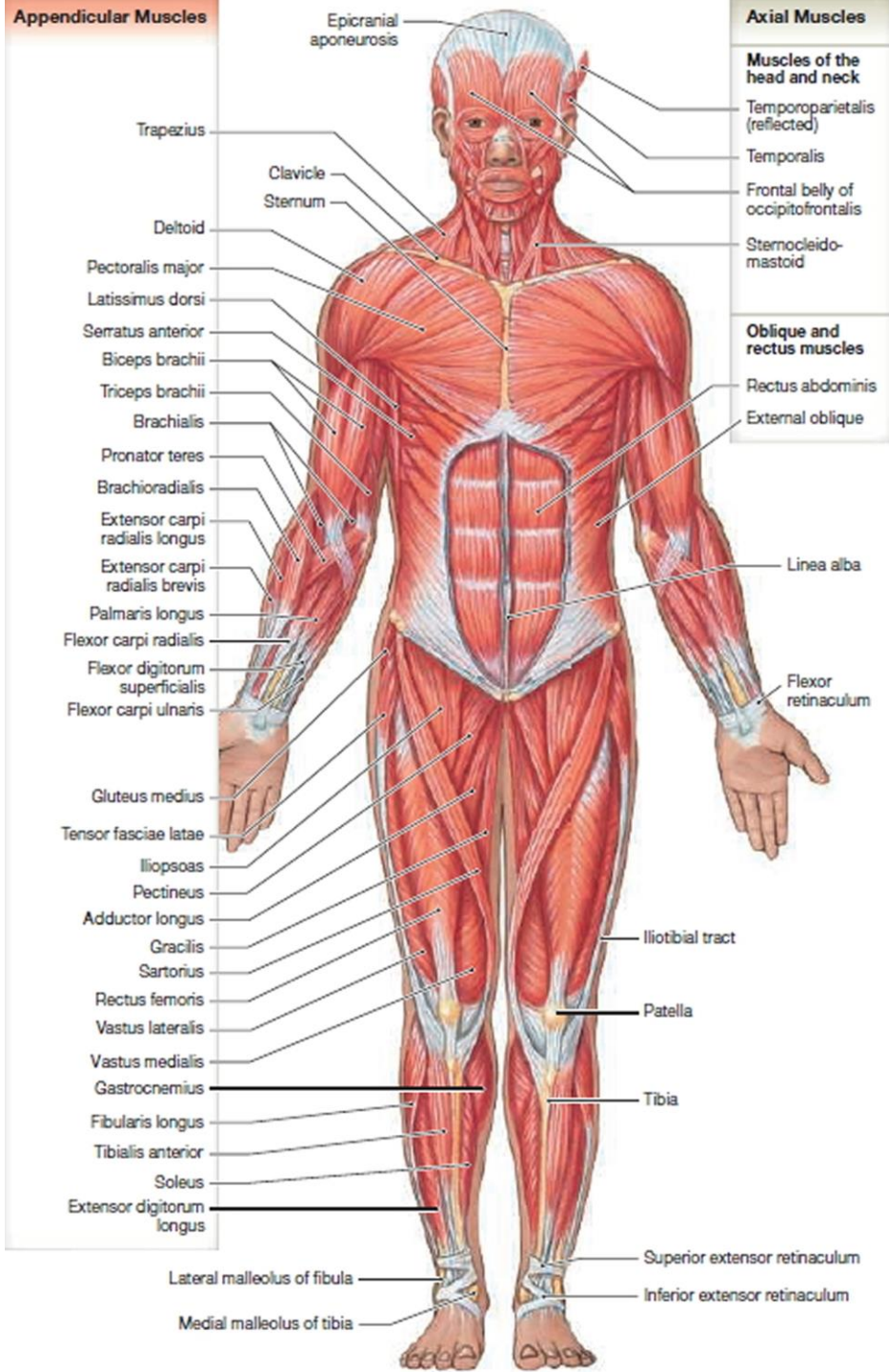
**FIGURE 11.6** Understanding a Muscle Name from the Latin

## Mnemonic Device for Latin Roots

Example	Latin or Greek Translation	Mnemonic Device
ad	to; toward	ADvance toward your goal
ab	away from	n/a
sub	under	SUBmarines move under water.
ductor	something that moves	A conDUCTOR makes a train move.
anti	against	If you are antisocial, you are against engaging in social activities.
epi	on top of	n/a
apo	to the side of	n/a
longissimus	longest	"Longissimus" is longer than the word "long."
longus	long	long
brevis	short	brief
maximus	large	max
medius	medium	"Medius" and "medium" both begin with "med."
minimus	tiny; little	mini
rectus	straight	To RECTify a situation is to straighten it out.
multi	many	If something is MULTicolored, it has many colors.
uni	one	A UNicorn has one horn.



Example	Latin or Greek Translation	Mnemonic Device
bi/di	two	If a ring is DIcast, it is made of two metals.
tri	three	TRIple the amount of money is three times as much.
quad	four	QUADruplets are four children born at one birth.
externus	outside	EXternal
internus	inside	INternal



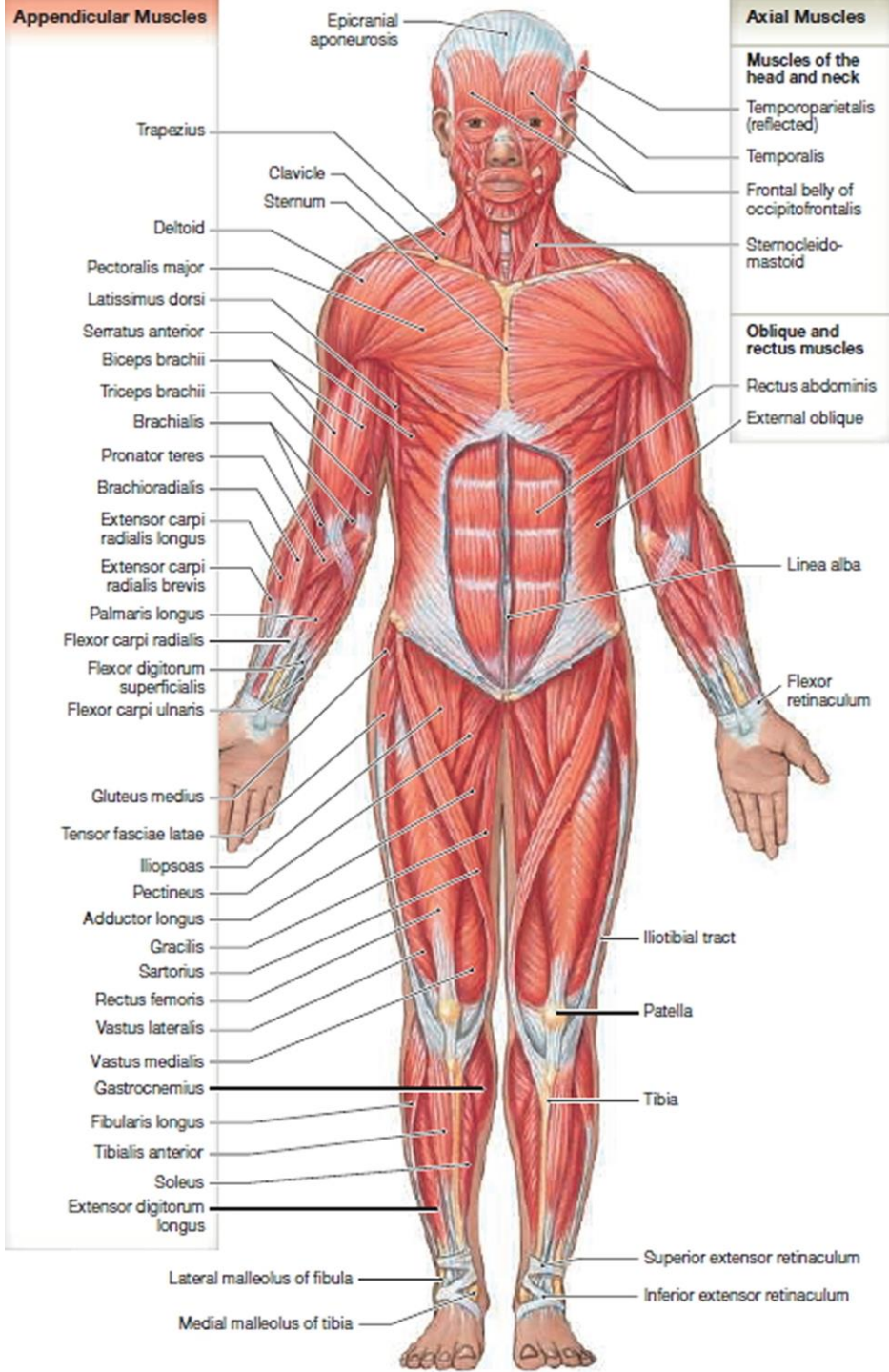
The skeletal muscles are divided into:

**AXIAL muscles** → muscles of the head and trunk  
They have both their origins and insertions on parts of the axial skeleton.

**APPENDICULAR muscles** → muscles of the limbs  
They control the movements of the upper and lower limbs and stabilize and control the movements of the pectoral and pelvic girdles.

## WHAT DO YOU NEED TO KNOW ABOUT MUSCLES?

- ORIGIN(S)
- INSERTION(S)
- ACTIONS/MOVEMENTS
- INNERVATION



The skeletal muscles are divided into:

**AXIAL muscles** → muscles of the head and trunk

**APPENDICULAR muscles** → muscles of the limbs

The axial muscles are grouped based on location, function, or both.

Some of the axial muscles may seem to overcome the boundaries because they cross over to the appendicular skeleton.

