

CHEST WALL ANATOMY & MEDIASTINUM

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Ospedale
di Bergamo

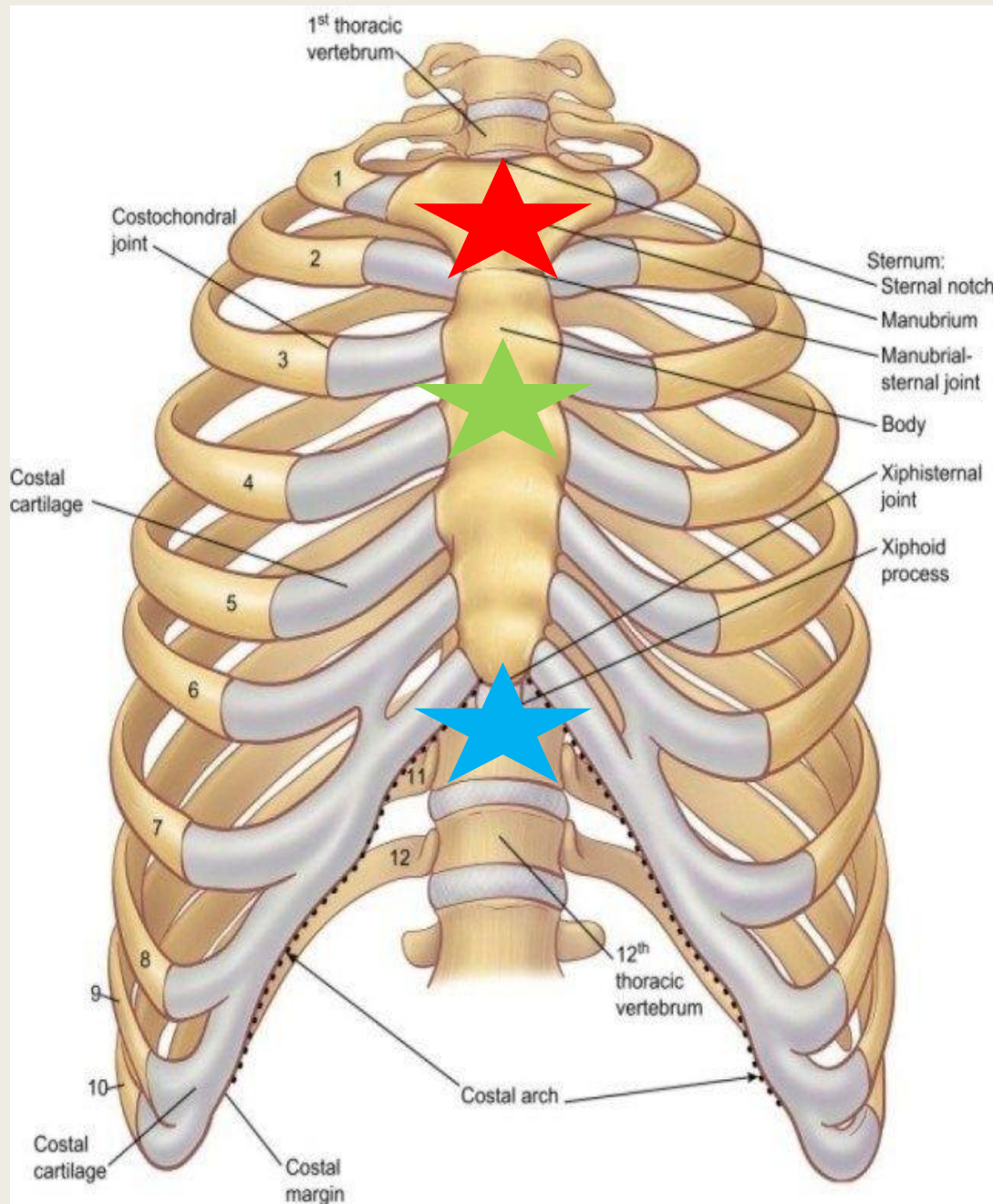
Sistema Socio Sanitario



Regione
Lombardia

ASST Papa Giovanni XXIII



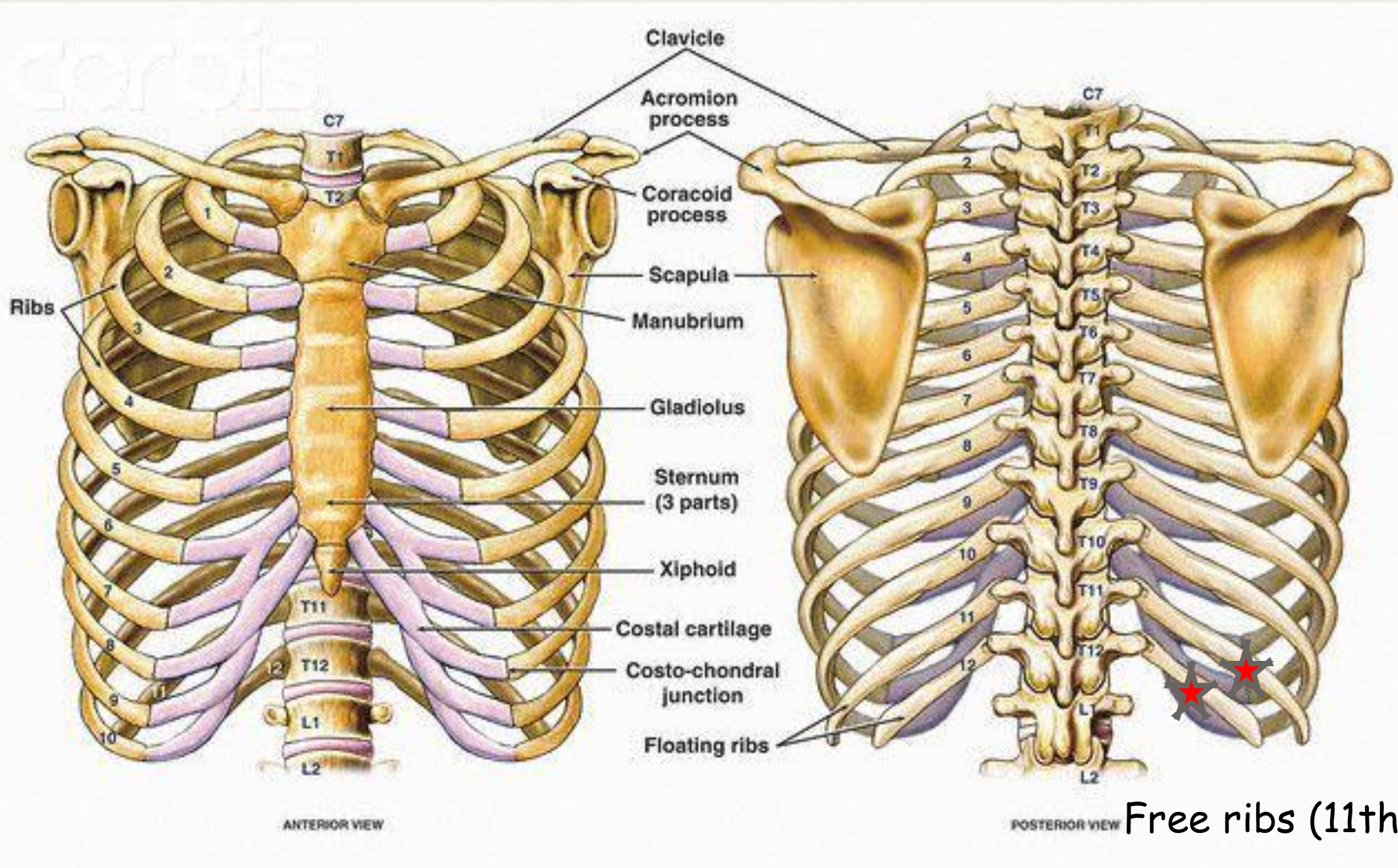


Sternum consists of the **manubrium sterni**, the **corpus sterni**, and the **processus xiphoideus**

The sternum and cartilage of ribs 1-10 represent the anterior chest wall.

The posterior part consists of 12 thoracic vertebrae and the posterior aspects of ribs 1-12.

Laterally the chest cavity consists of ribs 1-12

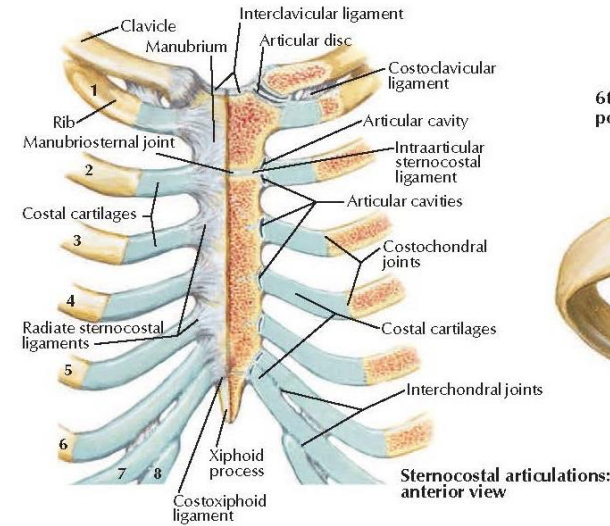


Free ribs (11th and 12th)

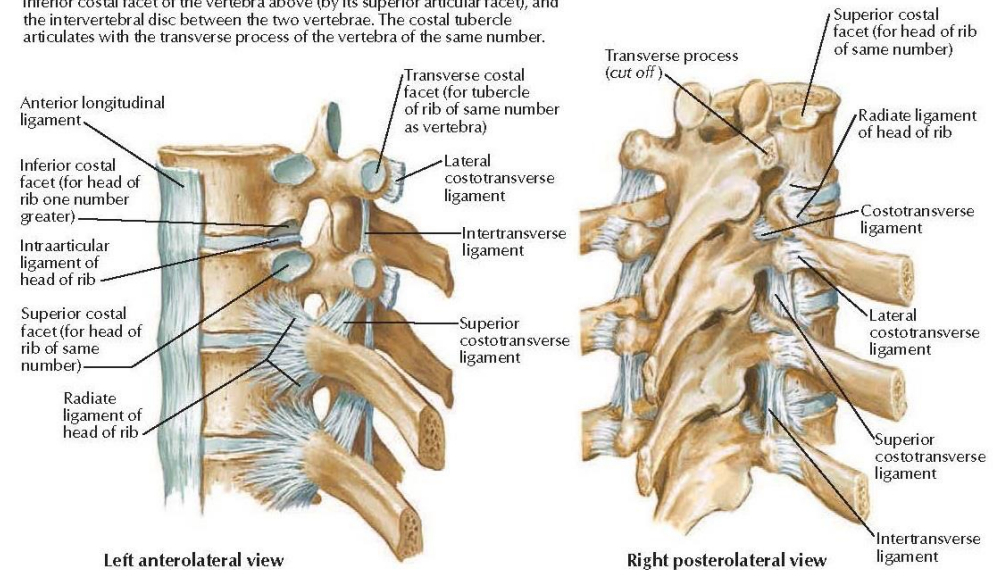
The **RIBS** are divided into

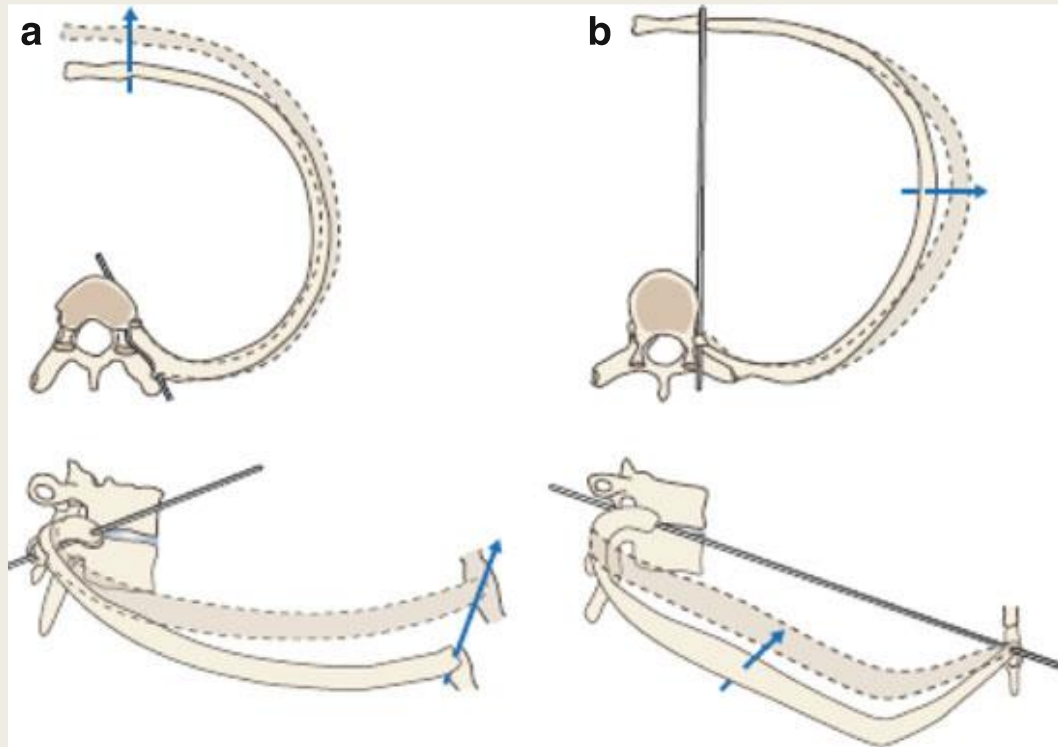
1. **real ribs** (costae verae, 1–7) that have sternal joints
2. **false ribs** (costae spuriae, 8–10) with cartilagenous joints to the costal arch (arcus costalis)
3. **free ribs** (costae fluctuantes, 11–12) that end in the soft tissue of the lateral chest wall. The 12th rib is not always present.

The ribs move upwards during inspiration around their rib neck and downwards during expiration as well as by the interactions between the cartilage, sternum, and costal arch.



Note: The head of a typical rib articulates with the superior costal facet of the thoracic vertebra of the same number (by its inferior articular facet), the inferior costal facet of the vertebra above (by its superior articular facet), and the intervertebral disc between the two vertebrae. The costal tubercle articulates with the transverse process of the vertebra of the same number.





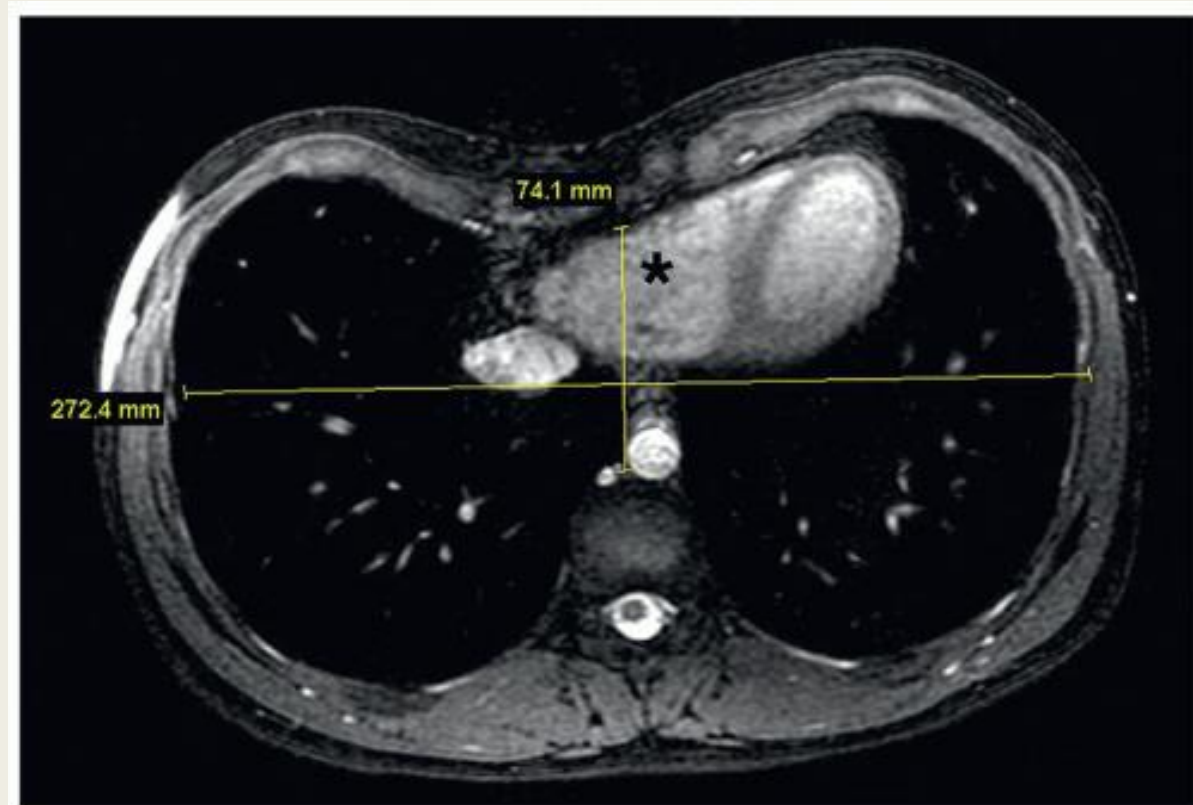
The ribs move upwards during inspiration around their rib neck and downwards during expiration as well as by the interactions between the cartilage, sternum, and costal arch.

FIGURE 1.3 Movement of the ribs during inspiration and expiration (van Gestel A et al. (2010), Atembewegungsapparat. In: Physiotherapie bei chronischen Atemwegs- und Lungenerkrankungen, Springer-Verlag Berlin Heidelberg, S. 17, Abb. 2.2)

Pectus Excavatum

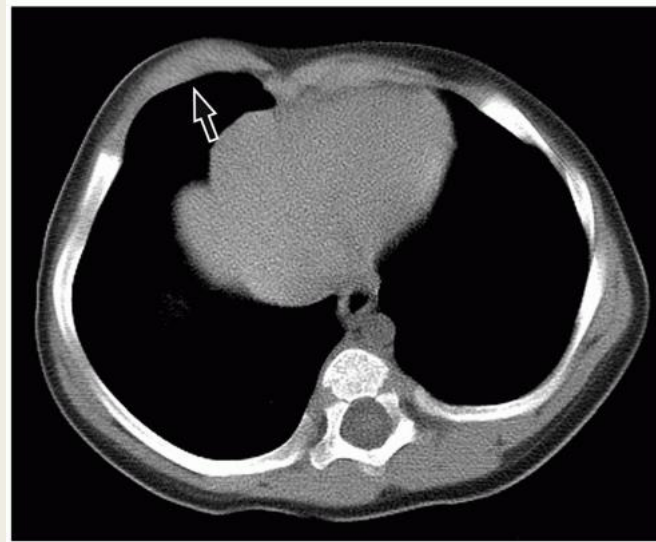
It is the most common congenital abnormalities of chest wall. It is characterized by prominent indentation of the lower sternum, which is usually asymmetric to the right, and resulting decrease in AP diameter of the rib cage. The mean pectus index in a normal population is around 2.56.

