
بسم الله الرحمن الرحيم

THORAX

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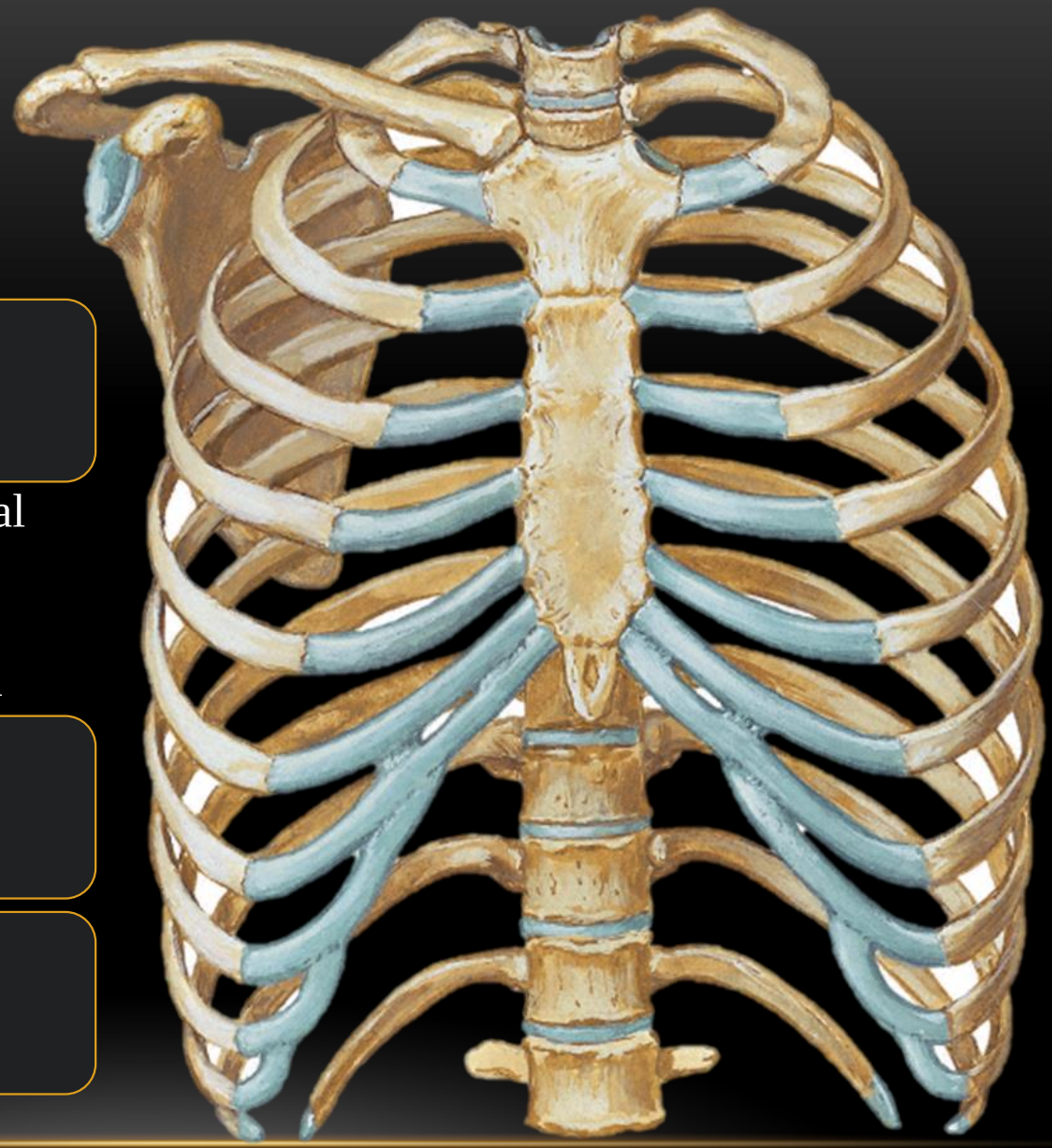
The Thoracic wall is formed of:

Thoracic cage: which is formed of:

- Anteriorly: sternum and costal cartilage
- On either side: ribs
- Posteriorly: vertebral column

Intercostal muscles

Neurovascular bundle



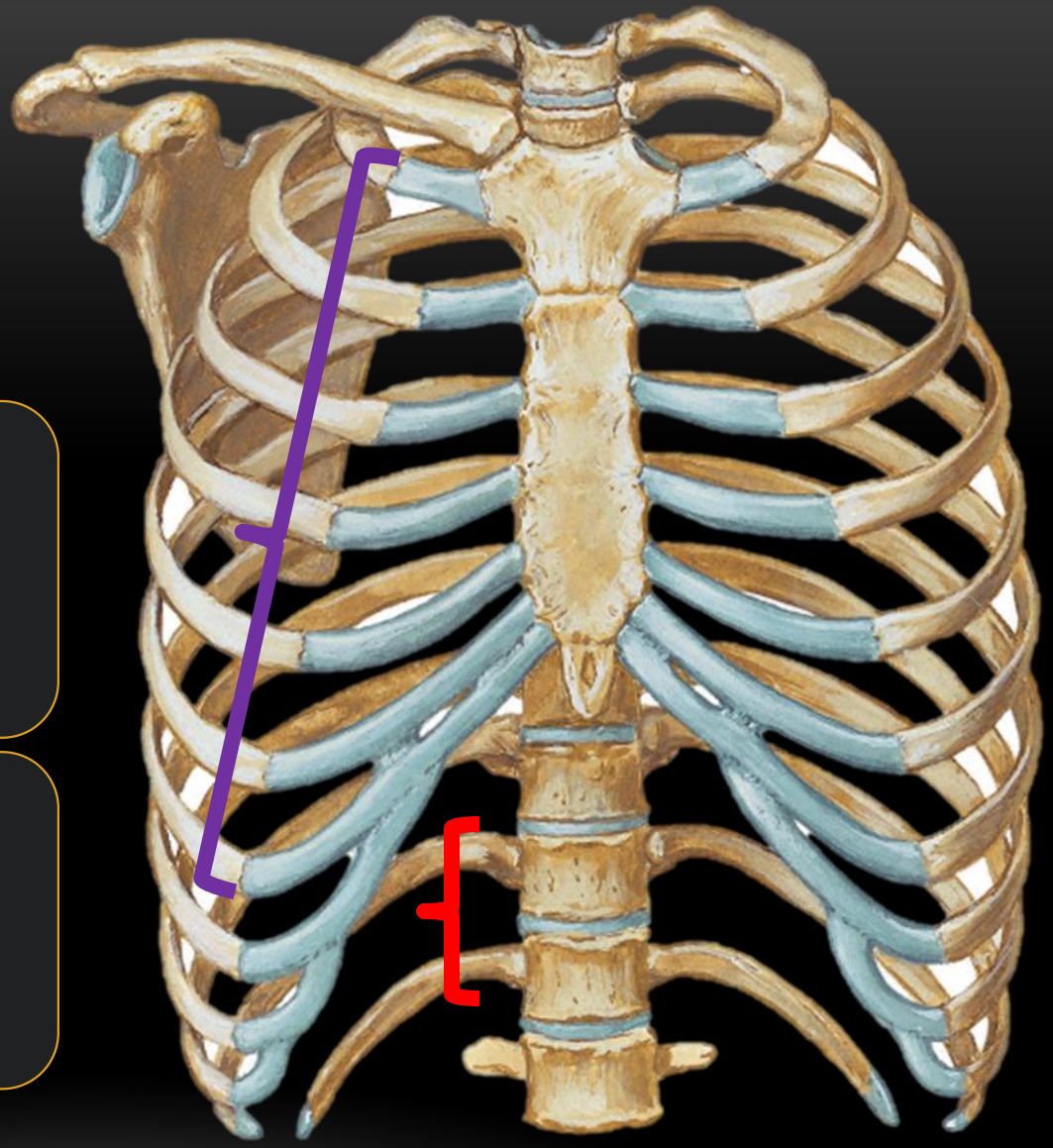
Ribs

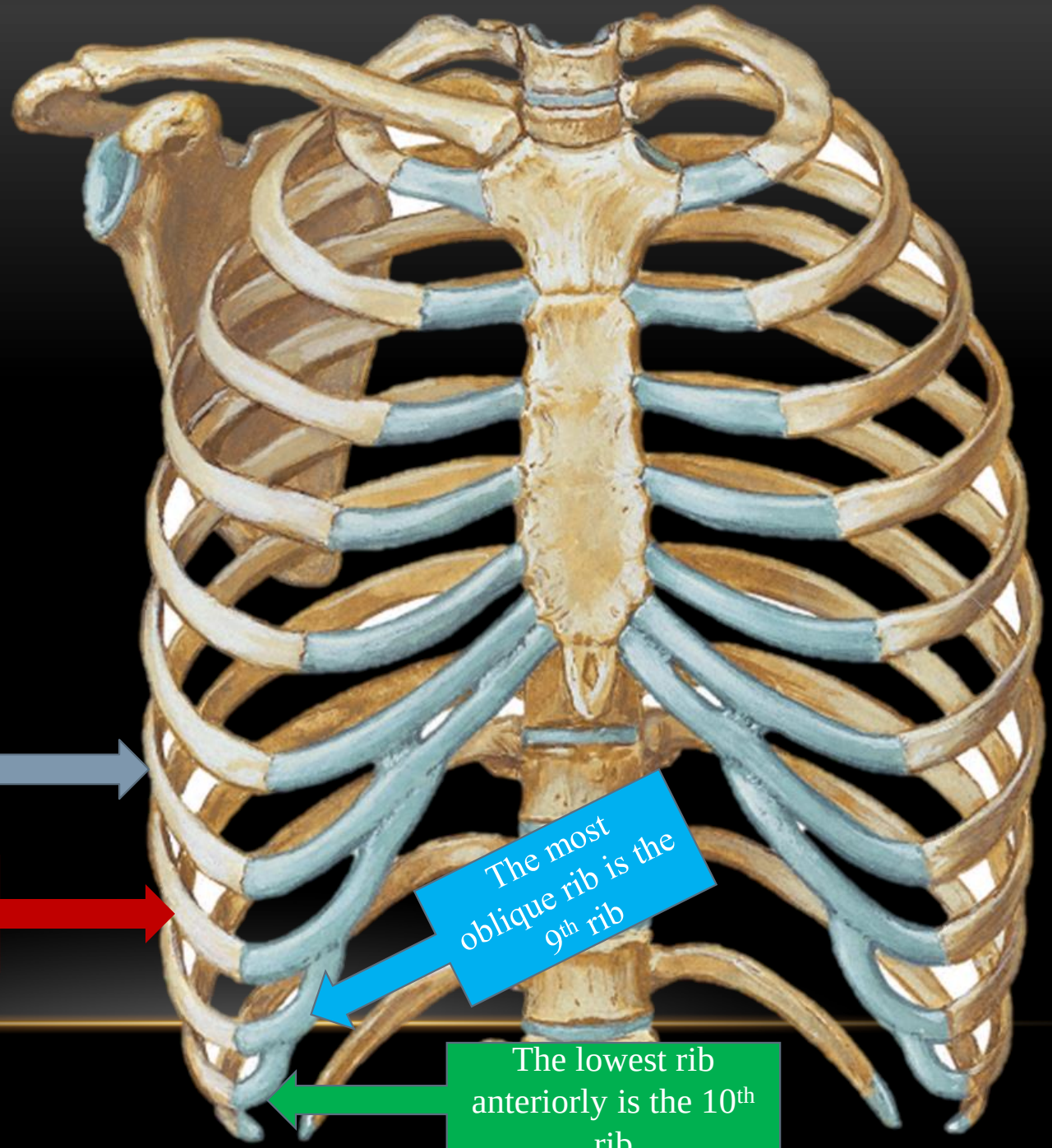
Ribs are classified into:

True ribs (1-7): are connected to the sternum by costal cartilage

False ribs (8, 9, 10, 11, 12): the costal cartilage of each of these ribs joins the costal cartilage of the rib above it.

- Ribs 11 & 12 are named floating ribs because their anterior ends are free anteriorly (not connected to the ribs above or to the sternum)




The longest rib is the 7th rib
The most laterally projected rib is the 8th rib
The most oblique rib is the 9th rib
The lowest rib anteriorly is the 10th rib

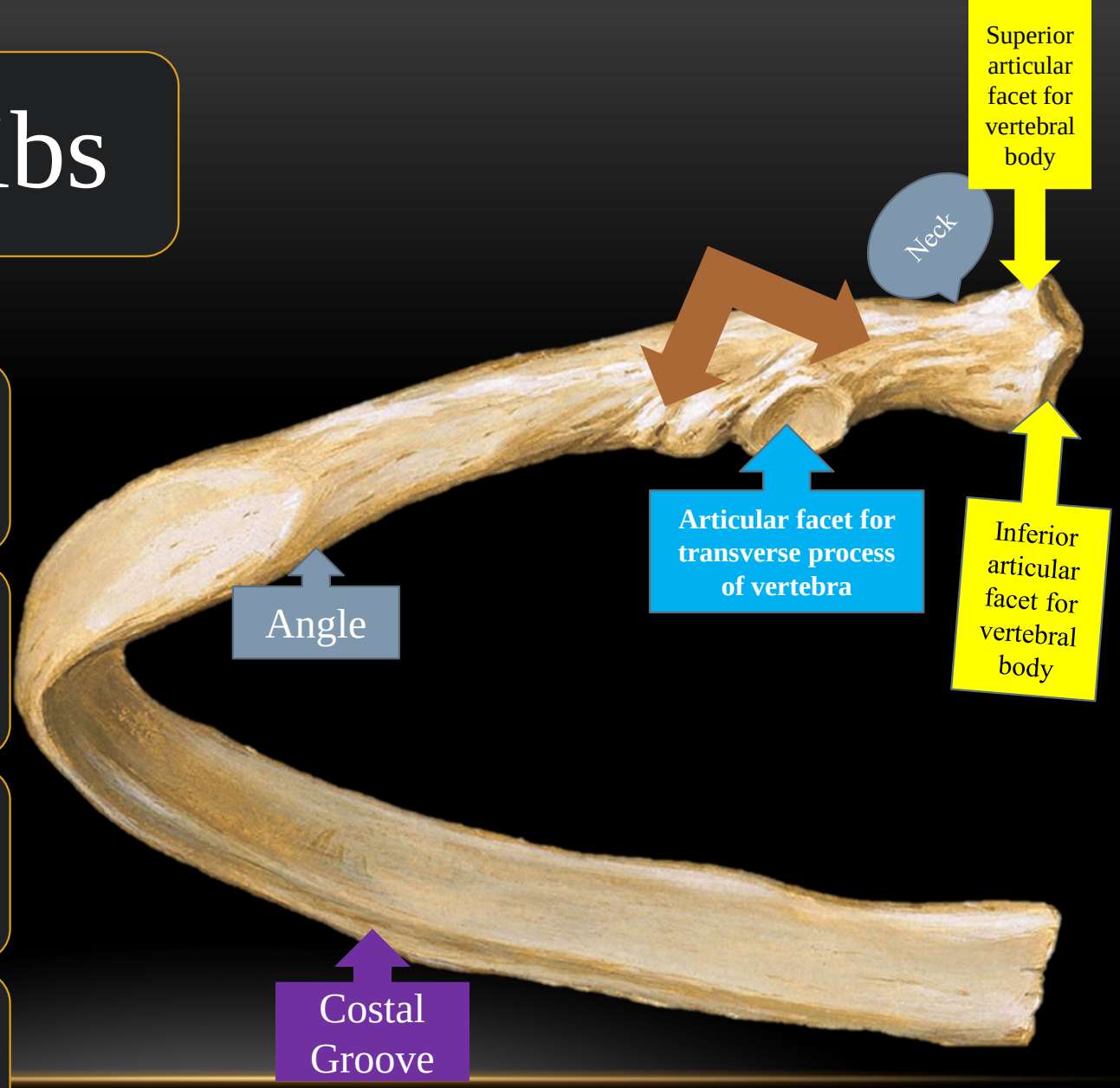
Typical ribs

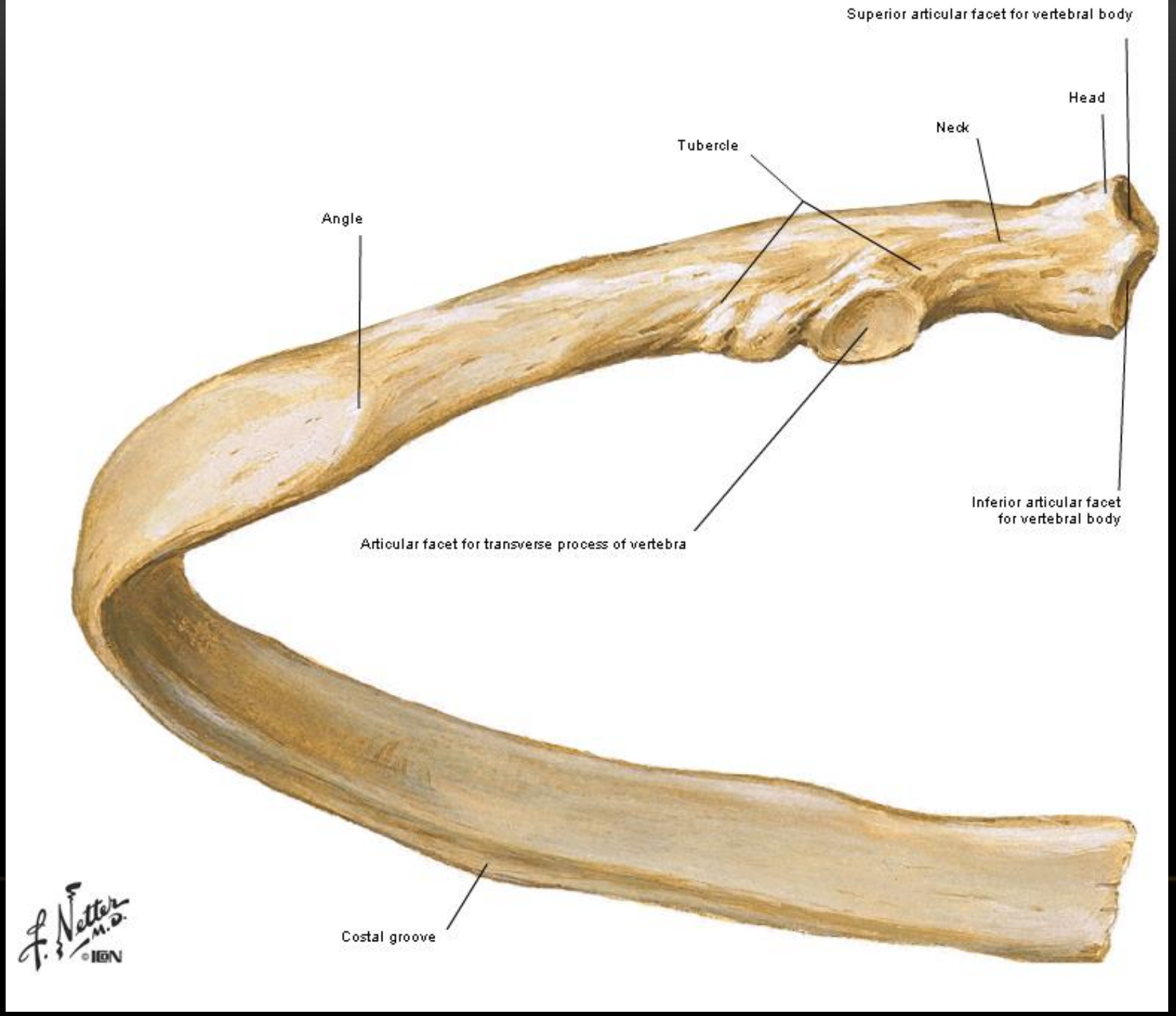
Typical ribs are the ribs 3-10.

Anterior end: cup-shaped and articulates with the costal cartilage.

Posterior end: has a head, neck and tubercle.

Shaft.




Superior articular facet for vertebral body
Head
Neck
Tubercle
Angle
Articular facet for transverse process of vertebra
Inferior articular facet for vertebral body
Costal groove
F. Netter M.D.
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Head of the typical rib

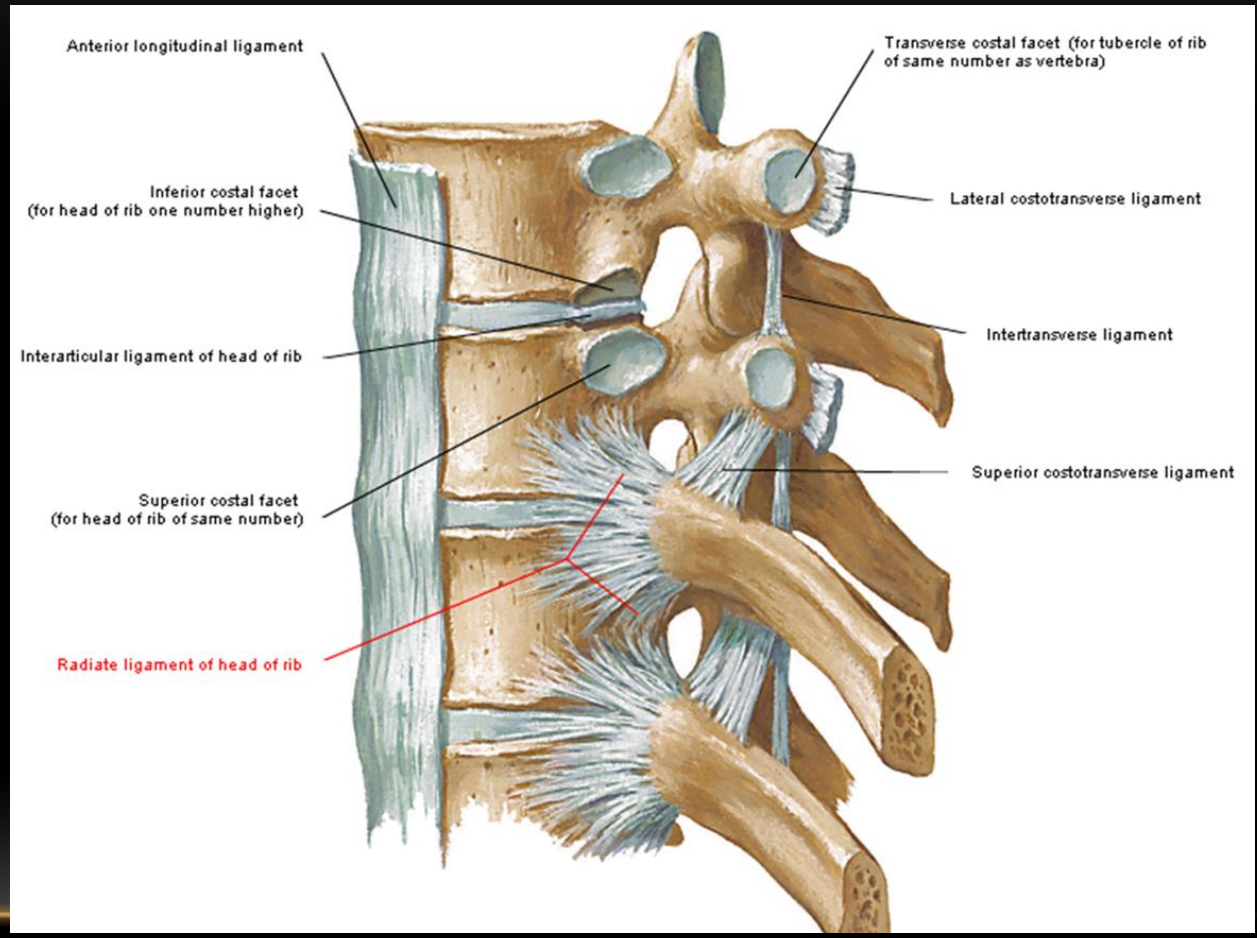
Has 2 facets and a ridge in between them.

The upper facet articulates with the body of the vertebra above.

The lower facet articulates with the body of the vertebra that has the same number.

The ridge articulates with the inter vertebral disc between the two related vertebra.

The head is connected to the bodies of 2 vertebra by the triradiate ligament.



Neck of the typical rib

It is the constriction that follows the head.

It is connected to the transverse processes of the:

- Corresponding vertebra by the inferior costo-transverse ligament.
- Vertebra above by the superior costo-transverse ligament.

Tubercles of the typical rib

Medial: forms a smooth articular facet for articulation with the transverse process of the corresponding vertebra.

Lateral: rough area connected to the tip of the corresponding transverse process by the lateral costo-transverse ligament.

Shaft of the typical rib

An angle is seen 5-6 cm anterior to the tubercle.

The shaft has the following features:

- Upper border: round and thick.
- Lower border: sharp.
- Outer surface: smooth.
- Inner surface concave and grooved at its lower part forming the costal groove that houses the neurovascular bundle.