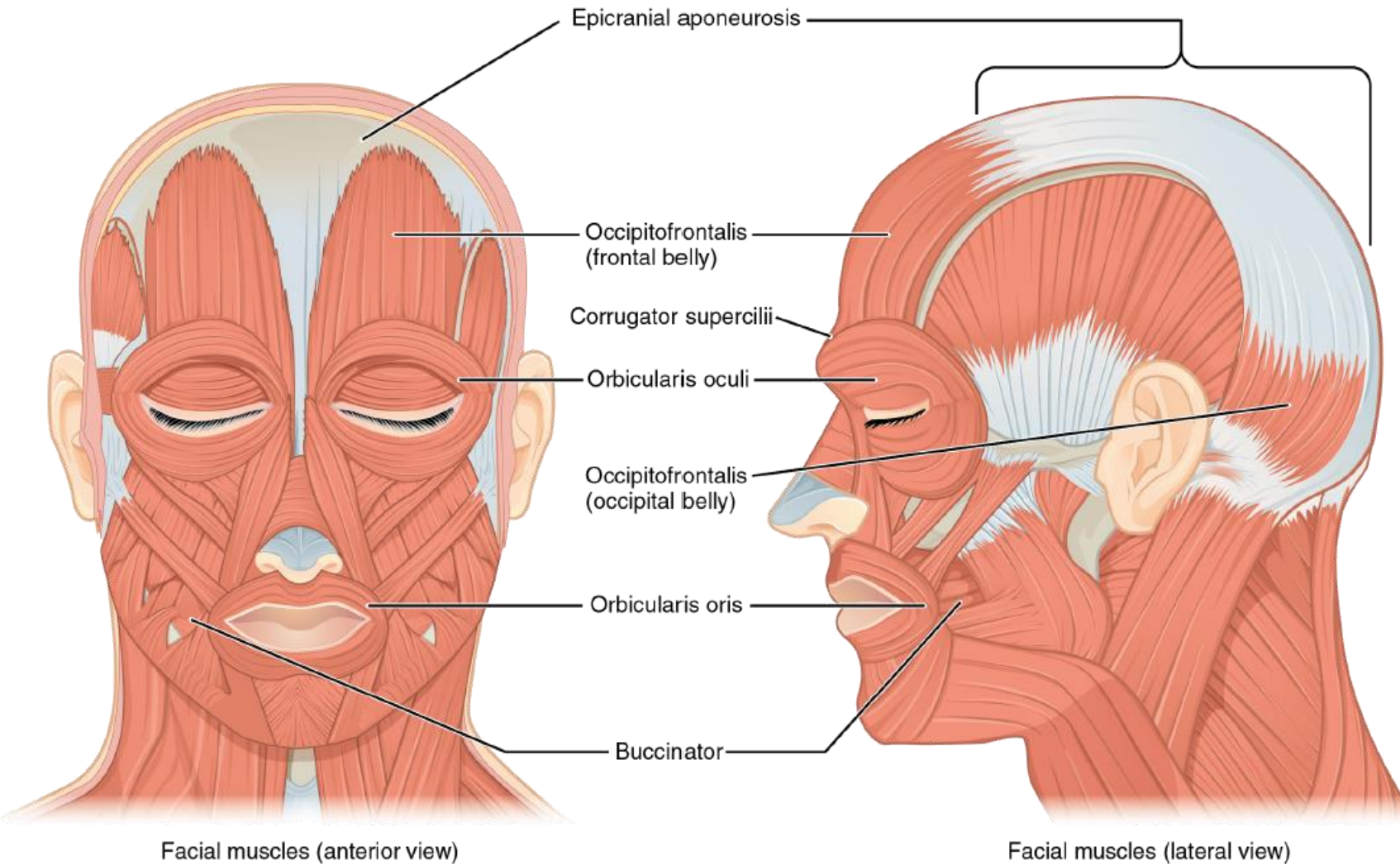
**AXIAL MUSCLES:**

- muscles of the head and neck
- muscles of the thorax and abdominal wall

# AXIAL MUSCLES OF THE HEAD AND NECK



# MUSCLES THAT CREATE FACIAL EXPRESSIONS

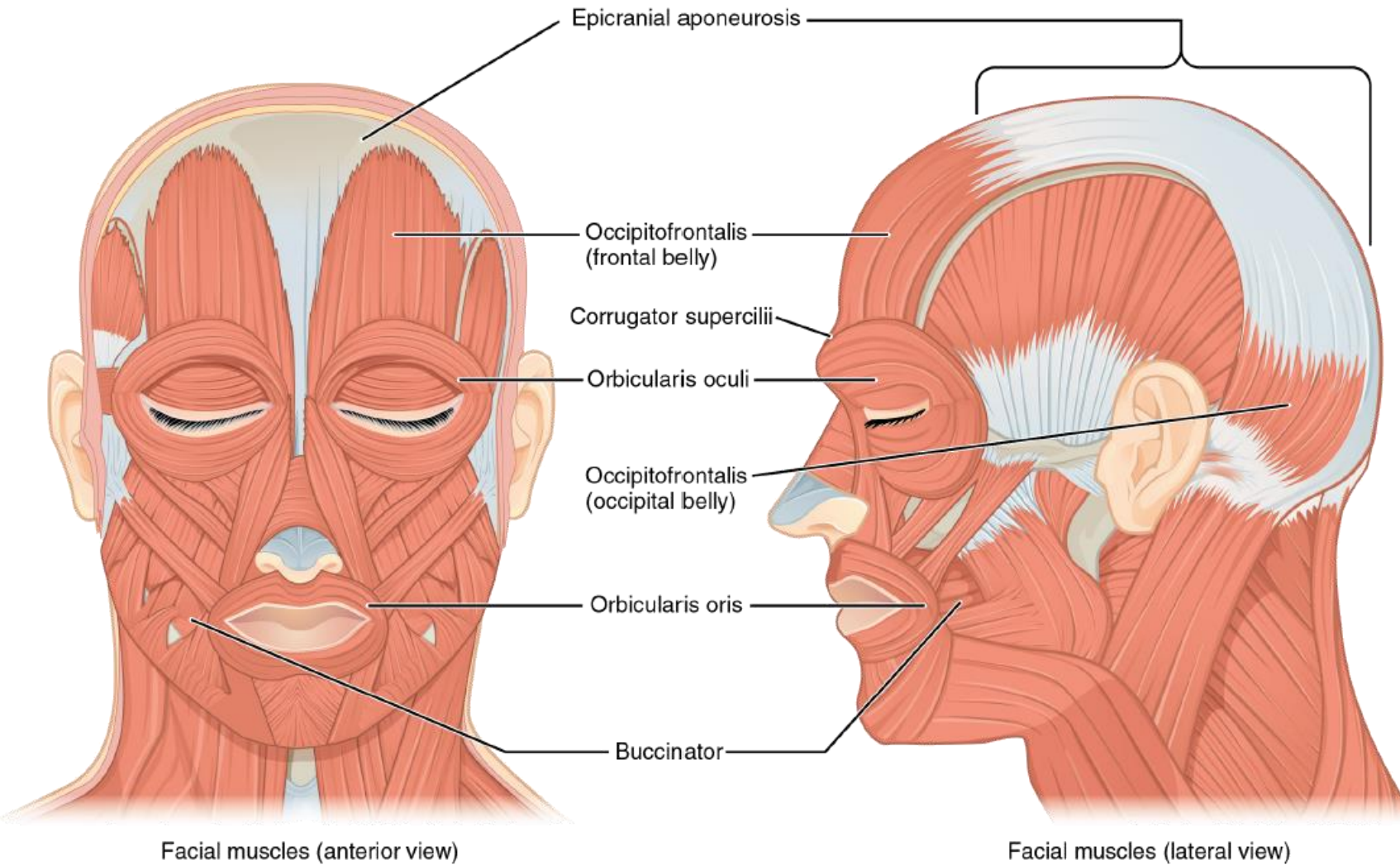


The **ORIGINS** of the muscles of facial expression are on the surface of the skull.  
*(remember, the origin of a muscle does not move!)*

The **INSERTION** of these muscles have fibers connected with connective tissue and the dermis of the skin.

↓  
Many of the muscles of facial expression insert into the skin surrounding the eyelids, nose and mouth, producing facial expressions by moving the skin rather than bones.

# MUSCLES THAT CREATE FACIAL EXPRESSIONS



## ORBICULARIS ORIS

is a circular muscle that moves the lips

## ORBICULARIS OCULI

is a circular muscle that closes the eye.

## OCCIPITOFRONTALIS MUSCLE

moves up the scalp and eyebrows.

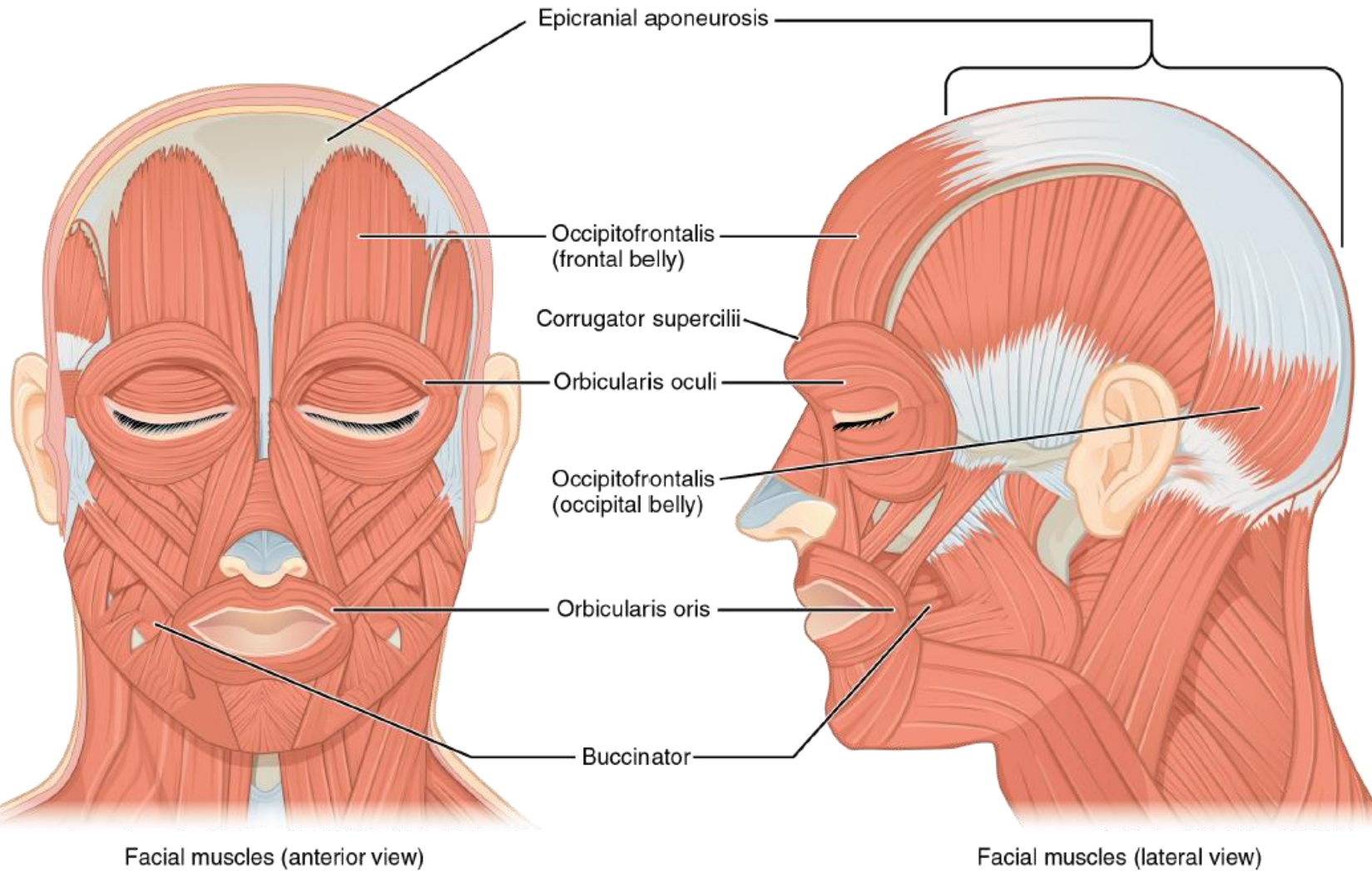
The muscle has a frontal belly and an occipital (near the occipital bone on the posterior part of the skull) belly.

In other words, there is a muscle on the forehead (**frontalis**) and one on the back of the head (**occipitalis**), but there is no muscle across the top of the head.

↓  
The two bellies are connected by a broad tendon called the **EPICRANIAL APONEUROSIS**



# MUSCLES THAT CREATE FACIAL EXPRESSIONS



## **BUCCINATOR MUSCLE**

It forms a large portion of the face and compresses the cheek.

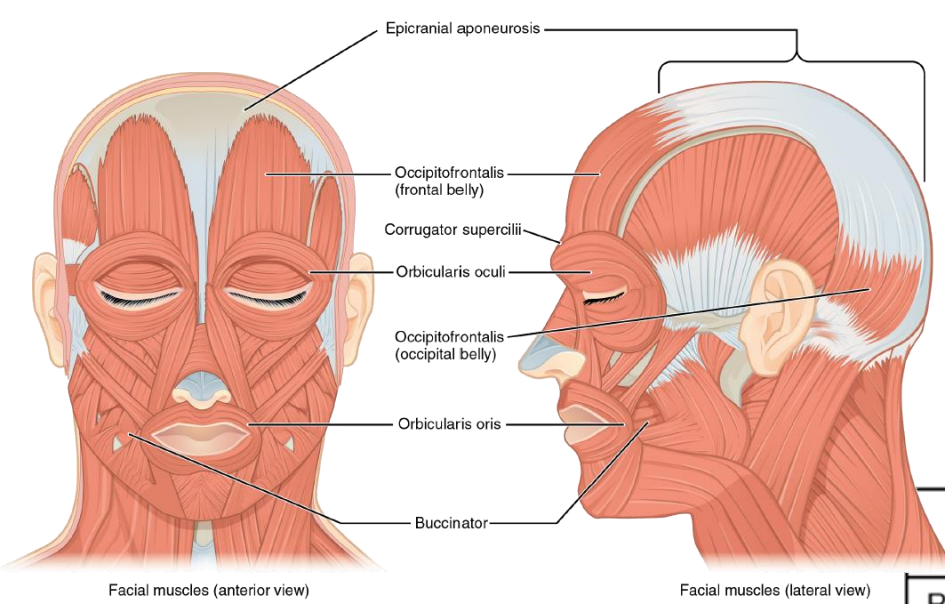
This muscle allows you to whistle, blow, and suck; and it contributes to the action of chewing.

There are several small facial muscles, one of which is the **CORRUGATOR SUPERCILII**, which is the prime mover of the eyebrows.

*Place your finger on your eyebrows at the point of the bridge of the nose. Raise your eyebrows as if you were surprised and lower your eyebrows as if you were frowning. With these movements, you can feel the action of the corrugator supercilii.*

The muscles of facial expression are innervated by the **FACIAL NERVE**.

# MUSCLES THAT CREATE FACIAL EXPRESSIONS



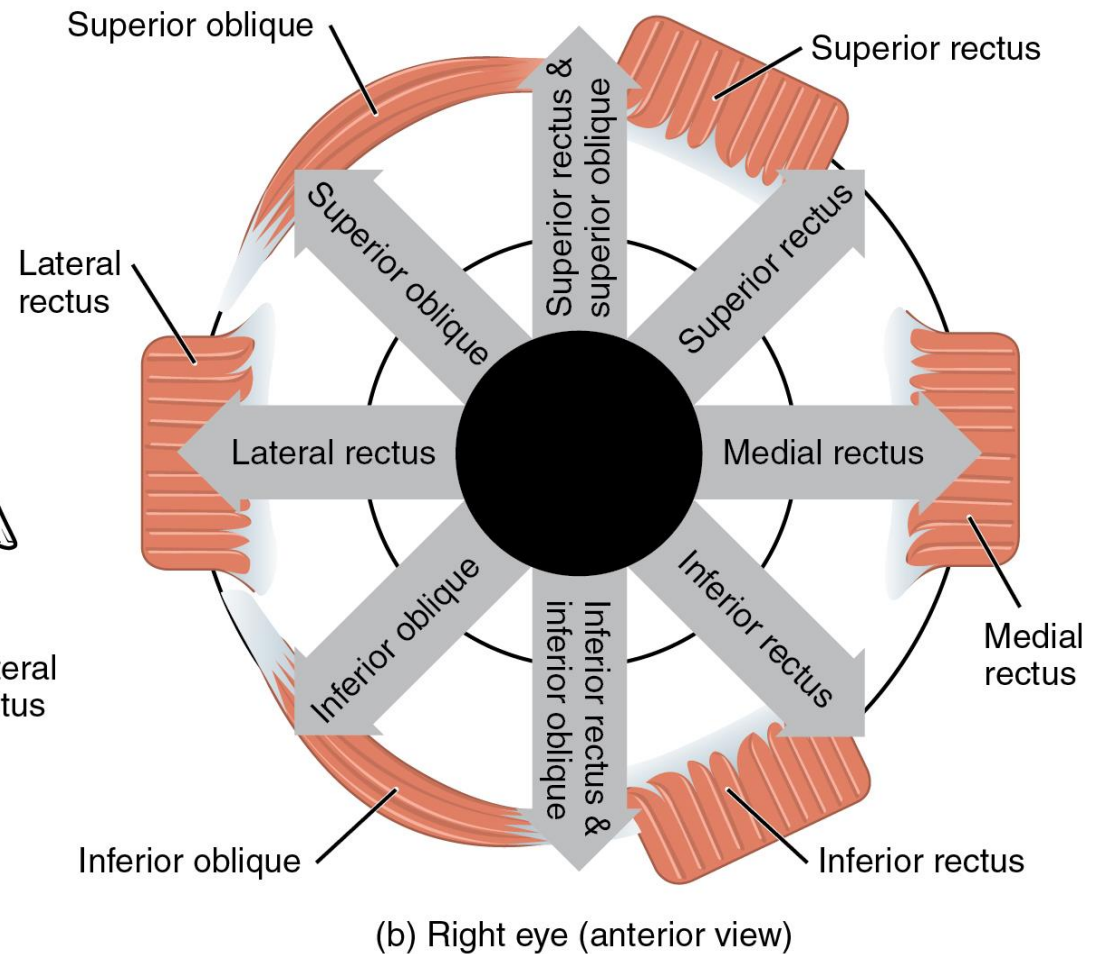
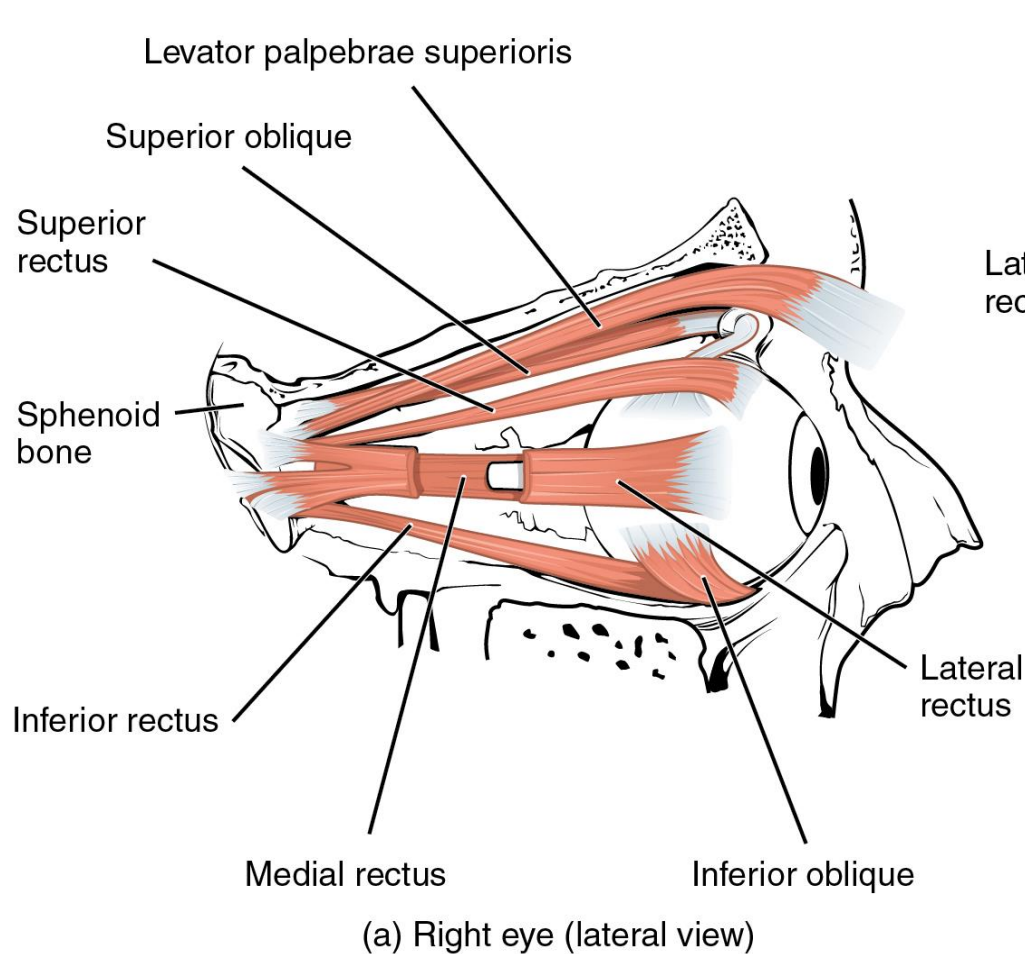
Facial muscles (anterior view)