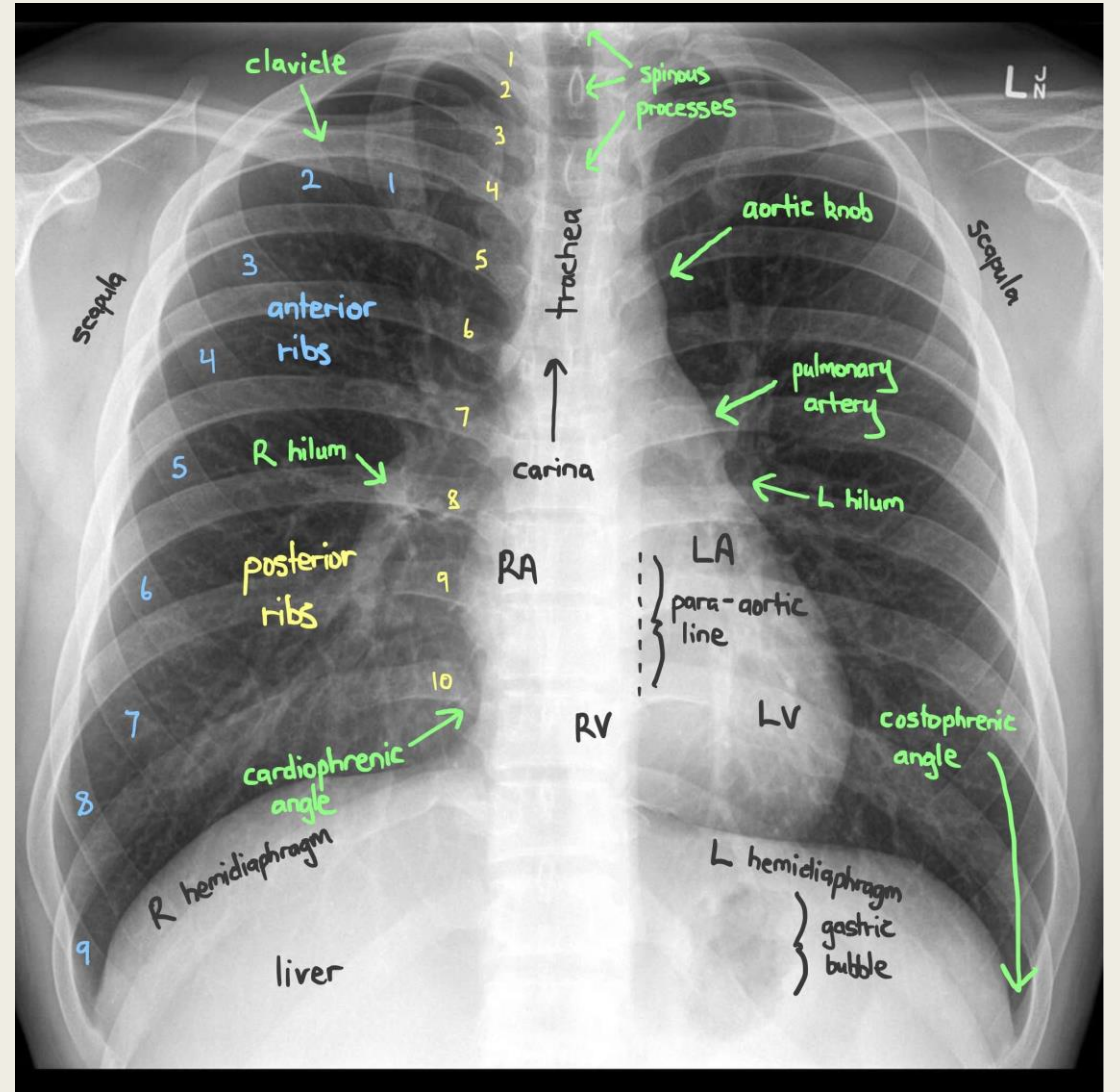
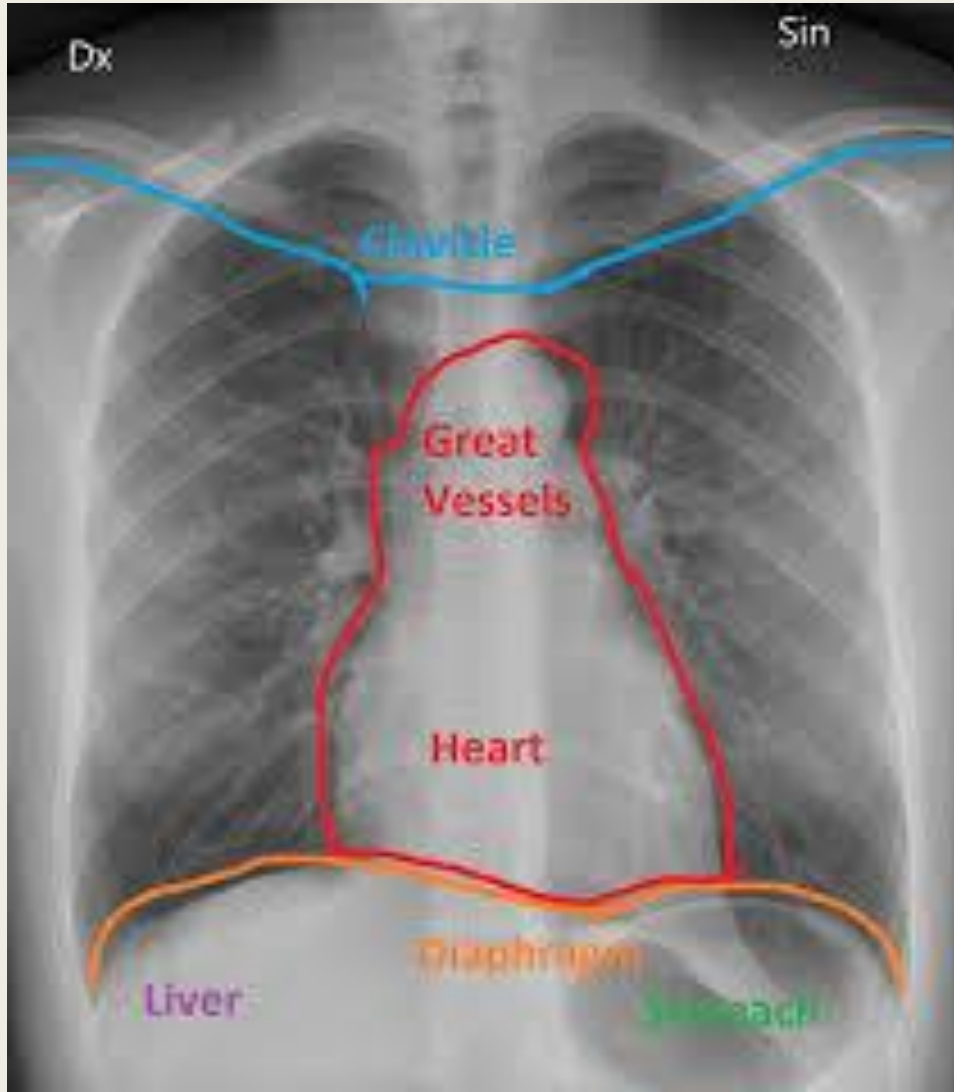
Haller index is 3.7 (272.4/74.1)



Pectus Carinatum

In contrast to pectus excavatum, pectus carinatum is an outward protrusion of the sternum resulting in increased AP diameter of the thorax. It is the second most common congenital chest wall deformity





Muscles

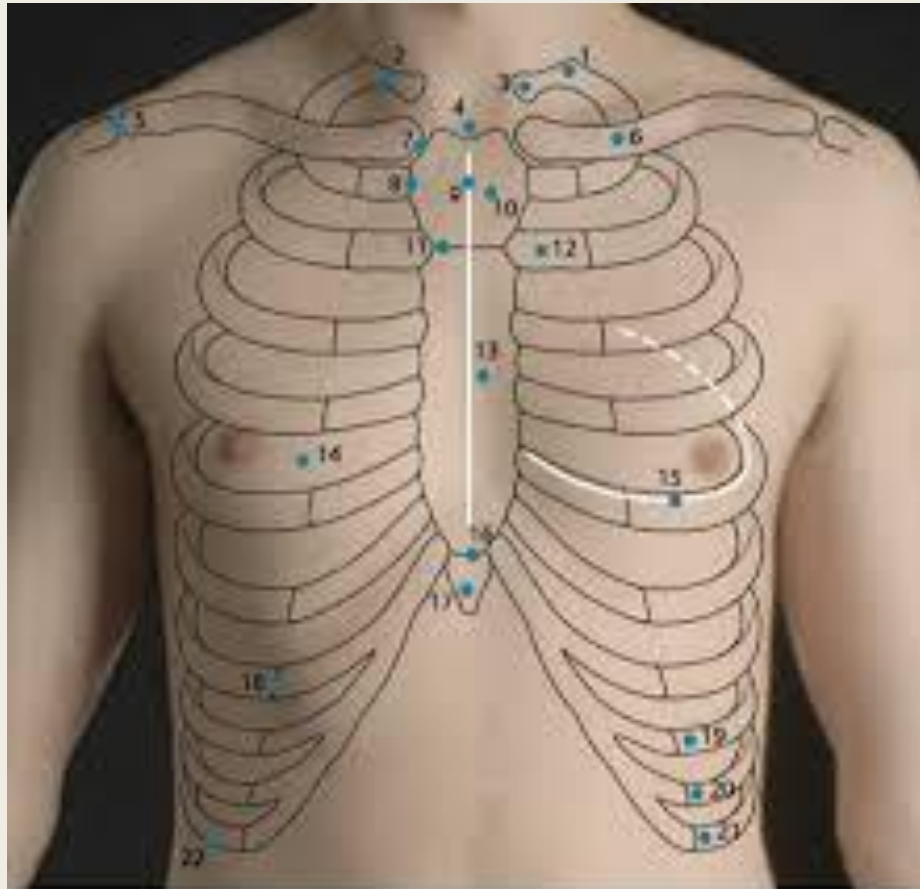
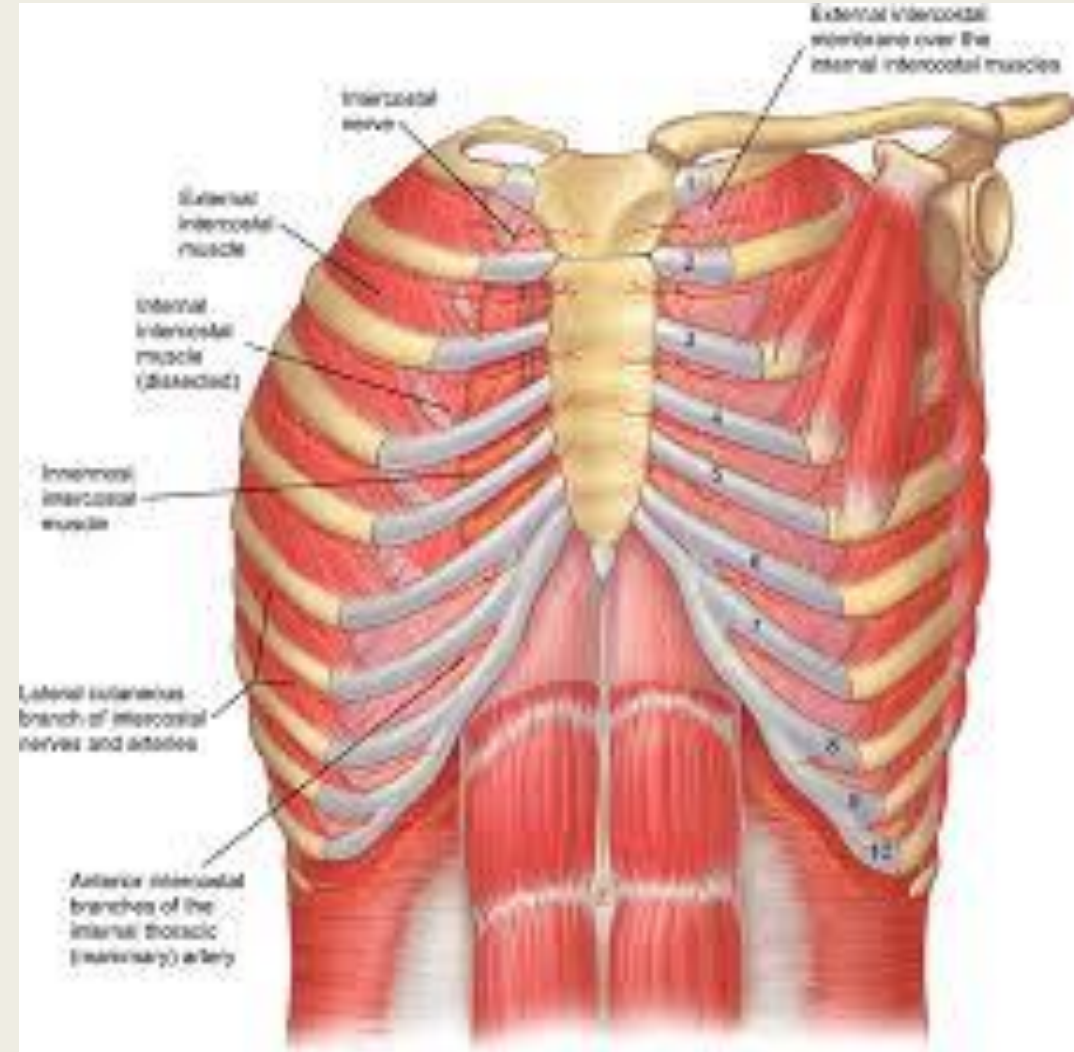


Figure 1 Surface anatomy of anterior chest wall.



Thoracic Wall

Intercostal muscles

1. External intercostal muscle
2. Internal intercostal muscle
3. Innermost intercostal muscle
4. Subcostalis
5. Transversus thoracis

Posterior Thorax

1. Levatores costarum
2. Serratus posterior superior and inferior muscles

Anterior/Superficial Thorax

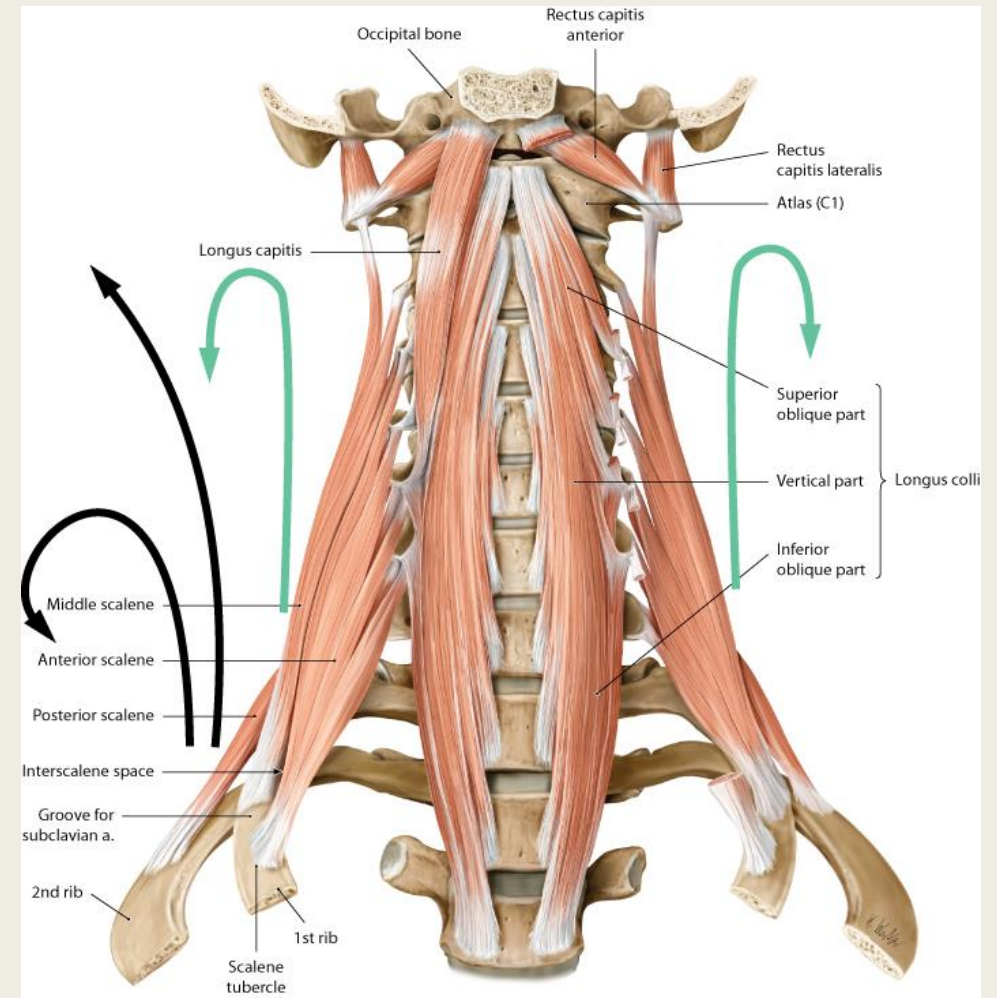
1. Pectoralis major and minor muscles
2. Subclavius
3. Serratus anterior

Floor

1. Diaphragm

At the neck, the chest is attached by the three **scalene muscles**, the intercostal muscles, and the muscles emanating from ribs 1 and 2 to the cervical vertebral bodies (1-7). They are responsible for the flexion of the upper spine anteriorly and for lifting the ribs during inspiration

As **accessory inspiratory muscles**, the scalene muscles (helps elevate the first and second ribs) and sternocleidomastoid muscle (assists in raising the sternum)

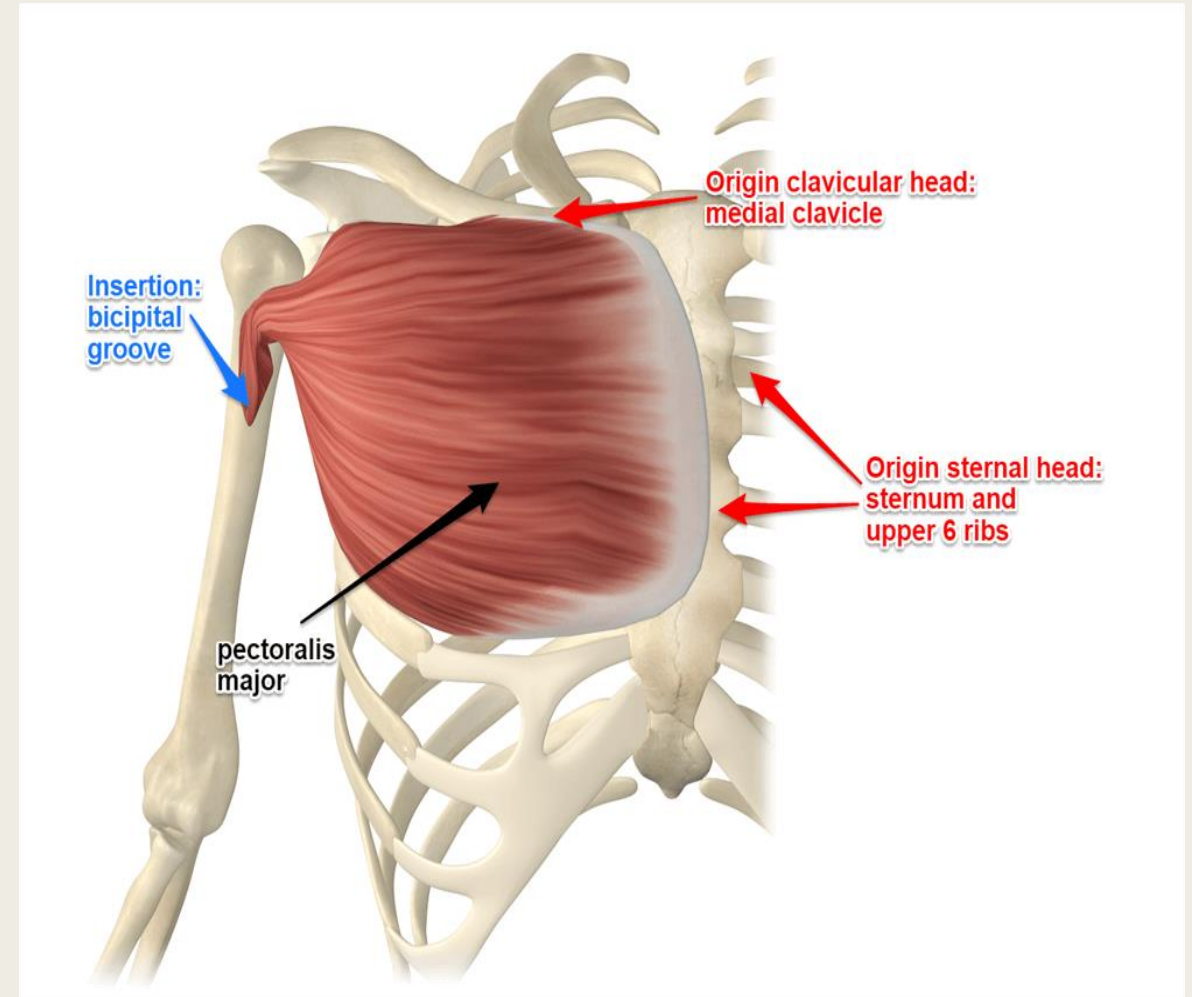


Pectoralis major

The Pectoralis major muscle covers the upper and lateral part of the chestwall like a shelf.

It originates from the medial clavicle, the sternum, the cartilages of ribs 5-7 as well as from rectus sheath

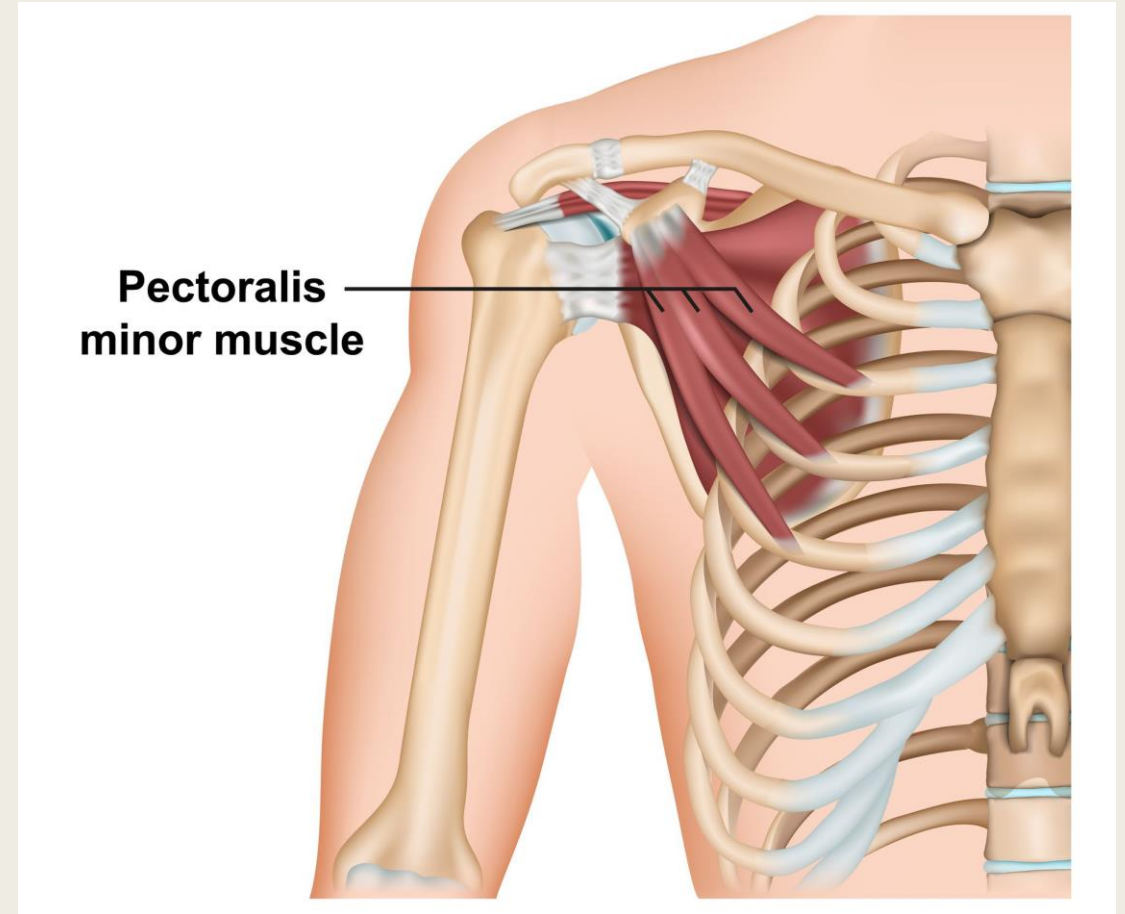
The lower edge of the muscle creates the anterior axillary plication. This muscle causes a strong adduction and rotation of the arm and as an auxiliary breathing muscle



Pectoralis minor

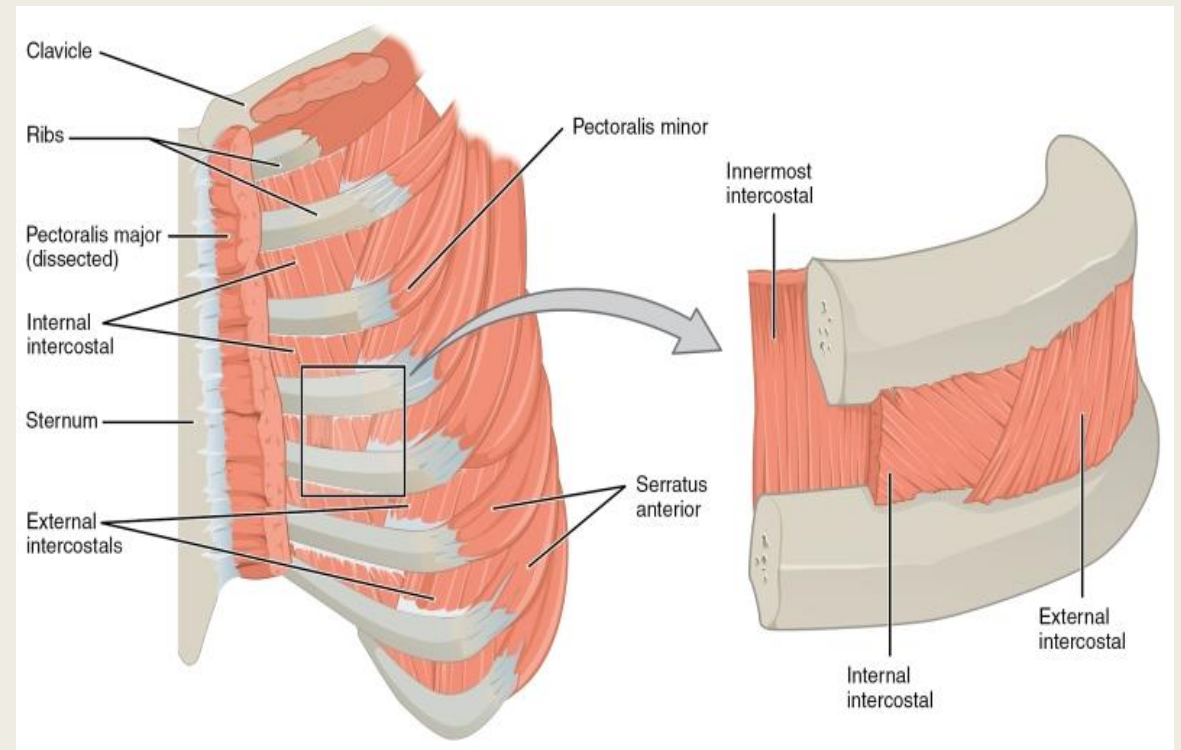
muscle is completely covered by the Pectoralis major muscle. It derives from the ribs 3-5 and connects to the processus coracoideus of the shoulder.