Atypical Ribs

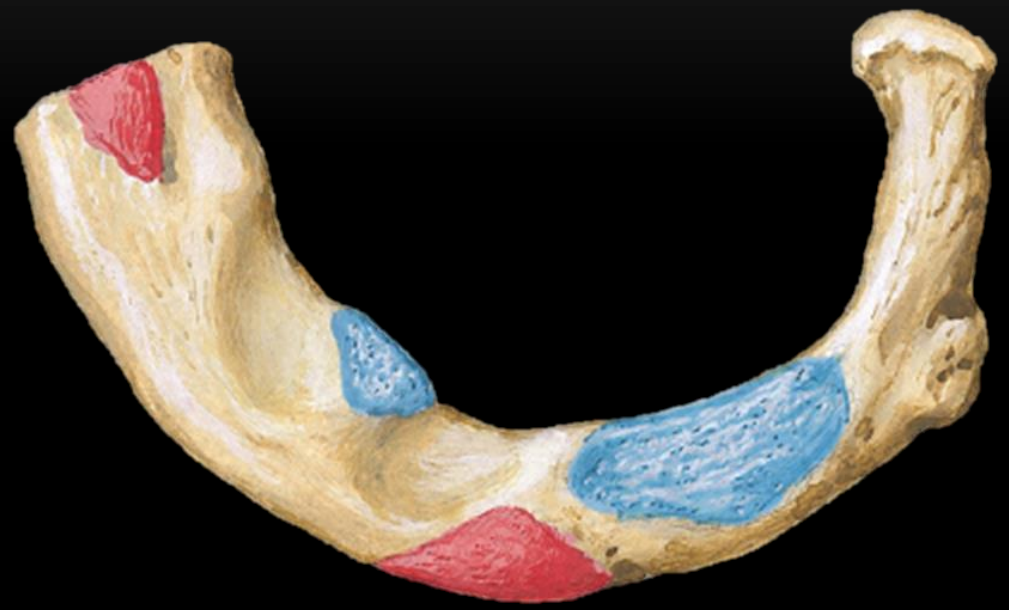
1st Rib

Difficult to palpate it as it lies mostly under the clavicle.

The anterior end of the first rib is larger than any other rib.

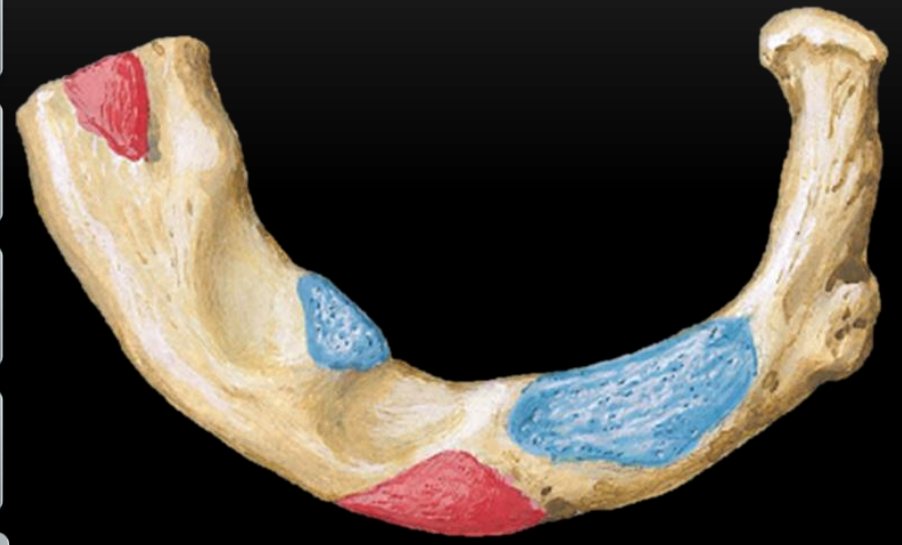
The head has one facet only for articulation with the 1st thoracic vertebra.

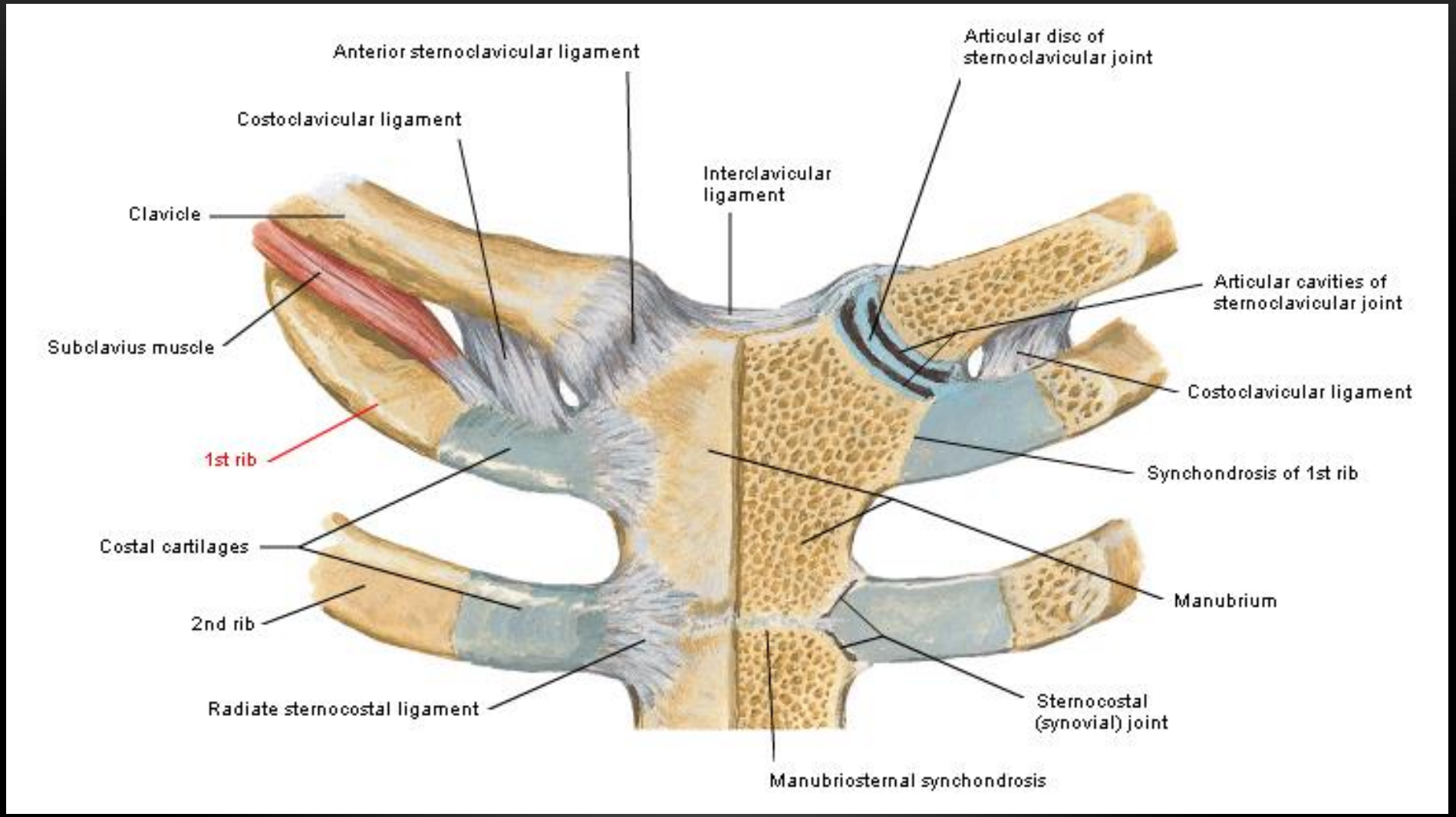
The lower surface is smooth.



Particular features of the 1st rib

- 2 origins
  - Subclavius
  - 1st digitation of serratus anterior
- 2 insertions
  - Scalenus anterior
  - Scalenus medius
- 2 grooves
  - Groove for subclavian vein
  - Groove for subclavian artery and lower trunk of brachial plexus
- 2 membranes
  - Pleura
  - Suprapleural membrane




Anterior sternoclavicular ligament
Articular disc of sternoclavicular joint
Costoclavicular ligament
Interclavicular ligament
Clavicle
Articular cavities of sternoclavicular joint
Subclavius muscle
Costoclavicular ligament
1st rib
Synchondrosis of 1st rib
Costal cartilages
Manubrium
2nd rib
Sternocostal (synovial) joint
Radiate sternocostal ligament
Manubriosternal synchondrosis

2nd rib

much longer than the first, but has a very similar curvature. The body is not flattened horizontally like that of the first rib.

The angle is slight, and situated close to the tubercle.

The body is not twisted, so that both ends touch any plane surface upon which it may be laid; but there is a bend, with its convexity upward, similar to, though smaller than that found in the first rib.

Its external surface is convex, and looks upward and a little outward; near the middle of it is a rough eminence for the origin of the lower part of the first and the whole of the second digitation of the Serratus anterior; behind and above this is attached the Scalenus posterior.

The costal groove is poorly developed.

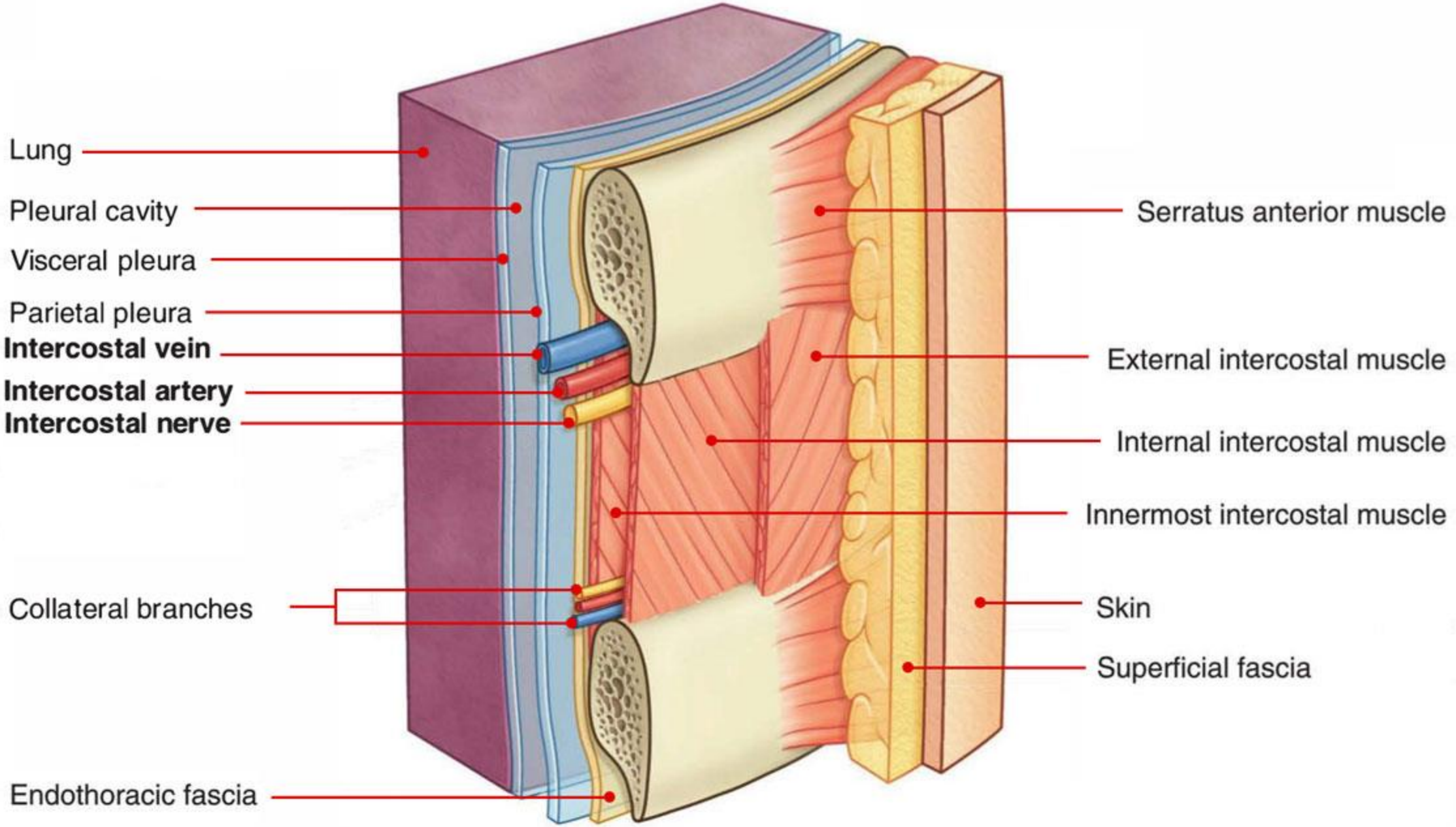
10^{th} rib

It has a single articular facet on its head.

Its tubercle is not eminent.

11th and 12th ribs

	11th rib	12th rib
Head	One facet	One facet
Neck	No neck	No neck
Tubercle	No tubercle	No tubercle
Groove	Faint	No groove
Articulation	With T11	With T12


Lung
Pleural cavity
Visceral pleura
Parietal pleura
Intercostal vein
Intercostal artery
Intercostal nerve
Collateral branches
Endothoracic fascia
Serratus anterior muscle
External intercostal muscle
Internal intercostal muscle
Innermost intercostal muscle
Skin
Superficial fascia

Sternum (Breast bone)

Consists of:

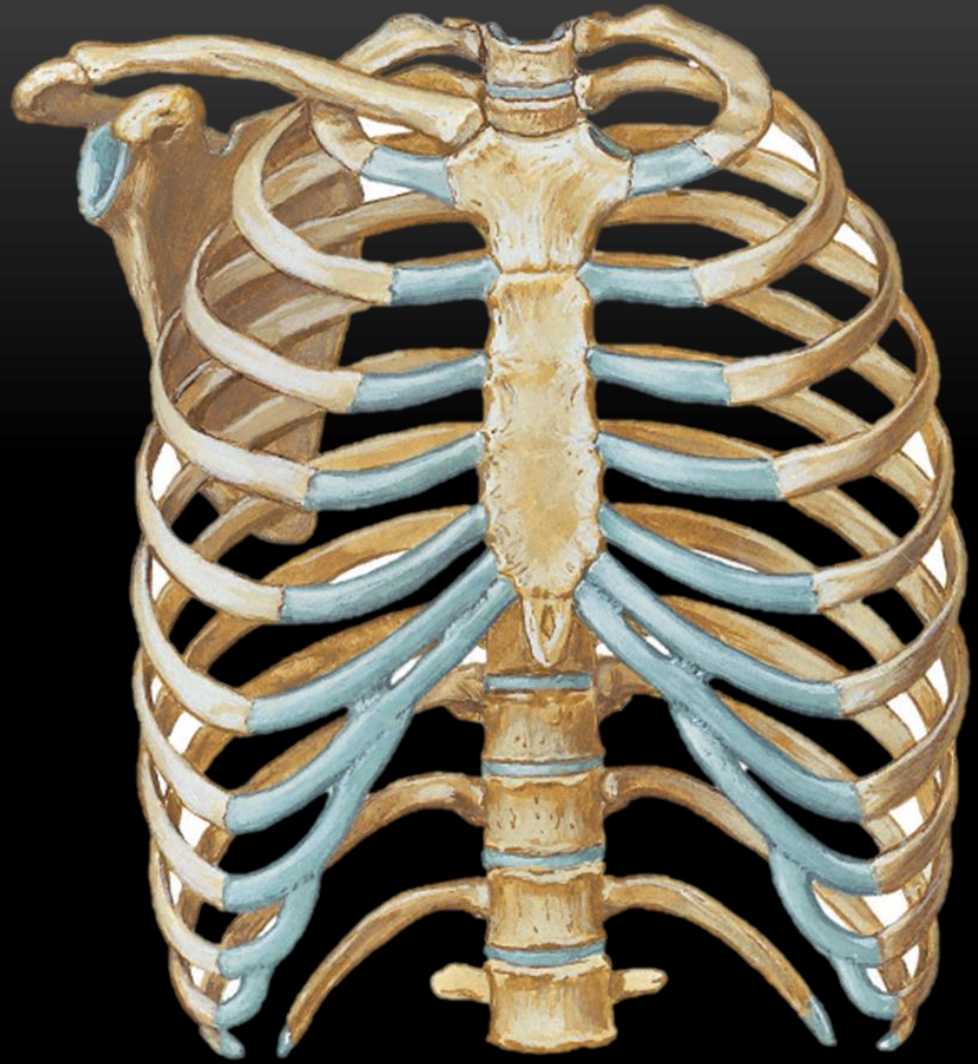
- Manubrium
- Body
- Xiphoid process

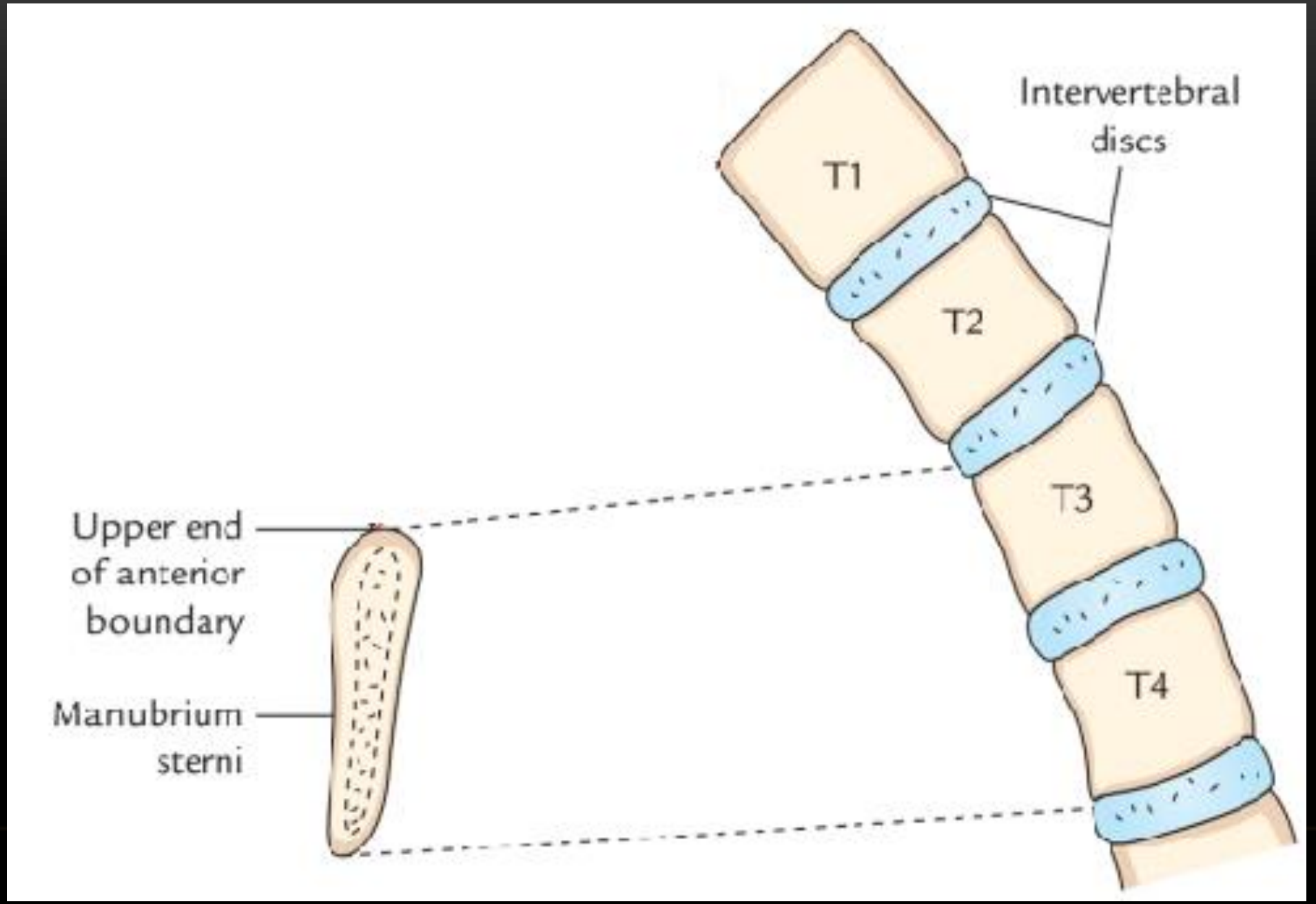
Manubrium sterni ..1/2

Lies opposite T3-T4.

It has the following features:

- **Upper border**:
  - Suprasternal notch
  - 2 Clavicular notches
- **Lower border**:
  - opposite the 2nd costal cartilage and T4.
  - Articulates with the body in the manubrio-sternal angle (angle of Louis).



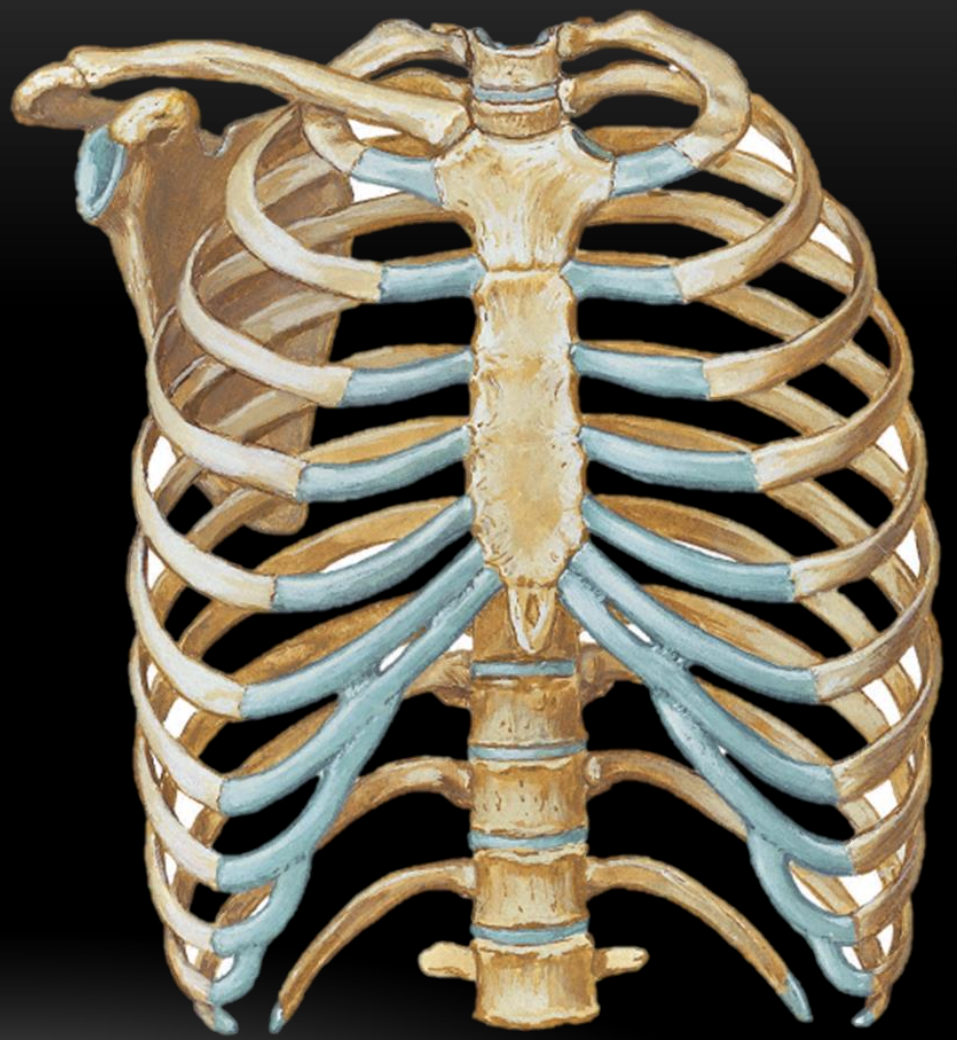

Intervertebral discs
T1
T2
T3
T4
Upper end of anterior boundary
Manubrium sterni

Manubrium sterni ..2/2

Lateral border: articulates with 1½ costal cartilages.

Anterior surface: convex.

Posterior surface: concave.