Facial muscles (lateral view)

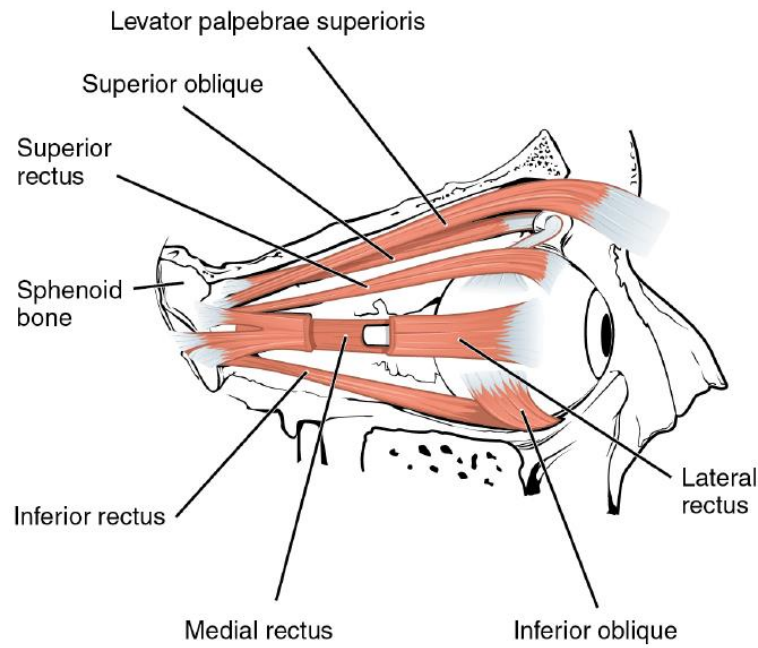
Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Raising eyebrows (e.g., showing surprise)	Skin of scalp	Anterior	Occipito-frontalis, frontal belly	Epicranial aponeurosis	Underneath skin of forehead
Tensing and retracting scalp	Skin of scalp	Posterior	Occipito-frontalis, occipital belly	Occipital bone; mastoid process (temporal bone)	Epicranial aponeurosis
Lowering eyebrows (e.g., scowling, frowning)	Skin underneath eyebrows	Inferior	Corrugator supercilii	Frontal bone	Skin underneath eyebrow
Shaping of lips (as during speech)	Lips	Multiple	Orbicularis oris	Tissue surrounding lips	Underneath skin at corners of the mouth
Lateral movement of cheeks (e.g., sucking on a straw; also used to compress air in mouth while blowing)	Cheeks	Lateral	Buccinator	Maxilla, mandible; sphenoid bone (via pterygomandibular raphe)	Orbicularis oris



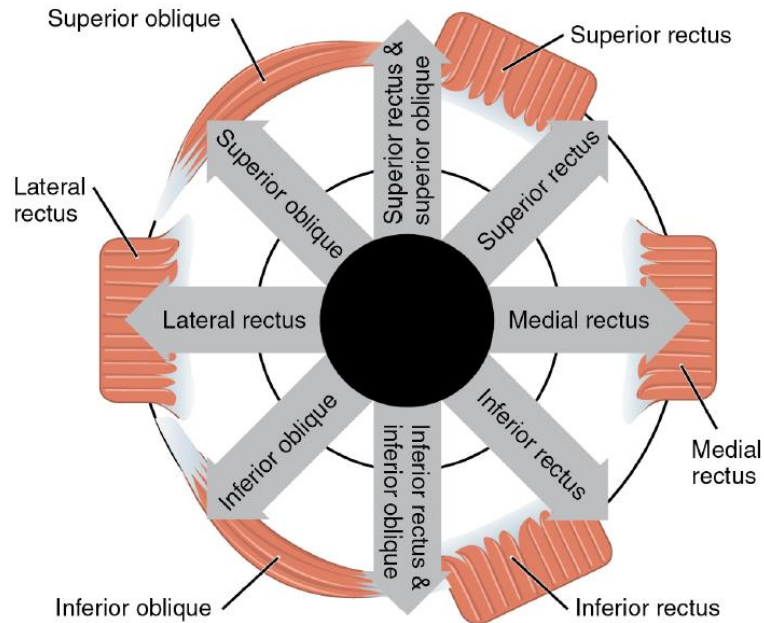
- ✓ The movement of the eyeball is under the control of the **EXTRINSIC EYE MUSCLES**
- ✓ They originate outside the eye and insert onto the outer surface of the white of the eye
- ✓ These muscles are located inside the eye socket and cannot be seen on any part of the visible eyeball



# MUSCLES THAT MOVE THE EYES



(a) Right eye (lateral view)

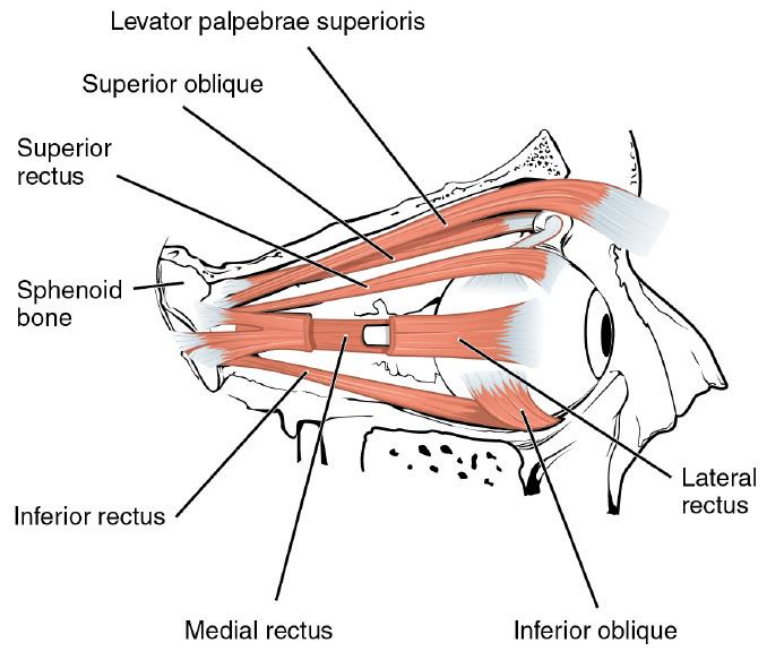


(b) Right eye (anterior view)

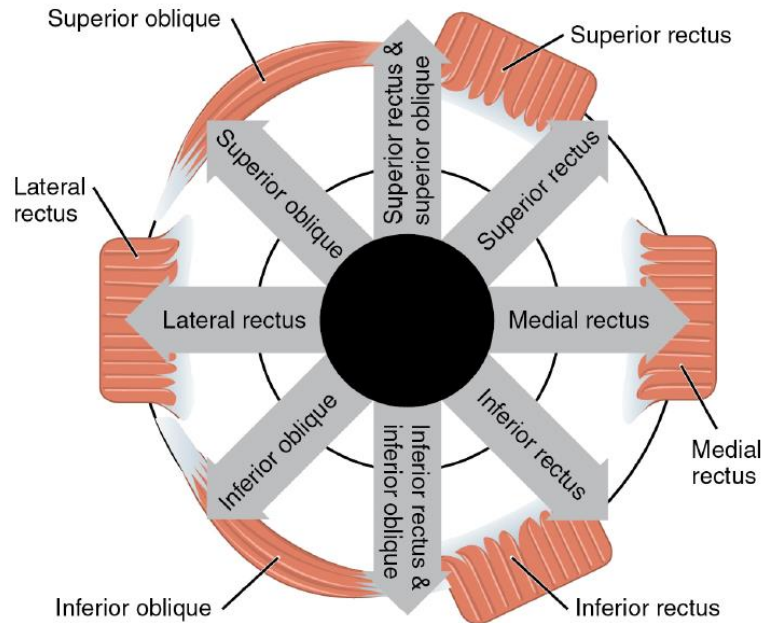
## Muscles of the Eyes

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Moves eyes up and toward nose; rotates eyes from 1 o'clock to 3 o'clock	Eyeballs	Superior (elevates); medial (adducts)	Superior rectus	Common tendinous ring (ring attaches to optic foramen)	Superior surface of eyeball
Moves eyes down and toward nose; rotates eyes from 6 o'clock to 3 o'clock	Eyeballs	Inferior (depresses); medial (adducts)	Inferior rectus	Common tendinous ring (ring attaches to optic foramen)	Inferior surface of eyeball
Moves eyes away from nose	Eyeballs	Lateral (abducts)	Lateral rectus	Common tendinous ring (ring attaches to optic foramen)	Lateral surface of eyeball
Moves eyes toward nose	Eyeballs	Medial (adducts)	Medial rectus	Common tendinous ring (ring attaches to optic foramen)	Medial surface of eyeball
Moves eyes up and away from nose; rotates eyeball from 12 o'clock to 9 o'clock	Eyeballs	Superior (elevates); lateral (abducts)	Inferior oblique	Floor of orbit (maxilla)	Surface of eyeball between inferior rectus and lateral rectus

# MUSCLES THAT MOVE THE EYES



(a) Right eye (lateral view)

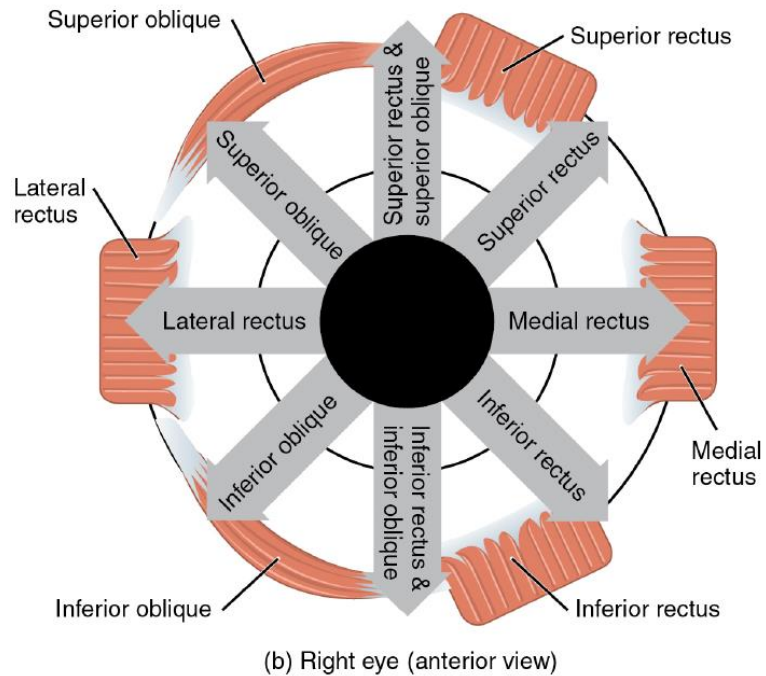
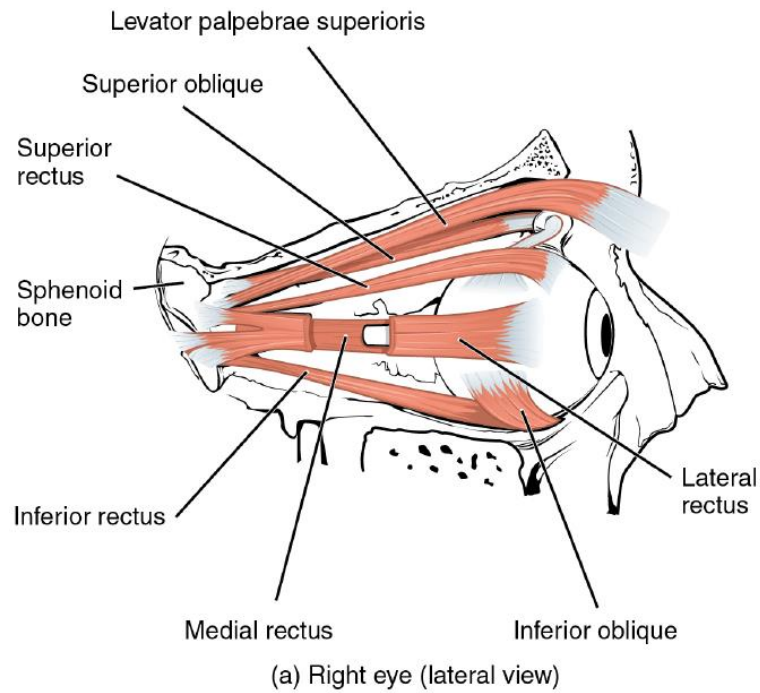