This muscle pulls the shoulder anteriorly and downwards and also lifts the chest as an auxiliary breathing muscle



The muscles that make up the thorax wall include the three intercostal muscles (EXTERNAL, INTERNAL and INNERMOST or Intercostales intimi), the SUBCOSTALIS and the TRASVERSUS THORACIS)

Eleven pairs of intercostal muscles are in each of the intercostal spaces, arranged from superficial to deep



The **external intercostal muscles**

extend from the rib tubercle posteriorly and attach to the costochondral junction anteriorly where they continue as thin connective tissue aponeuroses known as the Anterior intercostal membrane



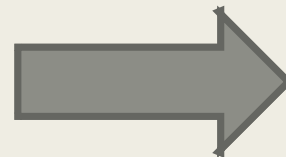
During inspiration, the external intercostals contract and raise the lateral part of the ribs, increasing the transverse diameter of the thorax

The **internal intercostal muscle** forms the intermediate layer. They originate from the lateral aspect of the costal groove of the rib above and insert into the superior aspect of the rib below in a direction perpendicular to the external intercostal muscles



They depress the ribs and subsequently reduce the thoracic volume during forced expiration

The **innermost intercostal muscles** originate from the medial aspect of the costal groove of the rib above and insert onto the internal aspect of the rib below. These muscles are lined internally by the endothoracic fascia right above parietal pleura

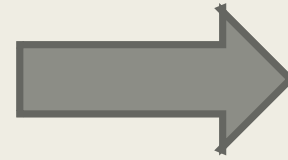


They are thought to act with the internal intercostal muscle during forced expiration

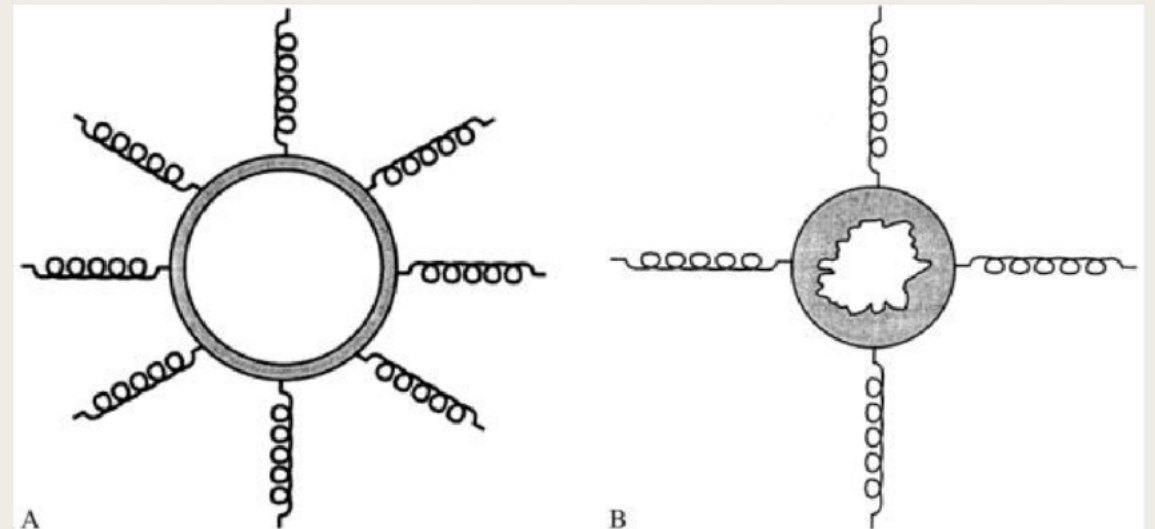
The **subcostalis muscles** are present in abundance in the lower regions of the posterior thoracic wall. They originate from the internal aspect of one of the lower ribs and insert onto the internal aspect of the second or third rib below.

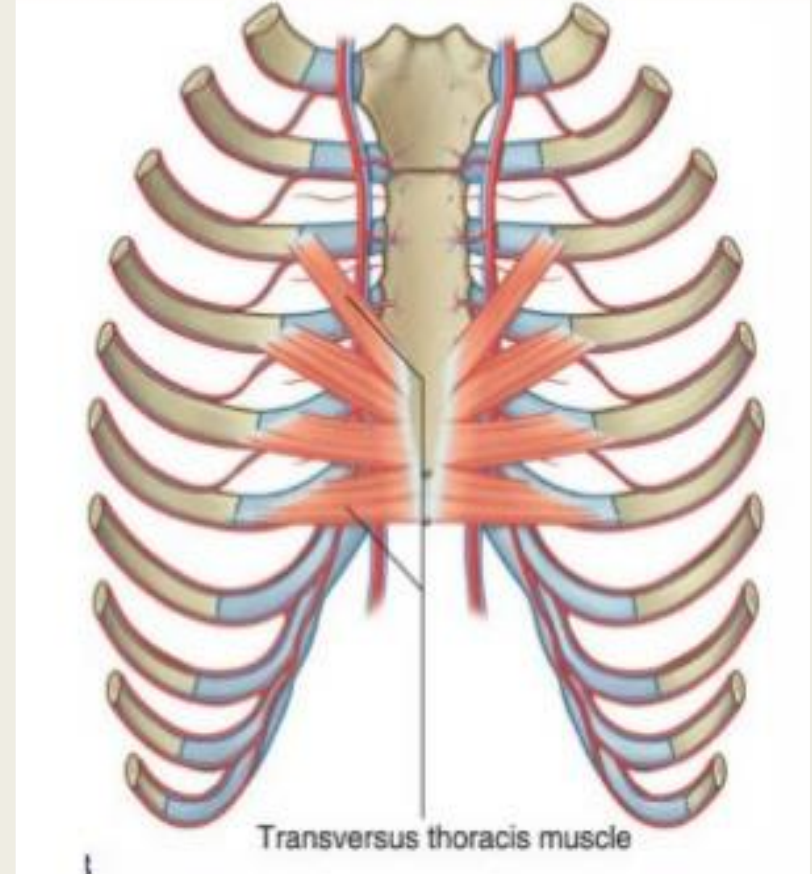
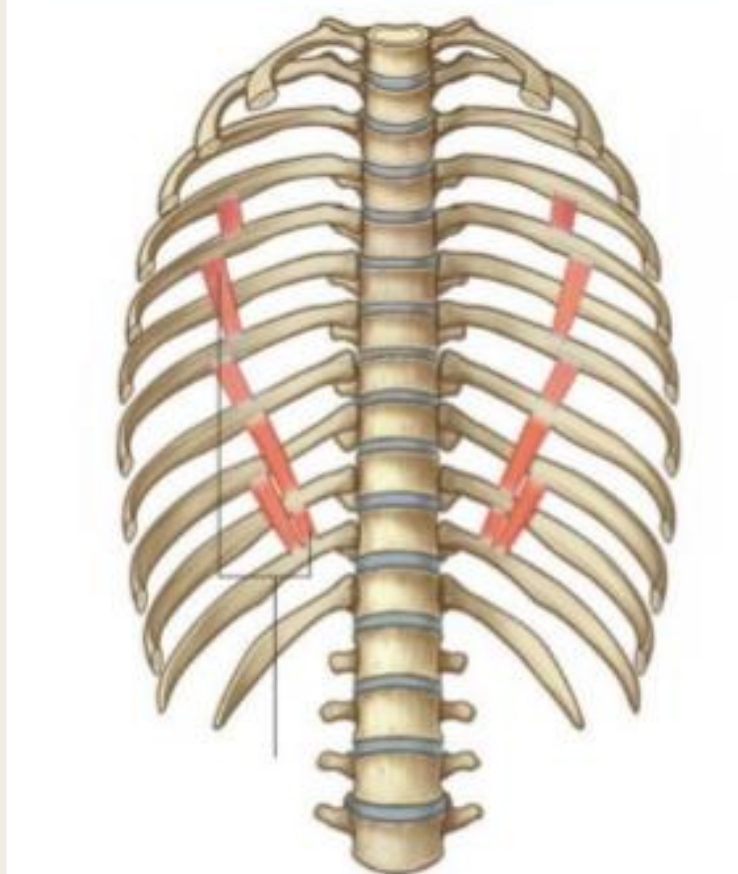
The **transversus thoracis** also originate from the lower posterior sternum, spread across the inner surface of the thoracic cage, and inserts onto ribs 2 through 6.

NORMAL EXPIRATION IS PASSIVE DUE TO ELASTIC RECOIL OF CHEST WALL



Both of these muscles aid in depressing the ribs during forced expiration.





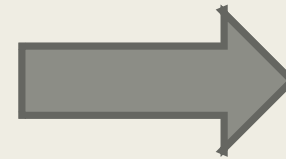
subcostalis muscles

Levatores costarum originates from the transverse processes of C7 to T11 and inserts onto the rib below

The **serratus posterior superior** attaches to ribs 2 through 5 and elevates them during inspiration whereas the **serratus posterior inferior** attaches the vertebrae to ribs 8 through 12

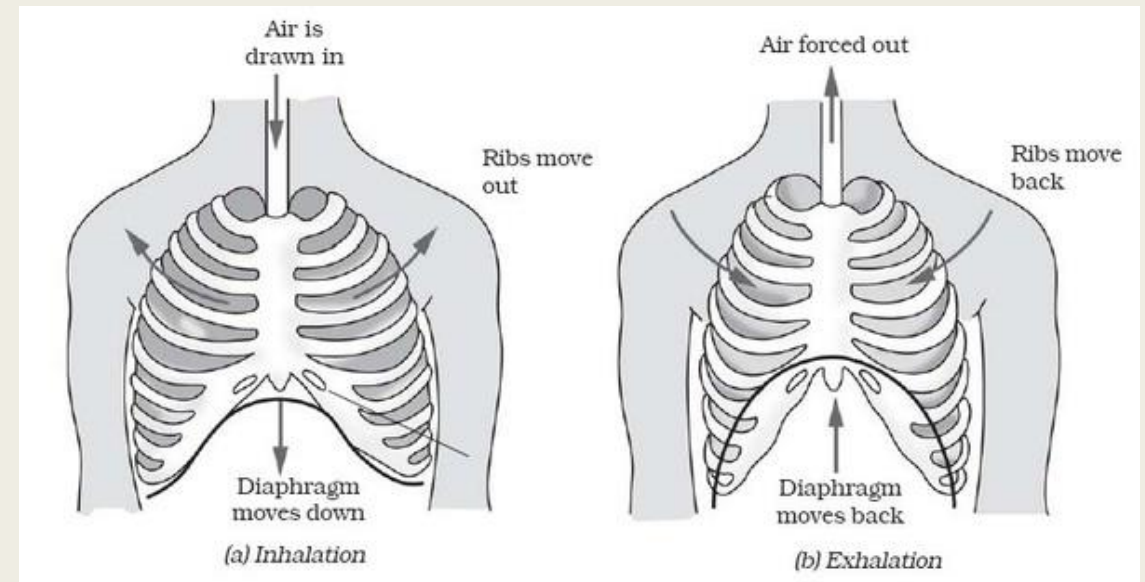


rib elevation during inspiration



depress ribs during forced expiration

THE MAJOR MUSCLE OF INSPIRATION COMES FROM THE DIAPHRAGM



Muscles of Inspiration

Principal

External intercostals (elevate ribs)

Parasternal intercartilaginous muscles (elevate ribs)

Diaphragm (domes descend, increasing longitudinal dimension of chest and elevating lower ribs)

Accessory

Sternocleidomastoid (elevates sternum)

Scalenus anterior
middle
posterior (elevate and fix upper ribs)

Muscles of Expiration

Quiet breathing

Expiration results from passive recoil of lungs

Active breathing

Internal intercostals, except parasternal intercartilaginous muscles (depress ribs)

Abdominal muscles (depress lower ribs, compress abdominal contents)