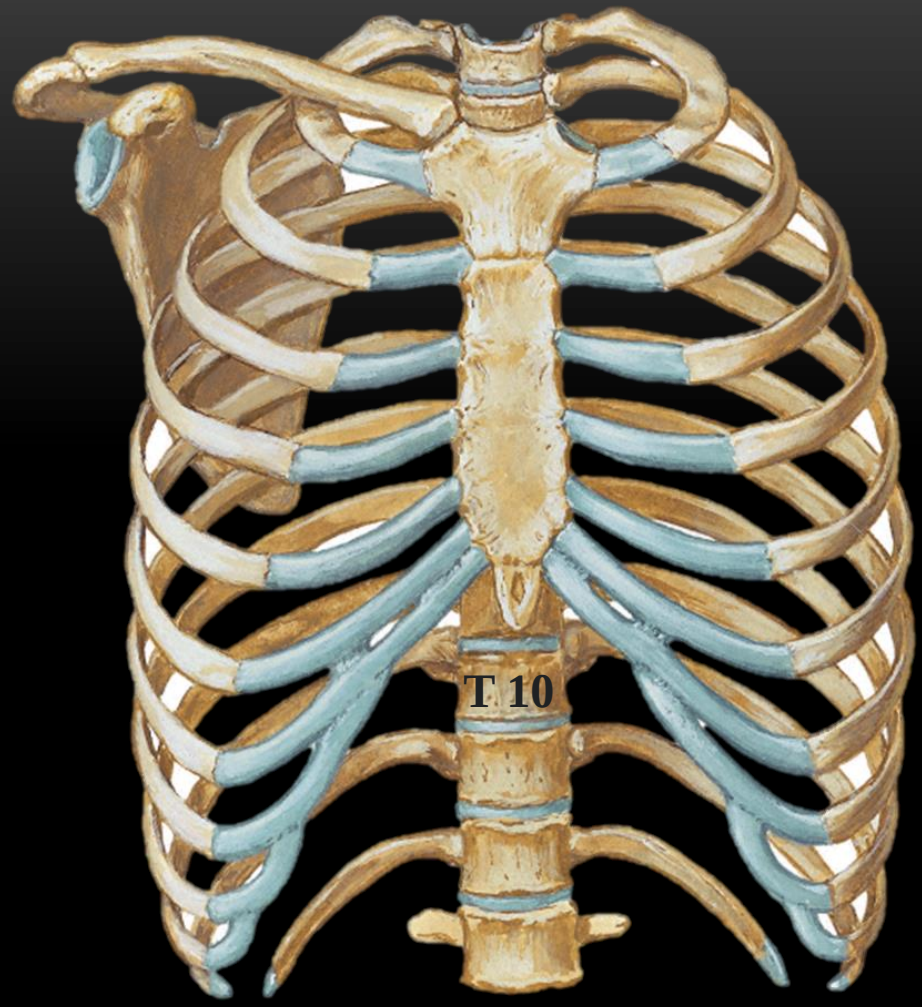
Body and xiphoid process of the sternum

Lies opposite T5-T8.

Consists of 4 pieces (sternbrae) that fuse together at the age of puberty.

Articulates half of the 2nd and 7th costal cartilages and costal cartilages 3-6.

Xiphoid process lies opposite T9.

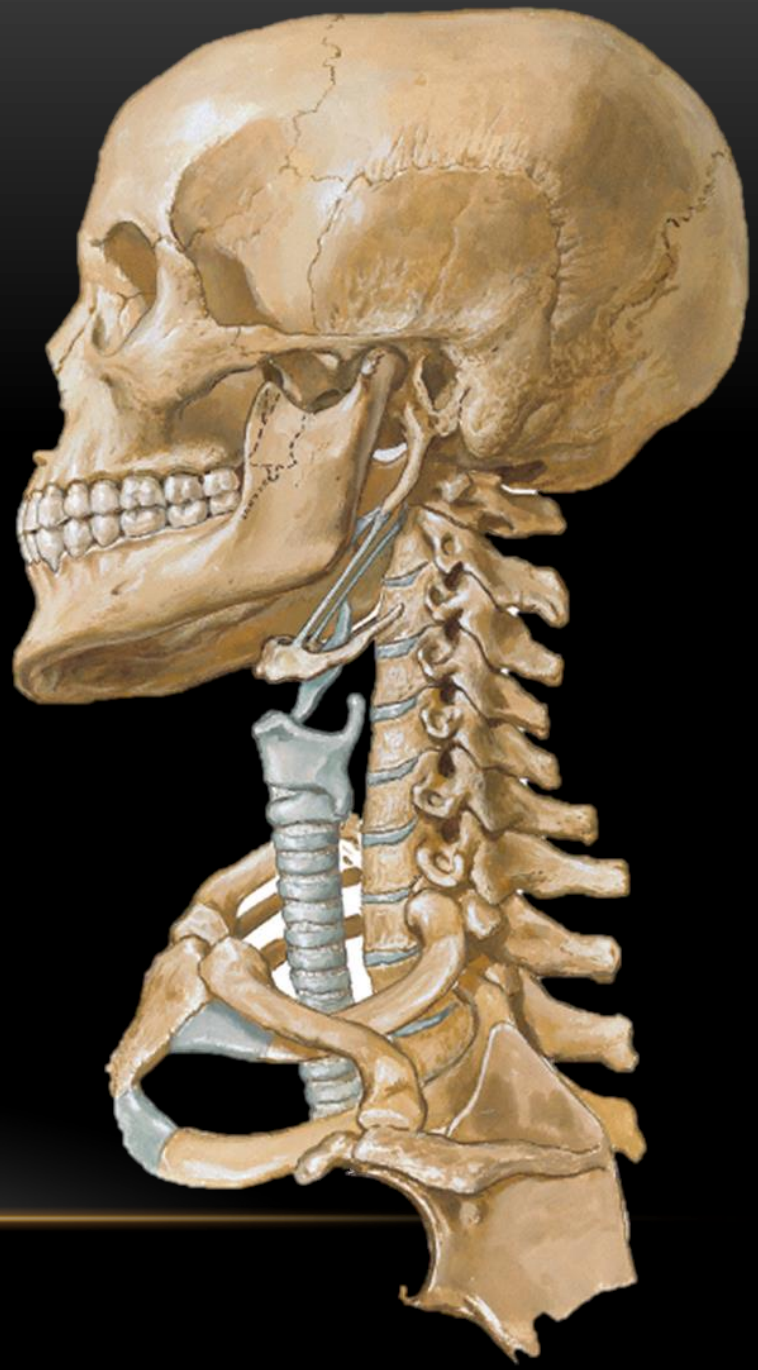


Superior Thoracic Aperture

(Thoracic Inlet)

Boundaries:

- Anteriorly: upper border of manubrium sterni.
- Posteriorly: upper border of T1.
- On either side: inner borders of the 1st ribs of both sides and their costal cartilage.



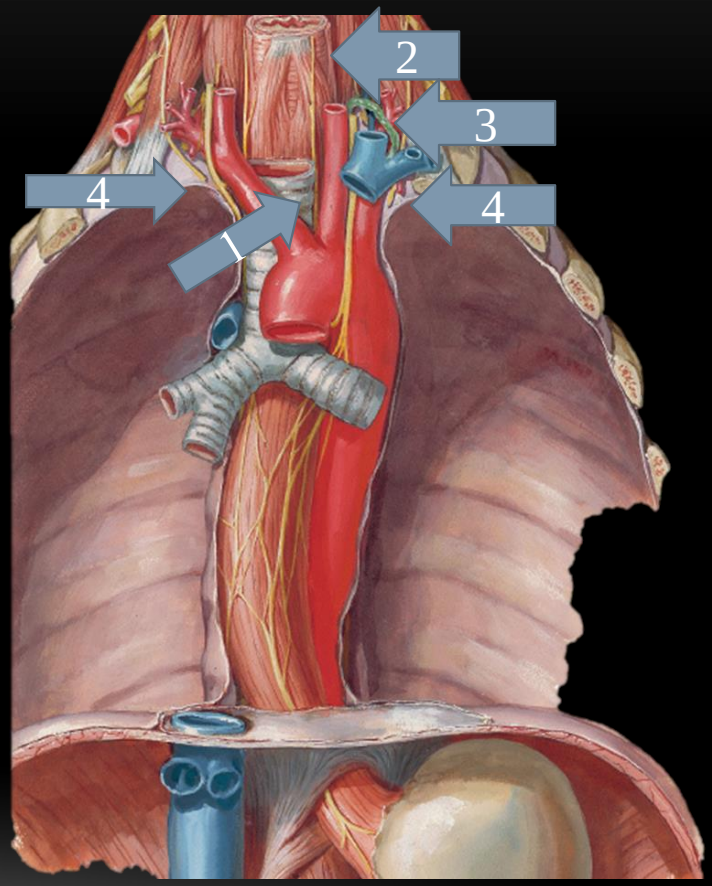
Structures passing through the thoracic inlet ..1/6

1- Trachea

2- Esophagus

3- Thoracic duct

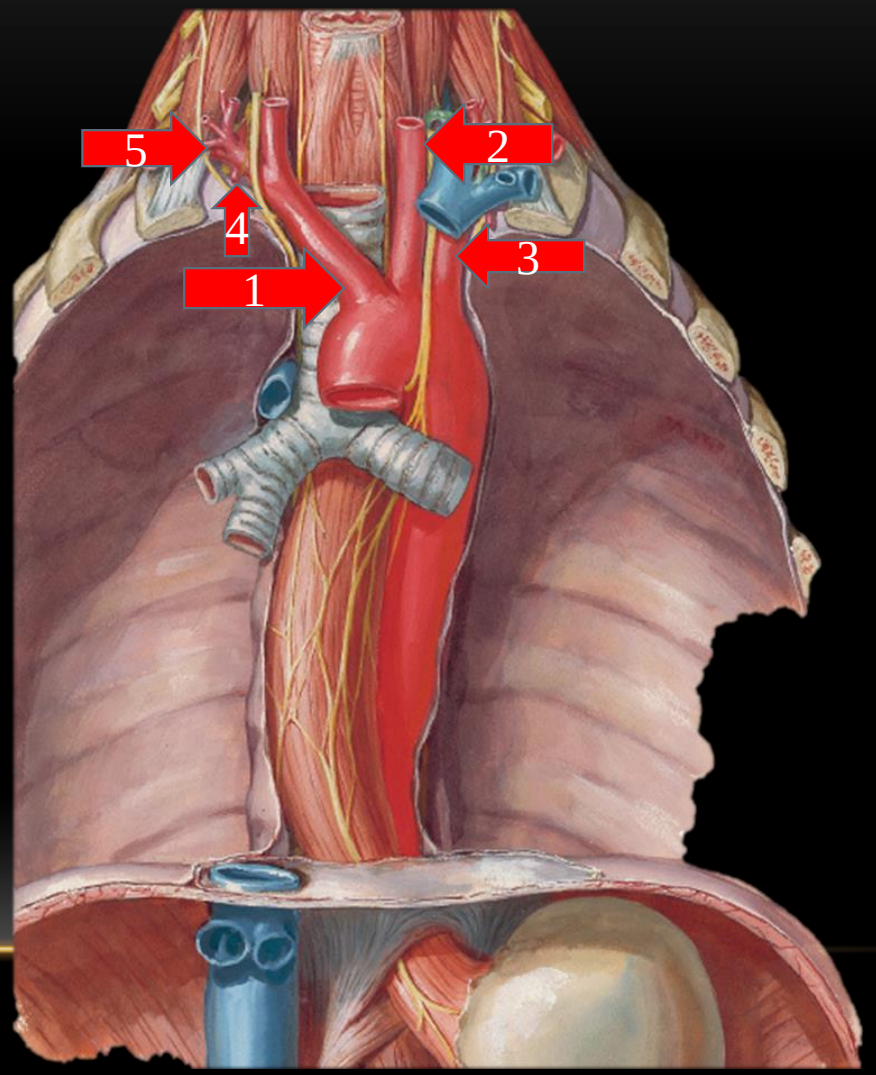
4- Apex of both lungs and their cervical pleura



Structures passing through the thoracic inlet ..2/6

Arteries:

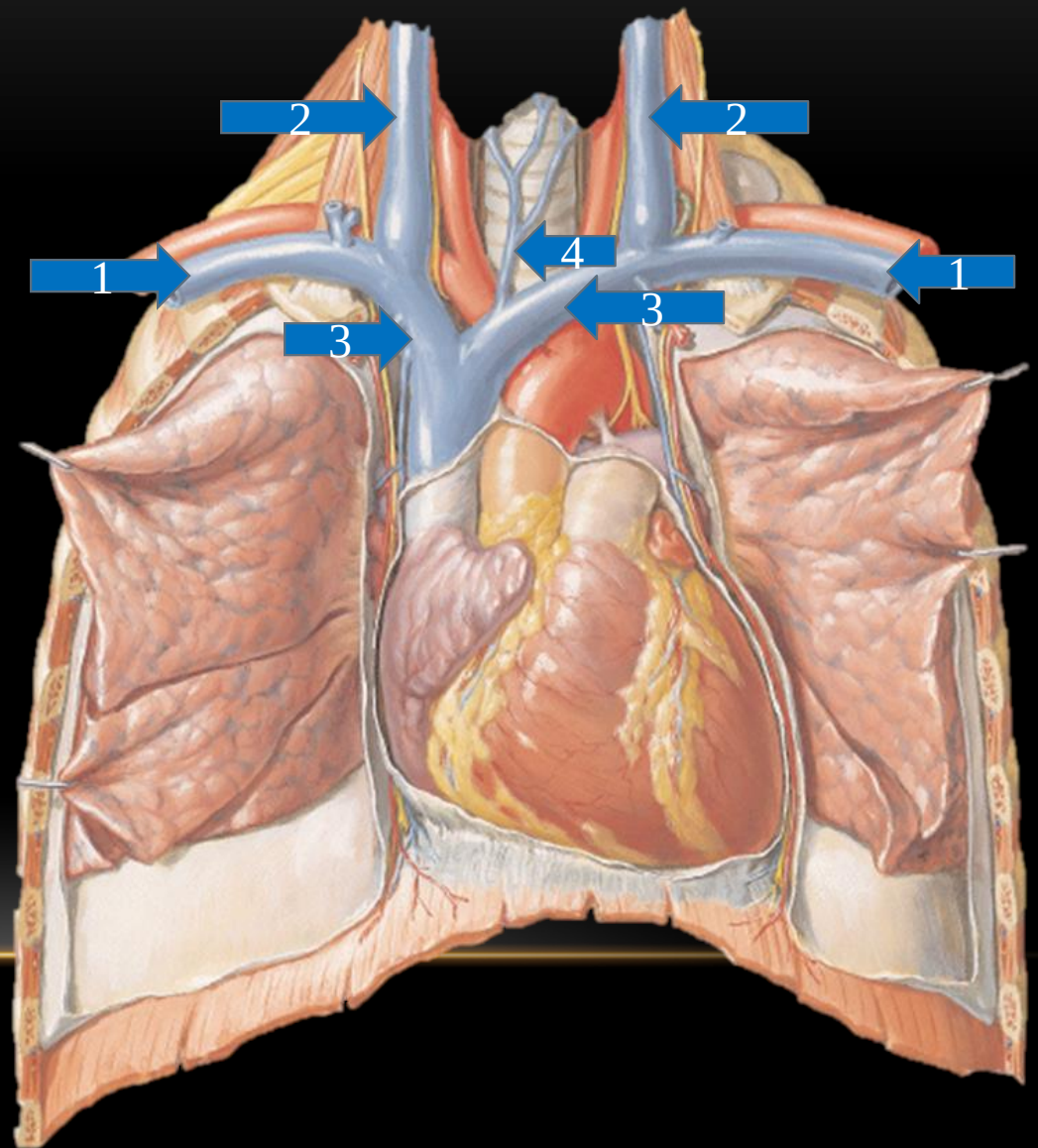
- 1- Brachiocephalic
- 2- Left common carotid
- 3- Left subclavian
- 4- Internal mammary
- 5- Superior intercostal
- 6- Thyroidea ima (if present)



Structures passing through the thoracic inlet ..3/6

Veins:

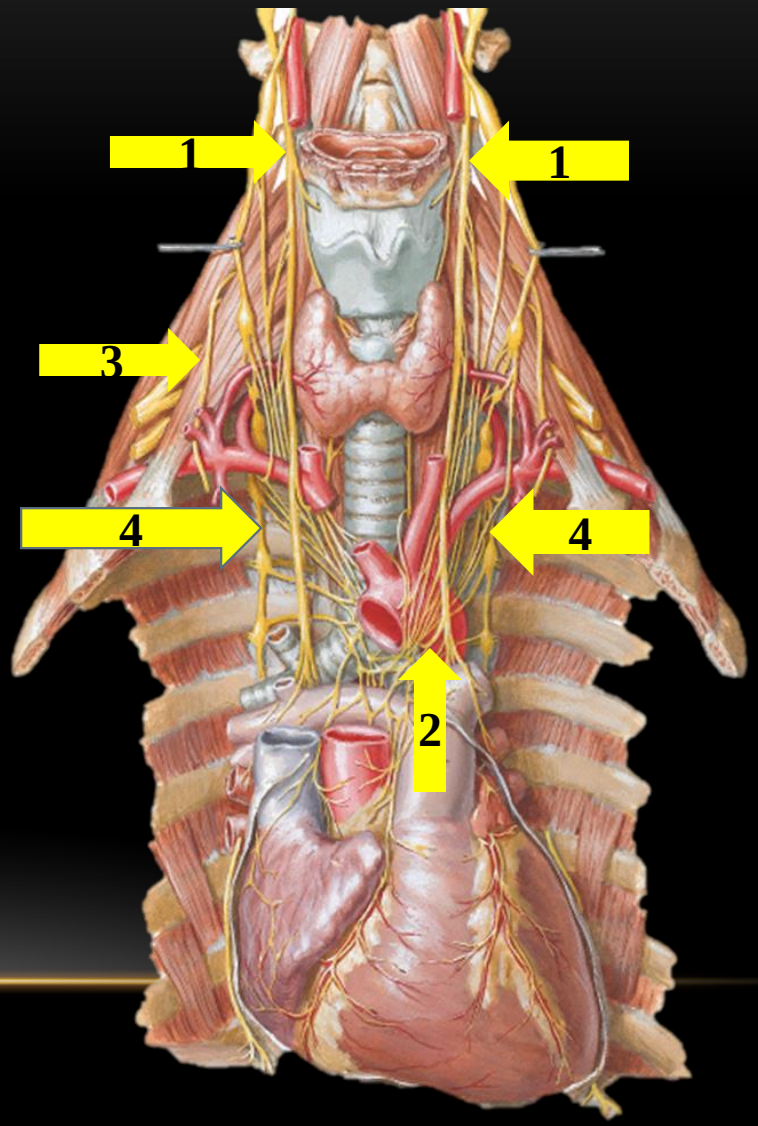
- Union of the subclavian veins (1) and the internal jugular veins (2) to form brachiocephalic veins (3).
- Inferior thyroid vein (4).



Structures passing through the thoracic inlet ..4/6

Nerves:

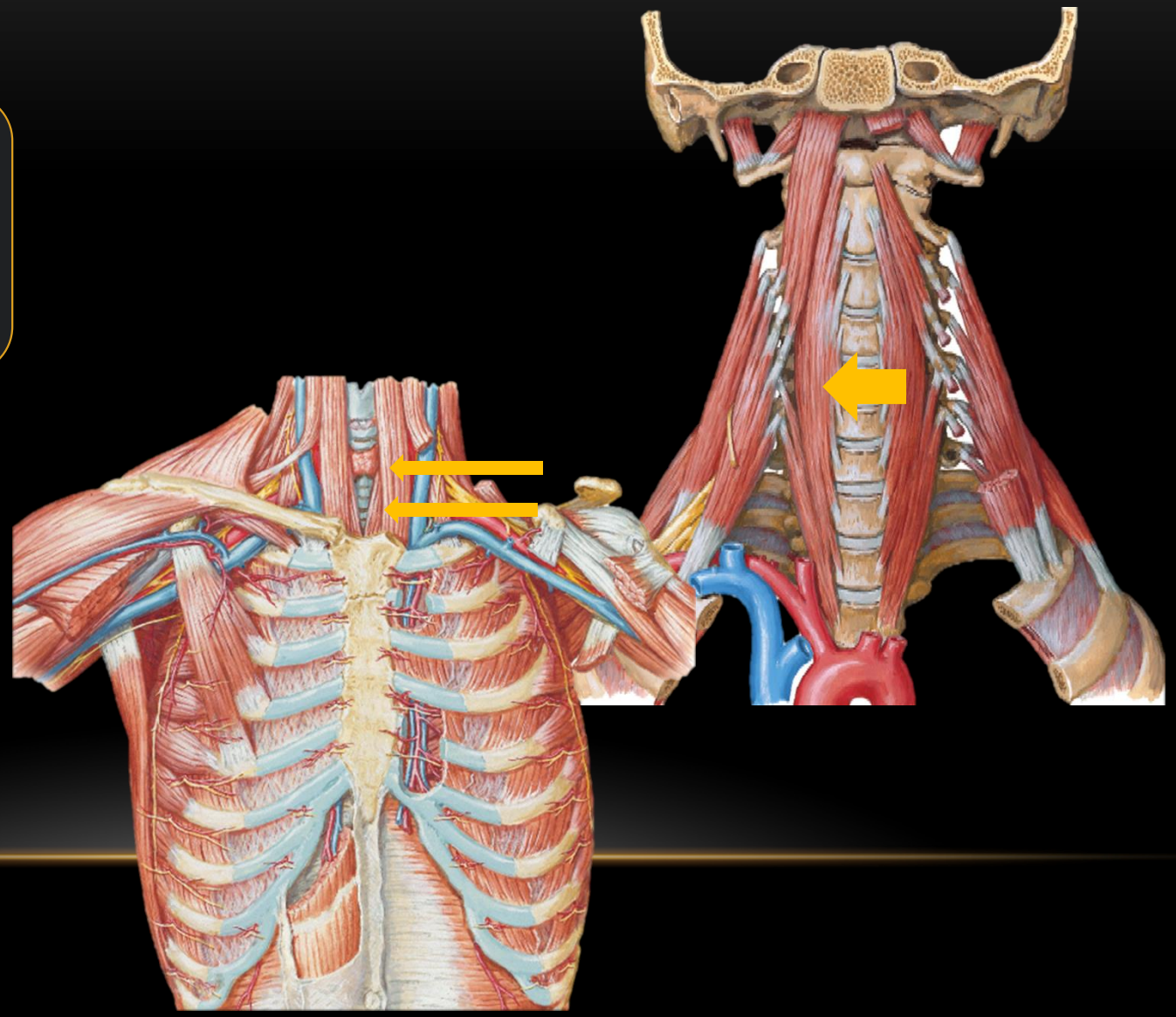
- 1- Vagi nerves
- 2- Left recurrent laryngeal nerve.
- 3- Phrenic nerves.
- 4- Sympathetic chains.



Structures passing through the thoracic inlet ..5/6

Muscles:

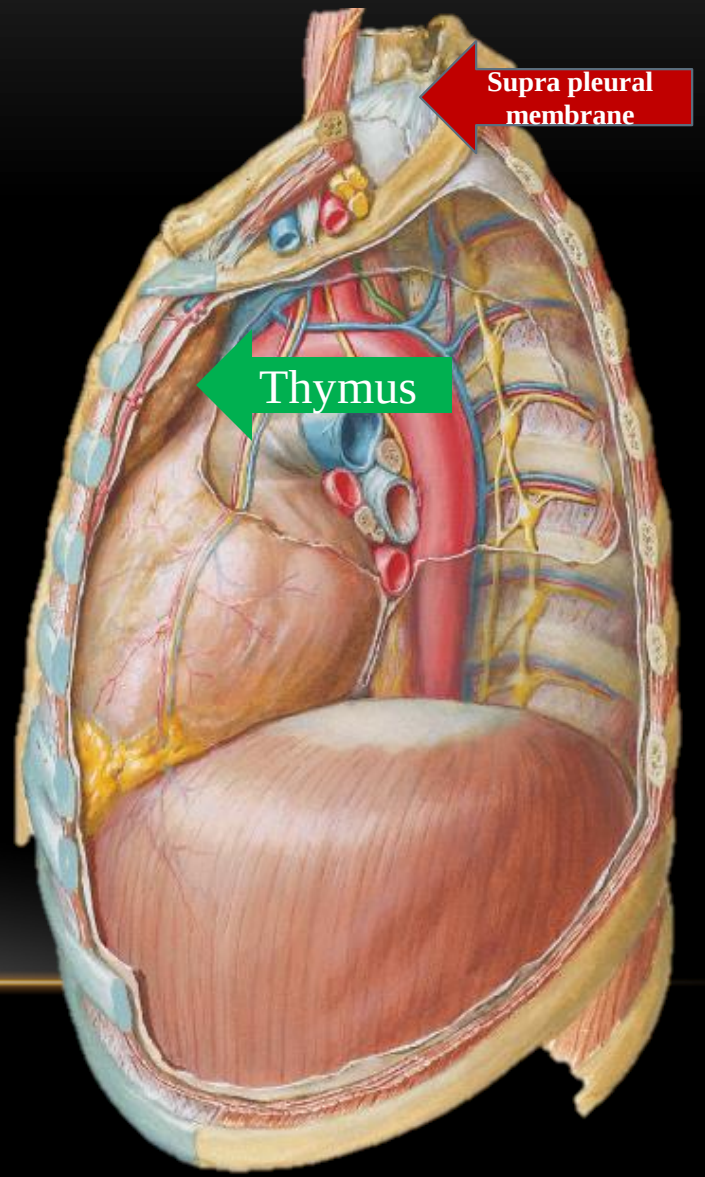
- Lower parts of the sternohyoid and sternothyroid muscles (anteriorly).
- Longus colli muscle (posteriorly).



Structures passing through the thoracic inlet ..6/6

Thymus gland (or its remains).

Suprapleural membrane (Sibson’s fascia).