(b) Right eye (anterior view)

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Moves eyes down and away from nose; rotates eyeball from 6 o'clock to 9 o'clock	Eyeballs	Inferior (depress); lateral (abducts)	Superior oblique	Sphenoid bone	Surface of eyeball between superior rectus and lateral rectus
Opens eyes	Upper eyelid	Superior (elevates)	Levator palpebrae superioris	Roof of orbit (sphenoid bone)	Skin of upper eyelids
Closes eyelids	Eyelid skin	Compression along superior-inferior axis	Orbicularis oculi	Medial bones composing the orbit	Circumference of orbit



# MUSCLES THAT MOVE THE EYES

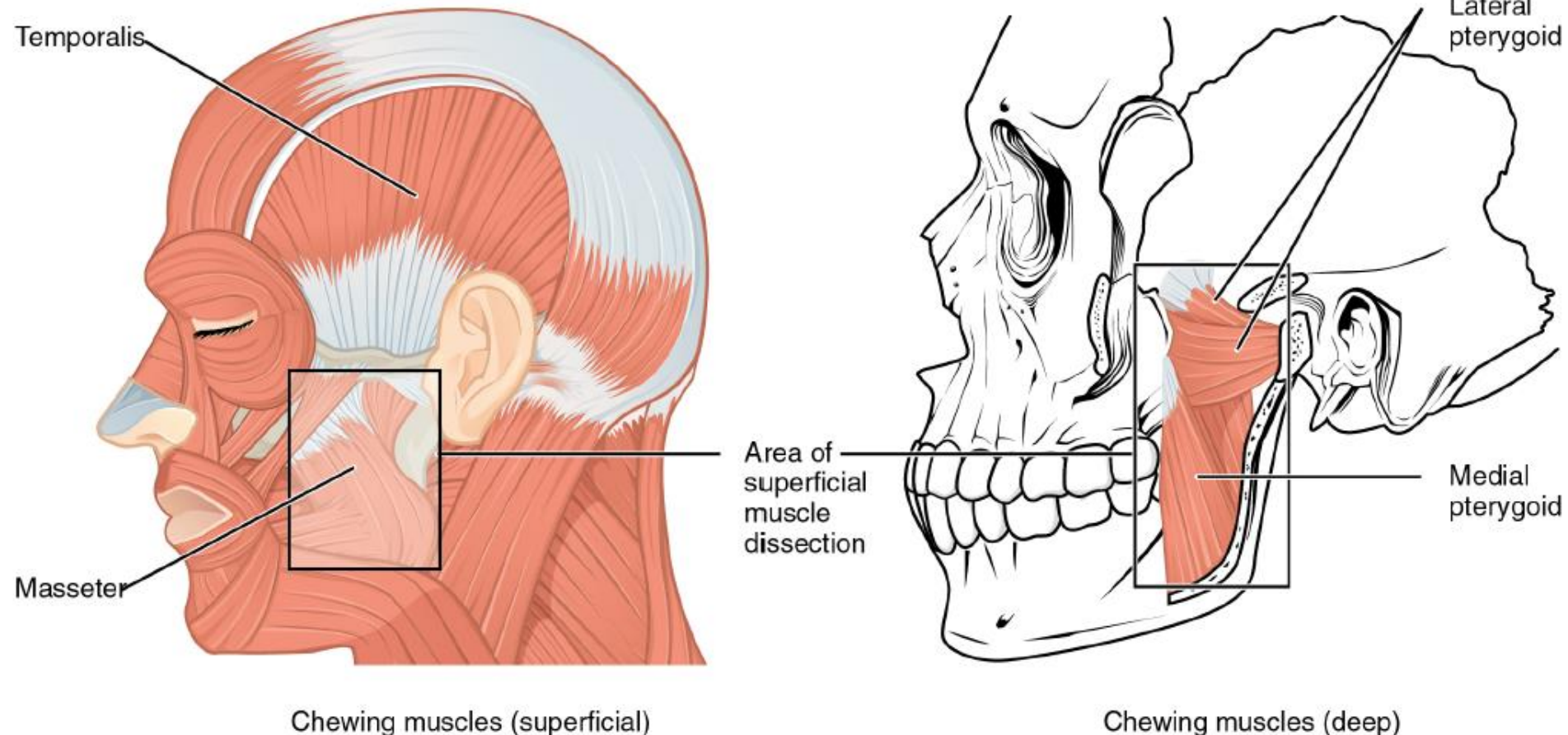


The nerve supply (innervation) of the eye muscles is from three CRANIAL NERVES

Cranial nerve	Muscle
Oculomotor nerve ( N. III )	Superior rectus muscle
	Inferior rectus muscle
	Medial rectus muscle
	Inferior oblique muscle
	Levator palpebrae superioris muscle
Trochlear nerve ( N. IV )	Superior oblique muscle
Abducens nerve ( N. VI )	Lateral rectus muscle

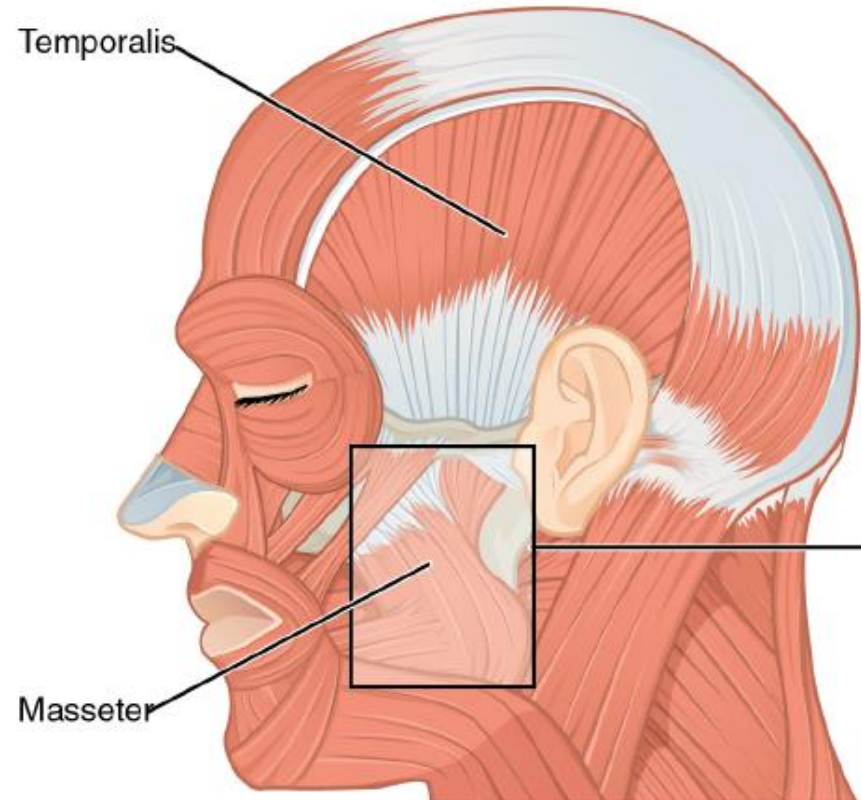


- ✓ These muscles are also called MUSCLES of MASTICATION, being responsible for the chewing movement of the mandible at the temporomandibular joint
- ✓ The muscles that move the lower jaw are typically located within the cheek and originate from the surface of the skull and they attach onto the rami of the mandible at the temporomandibular joint
- ✓ They are able to exert enough pressure to bite through and then chew food before it is swallowed

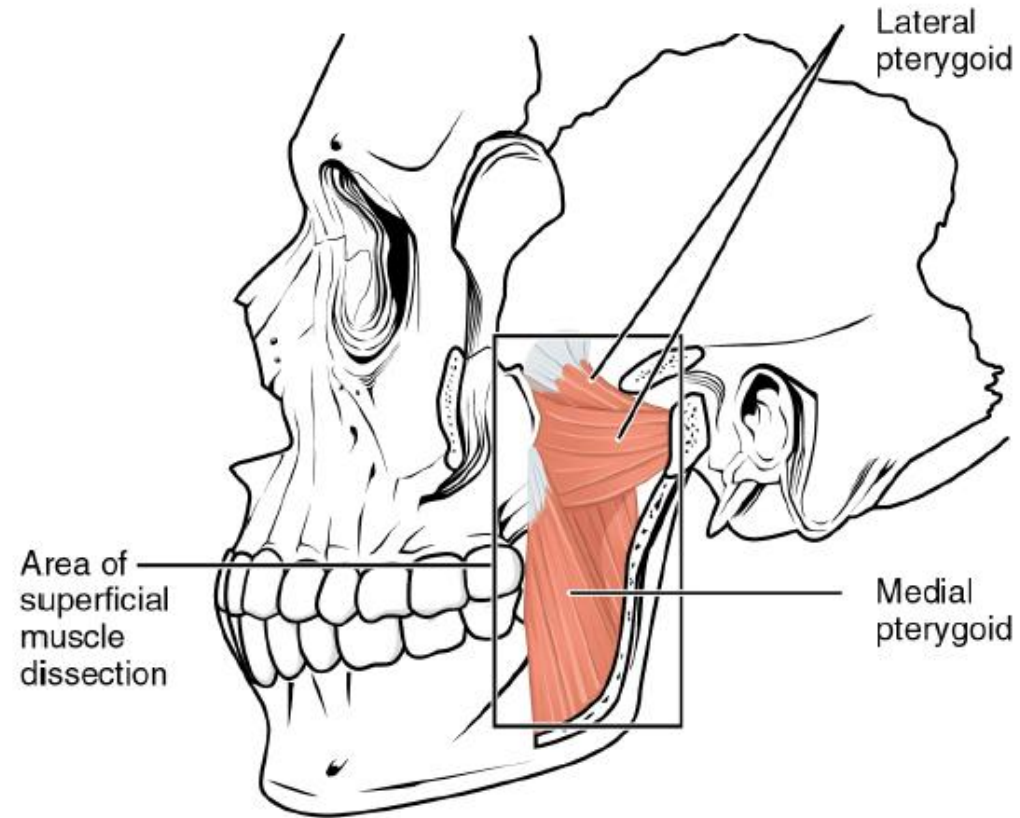


**MASSETER and TEMPORALIS** → are responsible for elevating and closing the jaw to break food into digestible pieces

**MEDIAL PTERYGOID and LATERAL PTERYGOID MUSCLES** → provide assistance in chewing and moving food within the mouth



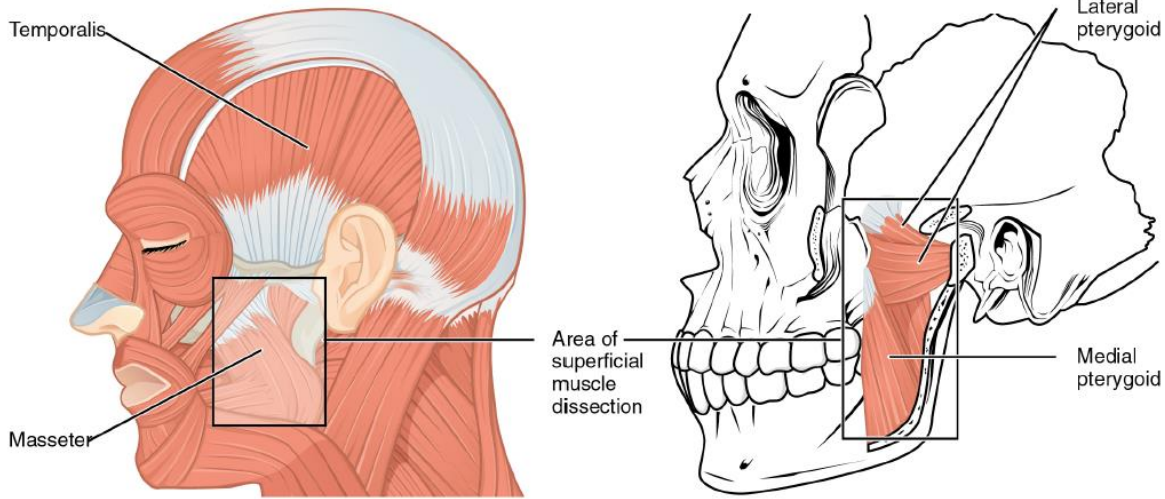
Chewing muscles (superficial)



Chewing muscles (deep)

# MUSCLES THAT MOVE THE LOWER JAW

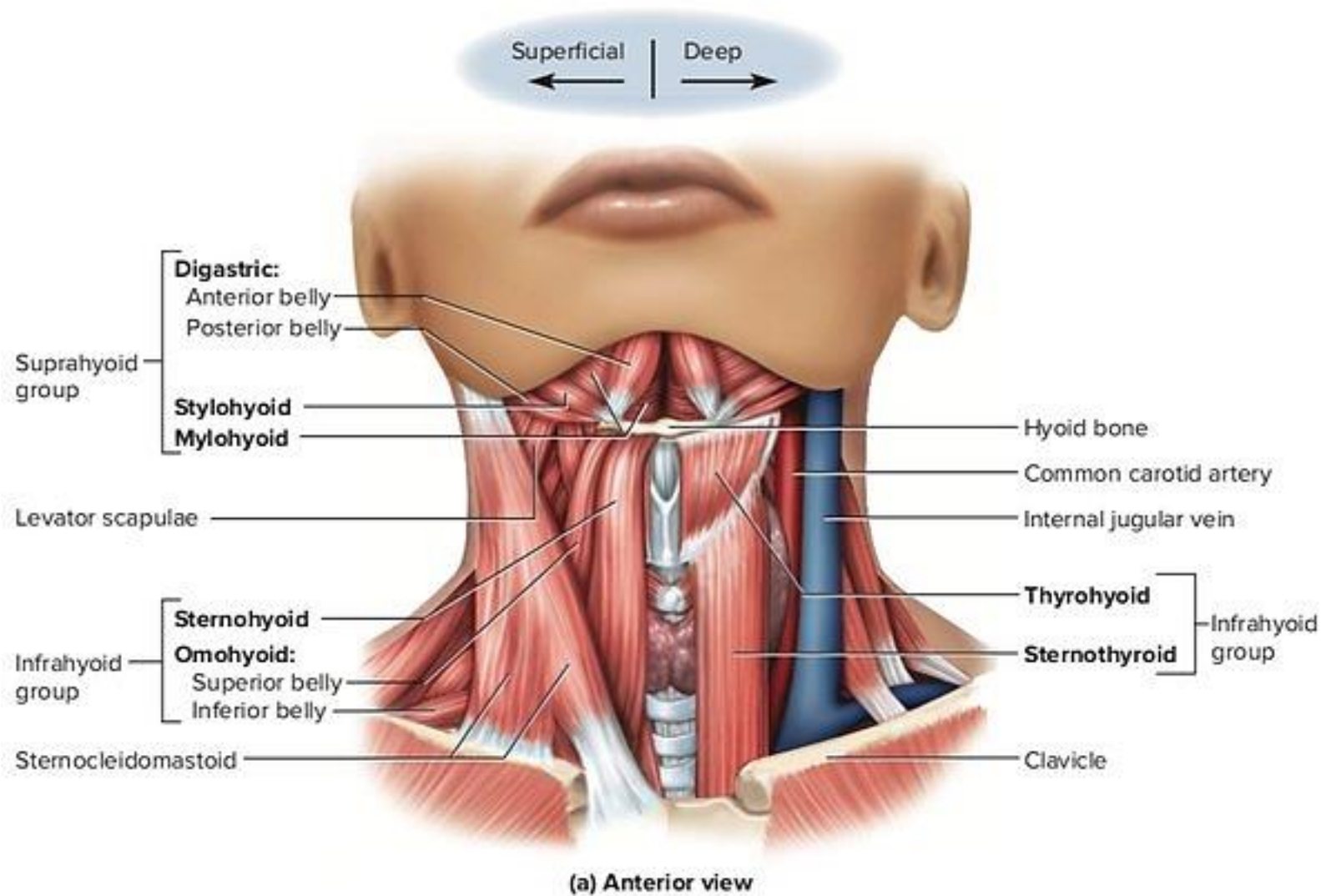
The muscles of mastication are innervated by motor branches of the mandibular division of the TRIGEMINAL NERVE



Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Closes mouth; aids chewing	Mandible	Superior (elevates)	Masseter	Maxilla arch; zygomatic arch (for masseter)	Mandible
Closes mouth; pulls lower jaw in under upper jaw	Mandible	Superior (elevates); posterior (retracts)	Temporalis	Temporal bone	Mandible
Opens mouth; pushes lower jaw out under upper jaw; moves lower jaw side-to-side	Mandible	Inferior (depresses); posterior (protracts); lateral (abducts); medial (adducts)	Lateral pterygoid	Pterygoid process of sphenoid bone	Mandible
Closes mouth; pushes lower jaw out under upper jaw; moves lower jaw side-to-side	Mandible	Superior (elevates); posterior (protracts); lateral (abducts); medial (adducts)	Medial pterygoid	Sphenoid bone; maxilla	Mandible; temporo-mandibular joint



# MUSCLES OF THE ANTERIOR NECK



The muscles of the anterior neck assist in deglutition (swallowing) and speech by controlling the positions of the larynx and the hyoid bone

The muscles of the neck are categorized according to their position relative to the hyoid bone:

**SUPRAHYOID MUSCLES** are superior to the hyoid bone:

**Geniohyoid muscle**  
**Digastric muscle**  
**Mylohyoid muscle**  
**Stylohyoid muscle**

**INFRAHYOID MUSCLES** are located inferiorly to the hyoid bone:

**Thyrohyoid muscle**  
**Omohyoid muscle**  
**Sternohyoid muscle**  
**Sternothyroid muscle**

# MUSCLES OF THE ANTERIOR NECK

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Raises the hyoid bone in a way that also raises the larynx, allowing the epiglottis to cover the glottis during deglutition; also assists in opening the mouth by depressing the mandible	Hyoid bone; larynx	Superior (elevates)	Digastric	Mandible; temporal bone	Hyoid bone
Raises and retracts the hyoid bone in a way that elongates the oral cavity during deglutition	Hyoid bone	Superior (elevates); posterior (retracts)	Stylohyoid	Temporal bone (styloid process)	Hyoid bone
Raises hyoid bone in a way that presses tongue against the roof of the mouth, pushing food back into the pharynx during deglutition	Hyoid bone	Superior (elevates)	Mylohyoid	Mandible	Hyoid bone; median raphe
Raises and moves hyoid bone forward, widening pharynx during deglutition	Hyoid bone	Superior (elevates); anterior (protracts)	Geniohyoid	Mandible	Hyoid bone
Retracts hyoid bone and moves it down during later phases of deglutition	Hyoid bone	Inferior (depresses); posterior (retracts)	Omoxyoid	Scapula	Hyoid bone
Depresses the hyoid bone during swallowing and speaking	Hyoid bone	Inferior (depresses)	Sternohyoid	Clavicle	Hyoid bone
Shrinks distance between thyroid cartilage and hyoid bone, allowing production of high-pitch vocalizations	Hyoid bone; thyroid cartilage	Hyoid bone: inferior (depresses); thyroid cartilage: superior (elevates)	Thyrohyoid	Thyroid cartilage	Hyoid bone
Depresses larynx, thyroid cartilage, and hyoid bone to create different vocal tones	Larynx; thyroid cartilage; hyoid bone	Inferior (depresses)	Sternothyroid	Sternum	Thyroid cartilage



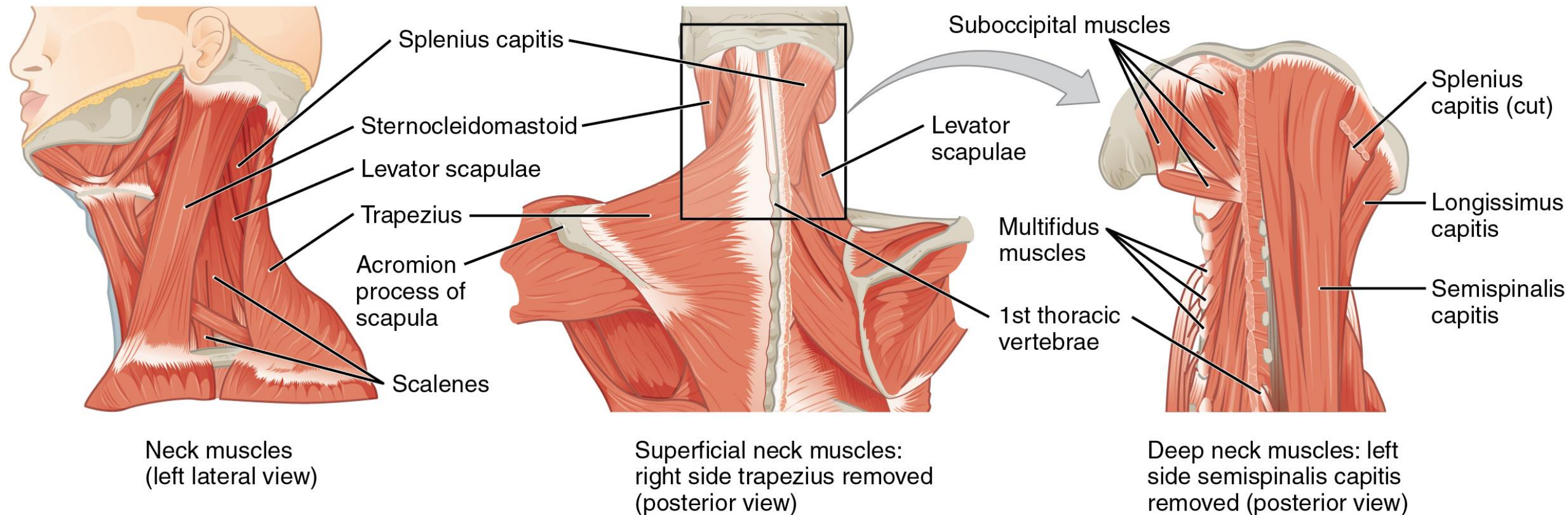
Muscle	Nerve
<b><i>Infrahyoid</i></b>	
Omohyoid	Ansa cervicalis (AR of C1, C2, C3)
Sternohyoid	Ansa cervicalis (AR of C1, C2, C3)
Sternothyroid	Ansa cervicalis (AR of C1, C2, C3)
Thyrohyoid	Thyrohyoid branch of hypoglossal nerve (hitchhiking branches of AR of C1)
<b><i>Suprahyoid</i></b>	
Digastric (posterior belly)	Facial nerve (cranial nerve VII)
Digastric (anterior belly)	Nerve to mylohyoid (cranial nerve V3)
Mylohyoid	Nerve to mylohyoid (cranial nerve V3)
Geniohyoid	AR of C1
Stylohyoid	Facial nerve (cranial nerve VII)

AR: anterior rami of spinal nerve

C1, C2, C3: the first three cervical nerves

Cranial nerve V3: branch of the mandibular division (V3) of the trigeminal nerve

- ✓ The head, attached to the top of the vertebral column, is balanced, moved, and rotated by the neck muscles
- ✓ When these muscles act unilaterally, the head rotates. When they contract bilaterally, the head flexes or extends
- ✓ The major muscle that laterally flexes and rotates the head is the **sternocleidomastoid muscle**

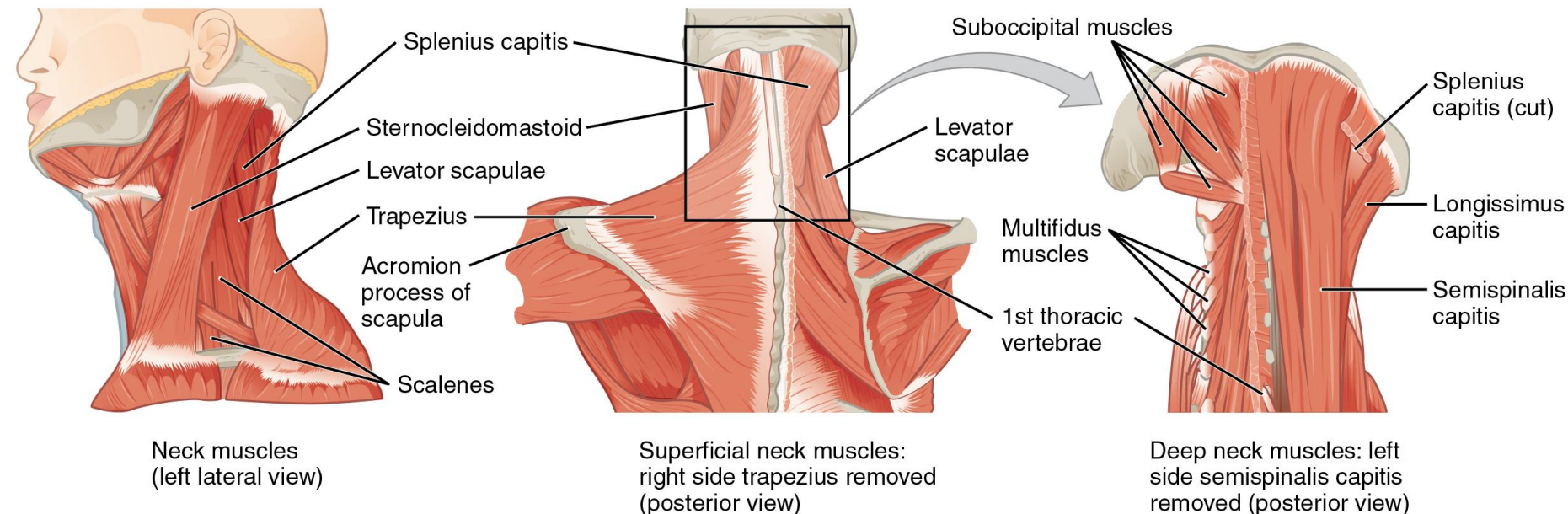


# MUSCLES THAT MOVE THE HEAD

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Rotates and tilts head to the side; tilts head forward	Skull; vertebrae	Individually: rotates head to opposite side; bilaterally: flexion	Sternocleidomastoid	Sternum; clavicle	Temporal bone (mastoid process); occipital bone
Rotates and tilts head backward	Skull; vertebrae	Individually: laterally flexes and rotates head to same side; bilaterally: extension	Semispinalis capitis	Transverse and articular processes of cervical and thoracic vertebra	Occipital bone
Rotates and tilts head to the side; tilts head backward	Skull; vertebrae	Individually: laterally flexes and rotates head to same side; bilaterally: extension	Splenius capitis	Spinous processes of cervical and thoracic vertebra	Temporal bone (mastoid process); occipital bone
Rotates and tilts head to the side; tilts head backward	Skull; vertebrae	Individually: laterally flexes and rotates head to same side; bilaterally: extension	Longissimus capitis	Transverse and articular processes of cervical and thoracic vertebra	Temporal bone (mastoid process)



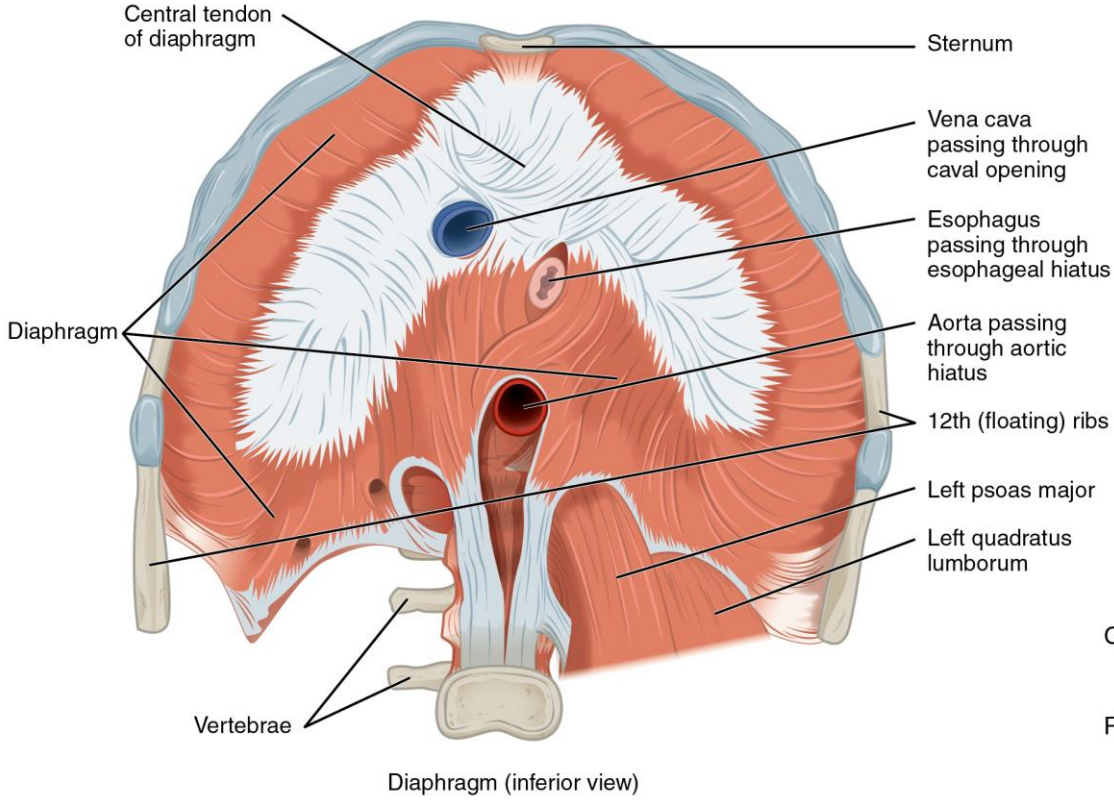
Muscle	Innervation
Sternocleidomastoid	Accessory nerve (cranial nerve XI) Direct branches of the cervical plexus (C2-C3)
Semispinalis capitis	Descending branches of greater occipital nerve (C2) and spinal nerve C3
Splenius capitis	Lateral branches of posterior rami of second and third cervical spinal nerves (C2-C3)
Longissimus capitis	Lateral branches of posterior/dorsal rami of cervical spinal nerves.