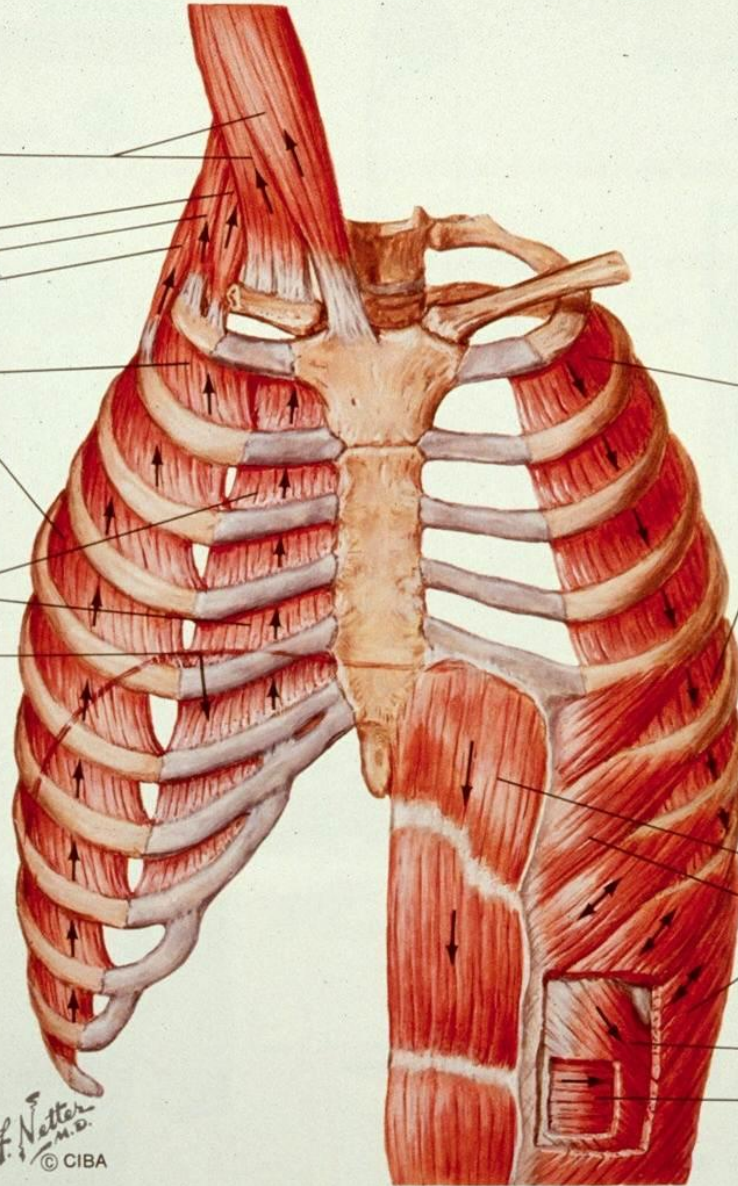
rectus abdominis

external oblique

internal oblique

transversus abdominis

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MUSCLES OF INSPIRATION

MUSCLES OF EXPIRATION

Sternocleidomastoid

Scalenes

External
intercostals

Diaphragm

Transversus
abdominis

Internal
intercostals

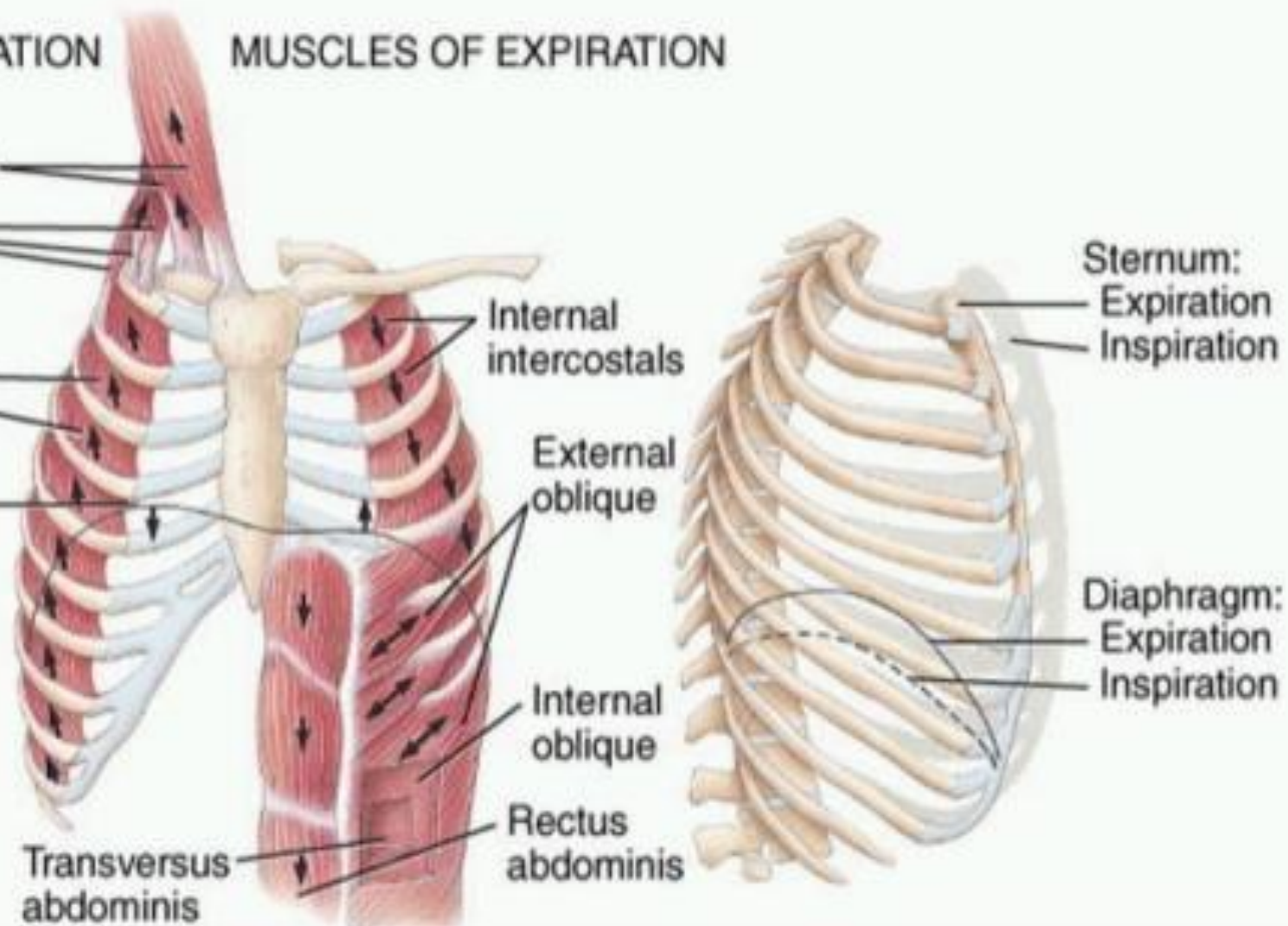
External
oblique

Internal
oblique

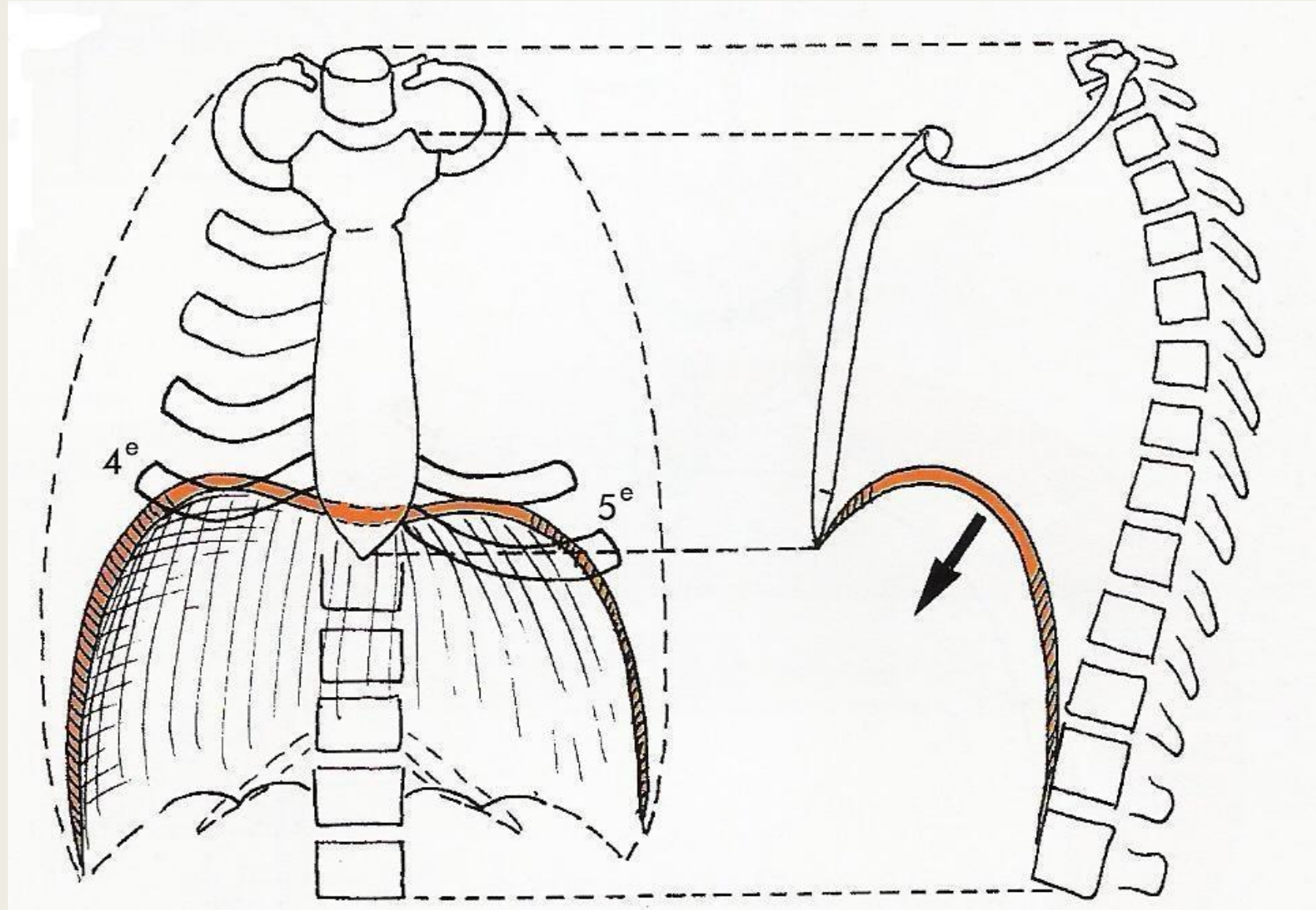
Rectus
abdominis

Sternum:
Expiration
Inspiration

Diaphragm:
Expiration
Inspiration

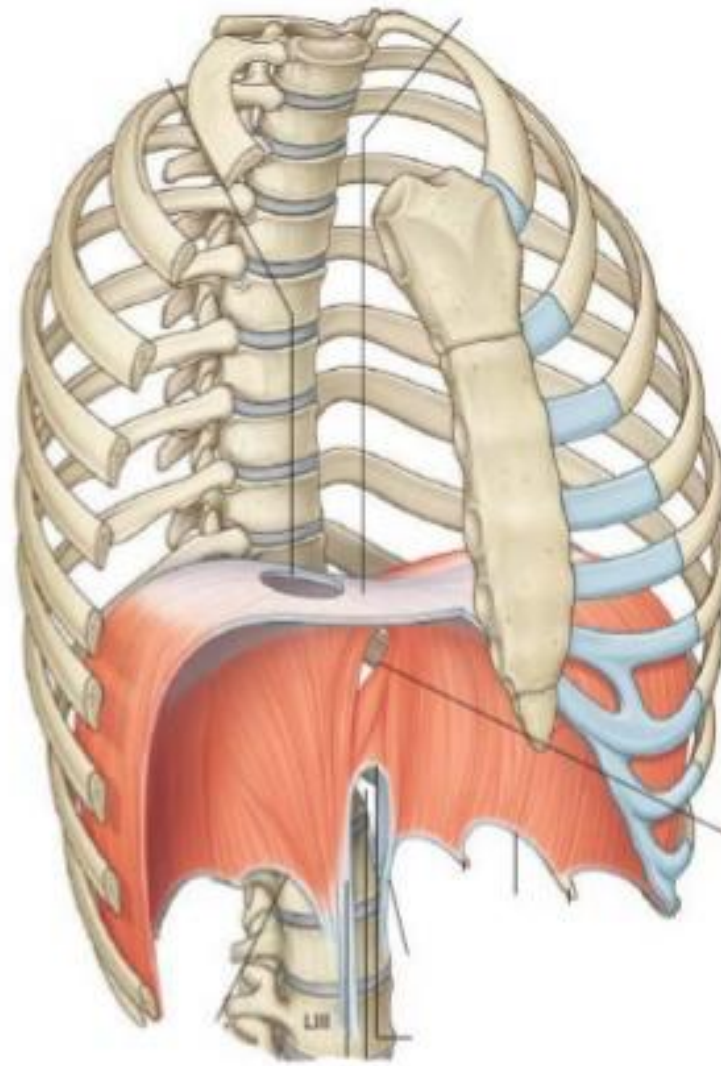


DIAPHRAGM

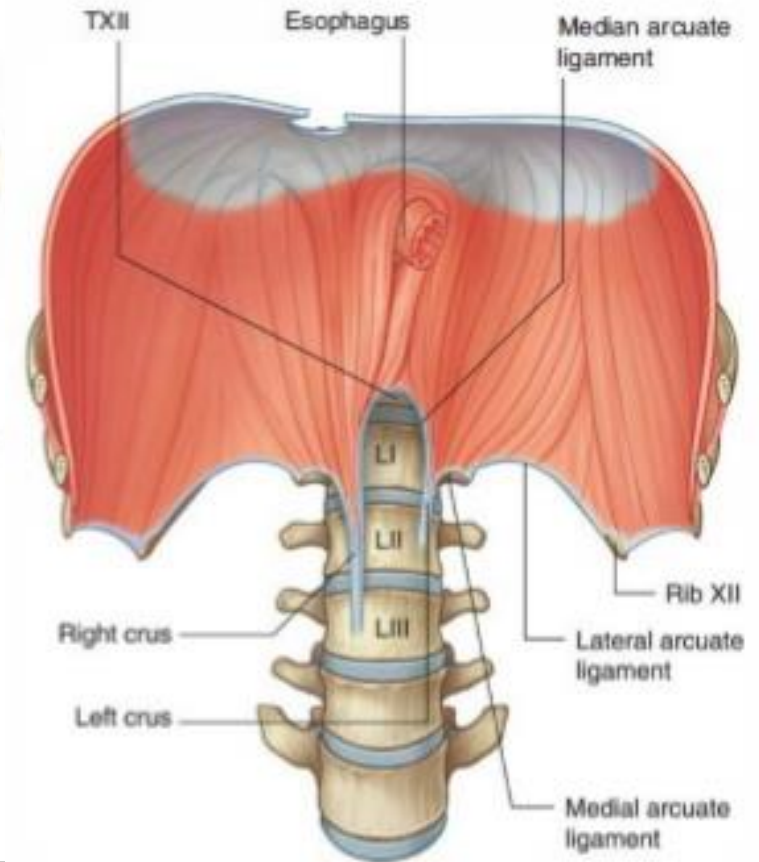


Diaphragm

- separates the thoracic cavity from the abdominal cavity
- It is attached peripherally to the:
 1. xiphoid process of the sternum,
 2. costal margin of the thoracic wall,
 3. ends of ribs XI and XII,
 4. ligaments that span across structures of the posterior abdominal wall, and
 5. vertebrae of the lumbar region.
- From these peripheral attachments, muscle fibers converge to join the central tendon. The pericardium is attached to the middle part of the central tendon.



Arcuate ligaments

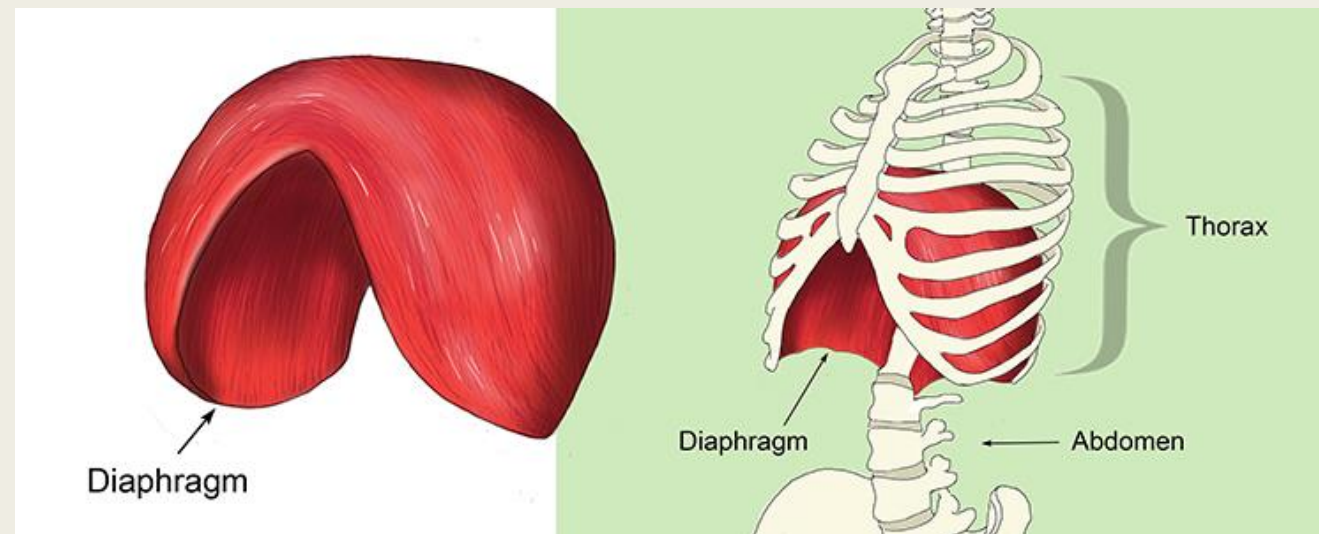


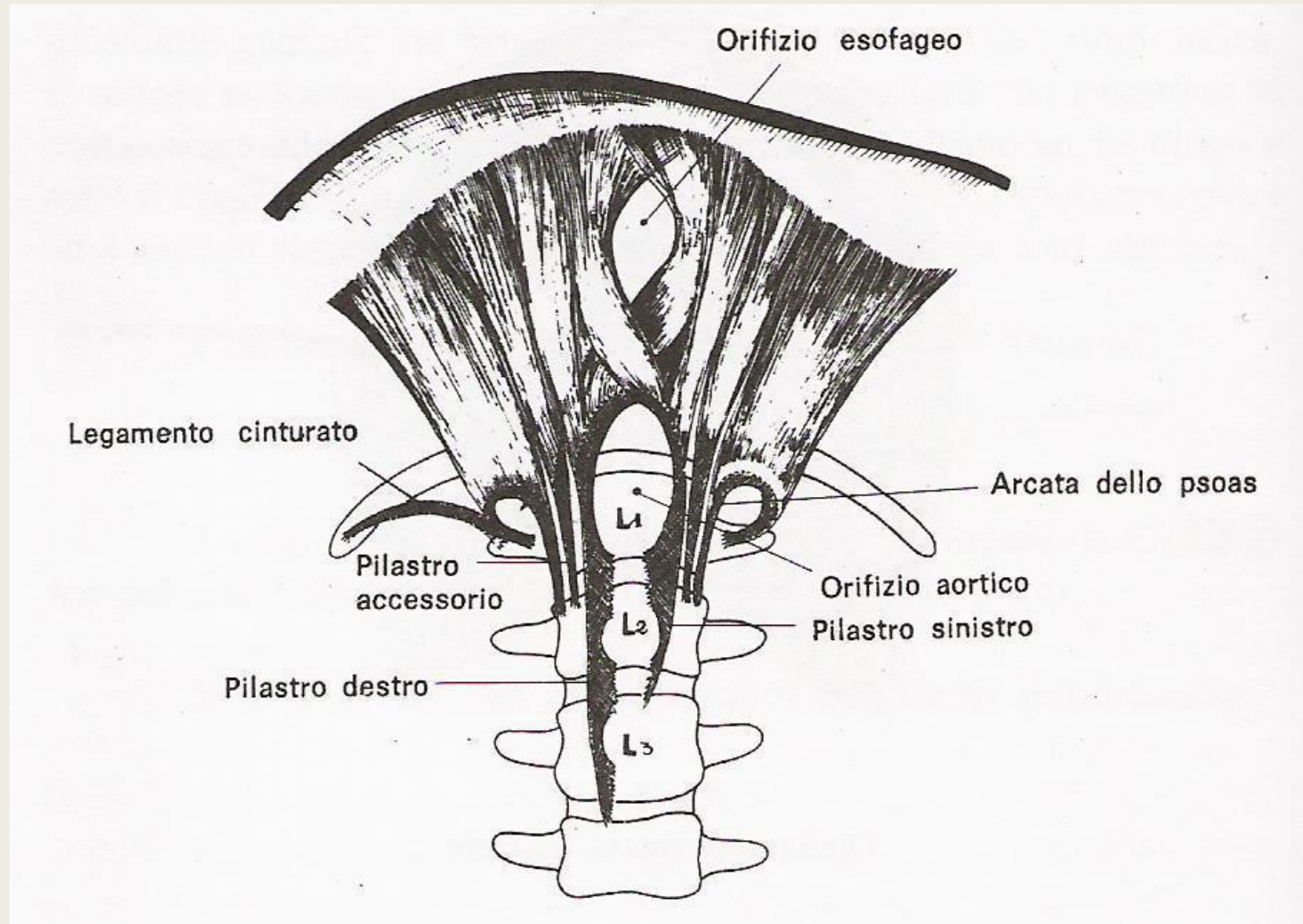
The **Diaphragm** originates from the lower chest aperture and the vertebral bodies 1-4 of the lumbar column.

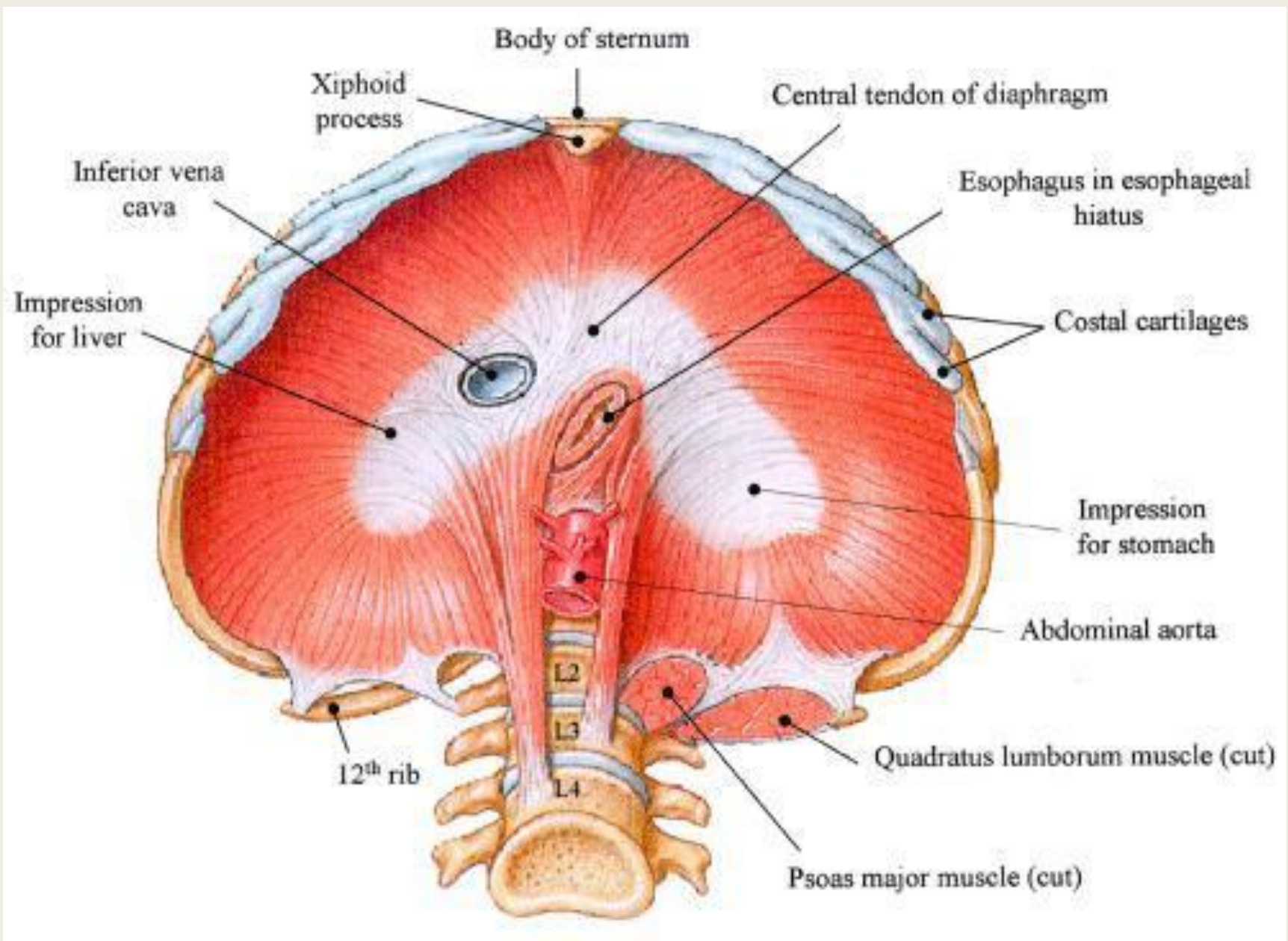
The muscle measuring 3-5 mm thick which creates a dome with a tendon in the center.

Due to the elastic recoil the diaphragm lifts upwards creating the diaphragmatic dome which is slightly higher on the right side. The excursion can vary 6-7 cm increasing negative pressure of pleural cavity during inspiration

Besides respiration, the diaphragm also functions to aid abdominal straining and increase intra-abdominal pressure (i.e. defecation)







**Foramen of Morgagni (Right)
And Larrey (Left)**

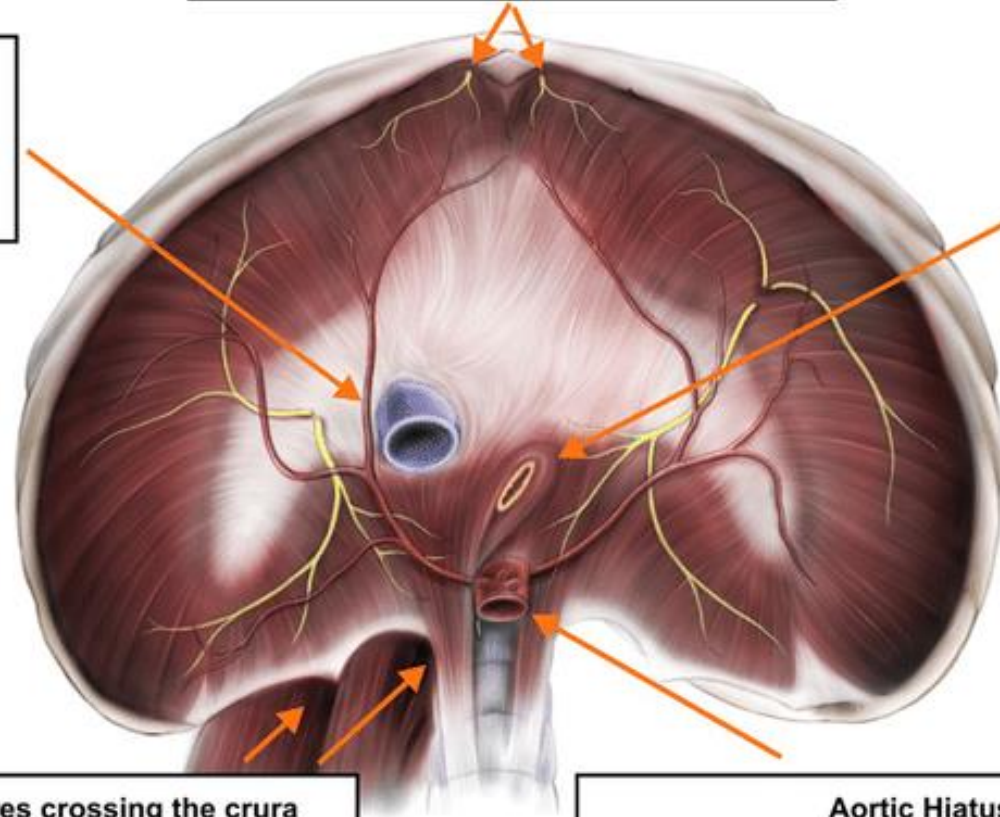
- Internal thoracic artery and veins
(turning into superior epigastric a. and vv.)