Muscles of Thorax ..1/3

Muscle	Origin	Insertion	Action	Innervation
Pectoralis major	Sternum, Ribs 2-6	Inter-tubercular groove of humerus	Adduct, Flex, Med Rotate Arm	M & L pectorals
Pectoralis minor	Ribs 3-5	Coracoid process of scapula	Depress, Rotate scapula	M & L pectorals
Serratus anterior	Ribs 1-9	Scapula	Protract, Rotate scapula	Long Thoracic

Muscles of Thorax ..2/3

Muscle	Origin	Insertion	Action	Innervation
Trapezius	Ligamentum nuchae, C_7-T_{12}	Clavicle, Spine & acromion of scapula	Elevate, Adduct, Rotate, Depress	Accessory
Levator Scapulae	C_1-C_4	Medial border of scapula	Elevate scapula	D. Scapular
Rhomboids	C_7-T_5	Medial border of scapula	Adduct, Elevate, Rotate	D. Scapular

Muscles of Thorax ..3/3

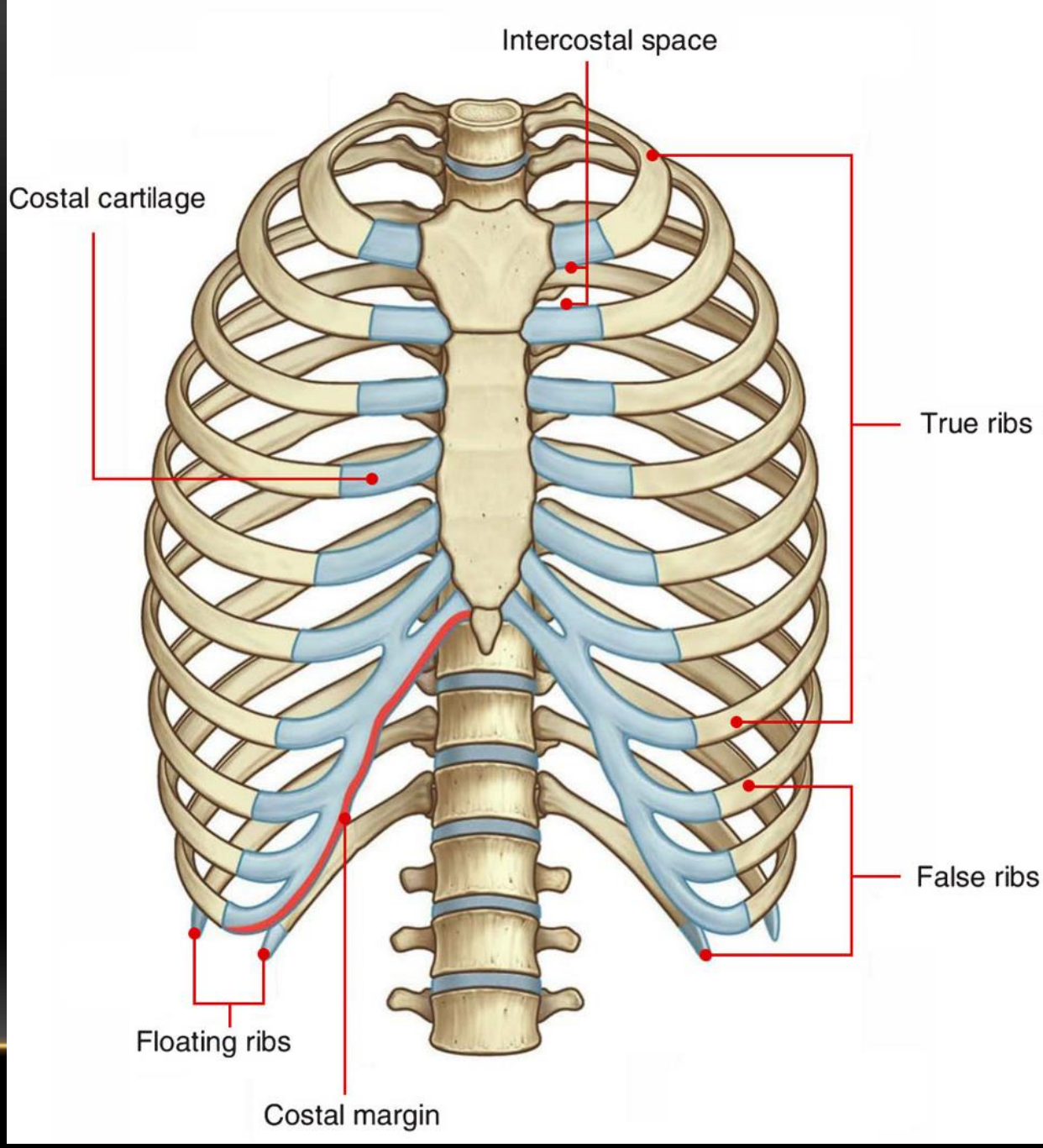
Muscle	*Origin*	*Insertion*	*Action*	*Innervation*
Deltoid	Clavicle, Spine & acromion of scapula	Deltoid tuberosity of humerus	Flex, Abduct, Extend, Lat & med. rotate arm	Axillary
Latissimus dorsi	Iliac crest, Sacrum, T_{7-12}, Lumbar fascia	Inter-tubercular groove of humerus	Extend, Adduct, Med. rotate arm	Thoraco-dorsal

The intercostal space

The **intercostal space** is the space between two ribs. Since there are 12 ribs on each side, there are 11 intercostal spaces,

They are important access points in medicine and surgery.

Each intercostal space contains muscles, nerves arteries, veins and lymphatics.

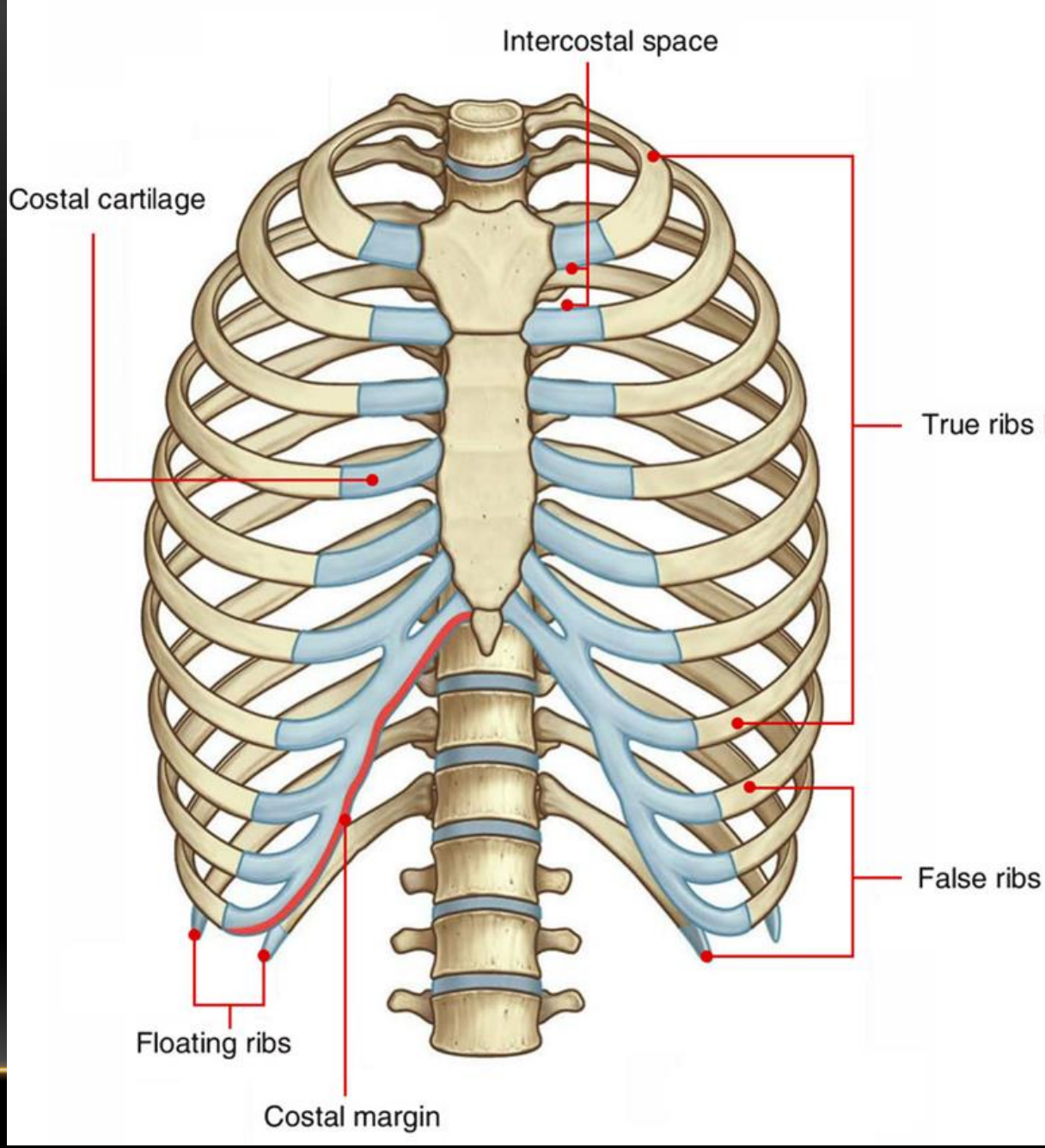


Intercostal muscles

They are 11 groups on each side; each numbered for the rib above it.

In each intercostal space there are 3 groups of intercostal muscles:

- External intercostal muscles
- Internal intercostal muscles
- Innermost intercostal muscles



External intercostal muscles

They originate on ribs 1-11 and have their insertion on ribs 2-12.

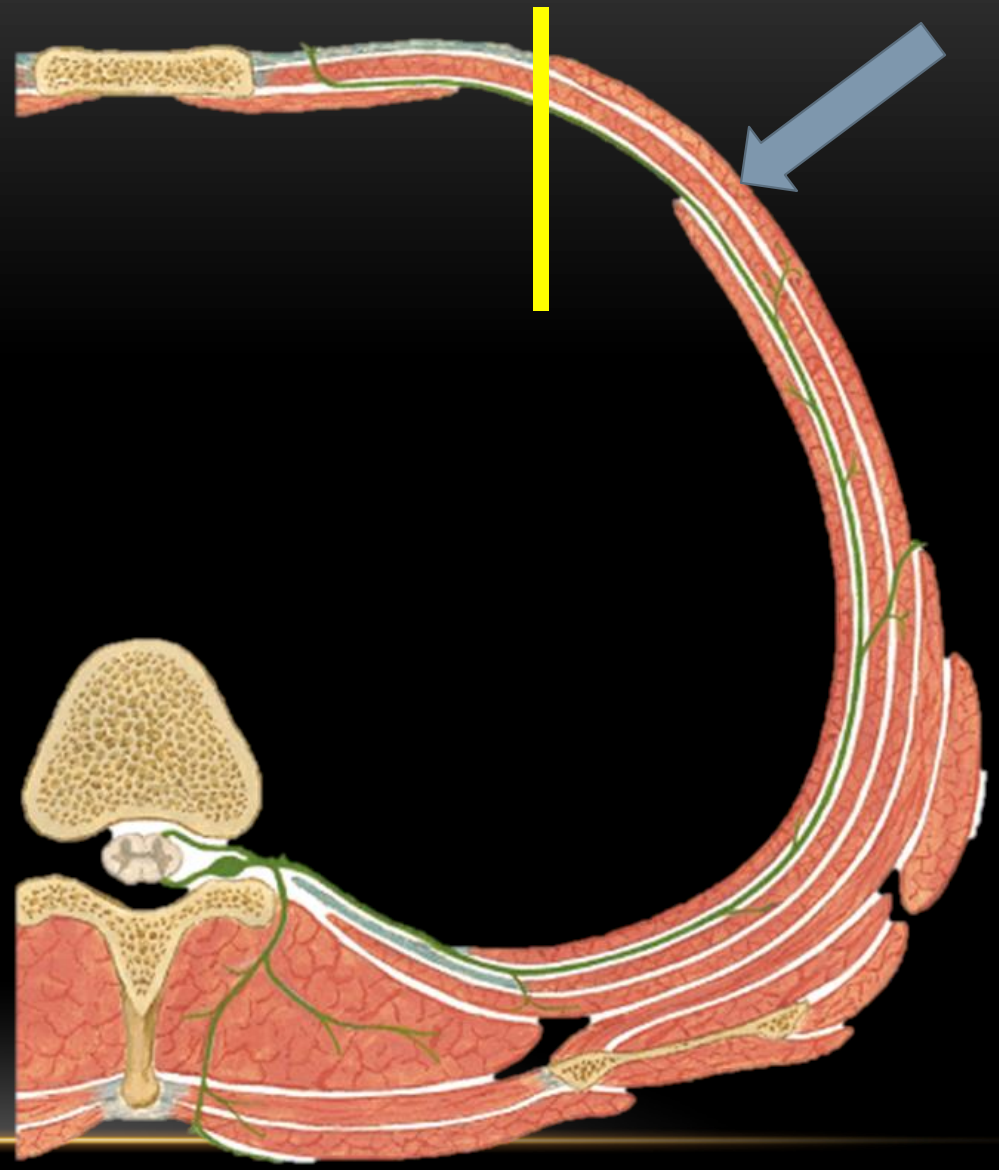
They start at the rib tubercle posteriorly and end at the costo-chondral junction anteriorly.

They originate the lower border of the rib above and insert into the upper border of the rib below.

Anteriorly they become replaced by the anterior intercostal membranes.

Their fibres are directed downwards forwards and medially.

Responsible for the elevation of the ribs and expanding the transverse dimensions of the thoracic cavity.



Internal intercostal muscles

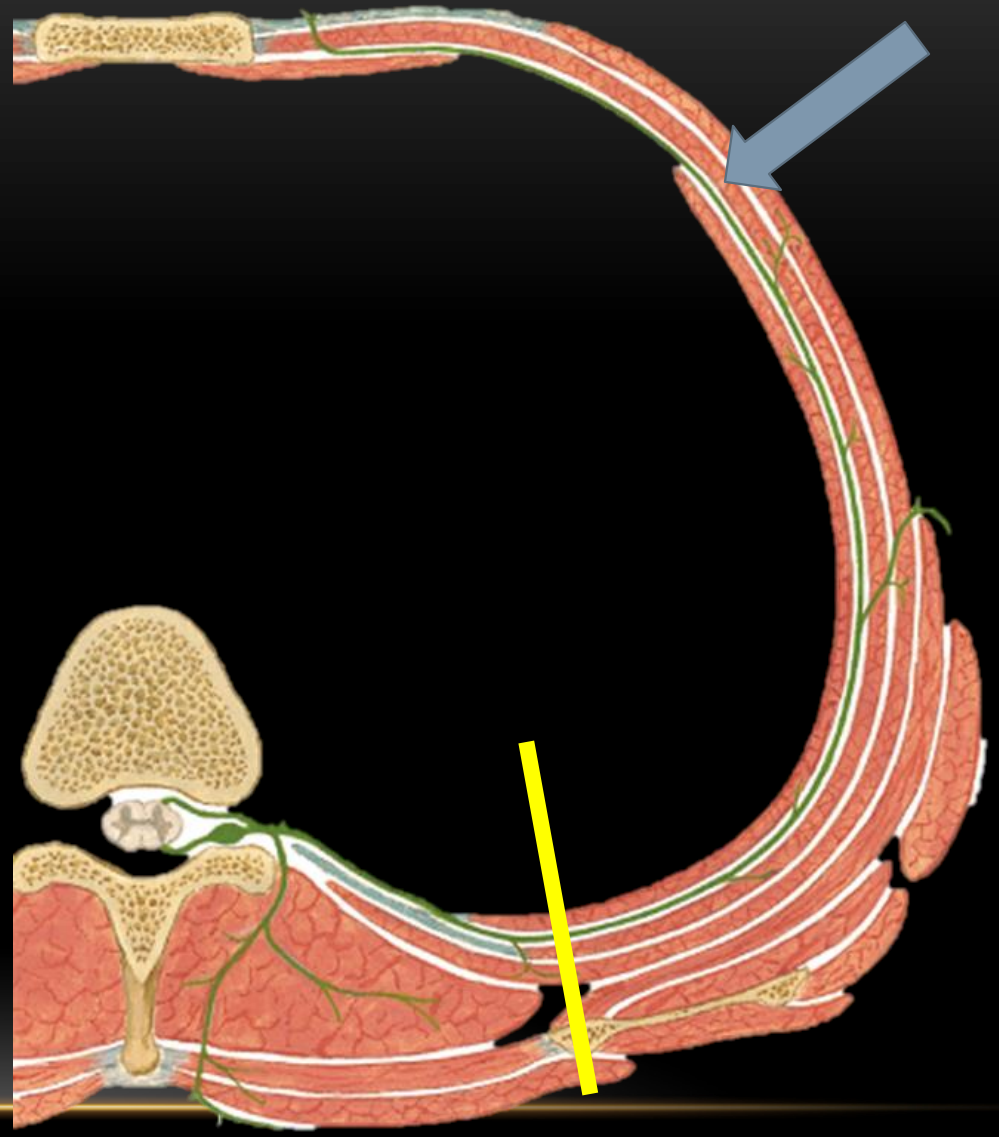
They originate on ribs 2-12 and have their insertions on ribs 1-11

They originate from the costal groove of the rib above and insert into the upper border of the rib below.

They extend from the margin of the sternum to the angle of the rib where they become replaced by the posterior intercostal membranes.

Their fibres are directed downwards backwards

Responsible for the depression of the ribs decreasing the transverse dimensions of the thoracic cavity.

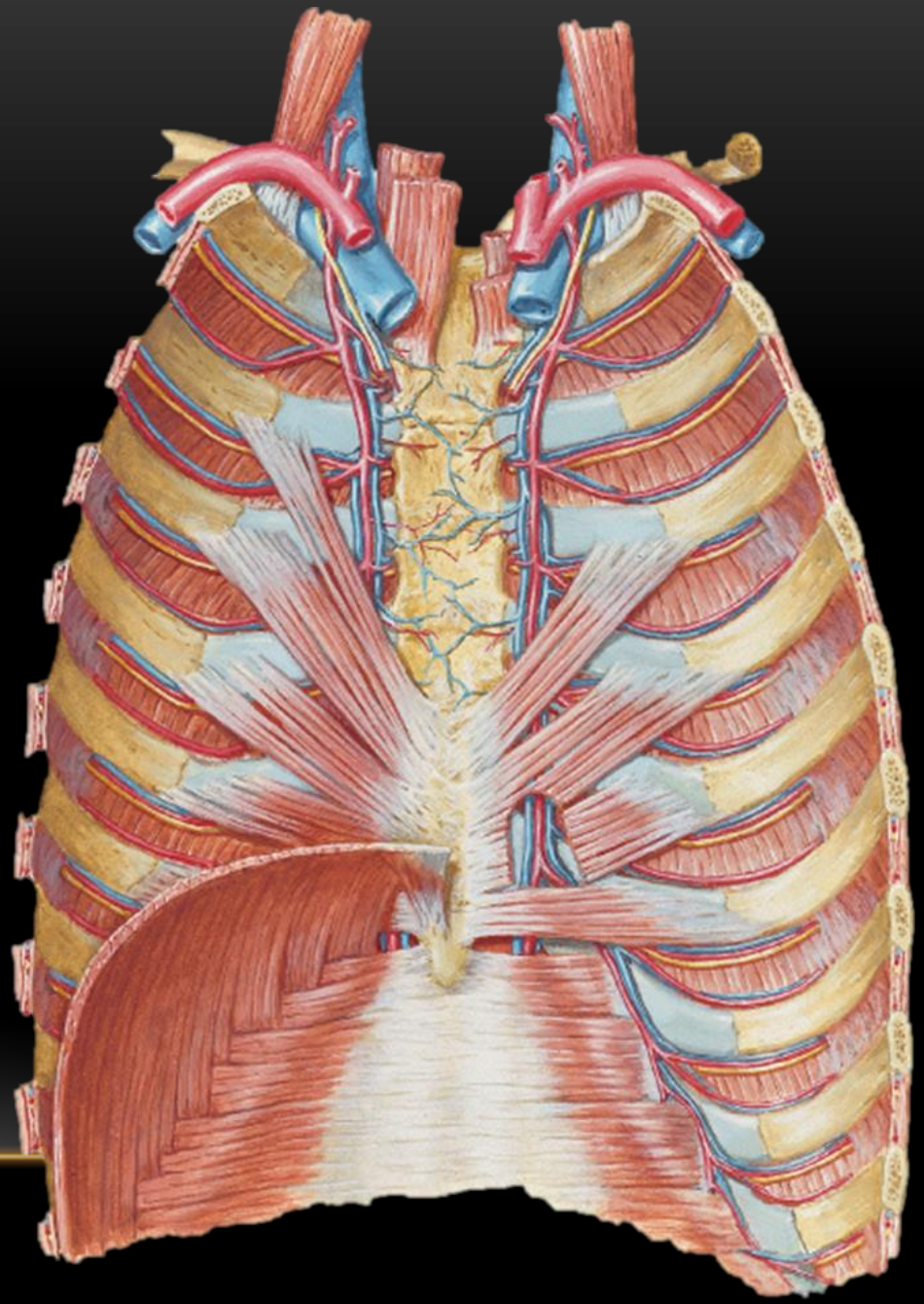


Innermost intercostal muscles

The deep layers of the internal intercostal muscles which are separated from them by the neurovascular bundle.

They are composed of:

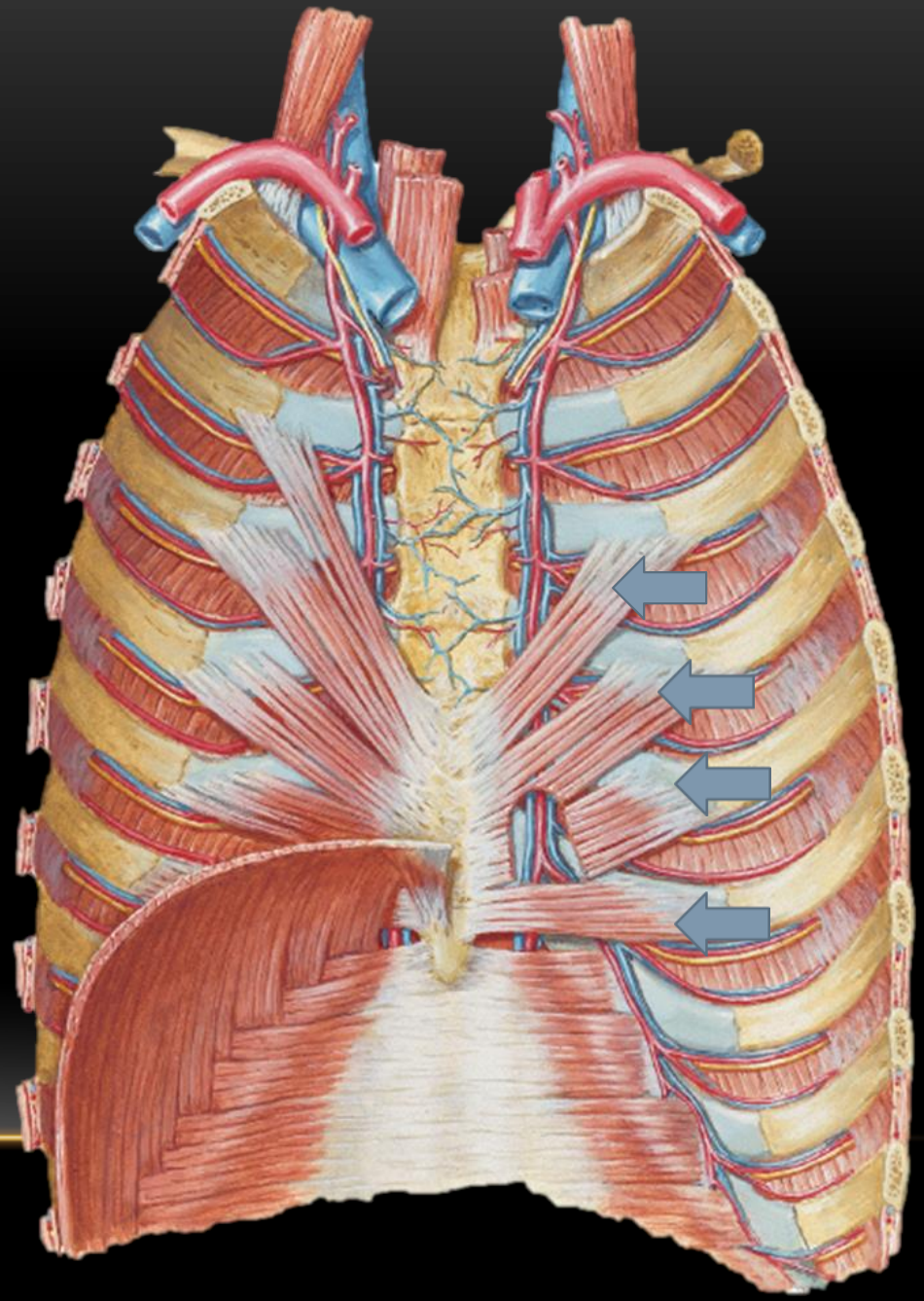
- Transversus thoracis (sternocostalis) muscle
- Intercostalis intimus
- Subcostalis muscle



Innermost intercostal muscles .. Transversus Thoracis

Lies anteriorly and formed by 4-5 slips .