# AXIAL MUSCLES OF THE THORAX AND ABDOMINAL WALL

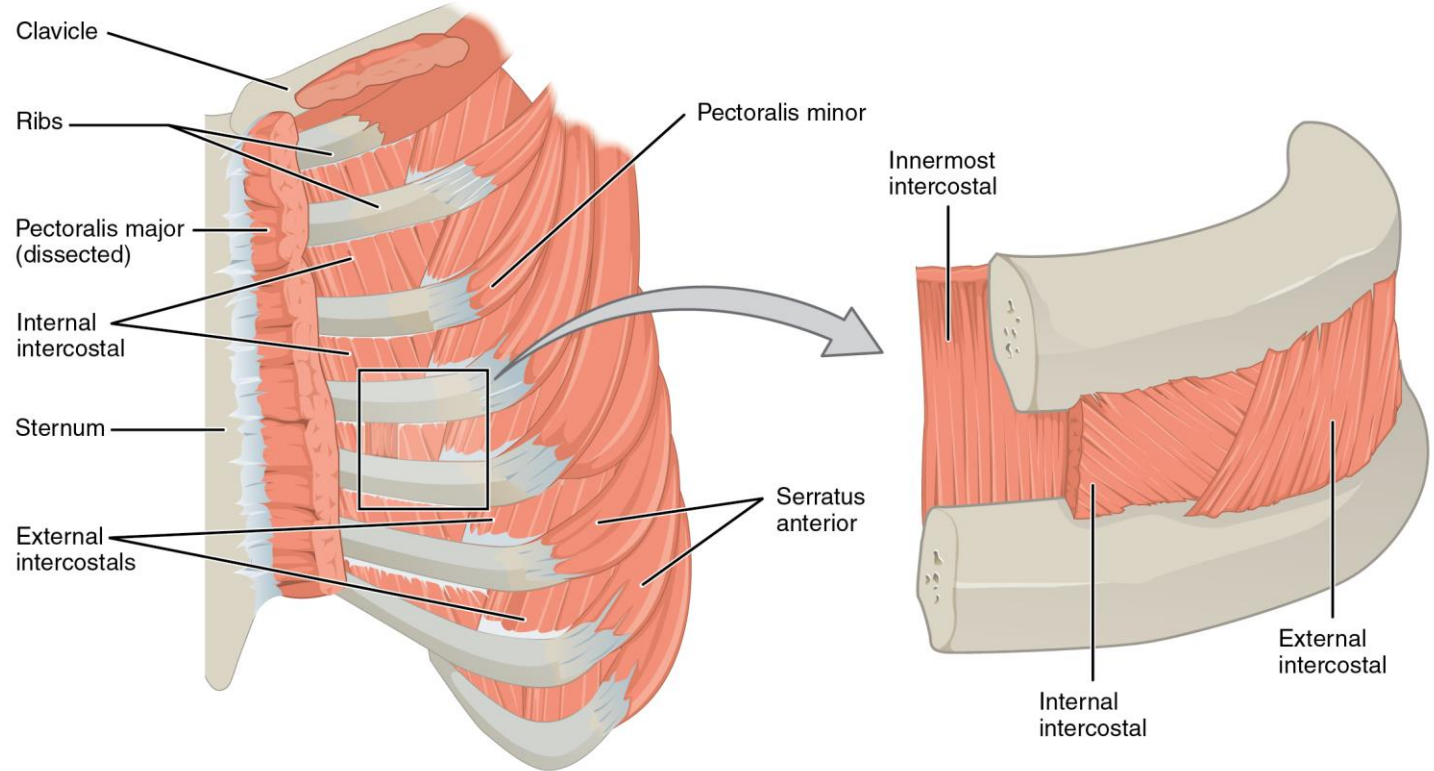


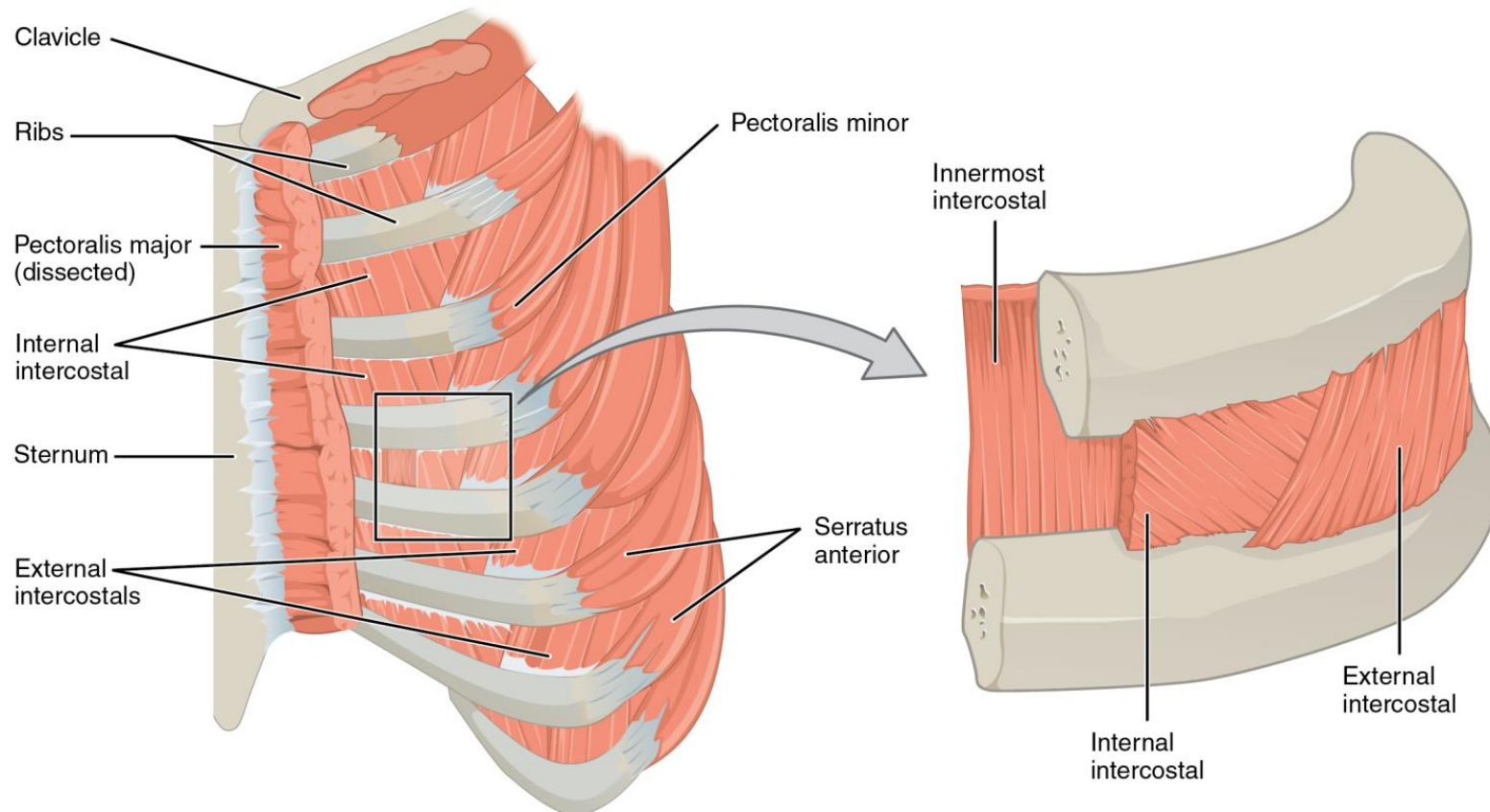
# MUSCLES OF THE THORAX



The muscles of the chest serve to facilitate breathing by changing the size of the thoracic cavity. The main are

- the Diaphragm
- the Intercostal muscles





They consist of three sets of muscles which assist in breathing by changing the dimensions of the rib cage.

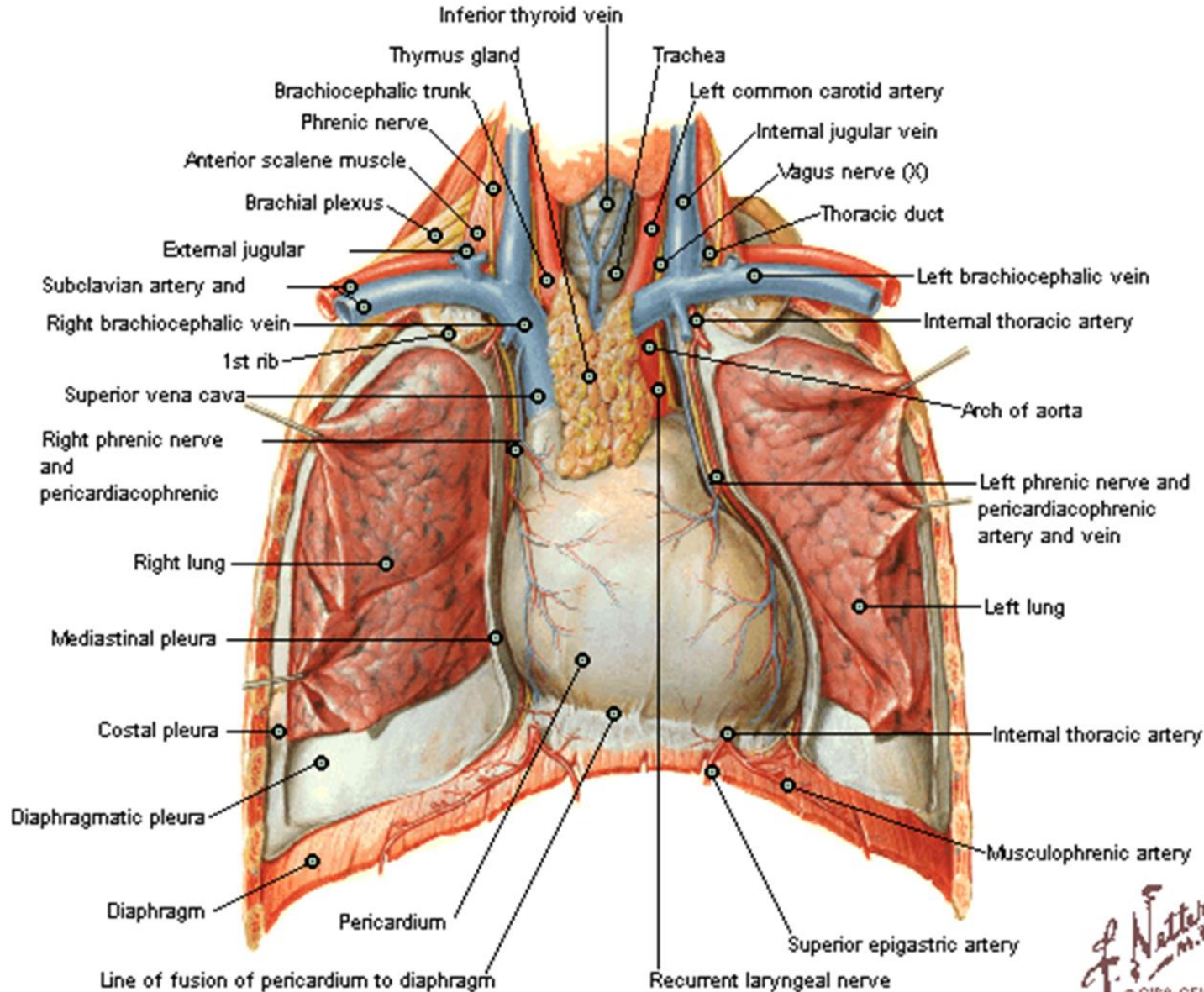
- The 11 pairs of **superficial external intercostal muscles** aid in inspiration of air during breathing because when they contract, they raise the rib cage, which expands it.
- The 11 pairs of **internal intercostal muscles**, just under the externals, are used for expiration because they draw the ribs together to constrict the rib cage.
- The **innermost intercostal muscles** are the deepest, and they act as synergists for the action of the internal intercostals.

The innervation comes from the **INTERCOSTAL NERVES**.

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Inhalation; exhalation	Thoracic cavity	Compression; expansion	Diaphragm	Sternum; ribs 6–12; lumbar vertebrae	Central tendon
Inhalation;exhalation	Ribs	Elevation (expands thoracic cavity)	External intercostals	Rib superior to each intercostal muscle	Rib inferior to each intercostal muscle
Forced exhalation	Ribs	Movement along superior/inferior axis to bring ribs closer together	Internal intercostals	Rib inferior to each intercostal muscle	Rib superior to each intercostal muscle



## Heart in Situ



The diaphragm is located at the inferior-most aspect of the ribcage.