Vena Cava hiatus

- Inferior Vena Cava
- R. phrenic nerve
(or branches)

Esophageal hiatus

- Esophagus
- Anterior and posterior
vagal trunks
- Phrenicoabdominal
(sensory) branch of the left
phrenic nerve
- Esophageal branch of left
gastric artery
- Esophageal tributaries of
left gastric vein



Minor apertures crossing the crura

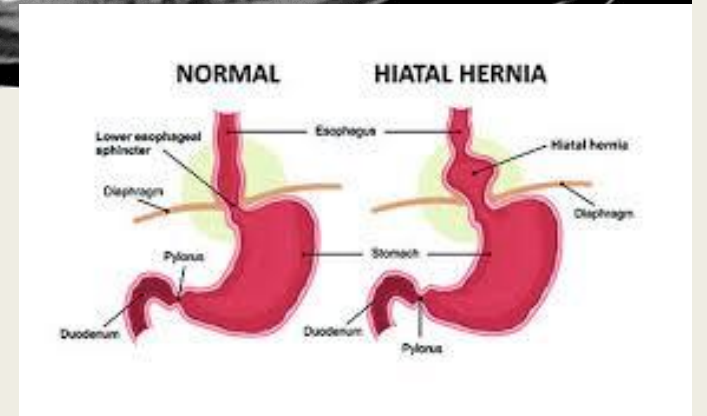
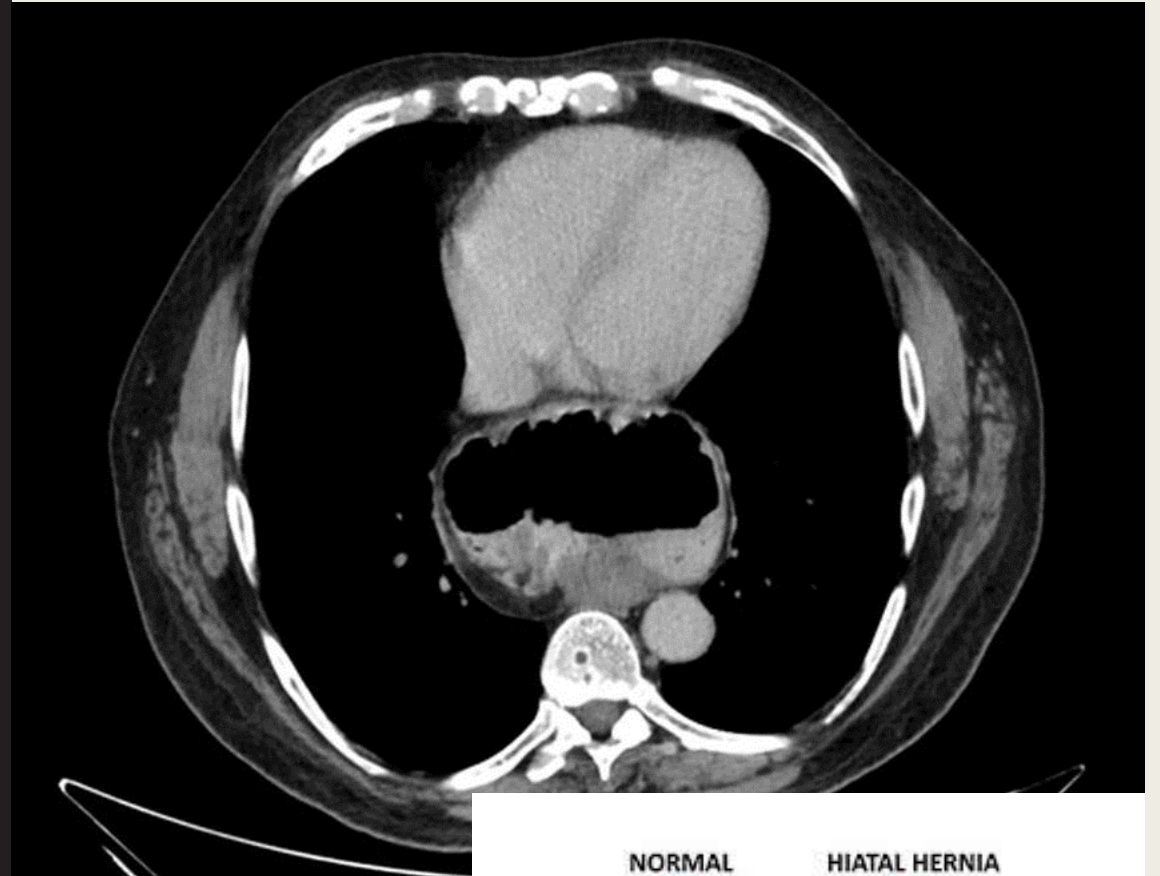
- Greater splanchnic nerve/s
- Lesser splanchnic nerve/s
- Least splanchnic nerves/s
- Azygos and hemiazygos veins (variable)

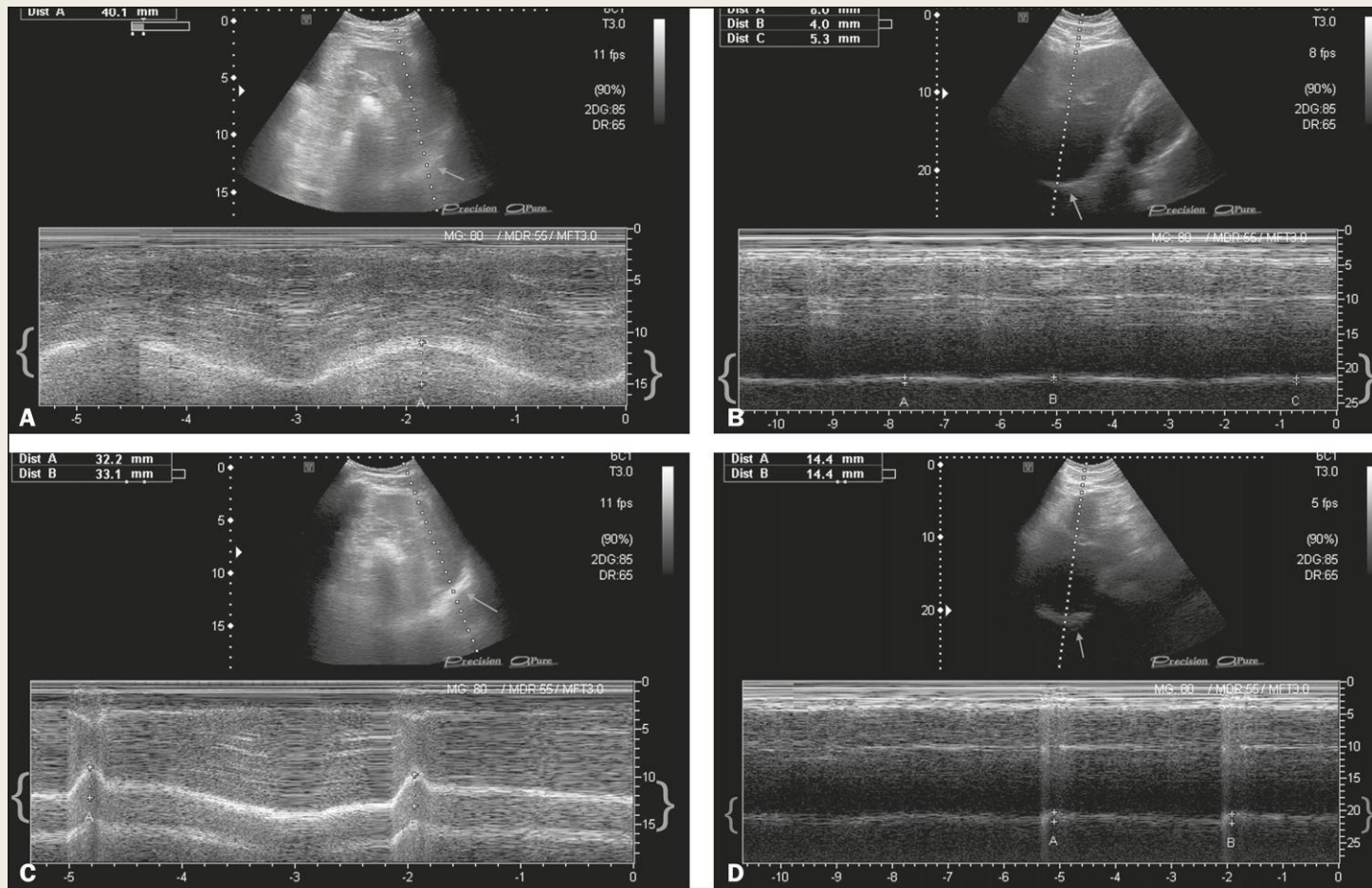
Aortic Hiatus

- Aorta
- Azygos and Hemiazygos veins (variable)
- Thoracic duct
- Aortic plexus and additional lymphatic vessels
descending to the cisterna chyli



Liver in the chest (traumatic herniation)





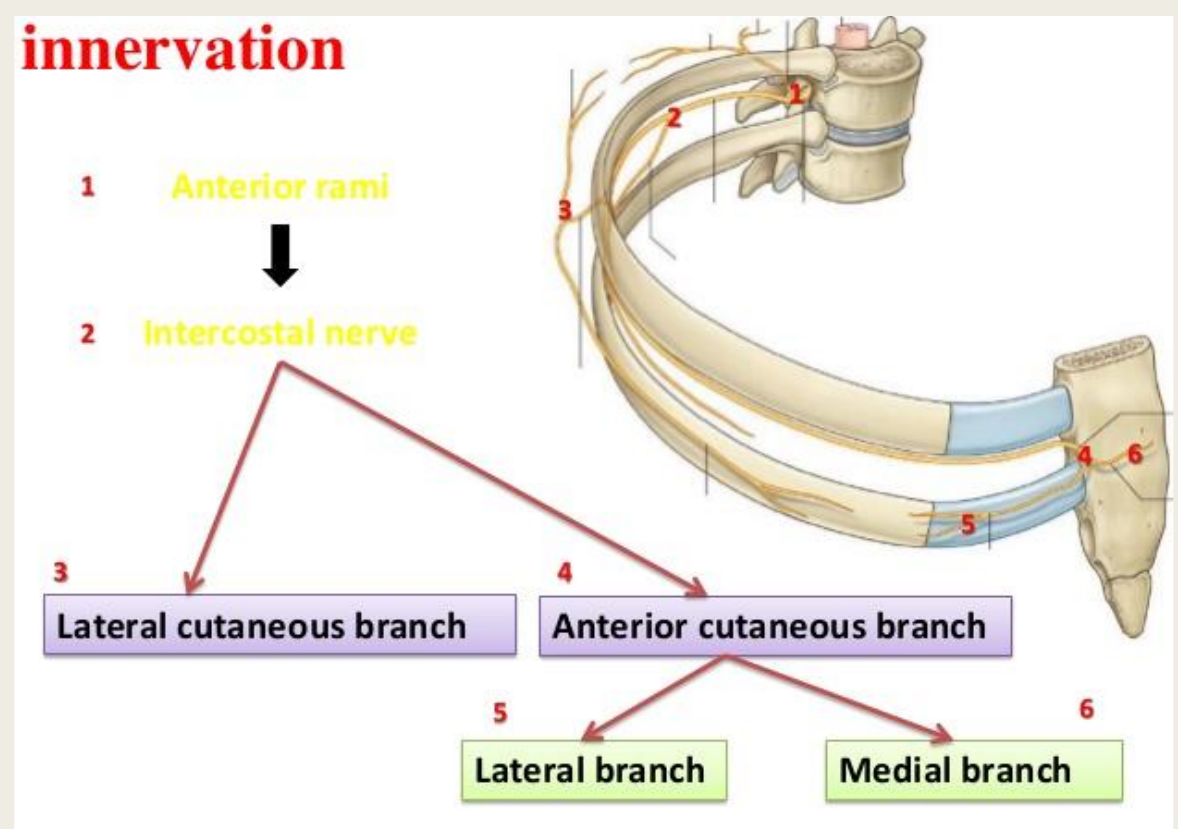
Diaphragm paralis detected by ultrasound

Chest wall nerves

The muscles that comprise the thoracic wall and the posterior thorax are innervated by the intercostal nerves, which mainly come from the anterior rami of spinal nerves T1 to T11.

Each intercostal nerve supplies a dermatome and a myotome

innervation



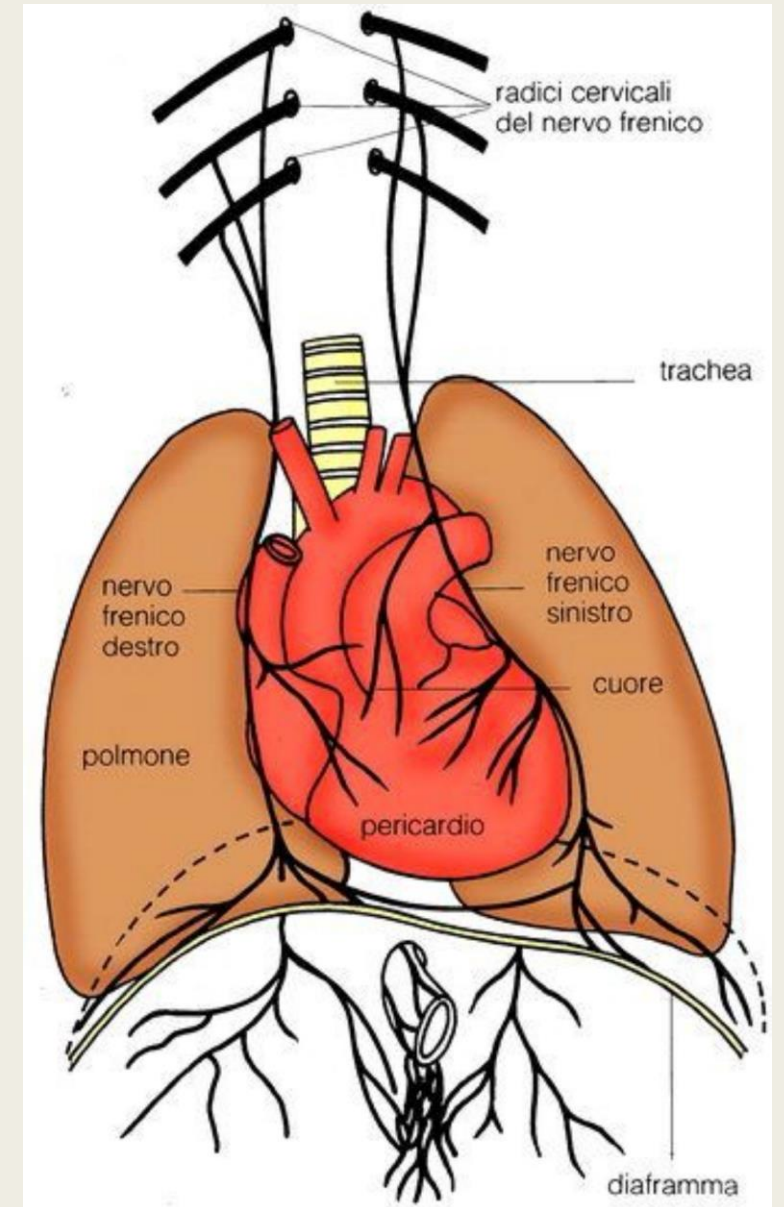
Of note, only a portion of the anterior ramus of spinal nerve T1 forms the lower trunk of the brachial plexus

Innervation to the muscles of the anterior thorax arises from different branches of the brachial plexus

Phrenic nerve

Innervation to the diaphragm comes from both the right and left phrenic nerves, which originate from the anterior rami of C3 to C5.

The phrenic nerve provides both the motor innervation to allow the diaphragm to contract during inspiration and sensory innervation to the parietal pleura and peritoneum covering the central aspect of the diaphragm



Chest wall blood supply

- Anterior

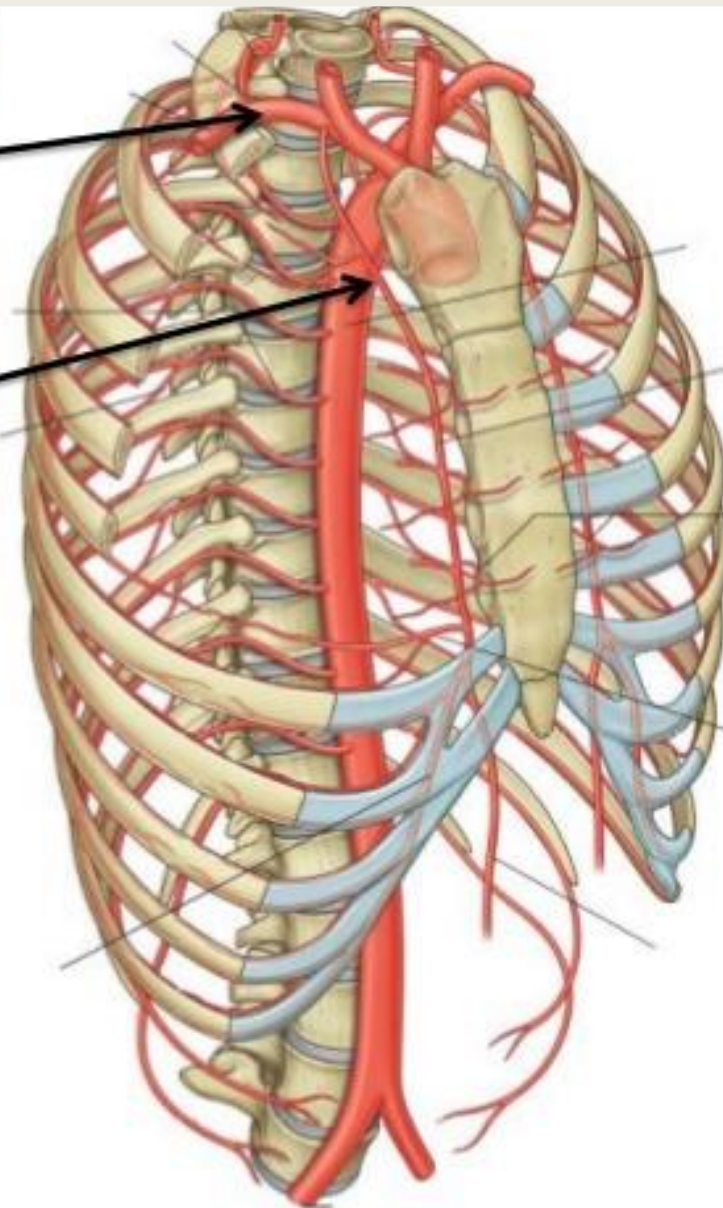
Subclavian a.



internal thoracic a.



internal intercostal a.
divided into 2 branches!
1- musculophrenic artery
2- epigastric artery



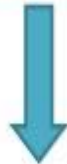
Chest wall blood supply

- Posterior
- First 2 intercostal spaces

Subclavian a.



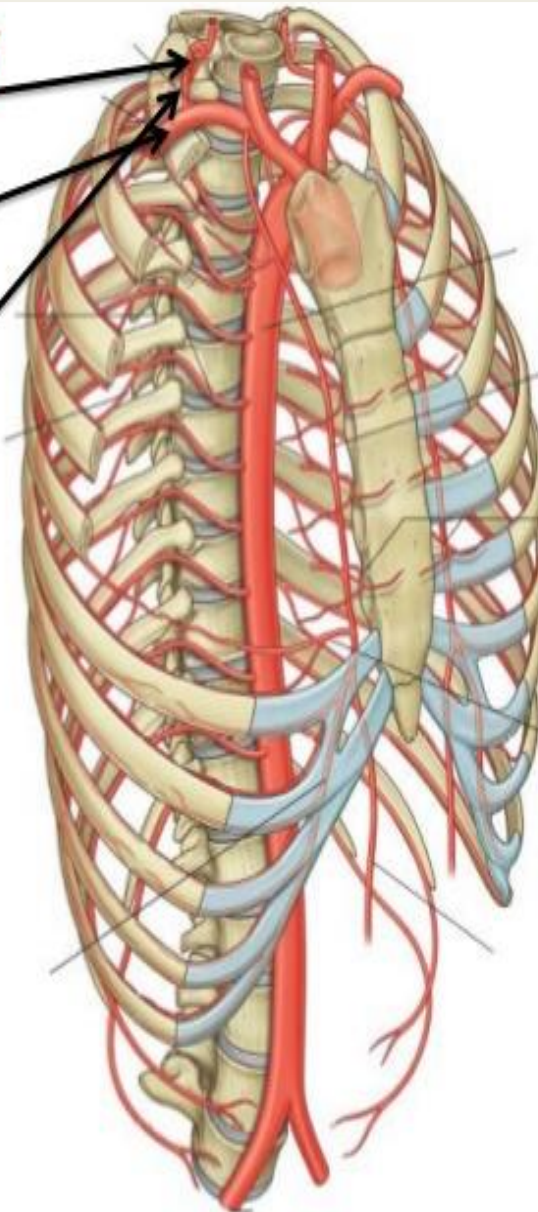
Costocervical trunk



Supreme intercostal a.



internal intercostal a.



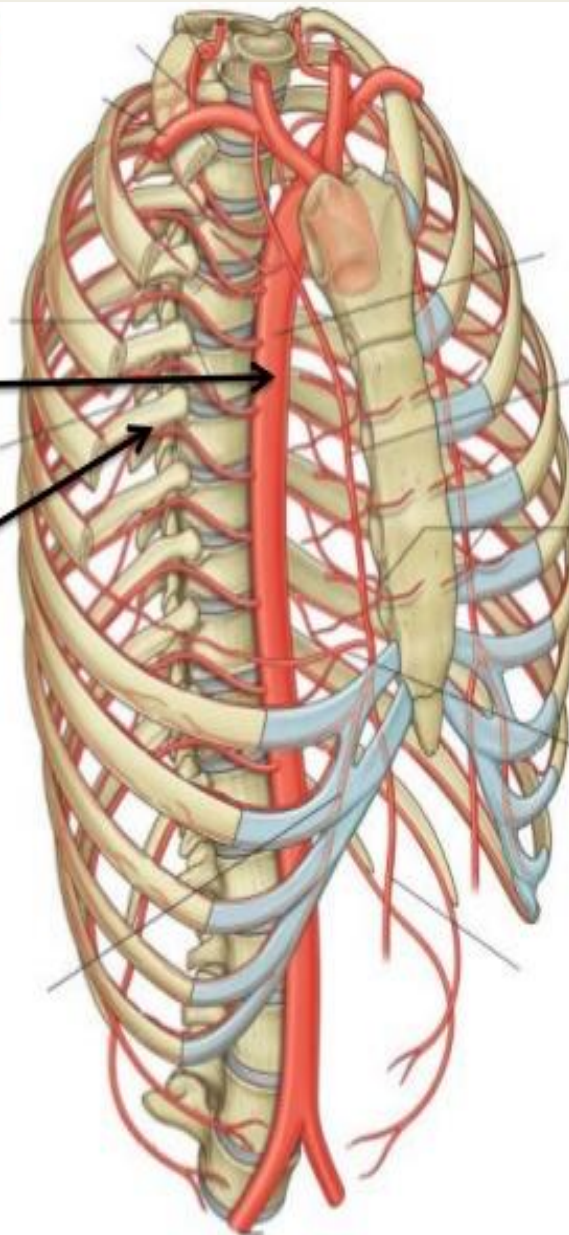
Chest wall blood supply

- Posterior
- The rest of intercostal spaces

thoracic aorta



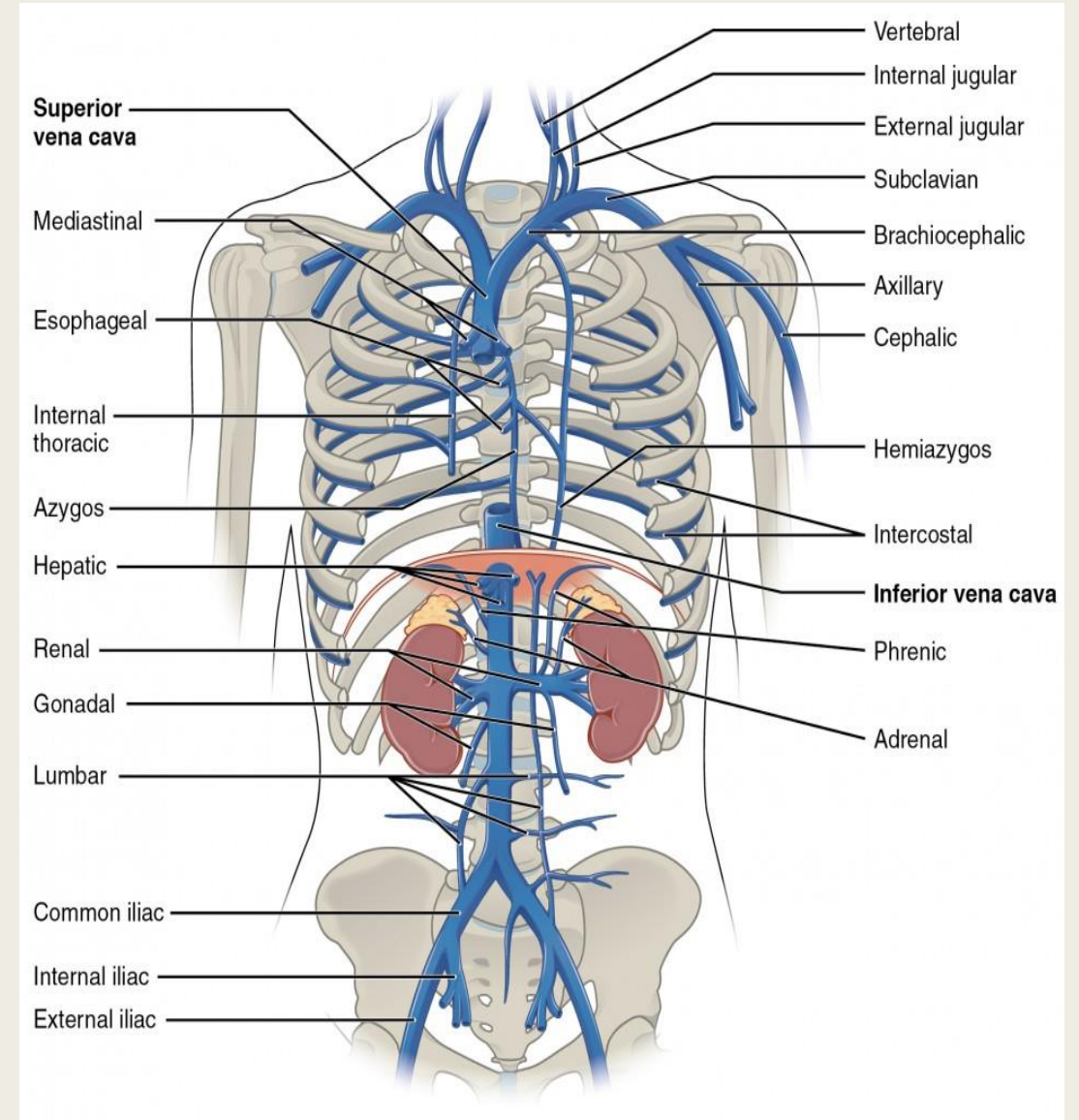
internal intercostal a.