Each slip arises from the back of the body of the sternum to the back of the costal cartilages of ribs 2-6.

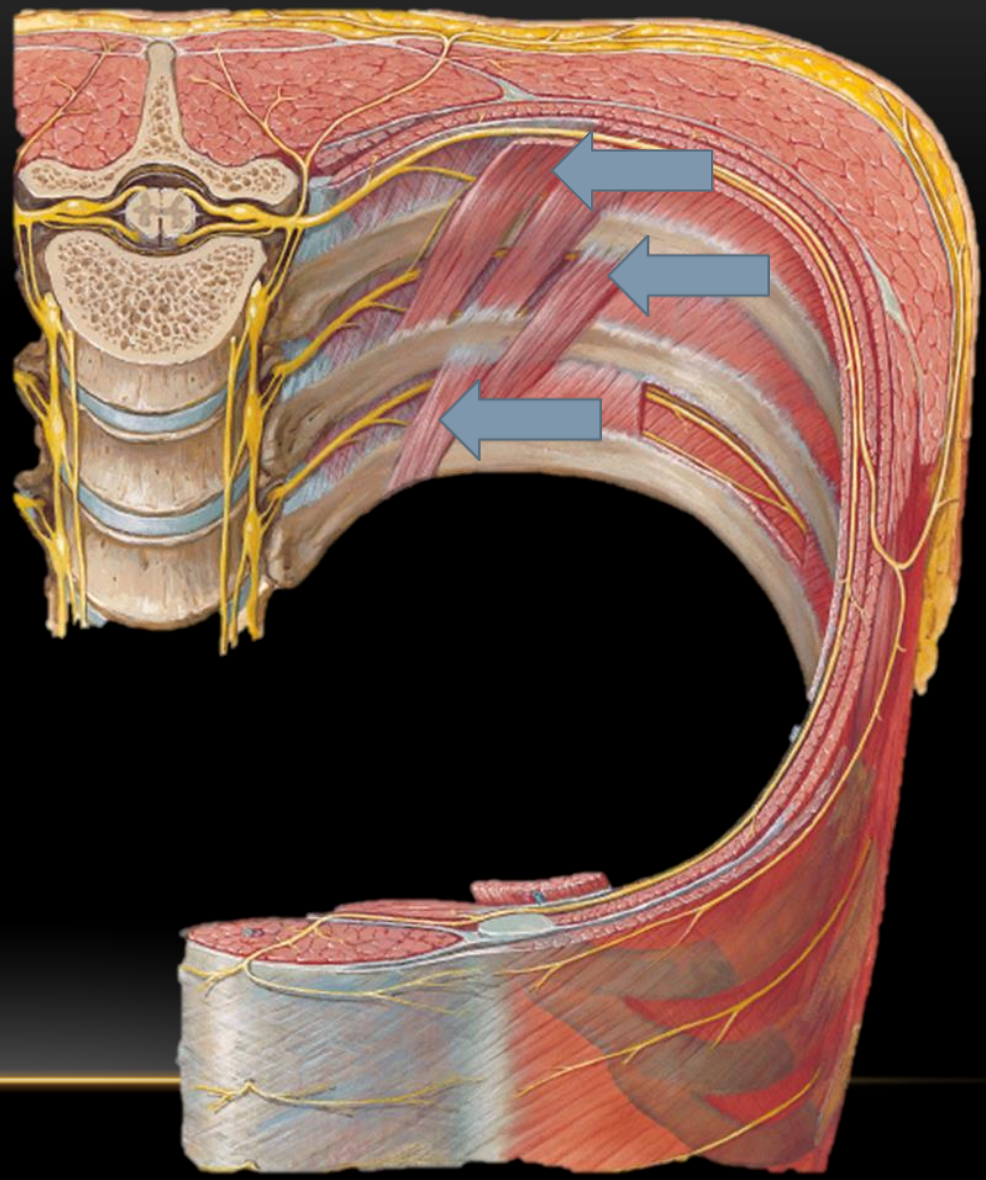


Innermost intercostal muscles .. Subcostalis

Well developed in the lower part of the thorax.

Arises from the inner surface of the rib close to the angle and is inserted to the inner surface of the rib below.

This muscle(s) depresses the rib.

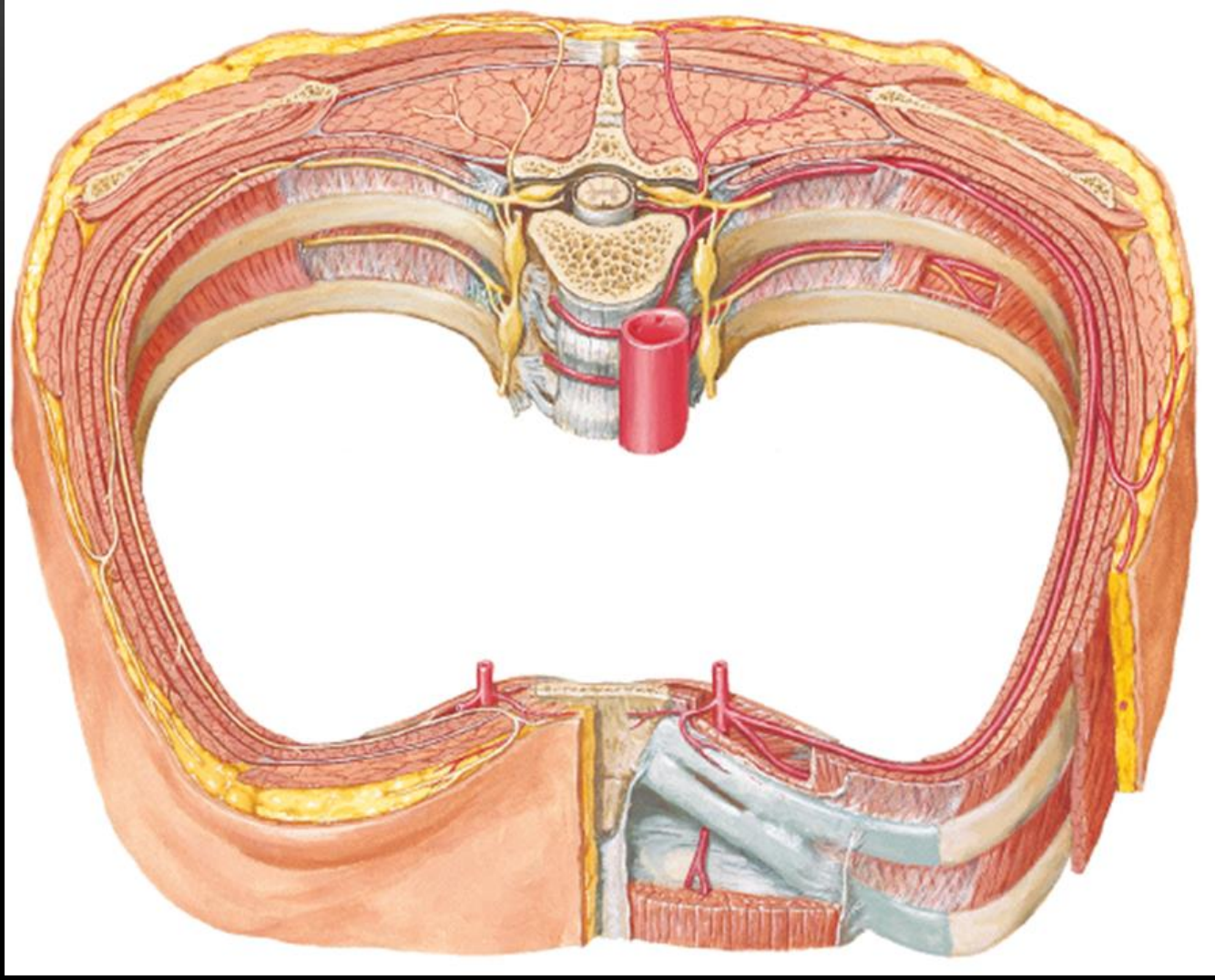


Intercostal nerves

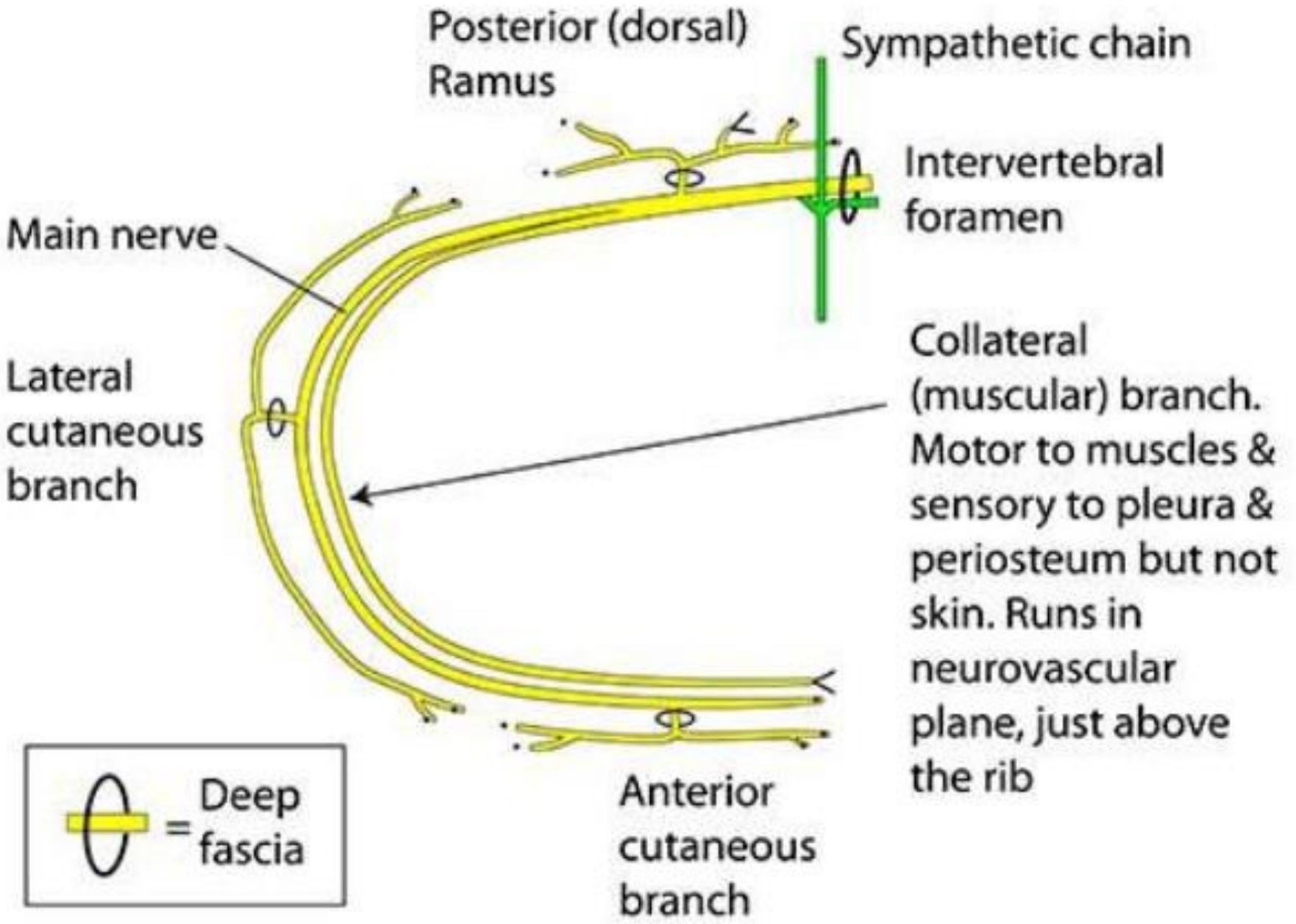
Intercostal nerves 3-7 are typical intercostal nerves.

Intercostal nerves 1-2 & 8-12 are atypical.

- **No. 1**: ascends infront of the neck of the 1st rib to join the cervical plexus.
- **No. 2**: its lateral cutaneous branch does not divide. It forms the intercostobrachial nerve.
- **No. 7-11**: are thoracoabdominal; they supply abdominal muscles.
- **No. 12**: is subcostal.



TYPICAL INTERCOSTAL NERVE

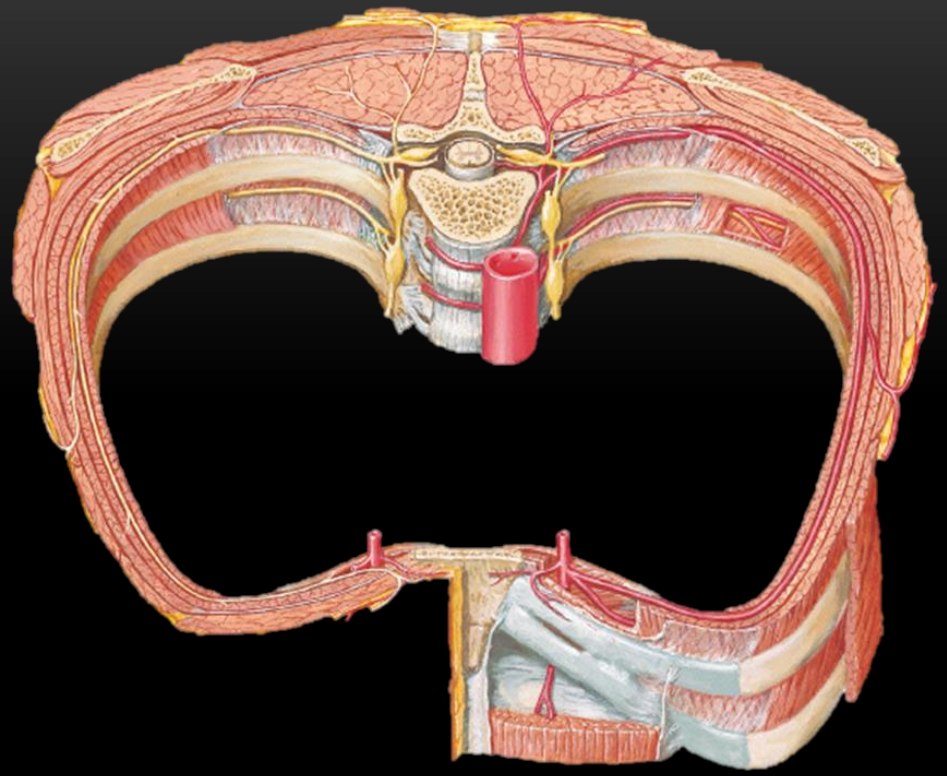


Typical intercostal nerves .. 1

They are the nerves in the intercostal spaces 3-6.

They are the primary rami of the of the corresponding thoracic nerves.

Runs forward between the internal intercostal membrane and the pleura then between the internal and innermost intercostal muscles.



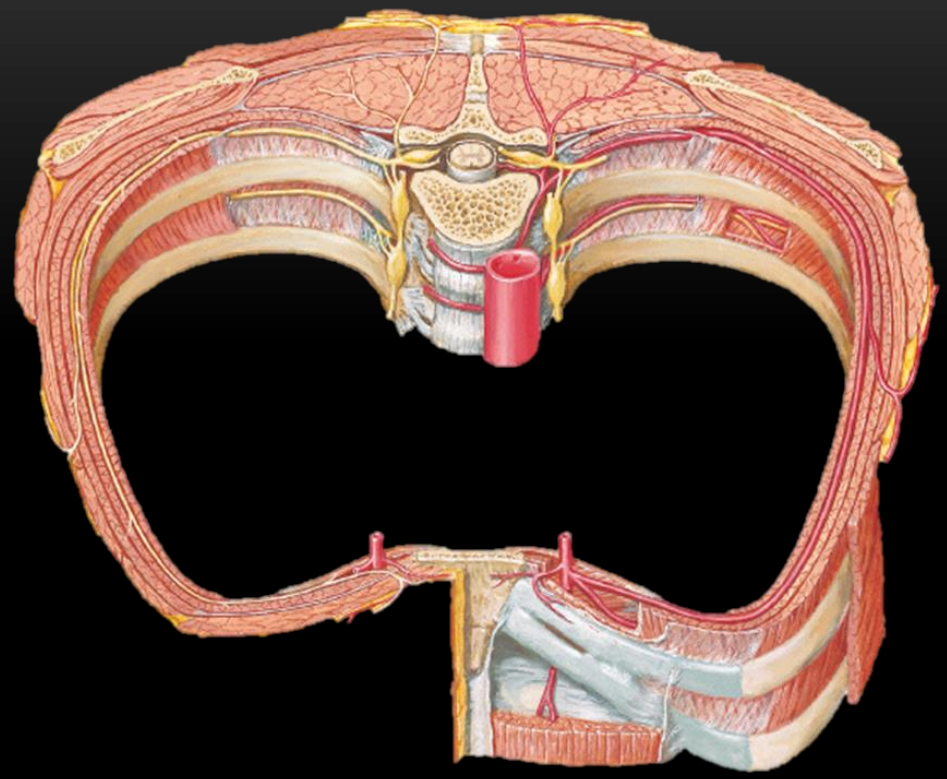
Typical intercostal nerves .. 2

At the mid-axillary line, each nerve gives the lateral cutaneous branch.

- The lateral cutaneous branch pierces the internal and external intercostal muscles to supply the skin on the side of the thorax.

The intercostal nerve continues and at the parasternal line pierces the internal intercostal muscle, the anterior intercostal membrane and the pectoralis major.

- It divides into medial and lateral branches to supply the skin on the front of the thorax.



Typical intercostal nerves .. 3 (Branches)

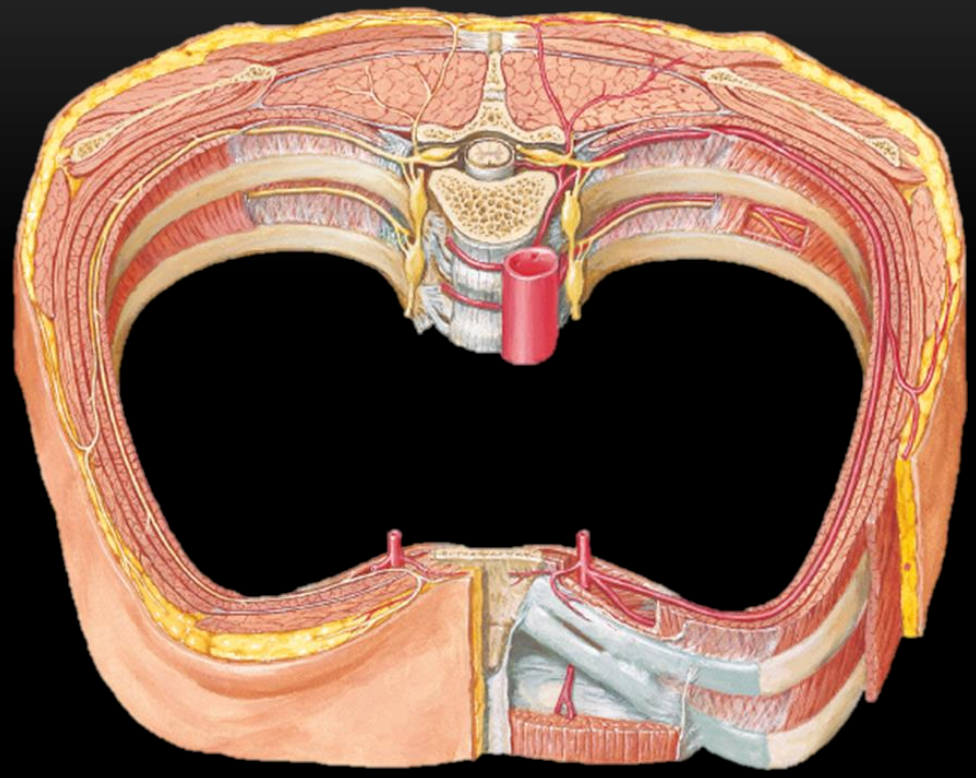
White ramus communicans to the nearby sympathetic ganglion (from which it receives grey ramus communicans).

Collateral muscular branches to the intercostal muscles.

Articular branches to the joint of the ribs.

Lateral cutaneous branch.

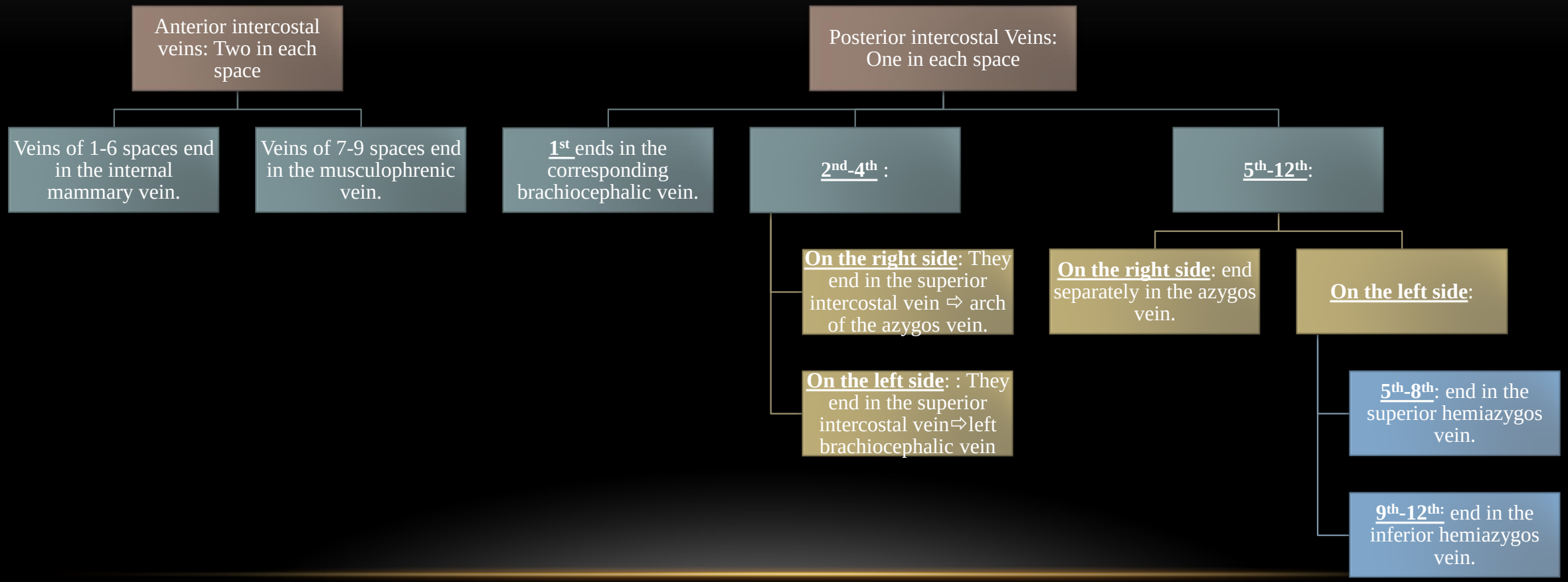
Anterior cutaneous branch.



Intercostal arteries

Anterior intercostal arteries	Posterior intercostal arteries
2 in every space: 1- Upper one anastomoses with the posterior intercostal artery. 2- Lower one anastomoses with the collateral branch of the posterior intercostal artery.	Single, gives collateral branch.
9 in number: 1- Upper 6 originate from the internal mammary artery. 2- Lower 3 originate from the musculophrenic artery.	11 in number and 1 subcostal artery: 1- Upper 2 originate from superior intercostal artery. 2- From 3-12 originate from the descending aorta.