### **TOPOGRAPHIC SIGNIFICANCE:**

This muscle **delimits inferiorly the thoracic cavity** dividing **thoracic cavity** | **abdominal cavity**  
*It acts as the floor of the thoracic cavity and the roof of the abdominal cavity.*

### **FUNCTIONAL SIGNIFICANCE:**

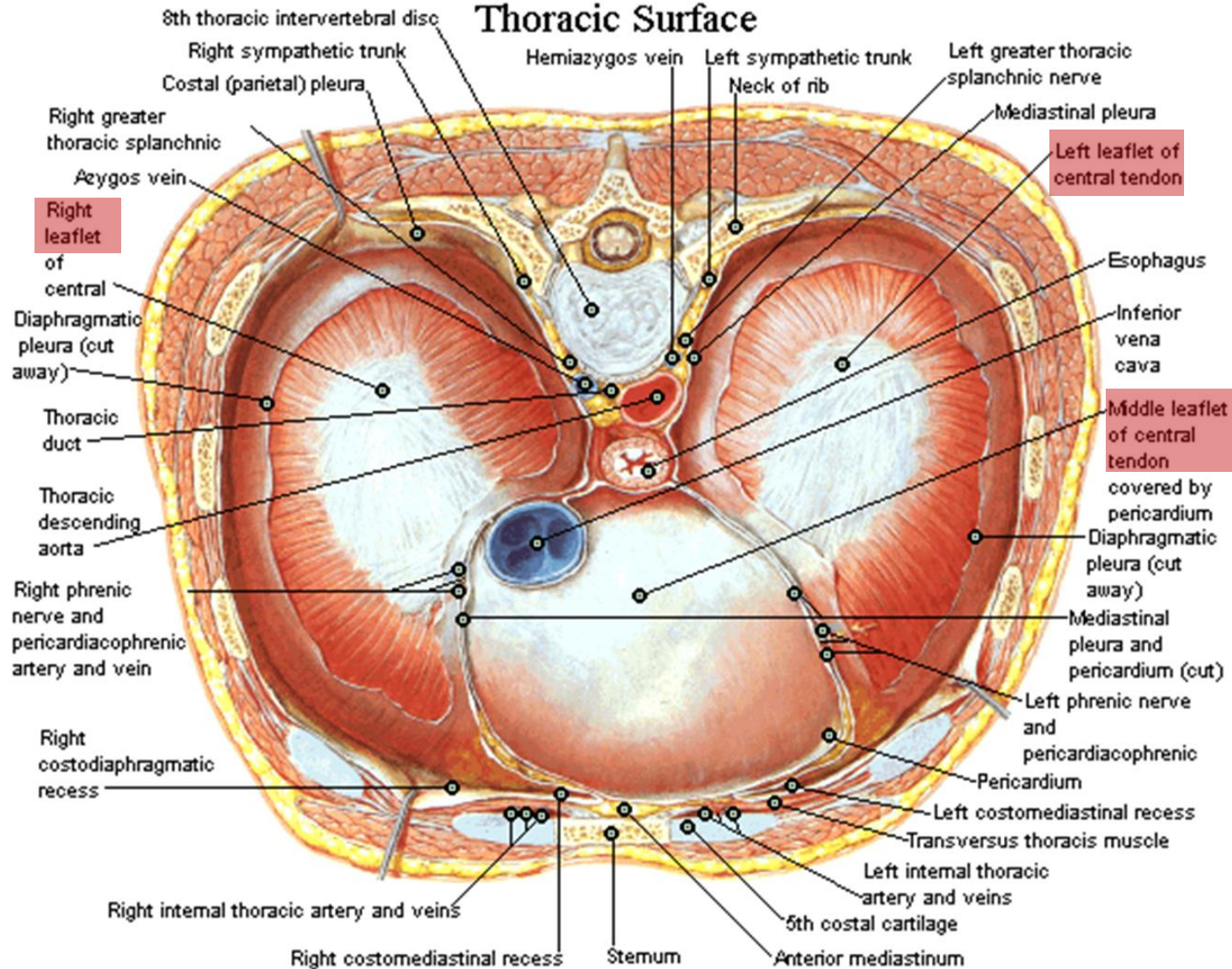
- It is essential for **VENTILATION**
- It is the main **RESPIRATORY MUSCLE** (others are the intercostal muscles and the accessory respiratory muscles like the main neck muscle, the sternocleidomastoid)

It is a large, thin and **DOME-SHAPED** muscle with **convexity directed upwards.**



# Diaphragm

## Thoracic Surface



Superior view

## STRUCTURE:

Central portion → **CENTRAL TENDON**

- The central tendon has three different parts → CLOVER SHAPE → Right leaflet, Middle leaflet, Left leaflet
- The **MUSCLE FIBERS** depart from the central tendon and attach to bony structures

The **MUSCULAR COMPONENT** of the diaphragm is divided into 3 portions, according to the connection with 3 different bony structures:

the **LUMBAR PORTION**

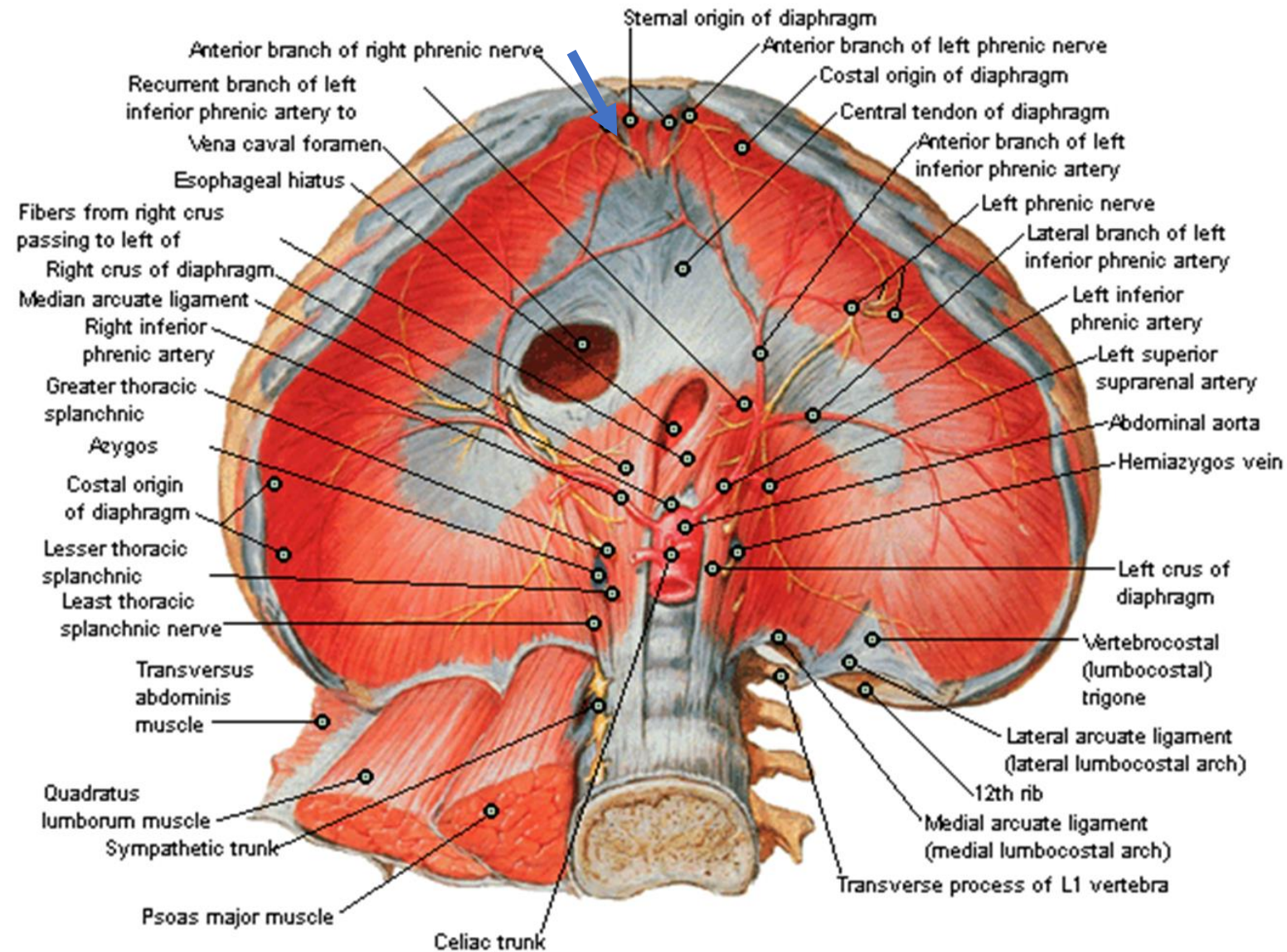
the **COSTAL PORTION**

the **STERNAL PORTION of the diaphragm**



# Diaphragm

## Abdominal Surface



### STRUCTURE:

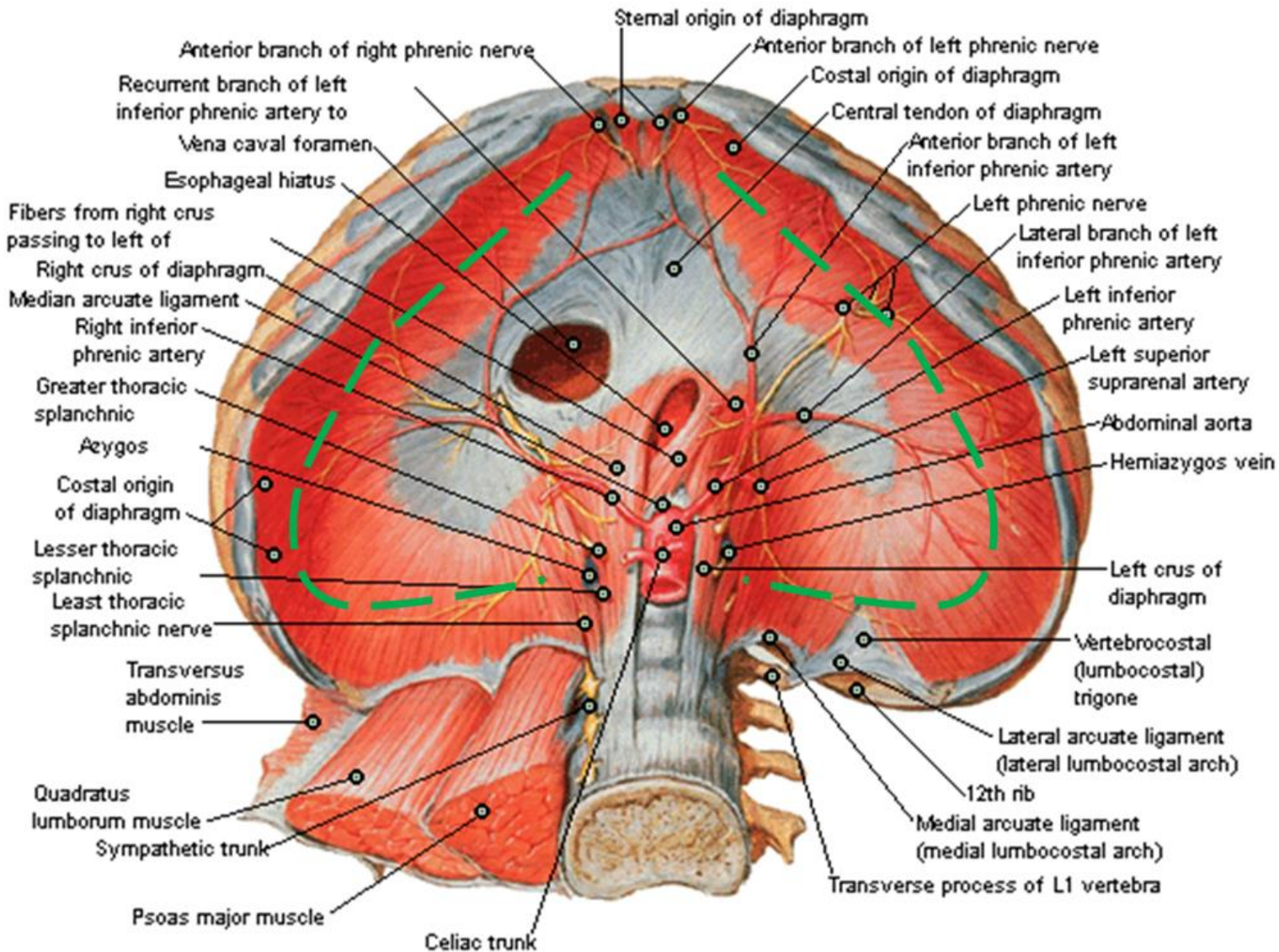
#### STERNAL PORTION

It is the most anterior portion of the diaphragm.

It is a very small muscular component formed by the muscle bundles that depart from the middle leaflet of the central tendon and insert into the XIPHOID PROCESS of the sternum.

## Diaphragm

### Abdominal Surface



### STRUCTURE:

#### COSTAL PORTION

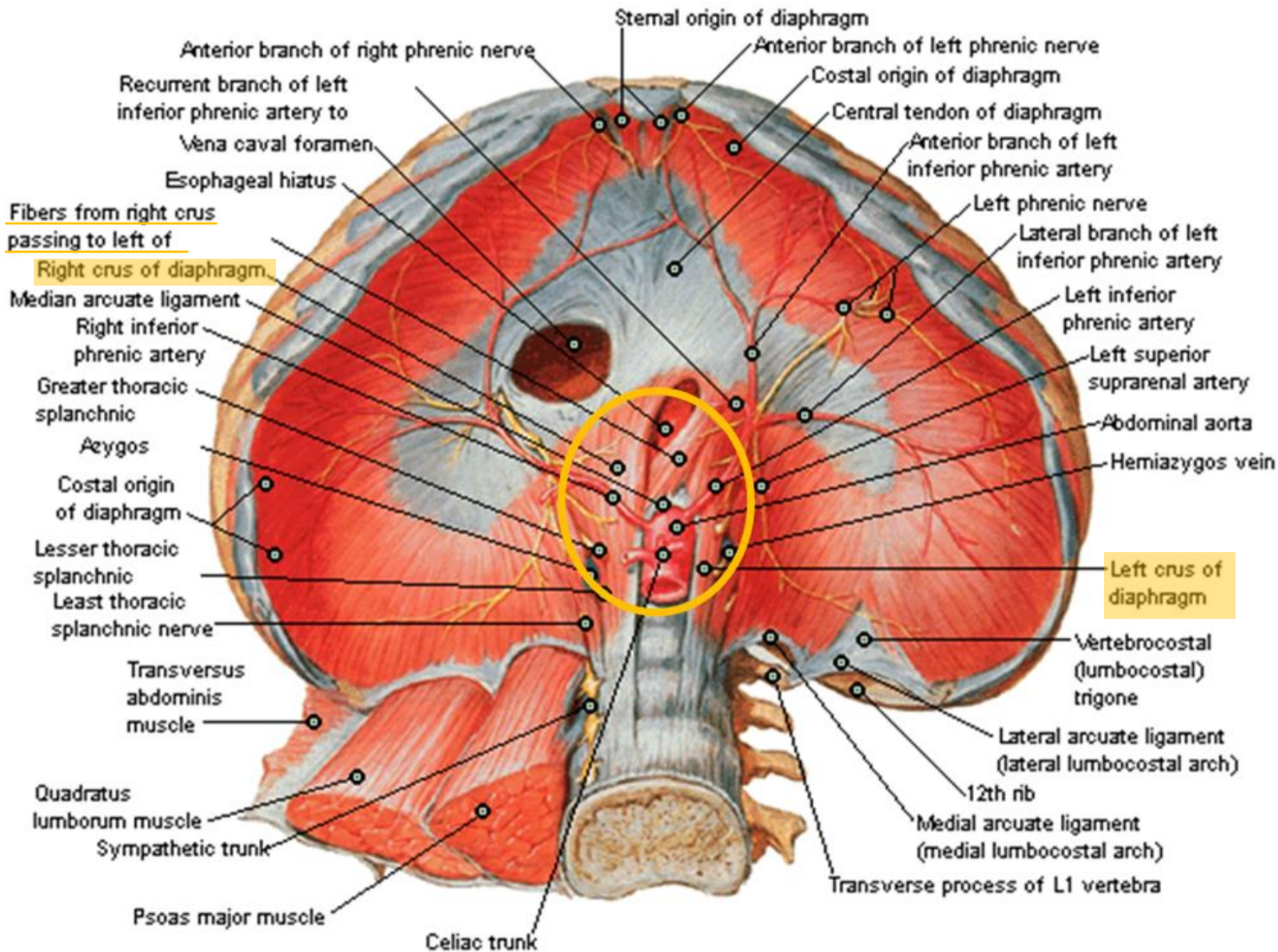
It is the largest portion.