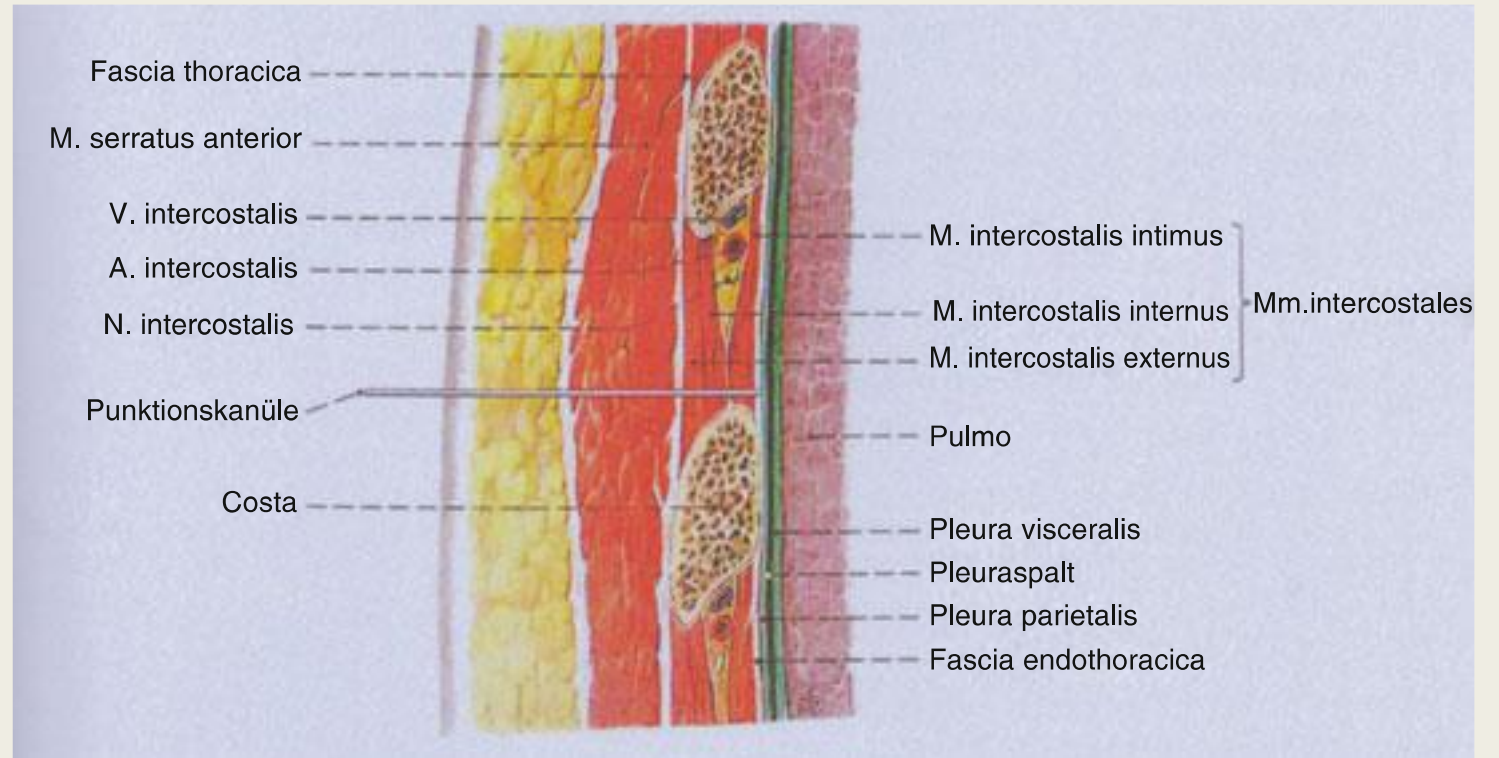
*right intercostal arteries are longer than left intercostal arteries, why?!

Intercostal veins run together with the arteries and drain into the azygos vein posteriorly and anteriorly into internal mammary vein into the subclavian vein.

The remaining anterior intercostal arteries from the seventh to ninth intercostal spaces come from the branches of the musculophrenic artery, which is a terminal branch of the internal thoracic artery



VAN

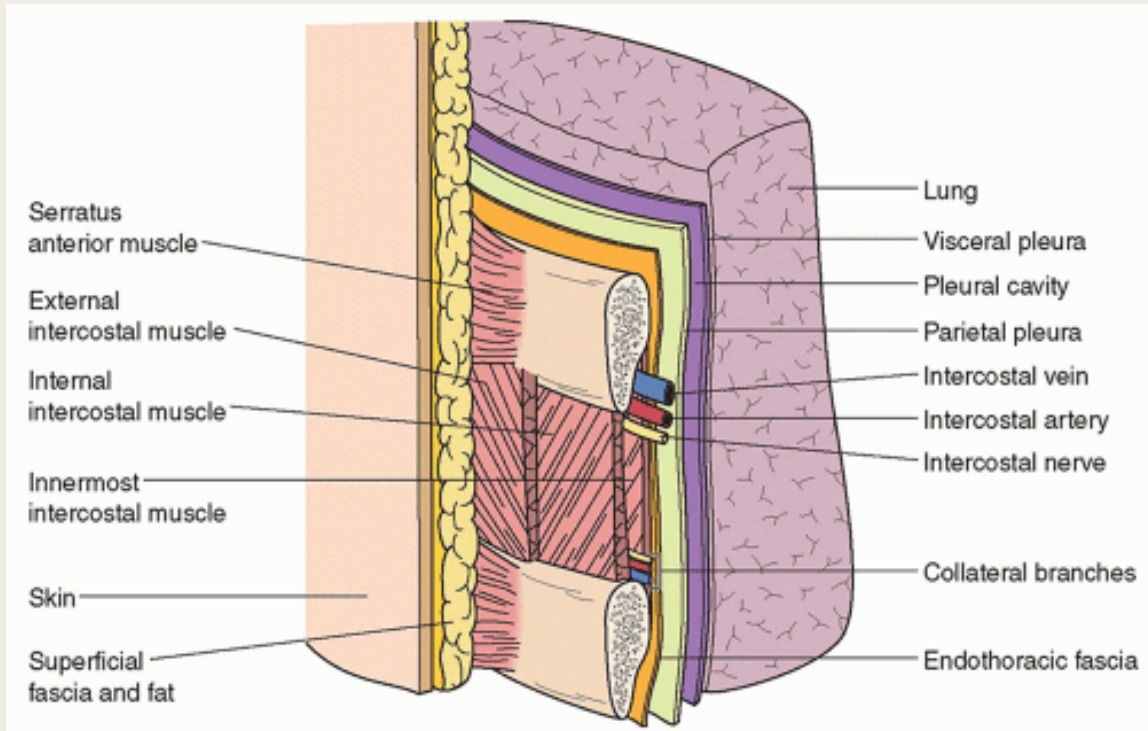


At the lower edge of the ribs, the structures are found in the following order: vein, artery, and nerve

Layers of the Chest wall

The anterior and lateral parts of the chestwall in particular are easily accessible for invasive procedures. Therefore a deep knowledge the anatomy is mandatory. Three layers can be described:

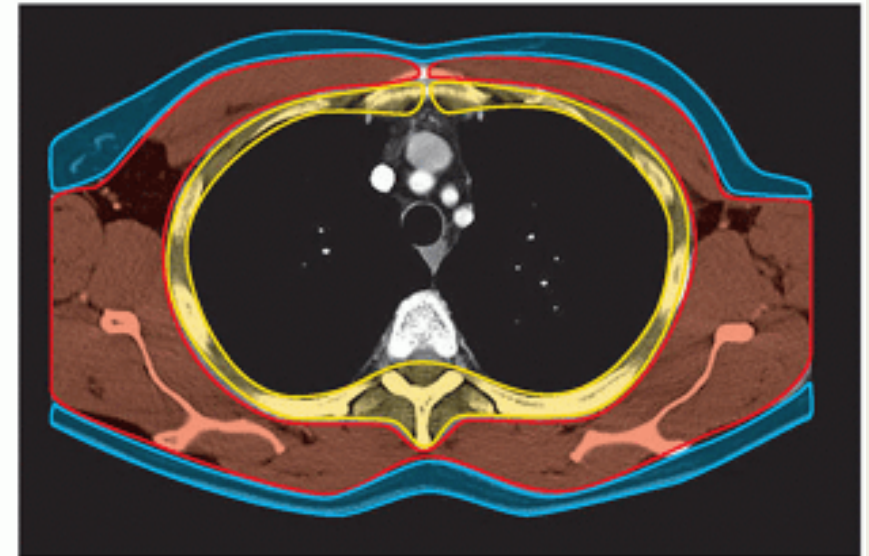
- **Superficial layer** consisting of skin, subcutaneous soft and fatty tissue (including the mammary gland, which is attached via the membrana sterni with the sternum)
- **Middle layer** consisting of muscles of the chest and the abdomen including their fascias
- **Deep layer** consisting of the skeleton, intercostal muscles, blood vessels/nerves, *fascia endothoracica* (covers the inner surface of the chest wall), and parietal pleura.

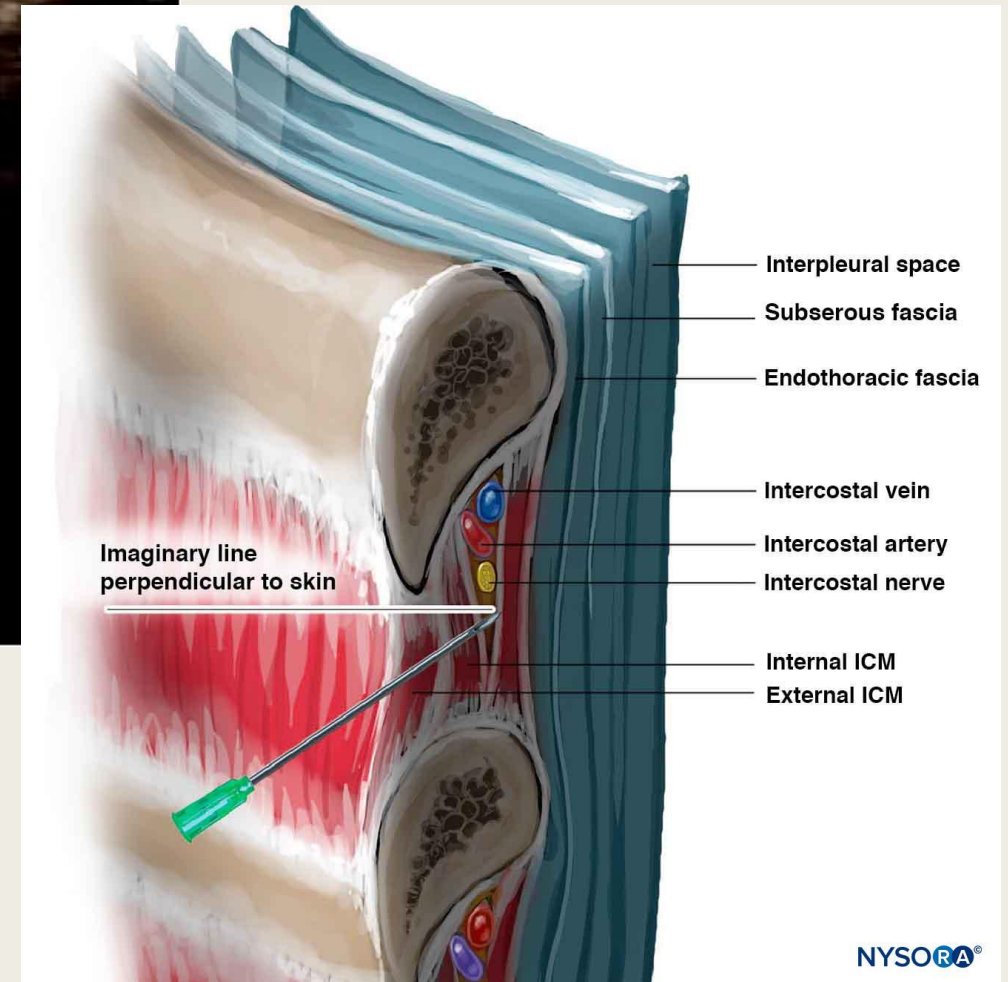
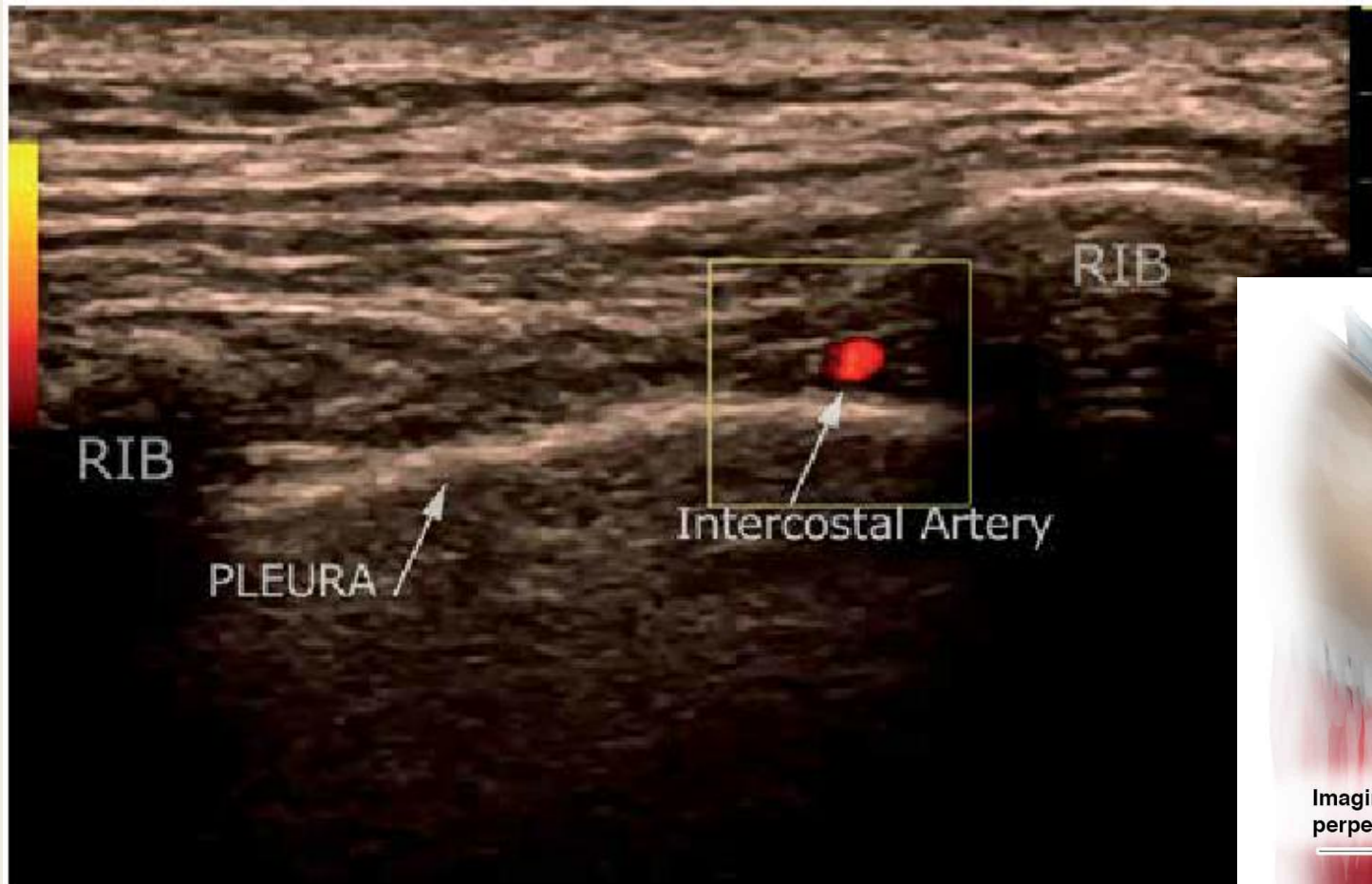


Chest wall: Skin → Parietal pleura

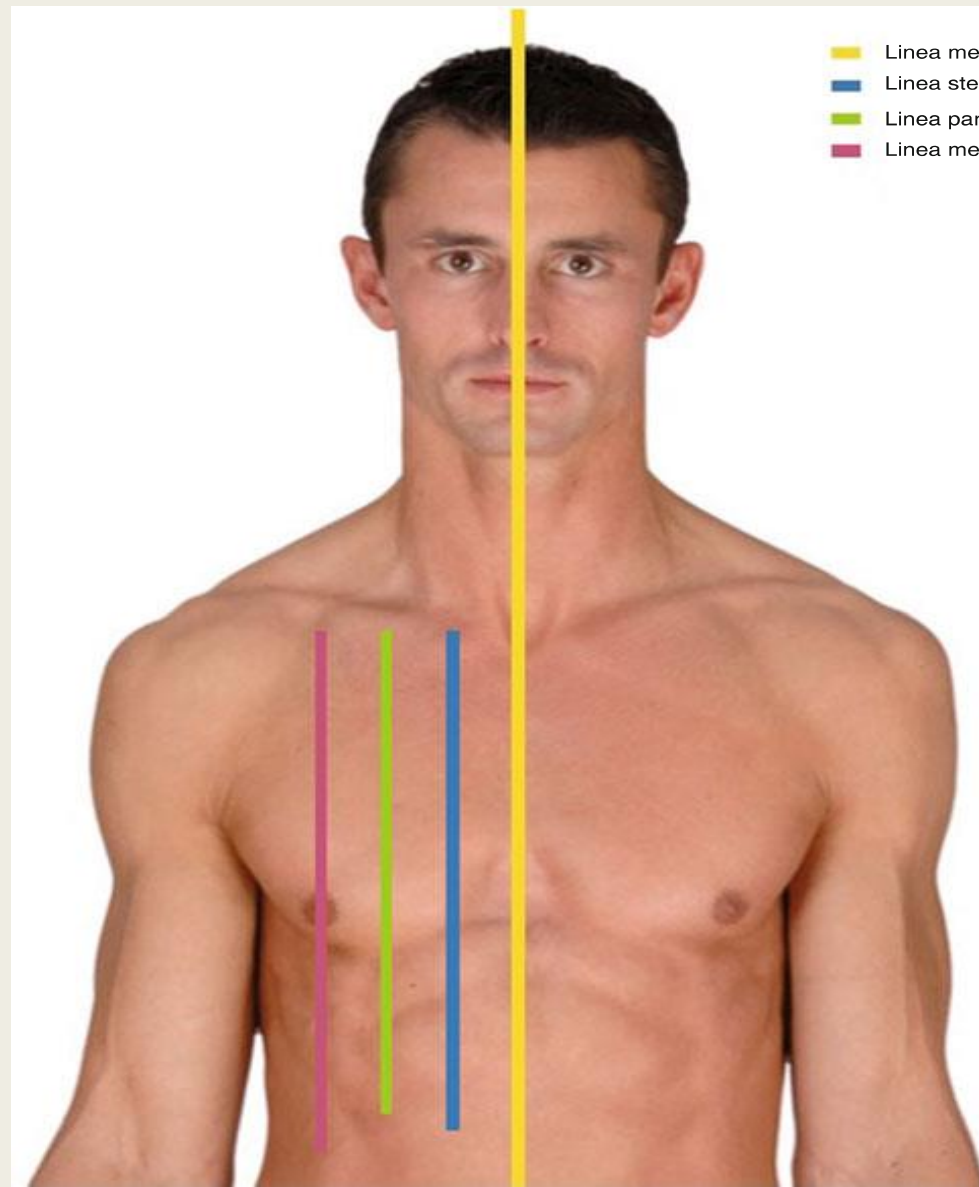
Three layers:

- Superficial (skin, subcutaneous fat)
- Intermediate (shoulder girdle, pectoralis muscles)
- Deep (dorsal spine, ribs, intercostal space, sternum, fascia, parietal pleura)





Thoracentesis



- Linea mediana anterior
- Linea sternalis
- Linea parasternalis
- Linea medioclavicularis