Intercostal veins



Internal thoracic artery ..1/2

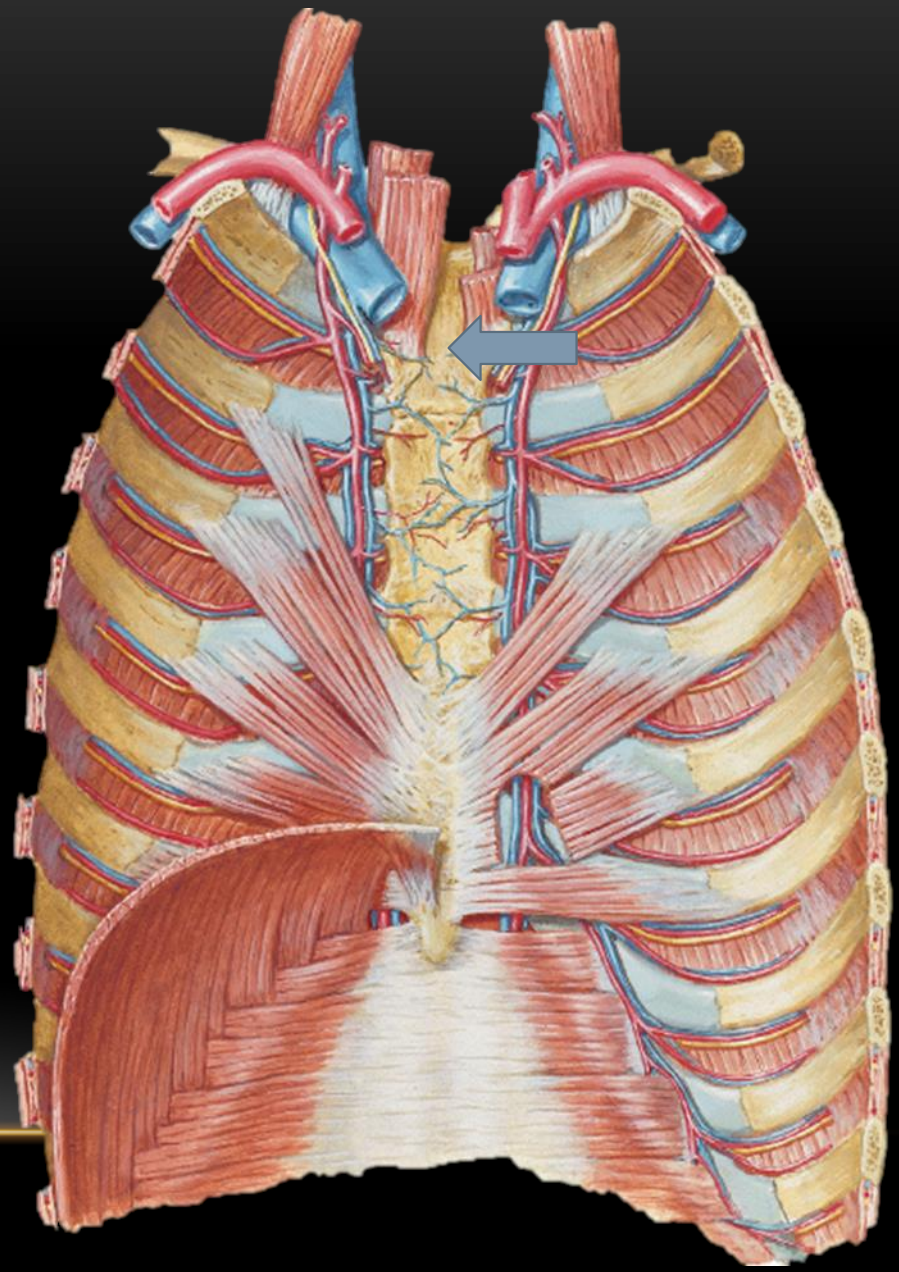
Still called clinically the internal mammary artery.

Arises from the lower surface of the first part of the subclavian artery.

Descends downwards behind the upper 6 costal cartilages, 1 cm from the margin of the sternum.

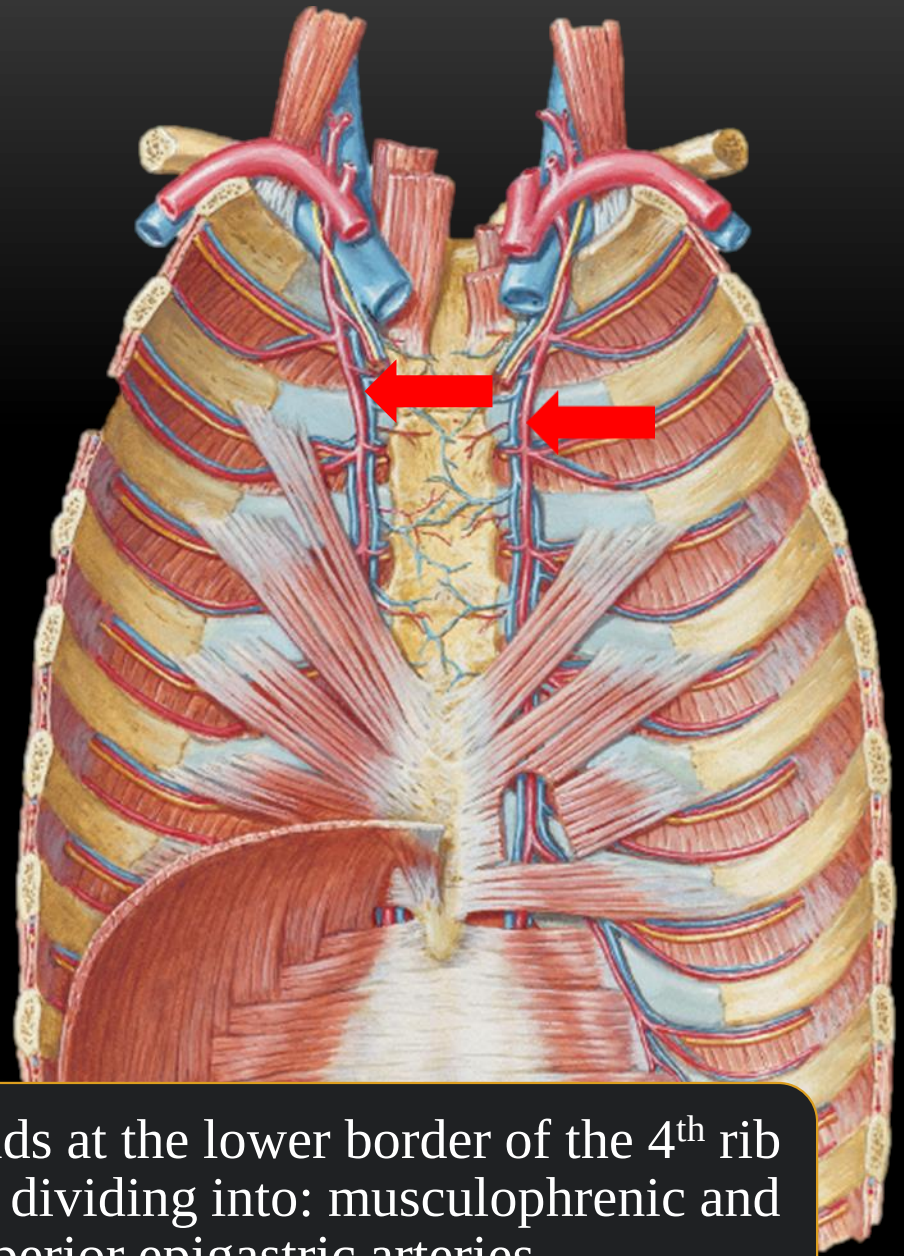
It divides in the 6th intercostal space into:

- Superior epigastric artery.
- Musculophrenic artery.



Internal thoracic artery ..2/2 Branches

- Anterior intercostal branches in the upper 6 intercostal space.
- Perforating branches to the breast (in the 2nd-4th intercostal spaces).
- Muscular branches to the transversus thoracis.
- Pericardial branches to the upper part of the pericardium.
- Mediastinal branches.
- Pericardio-phrenic branches to accompany the phrenic nerve.



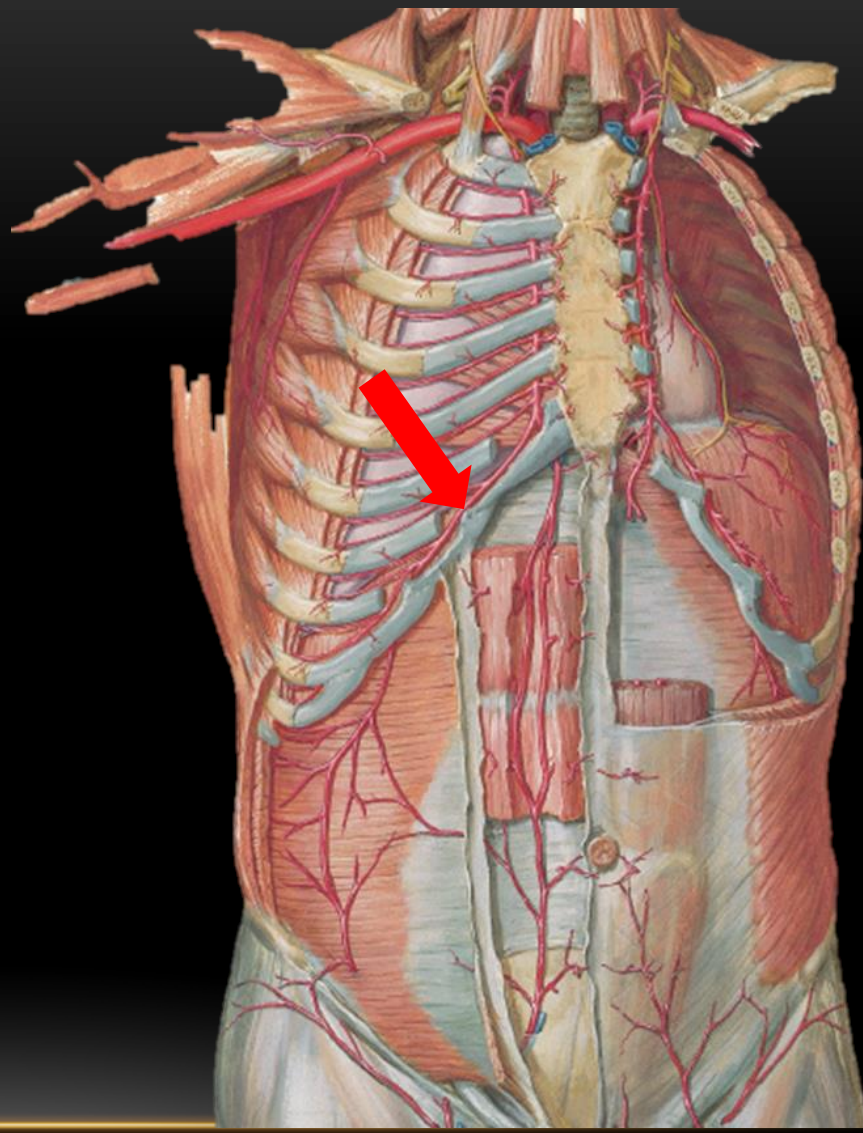
Ends at the lower border of the 4th rib by dividing into: musculophrenic and superior epigastric arteries

Branches of the musculophrenic artery

Anterior intercostal arteries in the intercostal spaces 7-9.

Pericaridal branches to the lower part of the pericardium.

Muscular branches to the abdominal muscles.

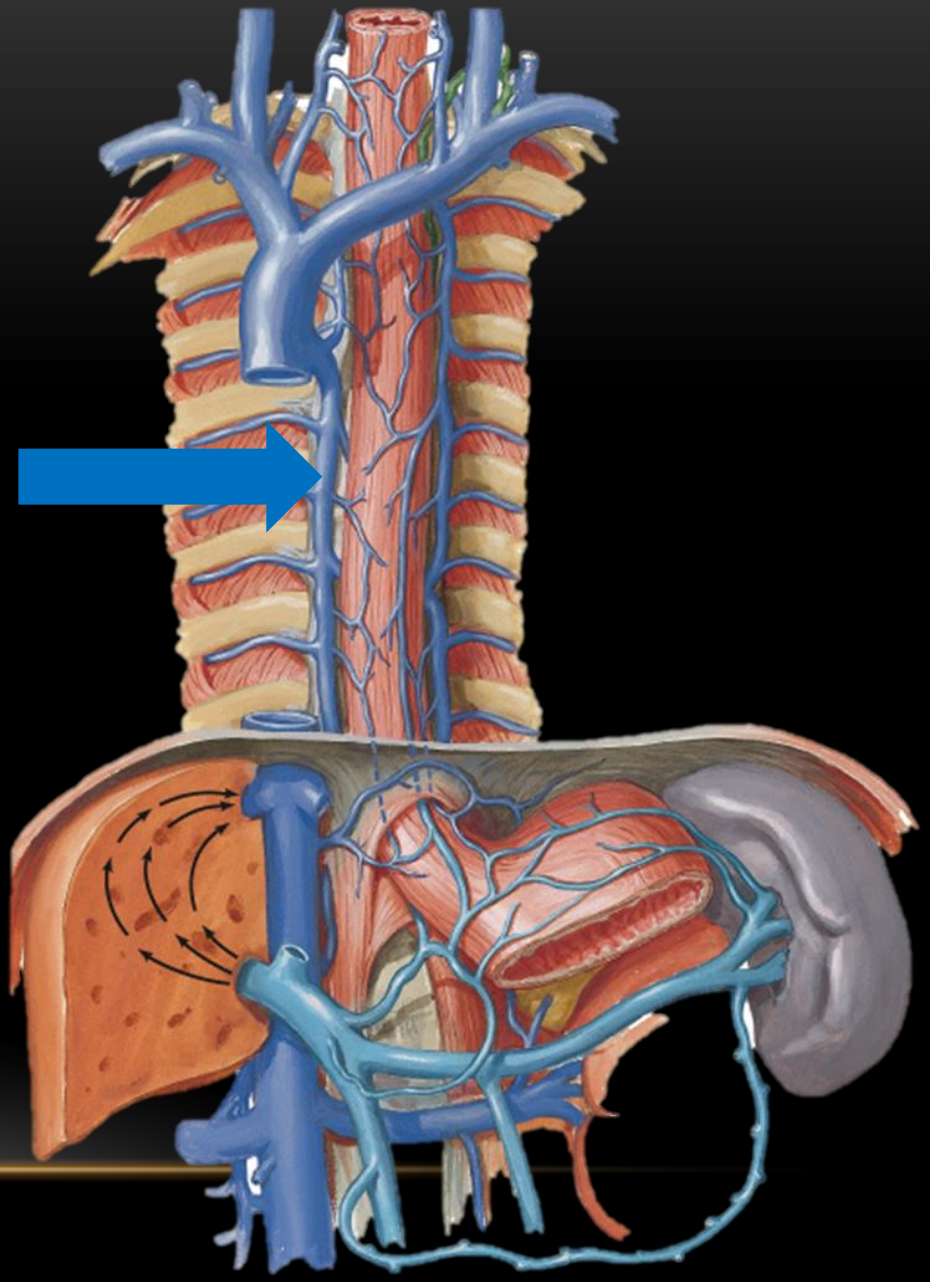


Azygos vein

Arises in the abdomen either:

- From the back of the inferior vena cava at the level of L2.
- As a continuation of the right subcostal vein.
- By union of the right subcostal and right ascending lumbar veins.

Enters the thorax through the aortic opening and ascends upwards. It passes behind the root of the right lung then arches above it to terminate in the superior vena cava at the level of T4.

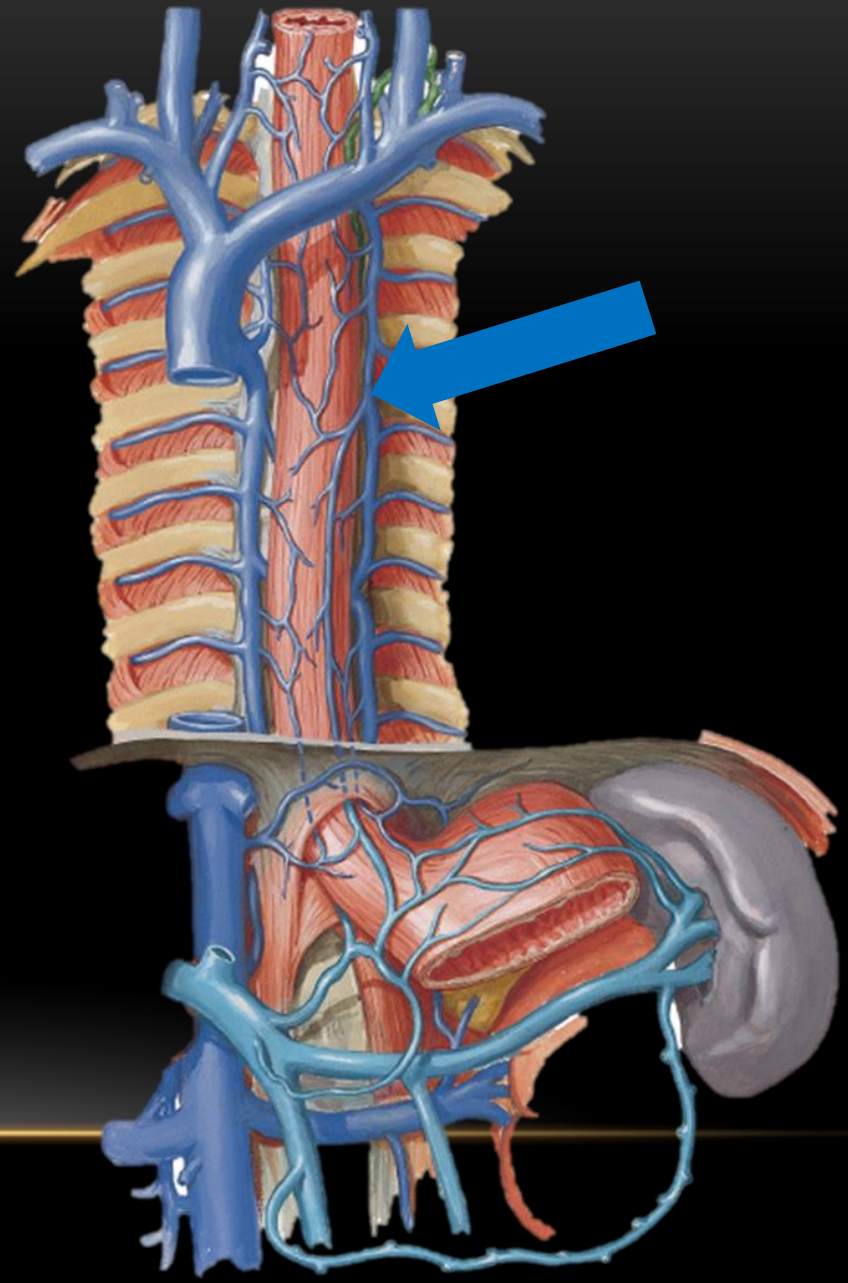


Superior (accessory) hemiazygos vein

Receives the posterior intercostal veins in the intercostal spaces 5-8.

Descends to the left of the vertebral column till the level of T8.

Curves behind the aorta, esophagus and thoracic duct to end in the azygos vein.

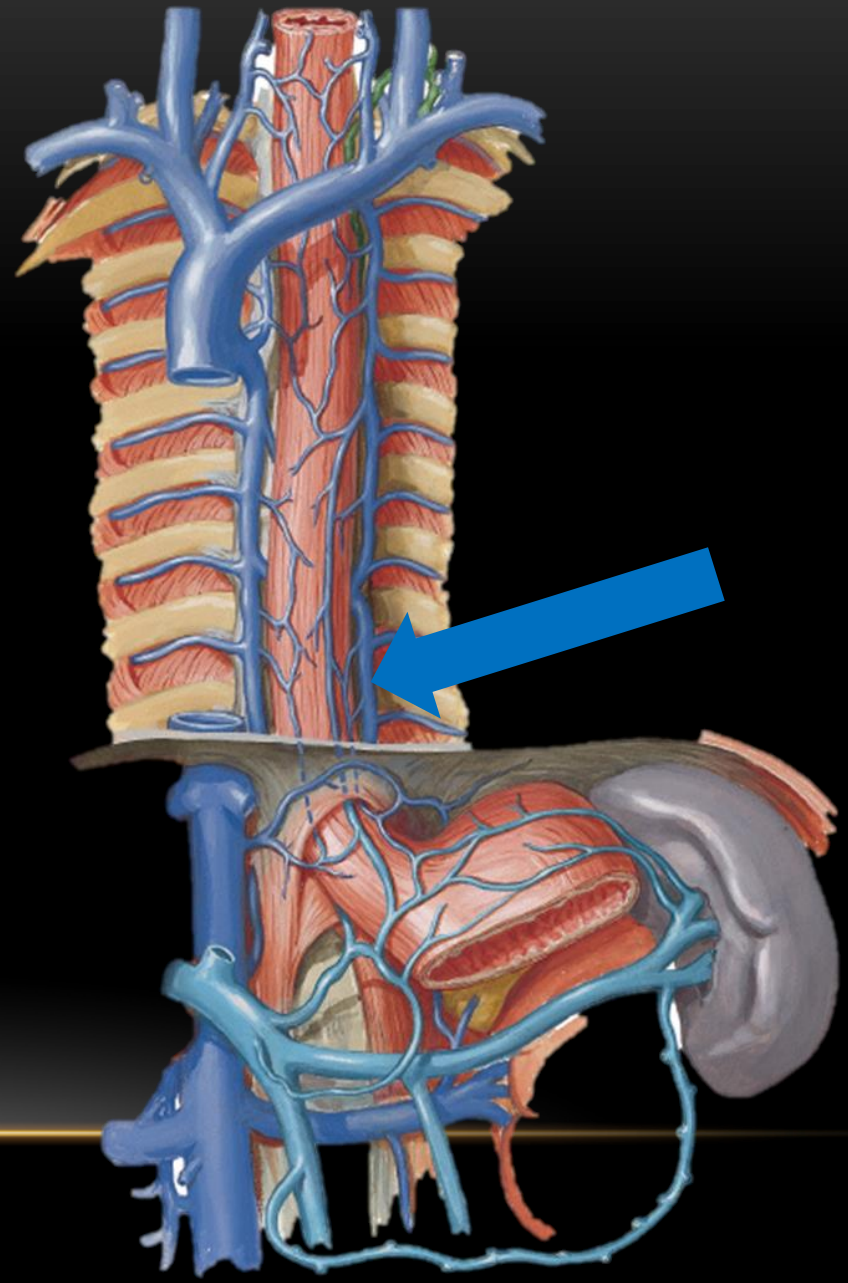


Inferior hemiazygos vein

Arises in the abdomen from either:

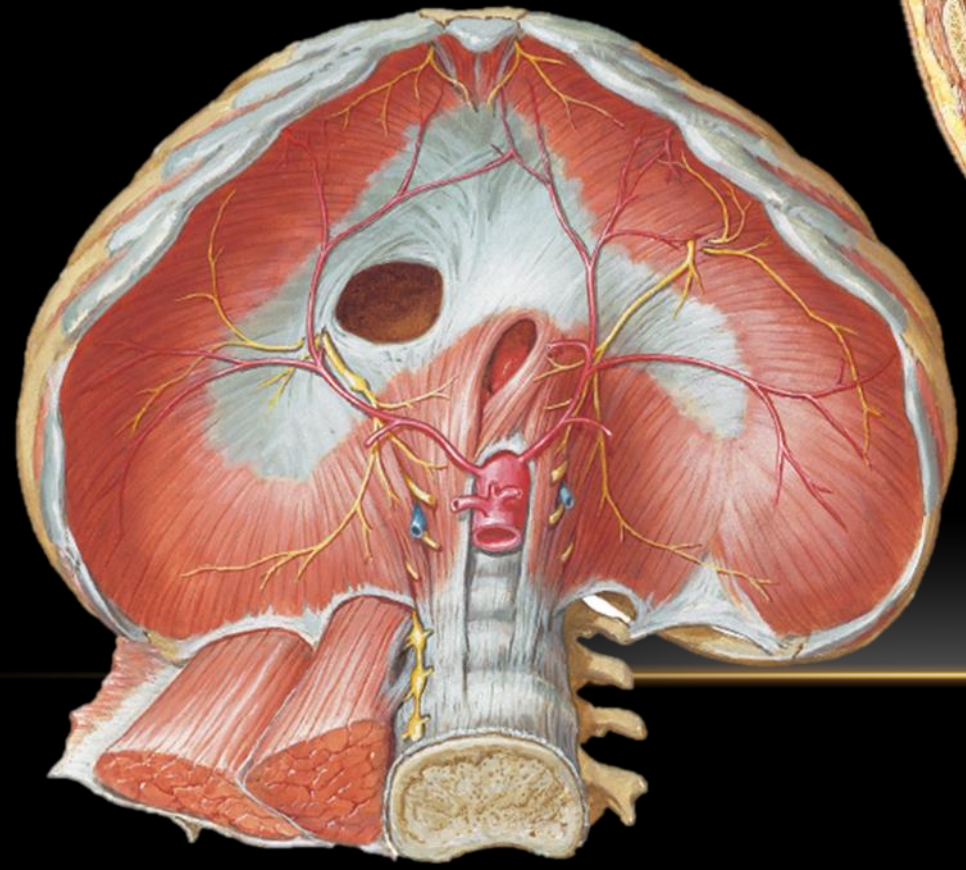
- Left renal vein.
- Union of the left ascending lumbar vein and the left subcostal vein.