It is inserted on the internal surfaces/internal sides of the last 6 pairs of ribs (starting posteriorly from the 12<sup>th</sup> pair and progressively the 11th, the 10th, the 9th etc.)



## Diaphragm

### Abdominal Surface



### STRUCTURE:

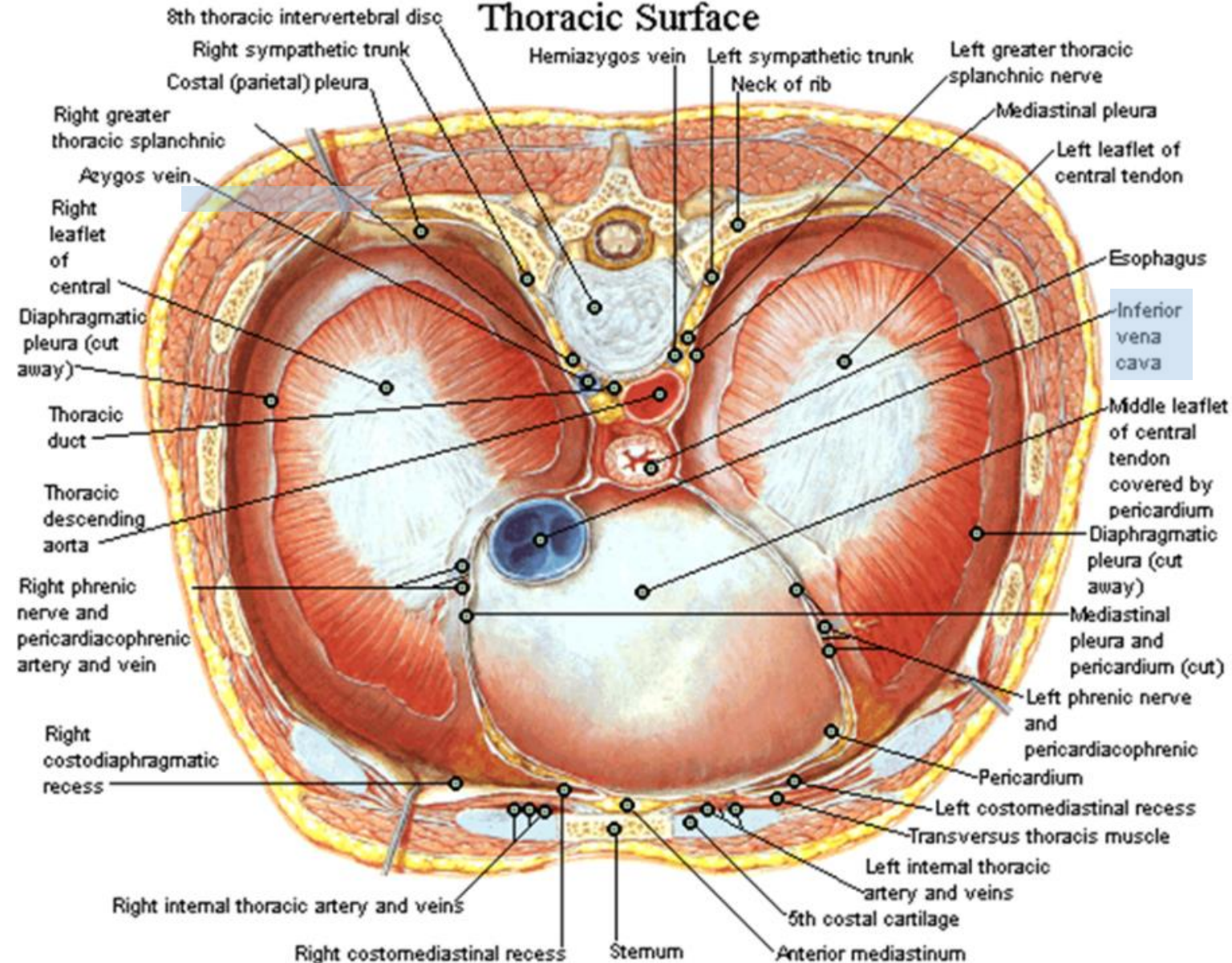
#### LUMBAR PORTION

It is formed by muscle fibers that are called the RIGHT CRUS and the LEFT CRUS, which insert on the vertebral column (i.e., on the anterior side of lumbar vertebrae L1-L3)



# Diaphragm

## Thoracic Surface



The diaphragm divides the thoracic and abdominal cavities. Thus, there are structures which need to cross the diaphragm to pass from a cavity to the other.

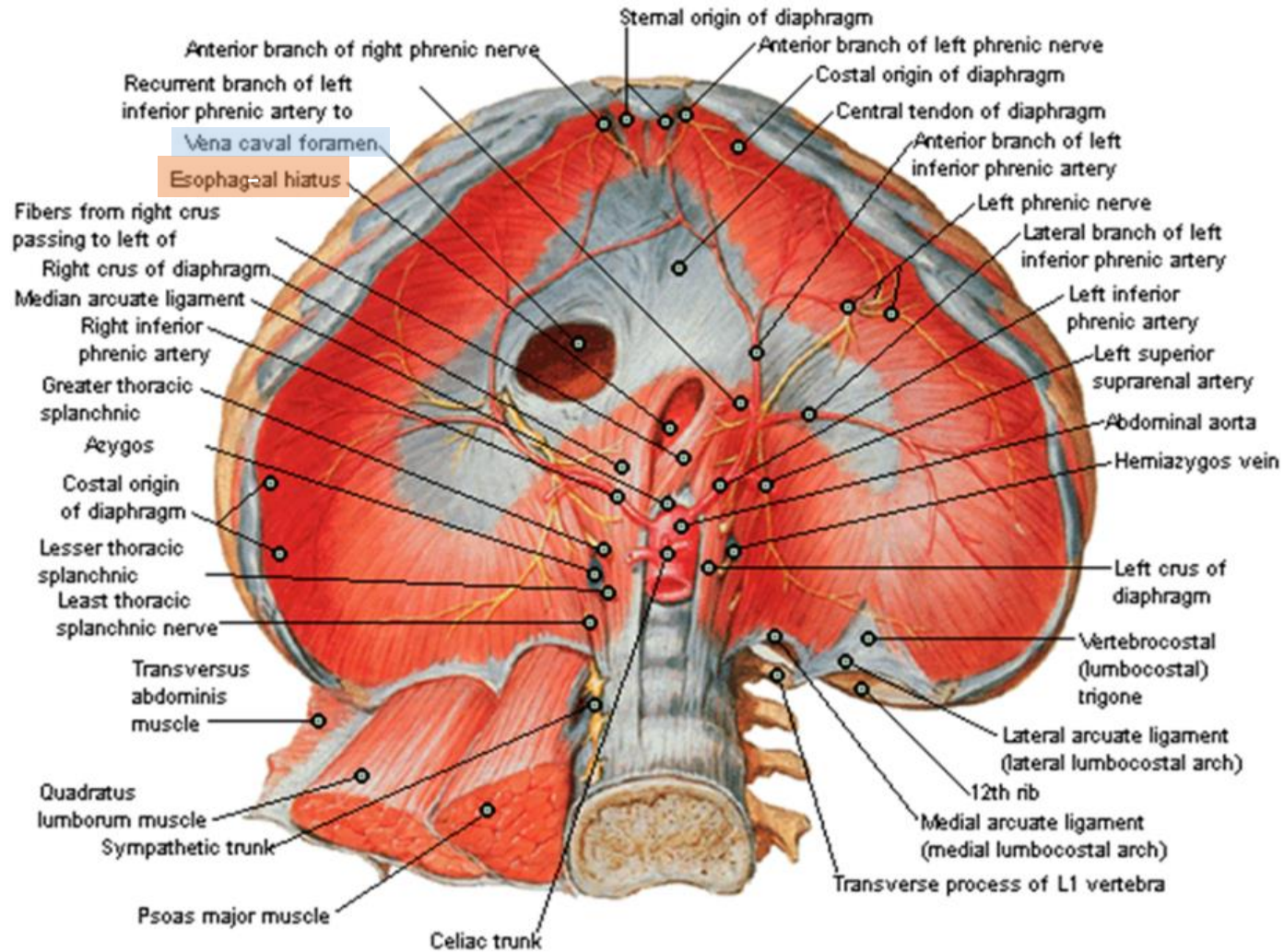
The diaphragm has 3 openings that act as conduit for these structures:

### 1. CAVAL FORAMEN (or hiatus)

It is located in the central tendon between the right and middle leaflets, giving passage to the inferior vena cava

*Inferior vena cava is one of the two main veins of the body that carries all venous blood from the lower half of the body to the heart*

## Diaphragm Abdominal Surface



## 2. ESOPHAGEAL FORAMEN

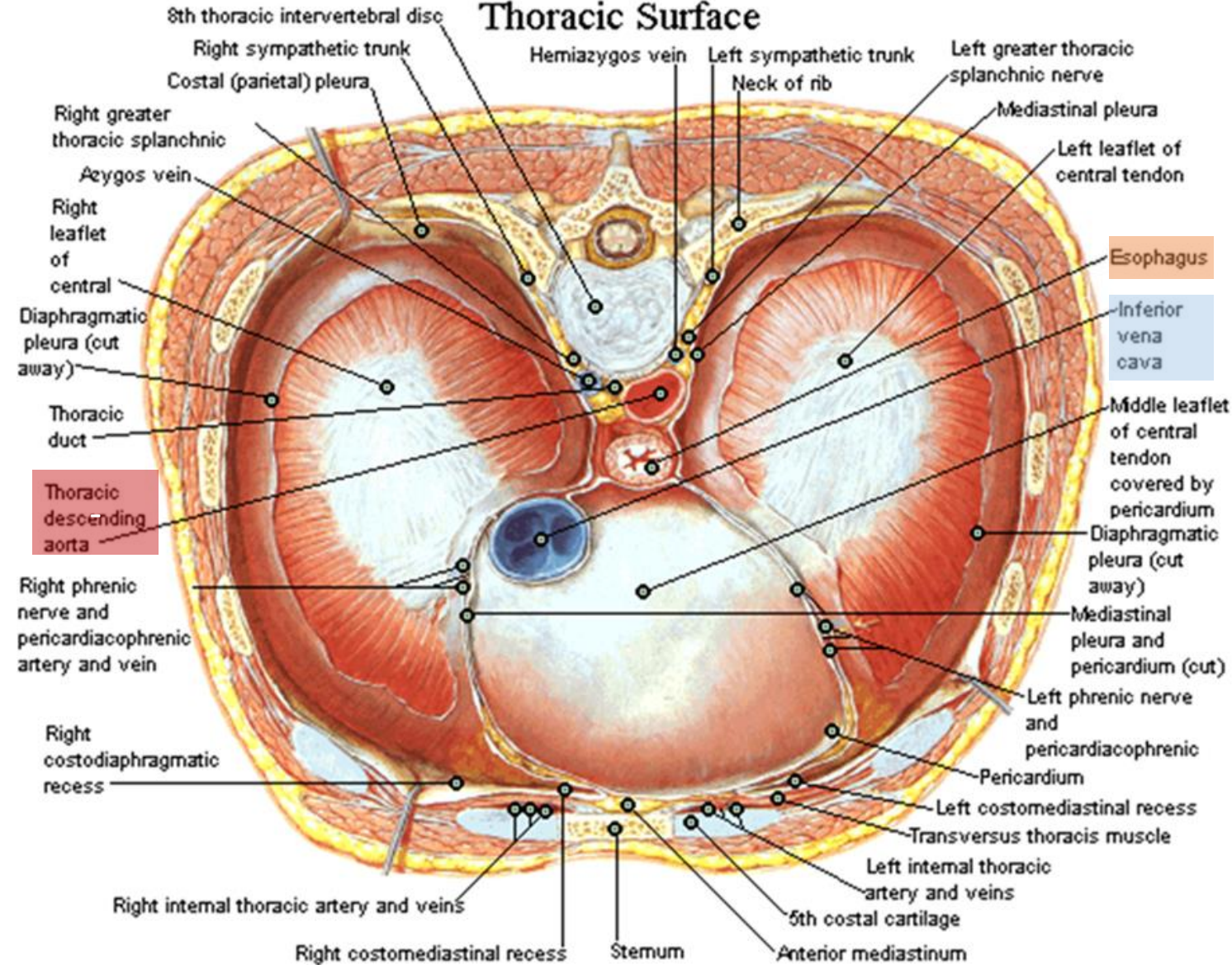
It is located among the right and left crus of the lumbar portion

*Esophagus passes from the thoracic cavity to the abdominal cavity, so it needs to cross the diaphragmatic muscle*



# Diaphragm

## Thoracic Surface



### 3. AORTIC FORAMEN

It is the most posterior foramen, giving passage to the descending aorta

*The aorta is the main artery of the body, it originates directly from the heart into the thoracic cavity and must pass through the diaphragm to reach the abdominal cavity*

The diaphragm is innervated by the PHRENIC NERVE