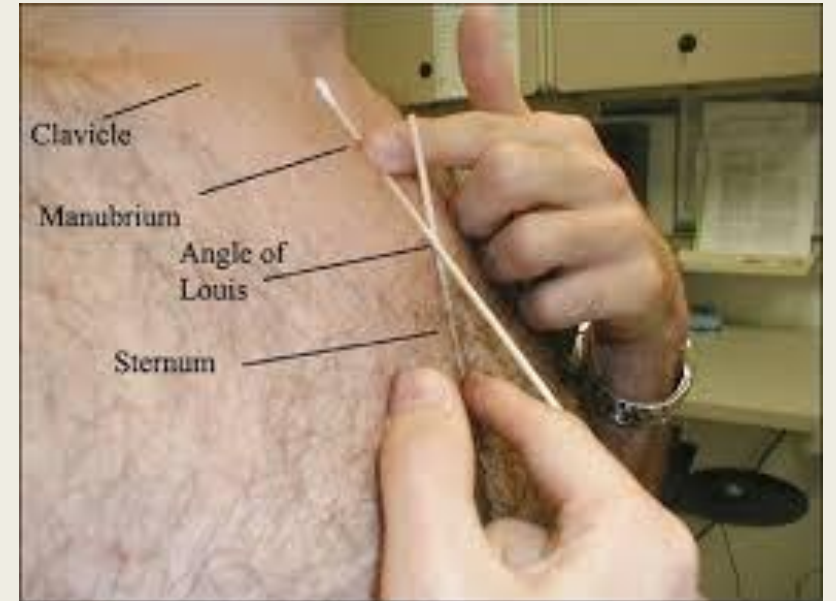


FIGURE 1.1 Anatomical lines of the anterior chest wall (Tilmann BN (2010), *Ventrale Rumpfwand*. In: *Anatomie*, Springer-Verlag Berlin Heidelberg, S. 816, Abb. 21.1)

ANATOMICAL REGIONS (defined by the chest wall's surface):

1) Ventral:

Regio pectoralis / mammaria, Regio infraclavicularis, Regio parasternalis, Regio hypochondriaca

2) Lateral:

Regio axillaris

3) Dorsal:

Regio suprascapularis, Regios scapularis, Regio infrascapularis

ORIENTATION during a examination and/or procedures:

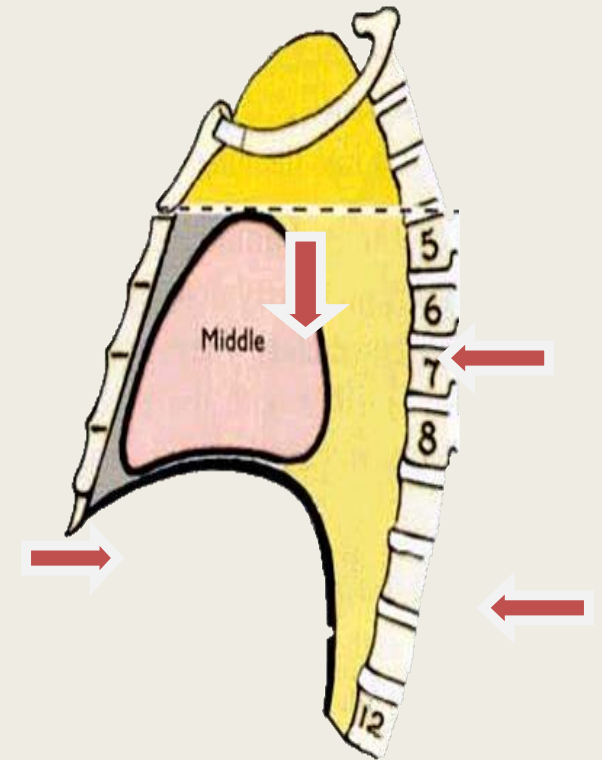
- *Linea sternalis*
- *Linea parasternalis*
- *Linea medioclavicularis (MCL)*
- *Linea axillaris anterior, media, posterior*
- *Linea scapularis*
- *Linea paravertebralis*

MEDIASTINUM

The thoracic mediastinum is the compartment that runs the length of the thoracic cavity between the pleural sacs of the lungs. This compartment extends longitudinally from the thoracic inlet to the superior surface of the diaphragm.

- **BOUNDARIES OF MEDIASTINUM**

Superior	Thoracic outlet
Inferior	Diaphragm
Anterior	Sternum
Posterior	Thoracic vertebrae
Lateral	Lungs & pleurae



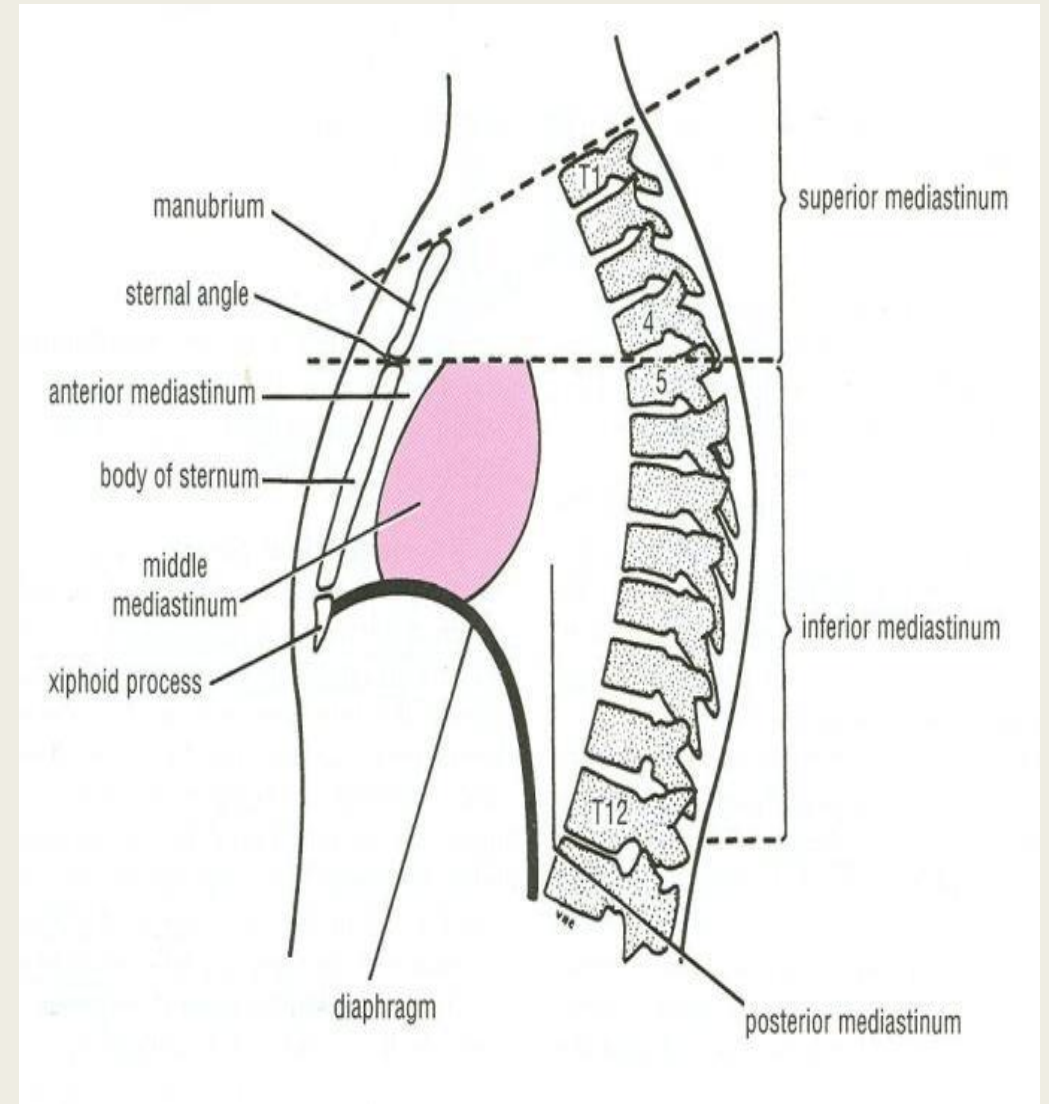
It is divided by a horizontal plane extending from sternal angle to lower border of 4 thoracic vertebra into:

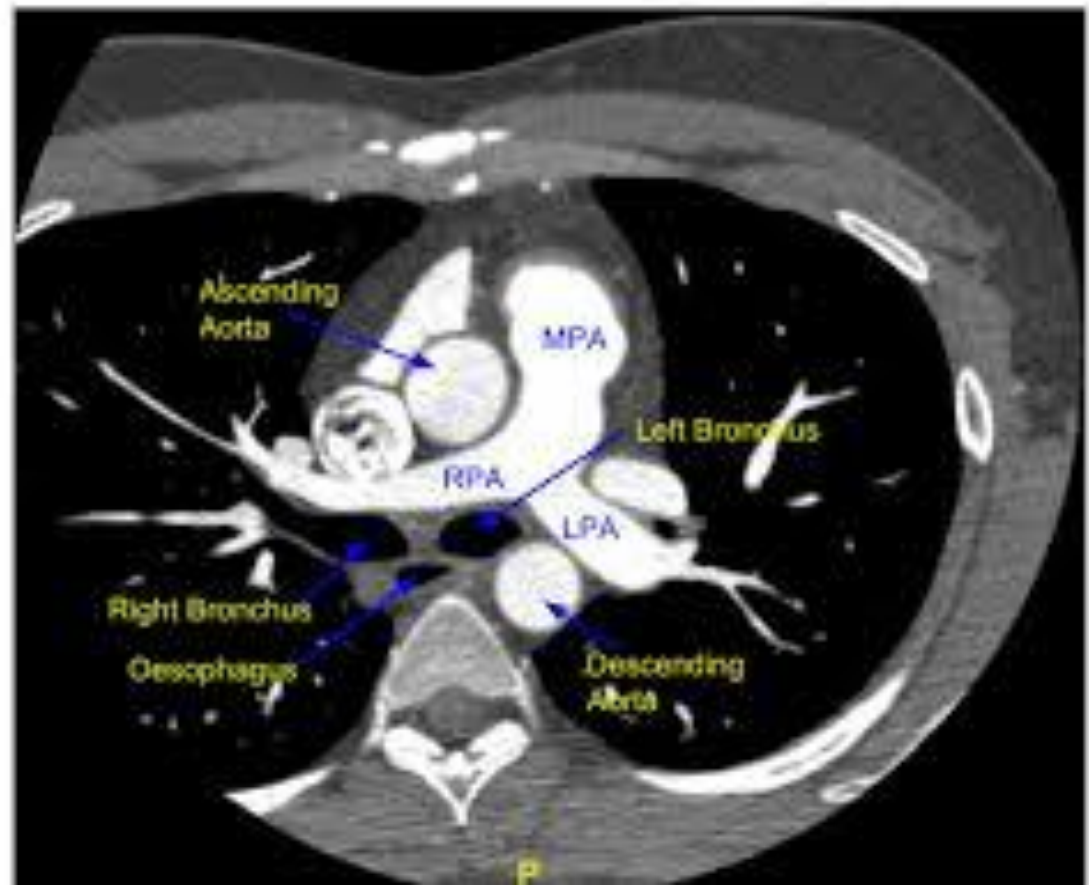
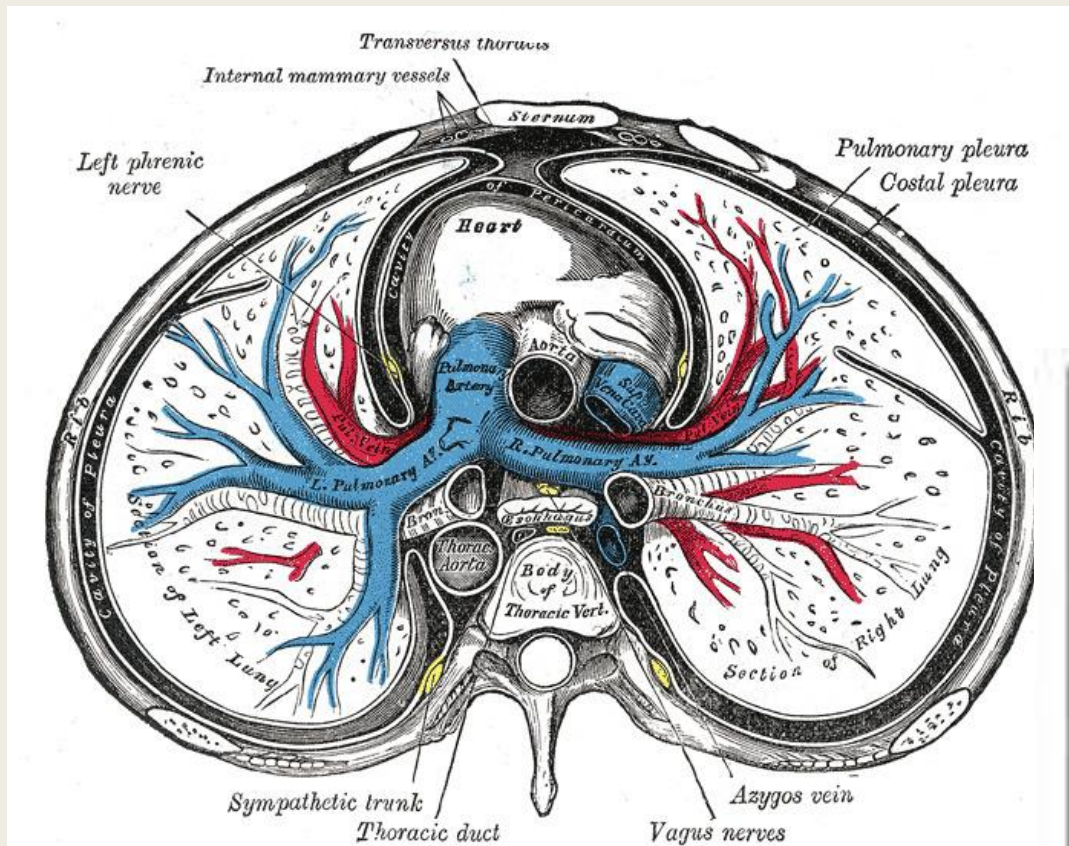
SUPERIOR
INFERIOR

INFERIOR MEDIASTINUM is divided by heart into:

ANTERIOR
POSTERIOR

MIDDLE Mediastinum contains heart



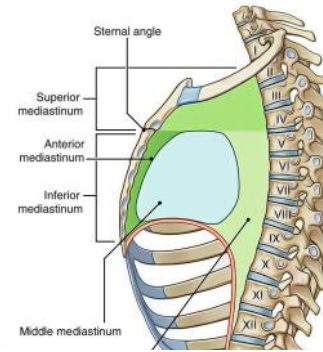


Superior Mediastinum



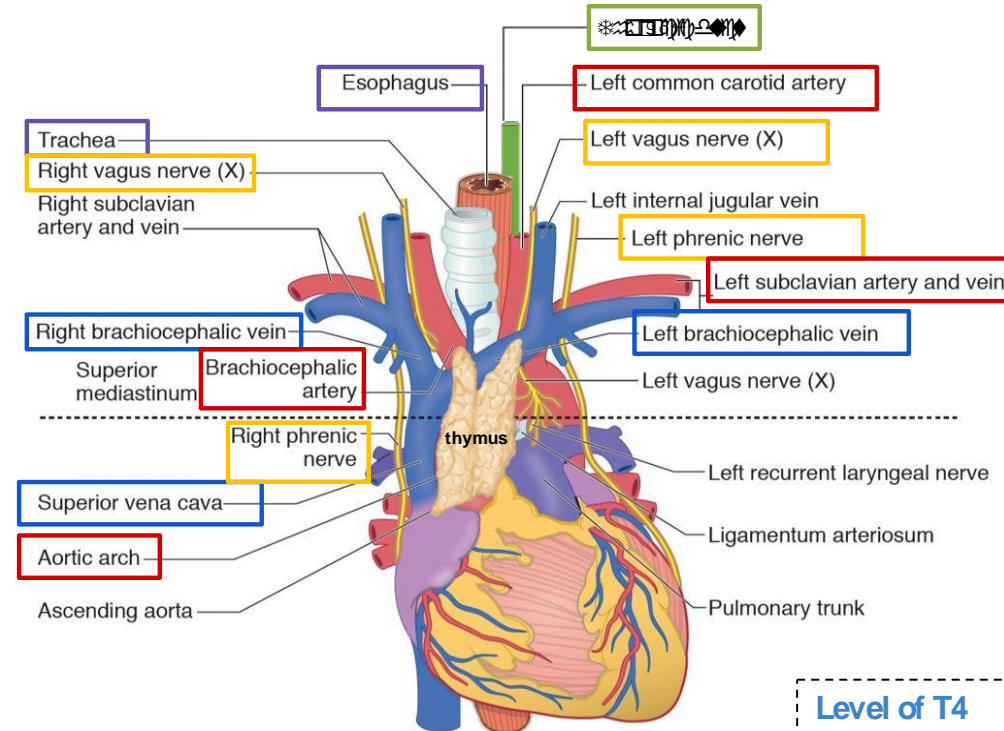
Boundaries

- **Superior:** Thoracic outlet
- **Inferior:** Horizontal plane
- **Anterior:** Manubrium of sternum
- **Posterior:** Upper 4 thoracic vertebrae
- **Lateral:** lungs & pleurae



Contents: From superficial to deep:

- | | |
|--------------|--|
| Superficial | <ul style="list-style-type: none"> □ (1) Gland: Thymus gland □ (3) Veins: <ul style="list-style-type: none"> □ right & left brachiocephalic □ superior vena cava |
| Intermediate | <ul style="list-style-type: none"> □ (4) Arteries: <ul style="list-style-type: none"> □ arch of aorta & its branches □ brachiocephalic artery □ left common carotid □ left subclavian □ (4) Nerves: <ul style="list-style-type: none"> □ right & left vagus □ right & left phrenic |
| Deep | <ul style="list-style-type: none"> □ (2) Tubes: <ul style="list-style-type: none"> □ Trachea □ Esophagus (most posterior) □ (1) Duct: thoracic duct (beside the esophagus) □ Lymph nodes |



Level of T4

- **It is the Level of:**
 1. Sternal angle
 2. Second costal cartilage
- **Why the Level of T4 is important:**
 1. Bifurcation of trachea
 2. Bifurcation of pulmonary trunk
 3. Beginning & termination of arch of aorta



Inferior mediastinum:

First part: Posterior Mediastinum



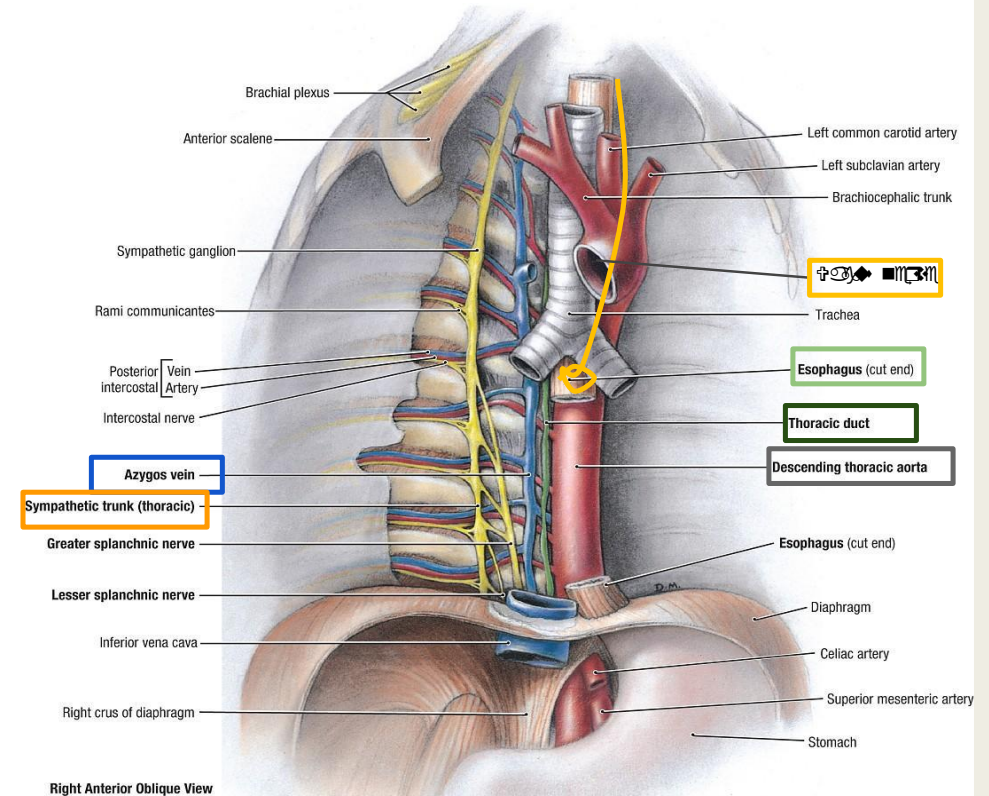
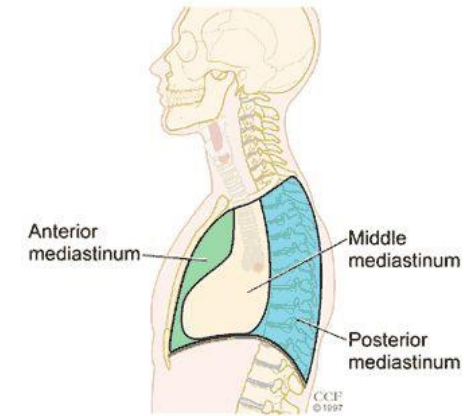
Boundaries:

- Superior: Horizontal plane
- Inferior: Diaphragm
- Anterior: Heart
- Posterior: Thoracic vertebrae from T5 to T12
- Lateral: Lungs & pleurae

Contents:

- Esophagus (most anterior)
- Right & left Vagus nerves: around esophagus
- Thoracic duct: posterior to esophagus
- Azygos vein: posterior & to the right of esophagus
- Descending aorta: posterior & to the left of esophagus
- Right & left sympathetic trunks
- Lymph nodes

Helpful Note: it contains one from each (artery, vein, nerve, duct, tube, trunk)