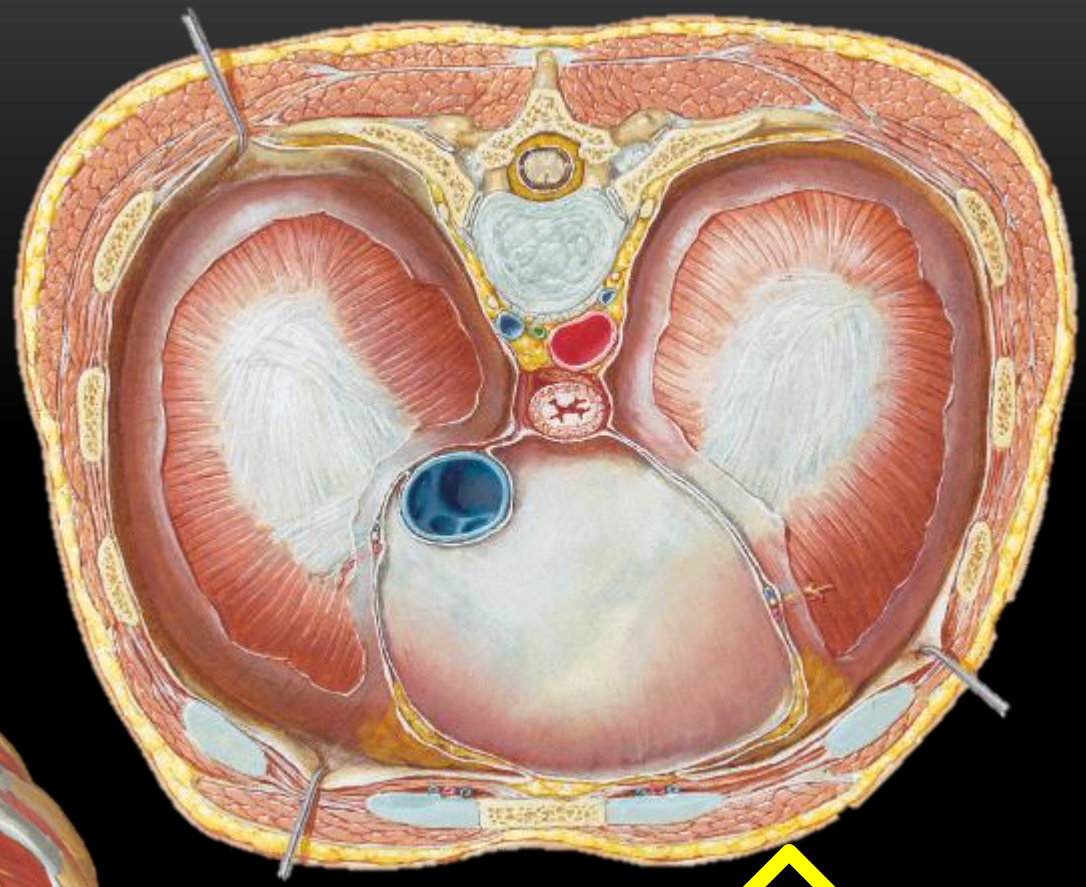
ascends through the left crus of the diaphragm till the lower border of T8 where it curves to the right to terminate in the azygos vein.



Inferior Thoracic Aperture
(Thoracic outlet)
(The Diaphragm)

Inferior view
(Abdominal)

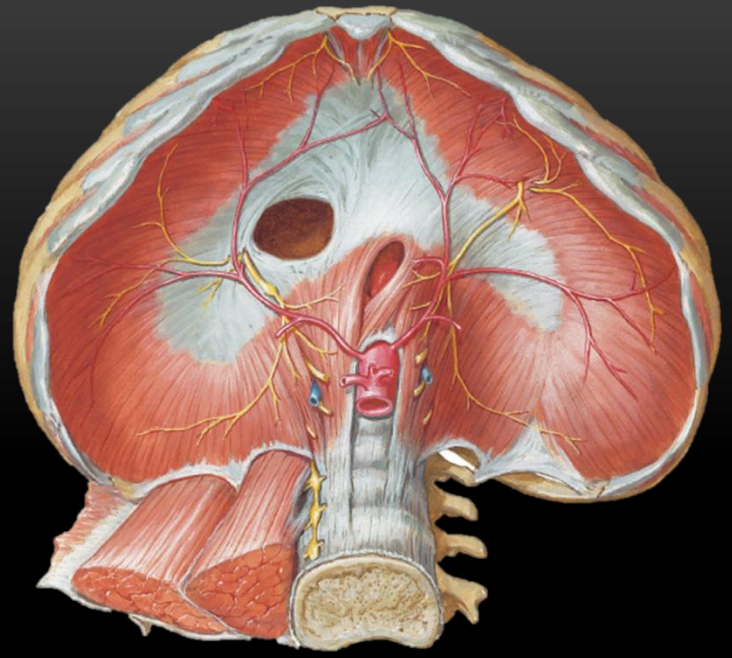


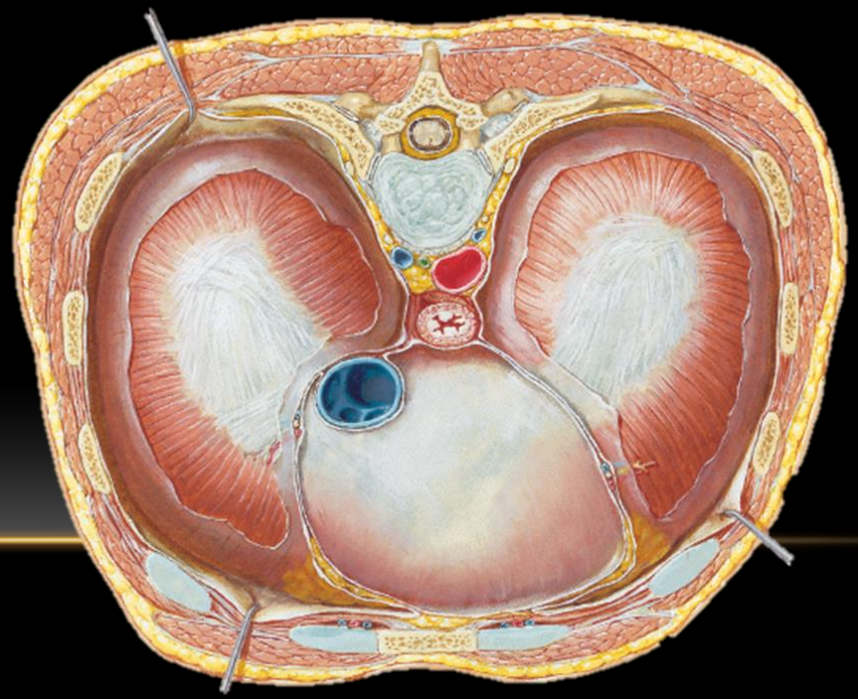


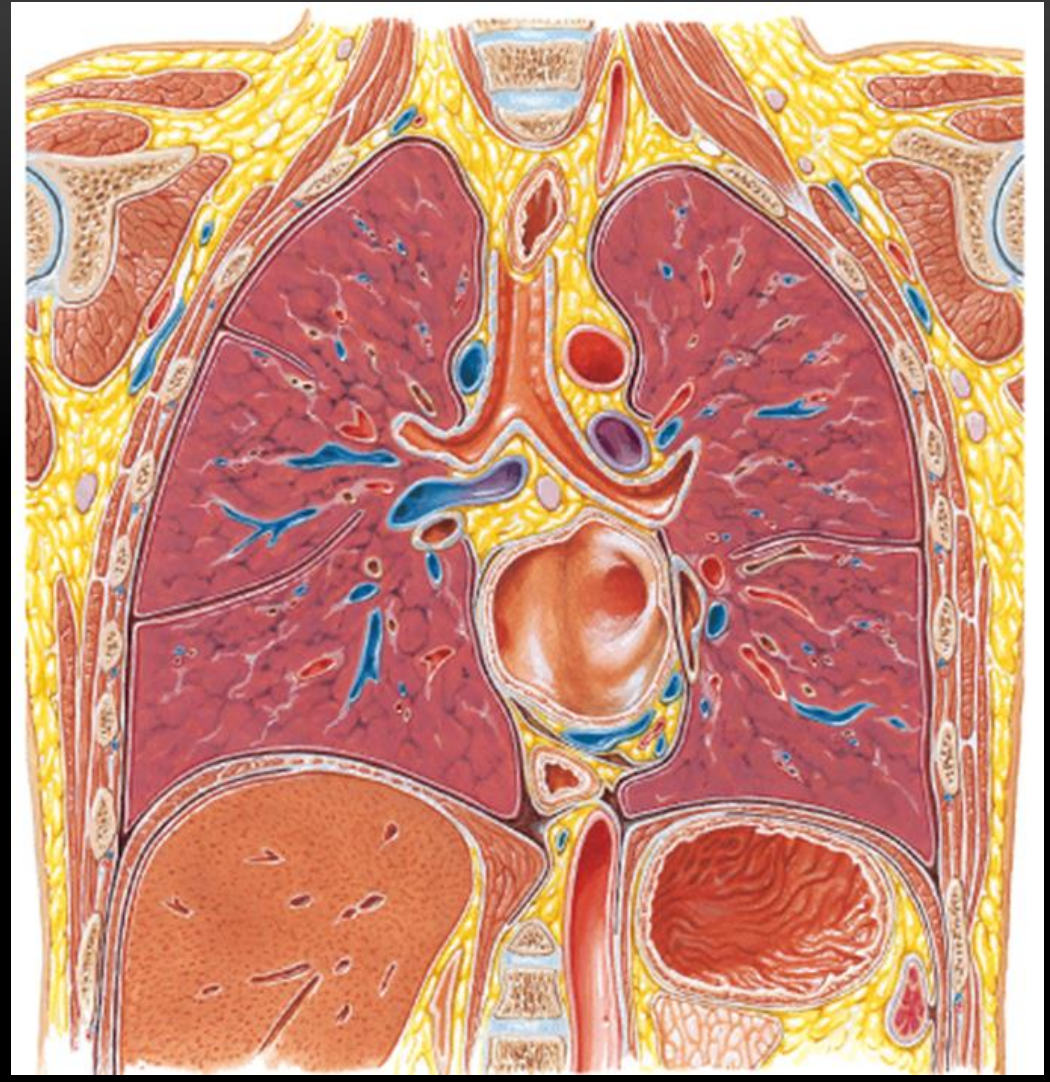
Superior view
(Thoracic)

It is a dome-shaped Musculo-fibrous septum that separates the thoracic from the abdominal cavity, its convex upper surface forming the floor of the thorax, and its concave under surface forming the roof of the abdomen.

Its peripheral part consists of muscular fibers that take origin from the circumference of the inferior thoracic aperture and converge to be inserted into a central tendon.





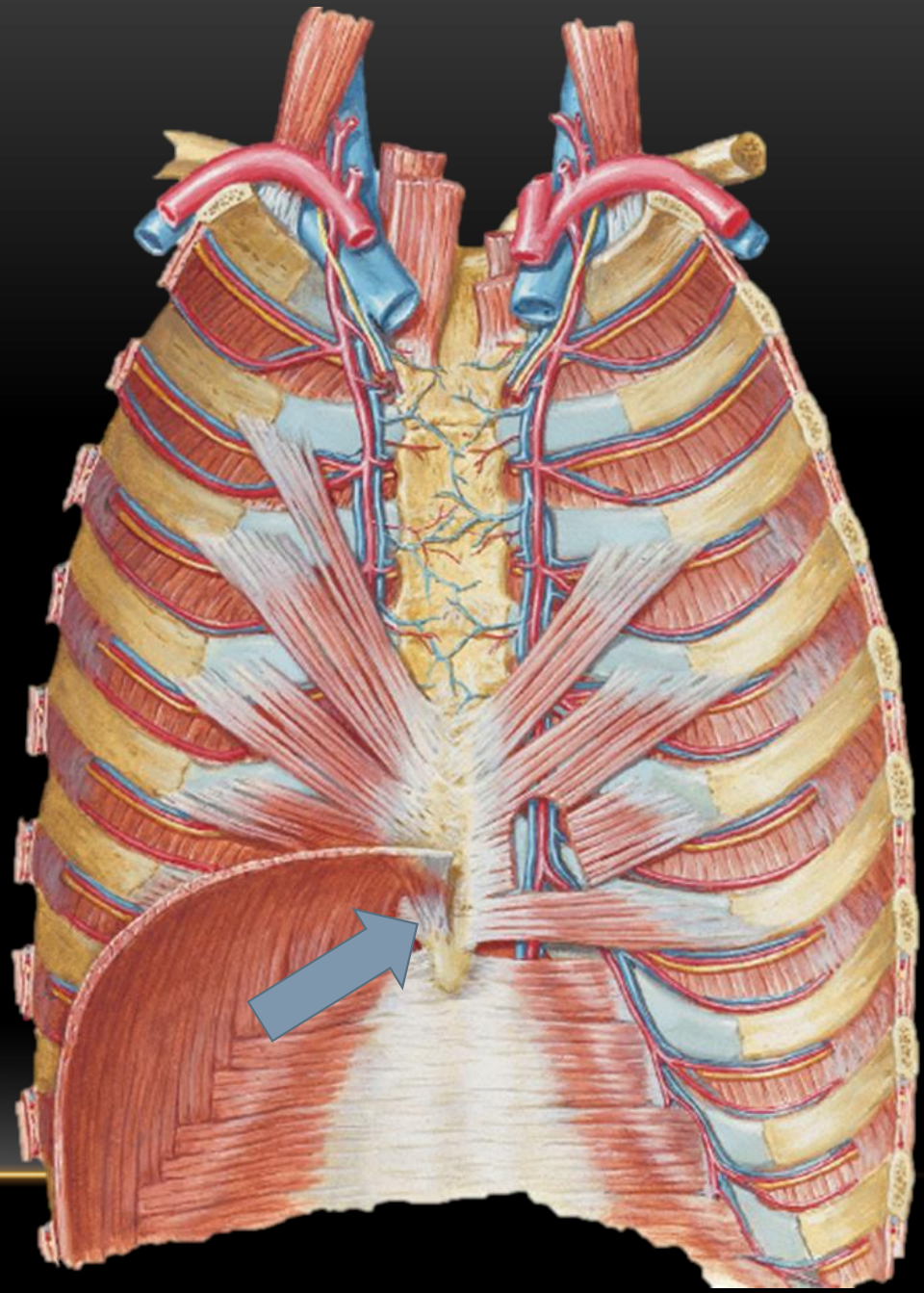


It is elevated on the right side due to the presence of the liver

Origin of the diaphragm ..1 / 3

Sternal origin:

- By 2 slips the back of the xiphoid process

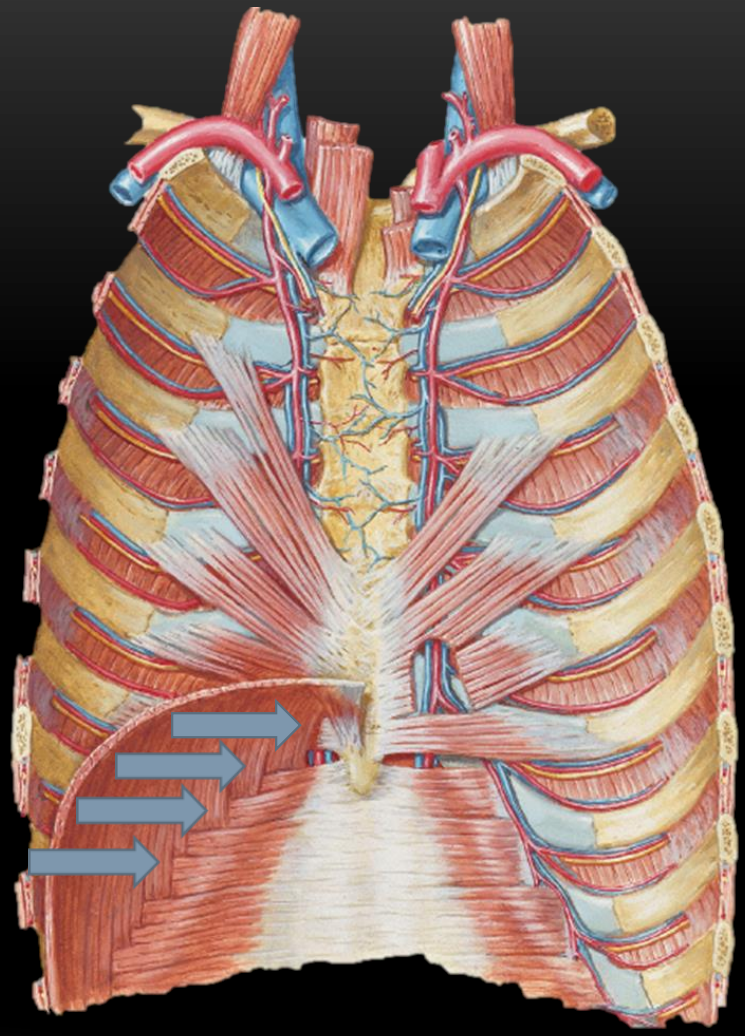


Origin of the diaphragm ..2 / 3

Costal origin:

- By 6 slips from the inner surface of the lower 6 ribs and their costal cartilage.

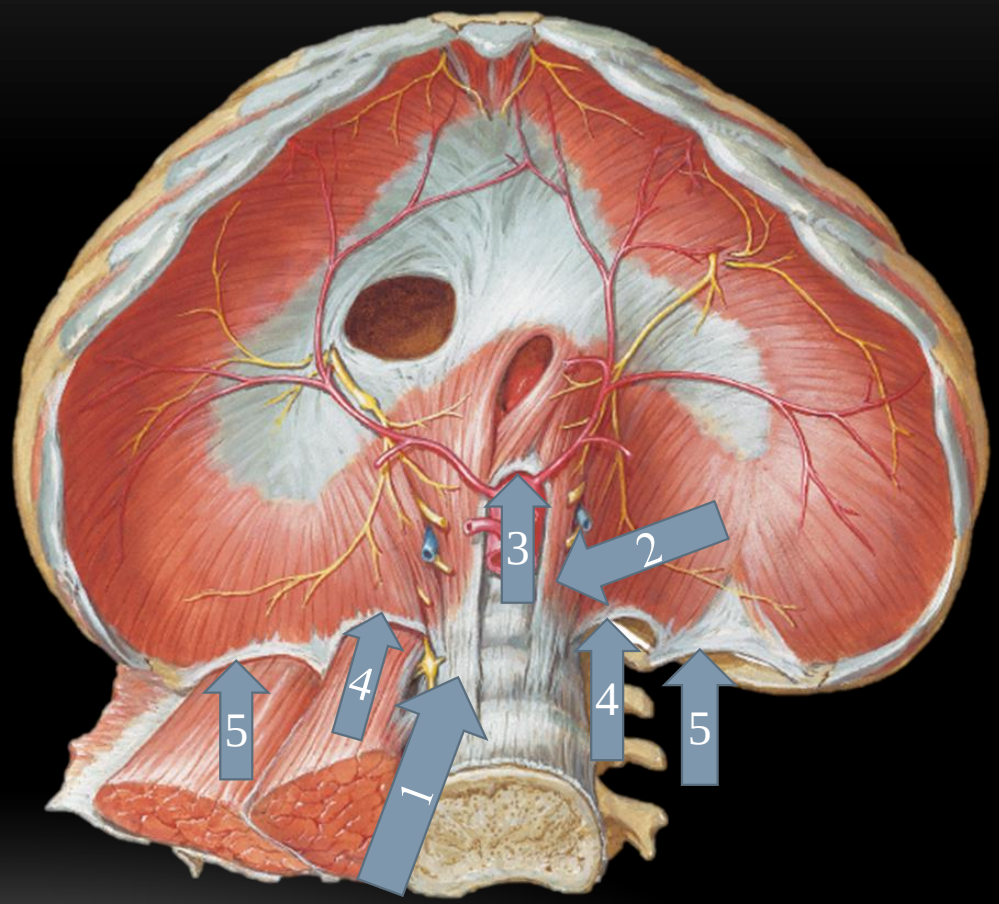
The slips of the costal origin interdigitate with the transversus abdominis muscle



Origin of the diaphragm ..3 / 3

Vertebral origin:

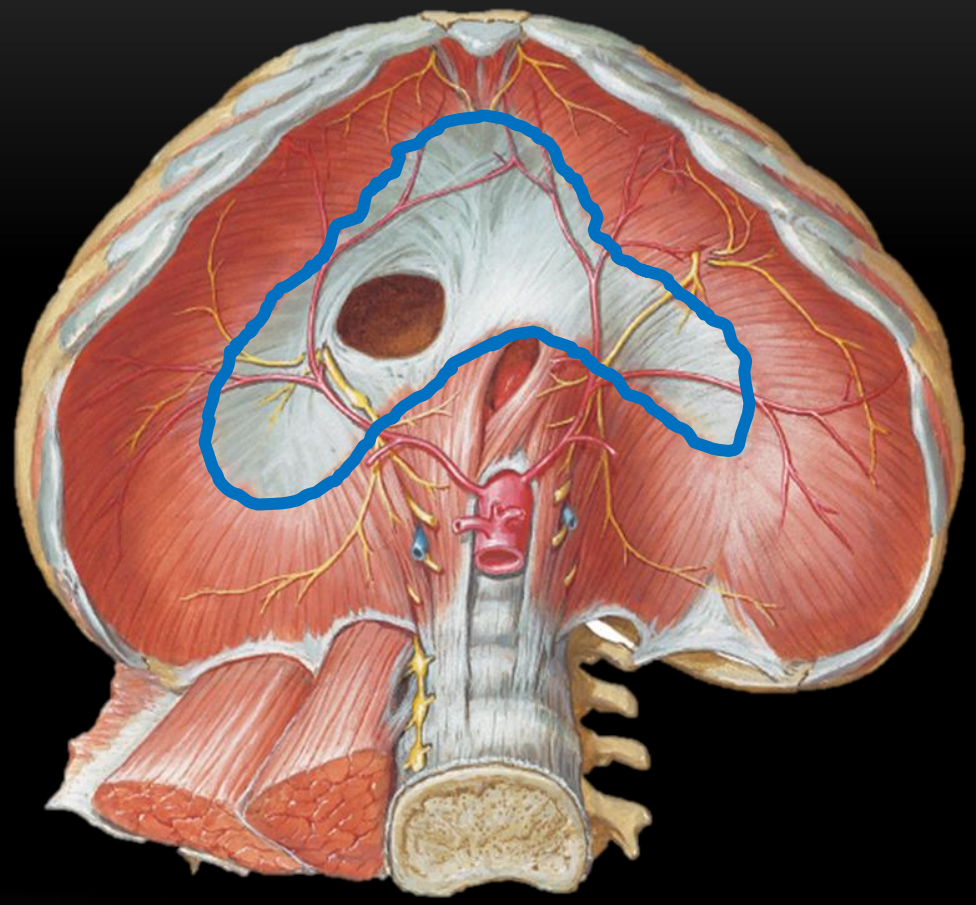
- **Right crus**: from the bodies of the upper 3 lumbar vertebrae (1).
- **Left crus**: from the bodies of the upper 2 lumbar vertebrae (2).
- **Median arcuate ligament**: arches over the aorta between the right and left crura (3).
- **2 medial arcuate ligaments**: arch over the psoas major muscles, each extends from the corresponding crus to the tip of the transverse process of the L1 (4).
- **2 lateral arcuate ligaments**: arch over the quadratus lumborum muscles, each extends from the transverse process of L1 to the 12th rib (5).



Insertion of the diaphragm

It is inserted into the central tendon.

The central tendon is shifted anteriorly (not central in position).



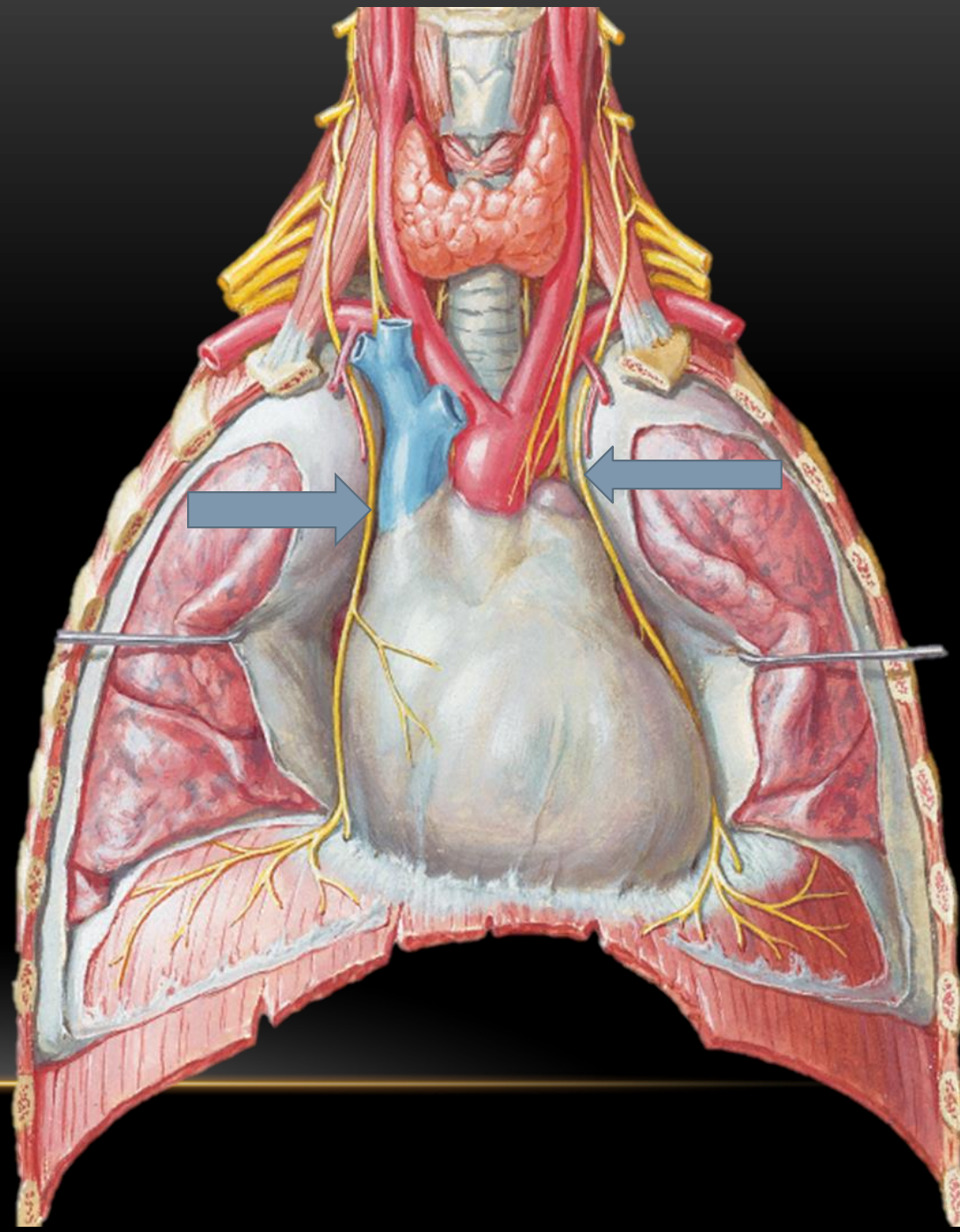
Innervation of the diaphragm

Right and Left Phrenic nerves (Mainly C4).

Both nerves supply motor fibres to the diaphragm and sensory fibres to the fibrous pericardium, mediastinal pleura, and diaphragmatic peritoneum.

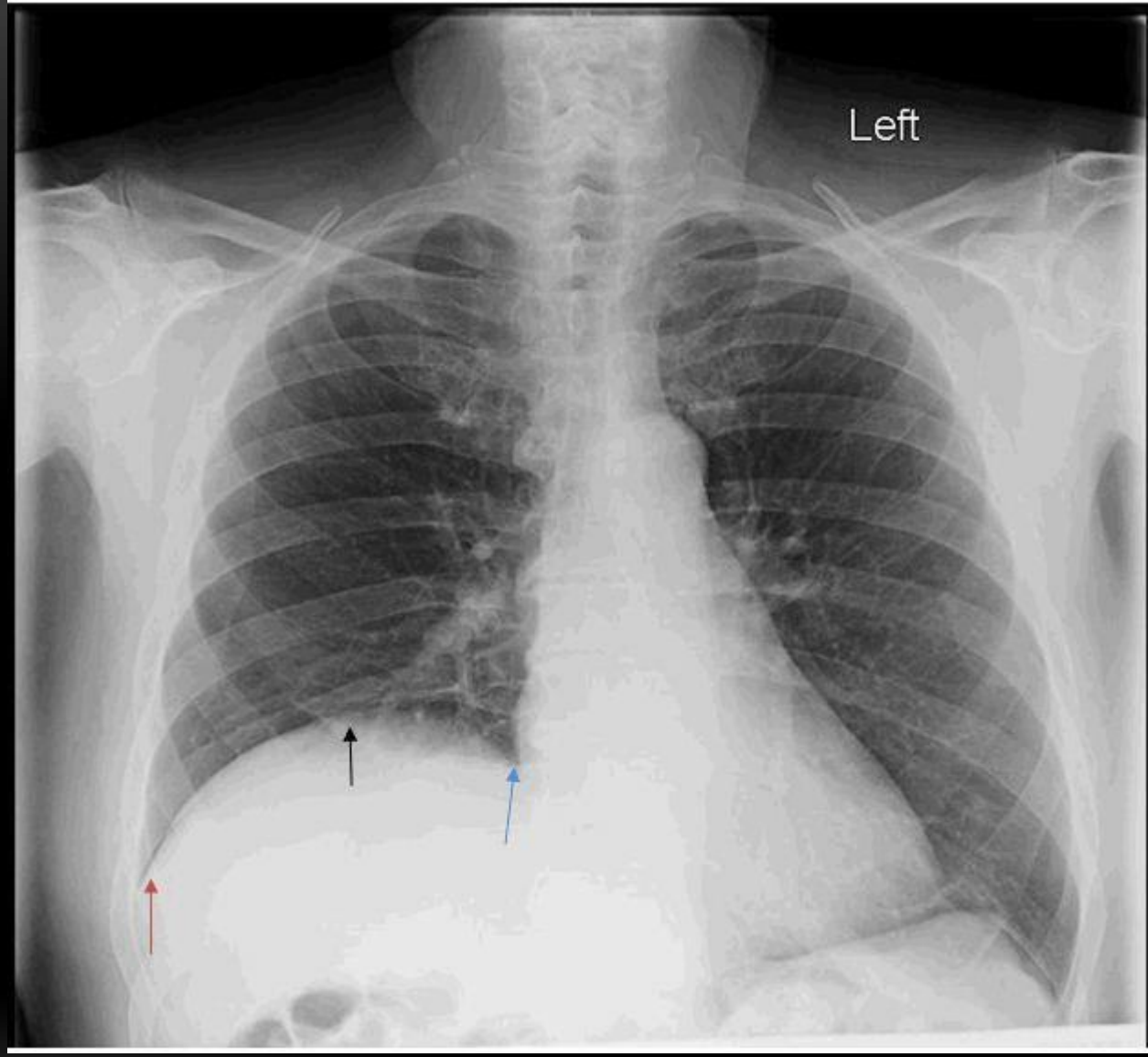
The pericardiaco-phrenic arteries and veins travel with their respective phrenic nerves.

The accessory phrenic nerve is a branch of the nerve to the subclavius and connects to the phrenic nerve in the thorax or the root of the neck. It may contain numerous phrenic nerve fibers.



Clinical note

Injury of the phrenic nerve can occur by multiple mechanisms; one common cause is from surgery (iatrogenic), primarily thoracic and cardiac surgery. The phrenic nerve can also be damaged from blunt or penetrating trauma, metabolic diseases like diabetes, infectious causes such as herpes zoster, direct invasion by tumor, neurological diseases such as cervical spondylosis and multiple sclerosis, myopathy (i.e., muscular dystrophy) and immunological disease (e.g., Guillain-Barre syndrome).



Black arrow = dome of the diaphragm (Elevated)

Red arrow = costophrenic angle

Blue arrow = cardiophrenic angle.

Major openings of the diaphragm ..1 / 3

Aortic Hiatus

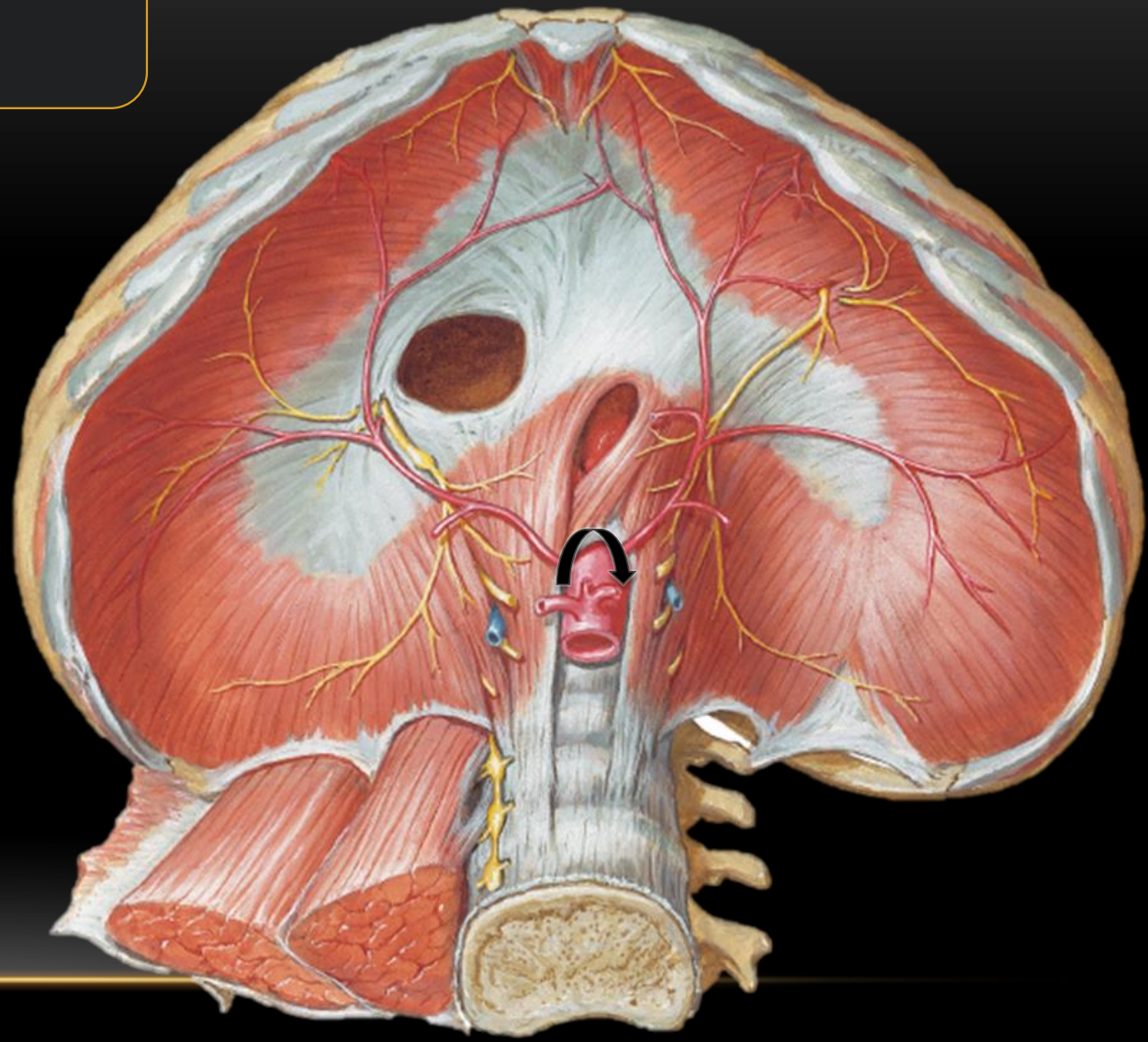
Lies exactly in the mid line at the level of the lower border of T12.

Lies behind the median arcuate ligament.

It transmits the:

- Aorta.
- Azygos vein.
- Thoracic duct.
- Lymphatics from the thorax to the cisterna chyli.

The blood flow in the aorta is not affected by contraction of the diaphragm.



Major openings of the diaphragm ..2 / 3

I. V. C. Hiatus

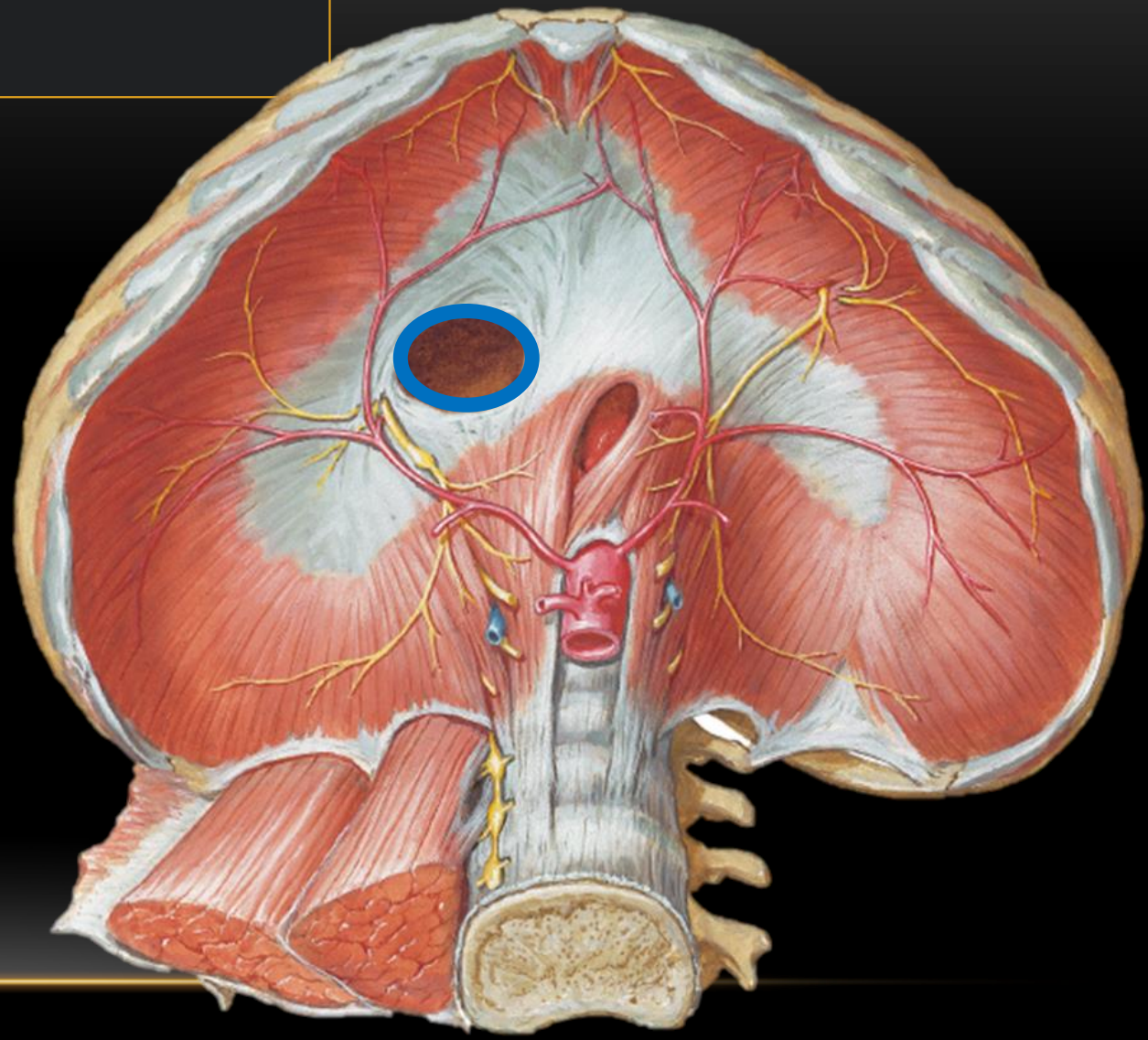
Lies one inch to the right of the mid line at the level of the lower border of T8.

Lies in the central tendon.

It transmits the:

- I. V. C.
- Right phrenic nerve.
- Lymphatics from the liver to the mediastinal lymph nodes.

The adventitia of I.V. C. fuses fibres of the central tendon



Major openings of the diaphragm ..3 / 3

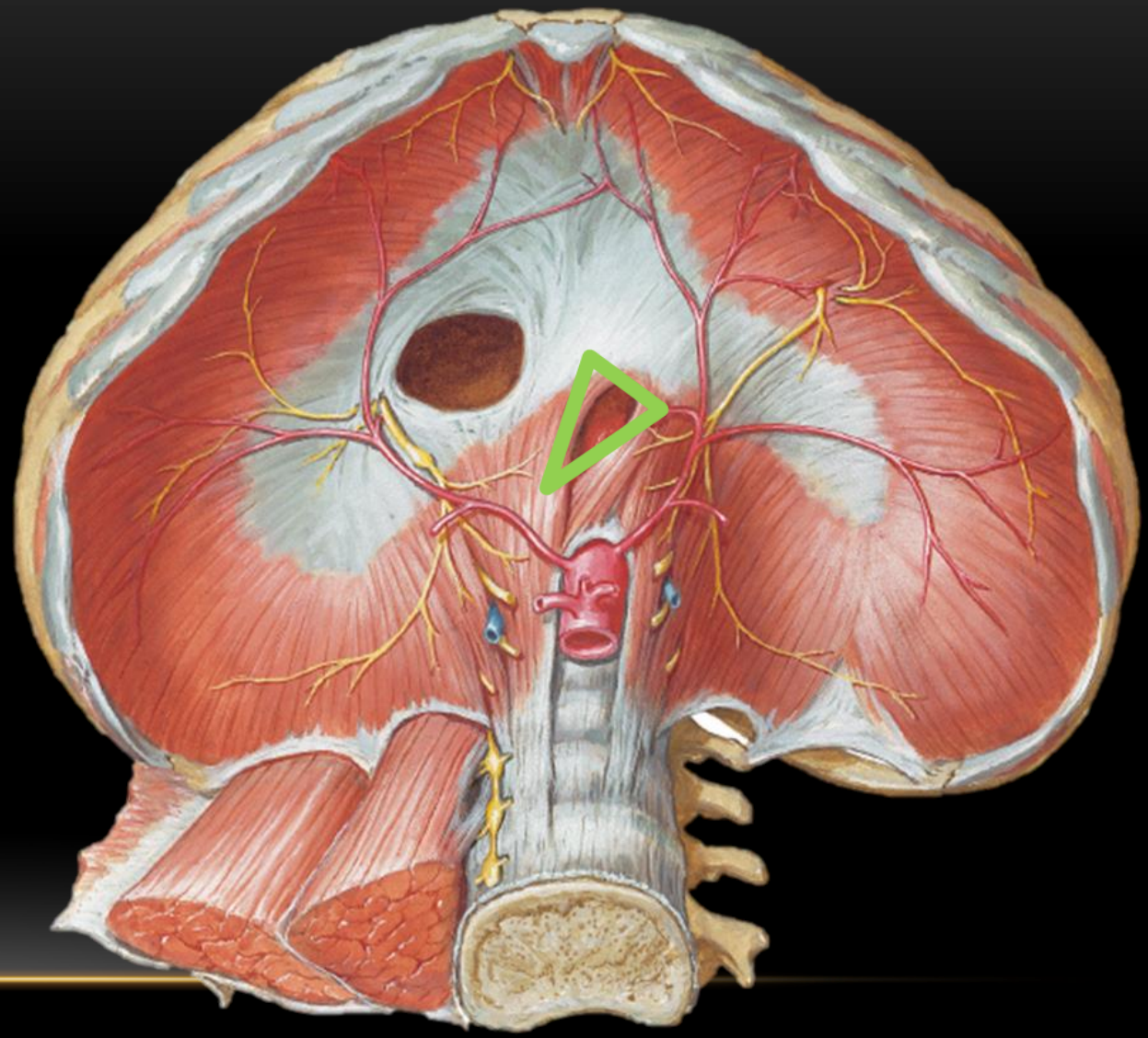
Esophageal Hiatus

Lies one inch to the left of the mid line at the level of the lower border of T10.

Lies in the left crus but is surrounded by a sling from the right crus. This acts as a physiological sphincter at the lower end of the oesophagus.

It transmits the:

- Esophagus.
- Anterior and posterior gastric nerves.
- Esophageal arteries and veins.



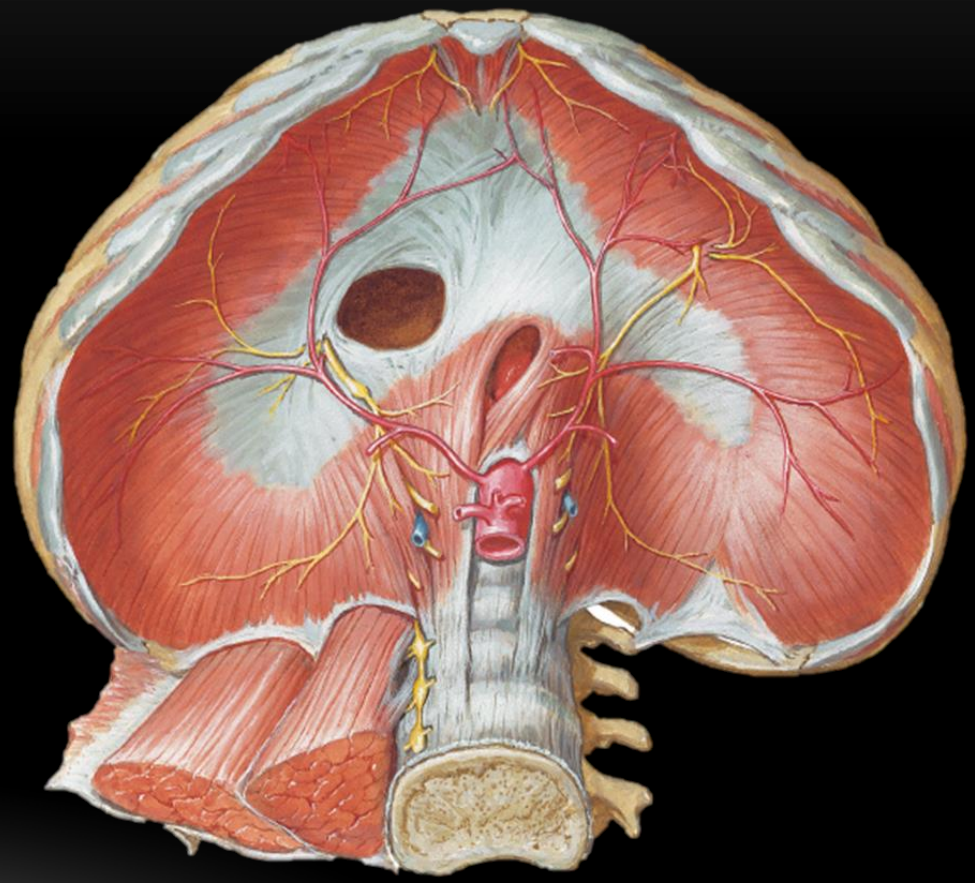
Minor openings of the diaphragm ..1 / 2

The superior epigastric artery passes between the sternal and costal origins of the diaphragm.

The musculophrenic artery passes between the 7^{th} and 8^{th} slips of costal origin.

The lower 5 intercostal nerves pass between all slips of costal origin of the diaphragm.

Subcostal nerves and vessels pass behind the lateral arcuate ligament.



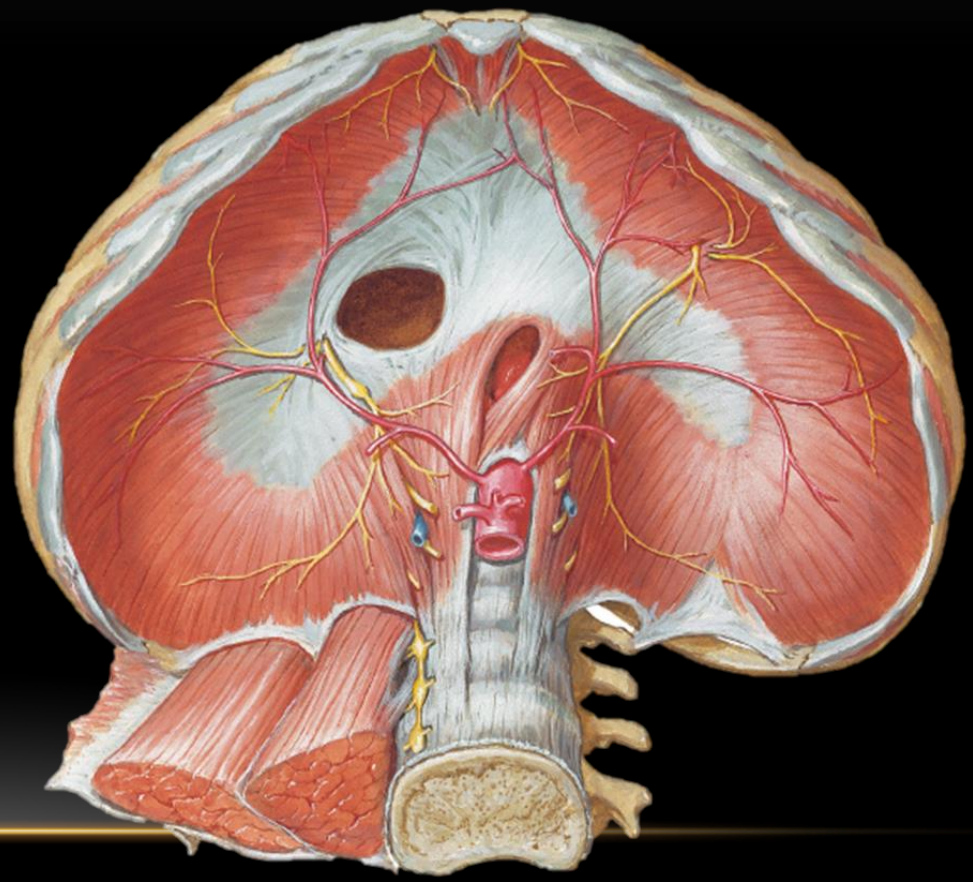
Minor openings of the diaphragm ..2 / 2

The sympathetic chain passes behind the medial arcuate ligament.

The greater and lesser splanchnic nerves pass through the corresponding crus of the diaphragm.

The inferior hemiazygos vein passes through the left crus.

The left phrenic nerve passes through the left crus.



Functions of the Diaphragm

- ***Main Muscle of Inspiration:*** The diaphragm pulls the central tendon down during contraction and increasing the vertical diameter of the thorax. This increases the negative pressure inside the thoracic cavity, which draws in air.

- ***Muscle of Abdominal Straining:*** The contraction of the diaphragm will assist in the contraction of the muscles of the anterior abdominal wall in raising the intra-abdominal pressure will normal processes like micturition, defecation, and parturition.

- ***Weightlifting Muscle:*** When a person takes and holds a deep breath, the diaphragm will assist the muscles of the anterior abdominal wall to raise the intra-abdominal pressure. This maneuver is also called as Valsalva maneuver and is used to augment heart murmurs and classify them whether they are clinically right-sided or left-sided.