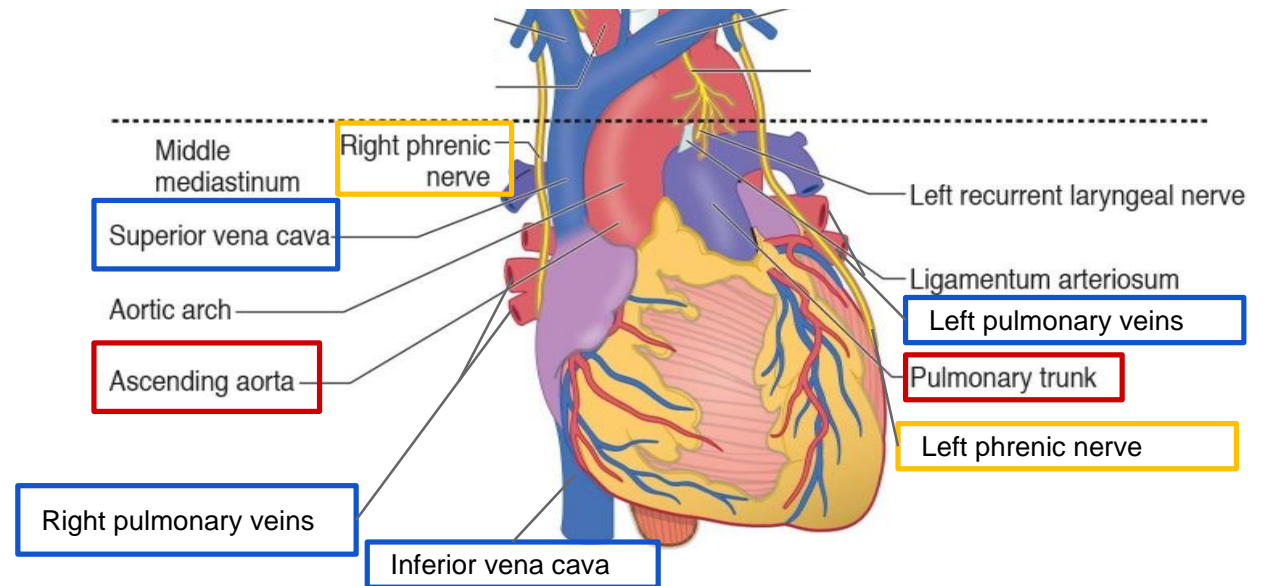
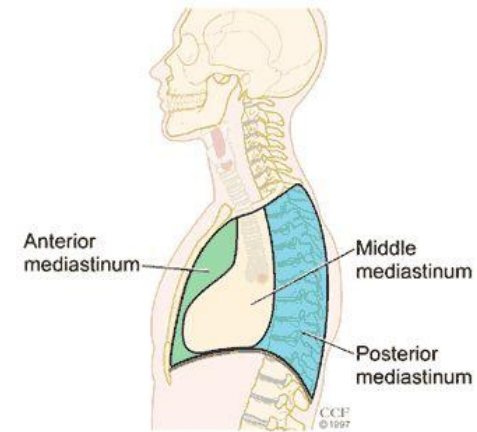
Inferior mediastinum:

Second part: Middle Mediastinum

Site: Between anterior & posterior mediastinum

Contents:

- Heart & pericardium
- **Ascending Aorta**
- **Pulmonary trunk**
- Superior & inferior vena cava
- Right & left pulmonary veins
- **Right & left phrenic nerves**
- Lymph nodes



Inferior mediastinum:

Third part: Anterior Mediastinum

□ Boundaries:

- **Superior:** Horizontal plane
- **Inferior:** Diaphragm
- **Anterior:** Body & xiphoid of sternum
- **Posterior:** Heart
- **Lateral:** Lungs & pleurae

□ Contents:

- **Thymus gland**
- **Lymph nodes**

Note: lymph nodes present in all mediastinum region

IMPORTANT NOTE: There are six structure present in more than one region in mediastinum

Three in superior and posterior mediastinum:

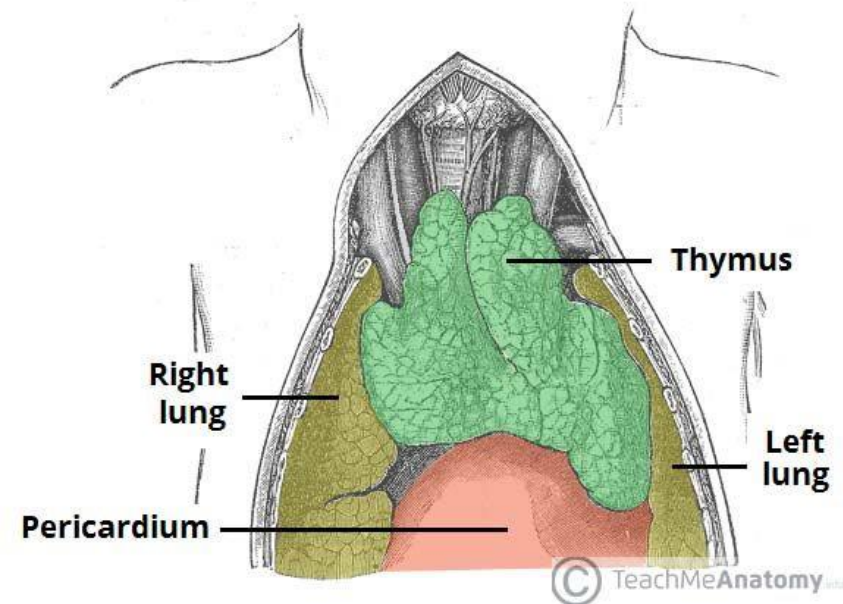
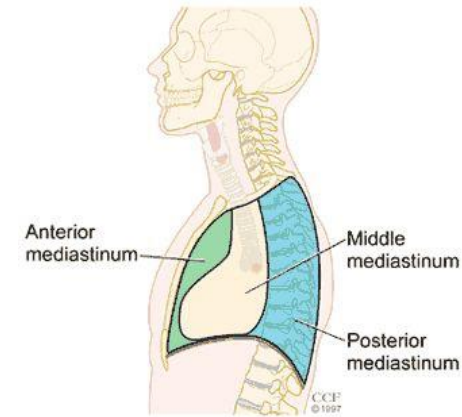
- Thoracic duct, Esophagus, vagus nerves

Two in superior and middle mediastinum:

- phrenic nerves, superior vena cava

One in superior and anterior mediastinum:

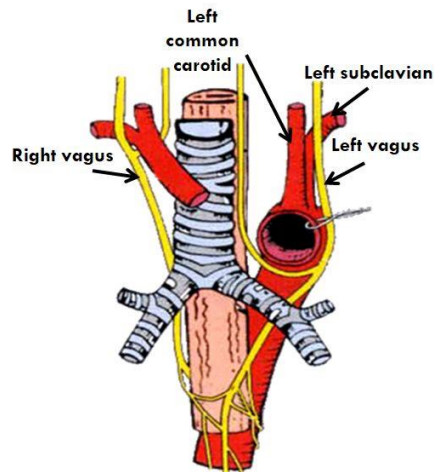
- Thymus gland



Important structures in Mediastinum

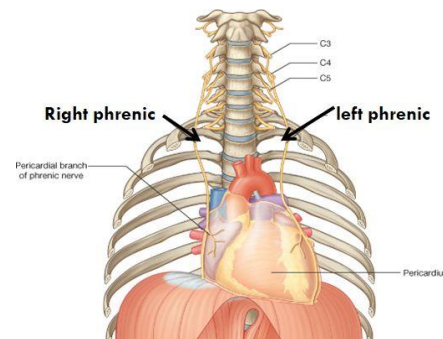
Vagus nerve

- It is the 10th cranial nerve.
- The right vagus descends to the right side of trachea, forms the **posterior** esophageal plexus & continues in abdomen as **posterior** gastric nerve.
- The left vagus descends between left common carotid & left subclavian arteries, forms the **anterior** esophageal plexus & continues in abdomen as **anterior** gastric nerve.



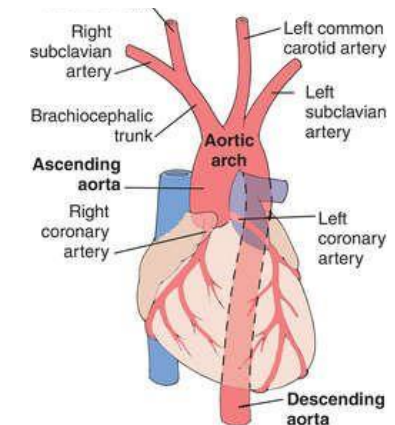
Phrenic nerve

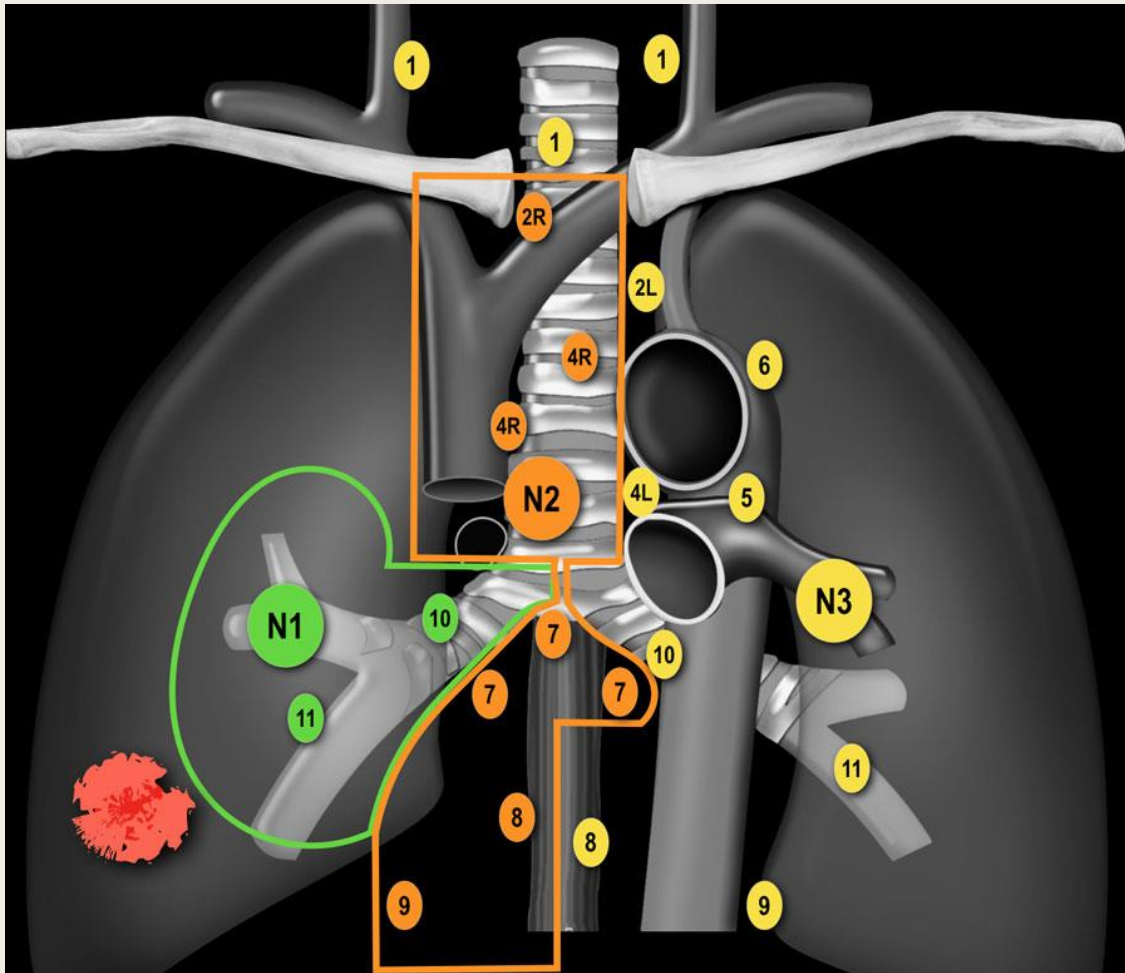
- **Root value: C3,4,5**
- **Course in thorax:** They pass through the Superior & Middle mediastinum
- The right phrenic descends on the right side of SVC (superior vena cava) & heart.
- The left phrenic descends on the left side of heart.
- Both nerves terminate in the diaphragm
- **Supply:**
 - 1) Motor & sensory fibers to diaphragm
 - 2) **Sensory fibers to pleurae & pericardium**



Aorta

- **Ascending aorta:**
 - **Beginning:** at aortic orifice of left ventricle.
 - **Course:** in middle mediastinum
 - **End:** continues as arch of aorta (at level of T4)
- **Arch of aorta:**
 - **Course:** in superior mediastinum
 - **End:** continues as descending thoracic aorta (at level of T4)
- **Descending aorta:**
 - **Course:** in posterior mediastinum
 - **End:** continues as abdominal aorta through diaphragm





Lung cancer stadiation by lymph nodes

Lymphatic vessels in thorax

- Lymph from the right side of the head, neck, thorax, & upper limb drains into the **Right lymphatic duct** and ends in the **right brachiocephalic vein**
- Lymph from the lower half of the body drains into the **Cysterna chyli** then to the **Thoracic duct**
- Lymph from the left side of the head, neck, thorax, & upper limb drains directly into the **Thoracic duct**

Thoracic duct

Beginning:

It is the continuation of **Cysterna chyli** at the level of L1

Course:

It passes through the aortic opening of diaphragm.

It ascends in the posterior mediastinum (posterior to esophagus).

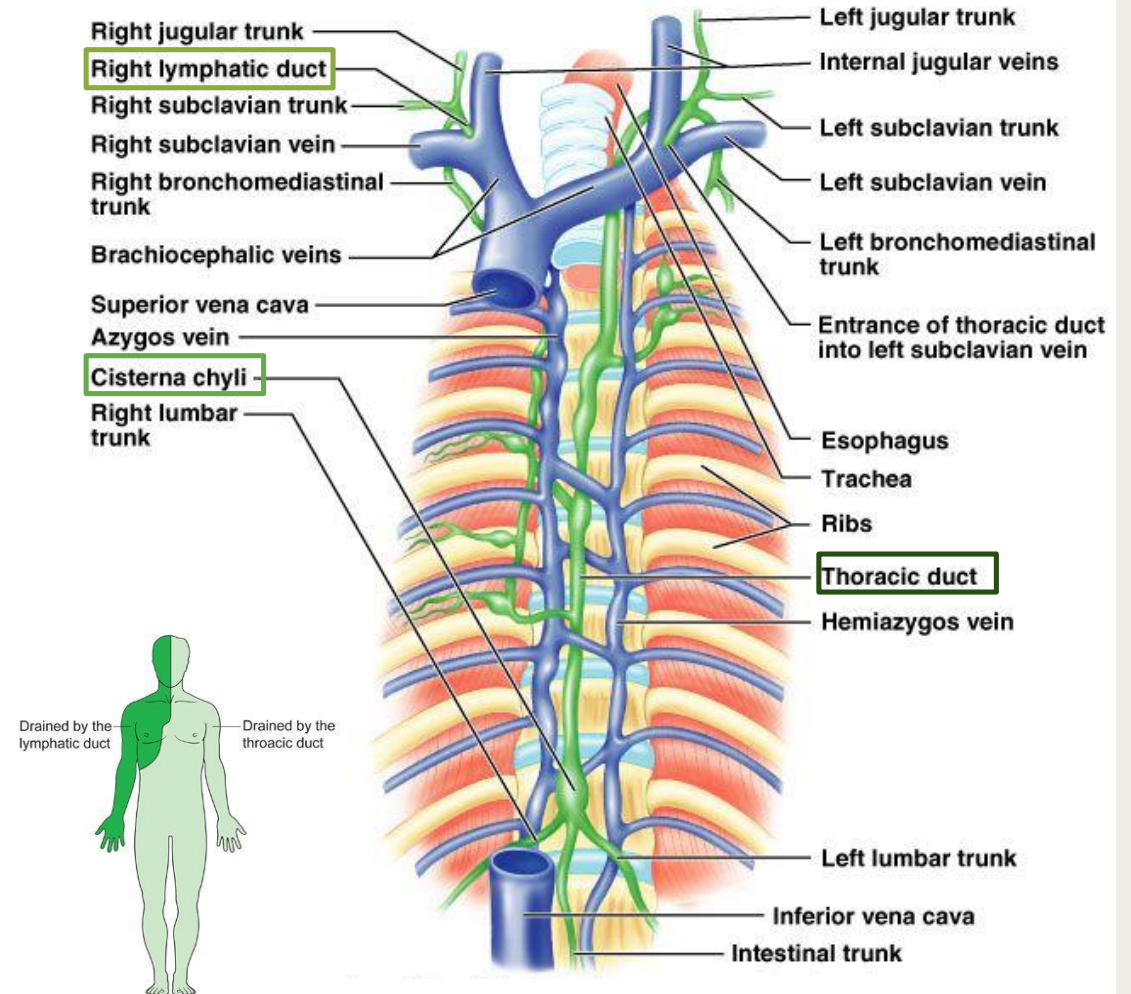
It ascends in the superior mediastinum (to the left of esophagus).

Tributaries:

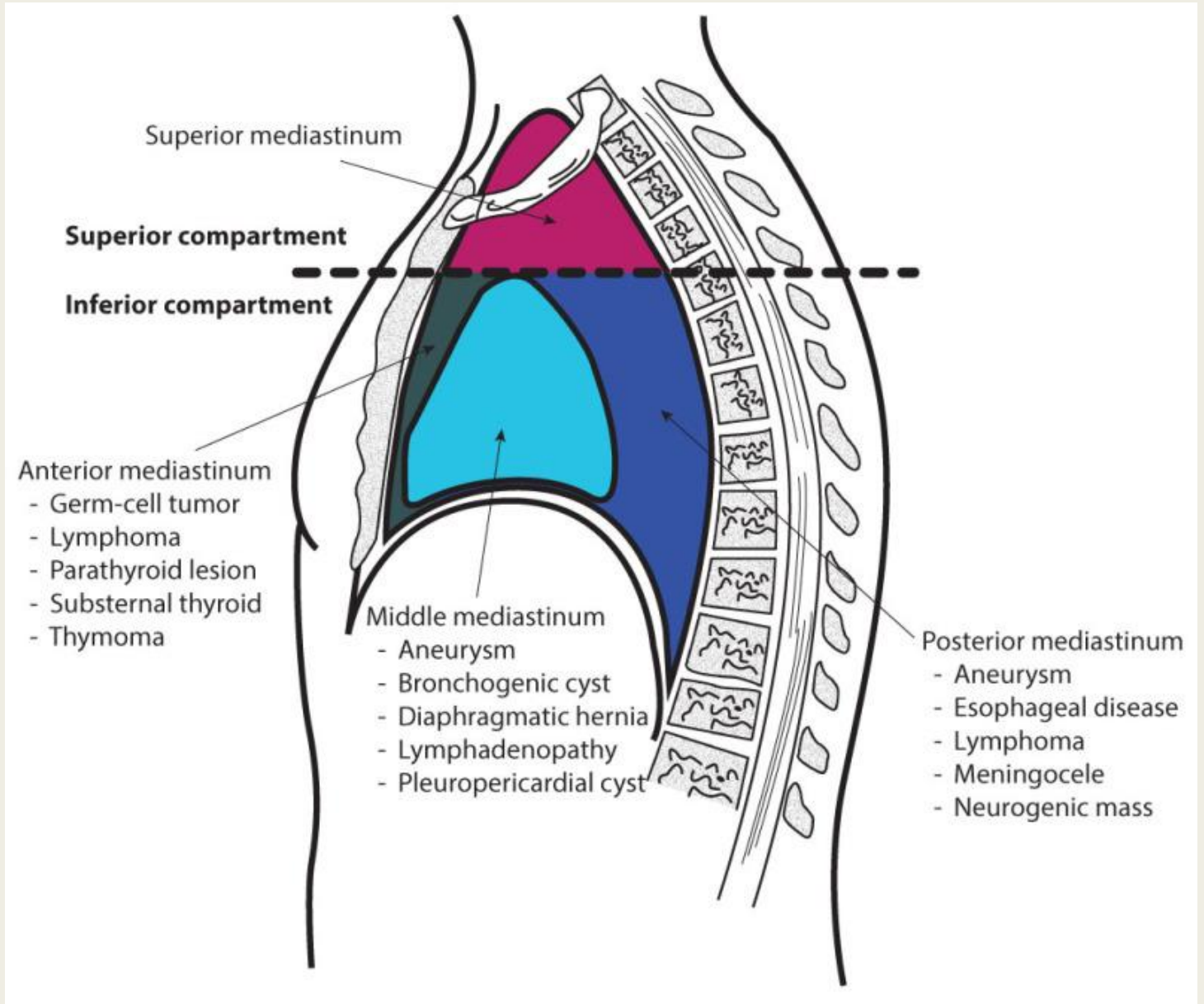
It receives Lymphatics from all body **EXCEPT** right side of (head & neck, thorax, upper limb) as we mentioned before

End:

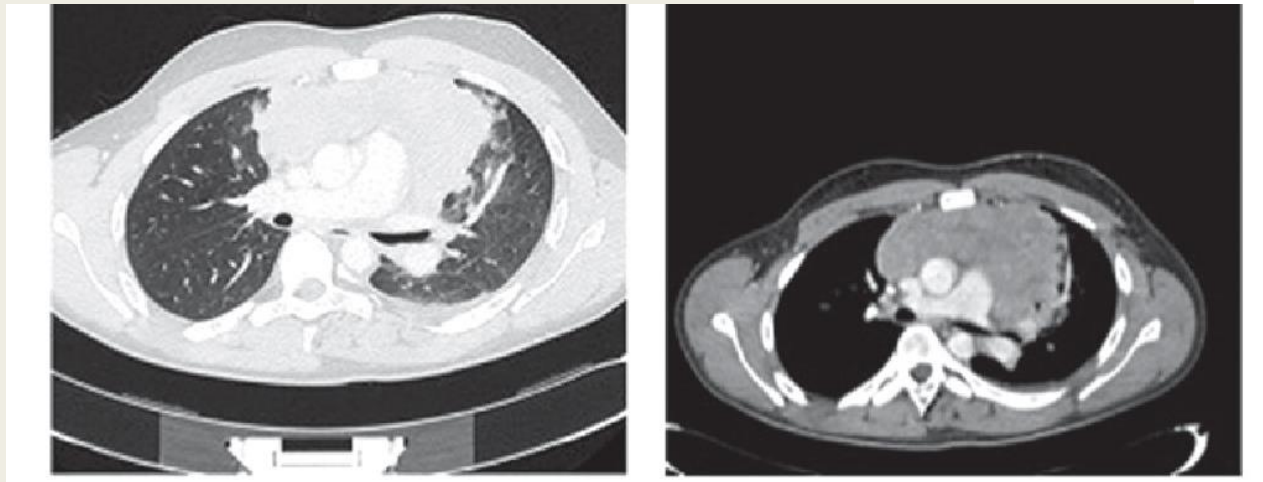
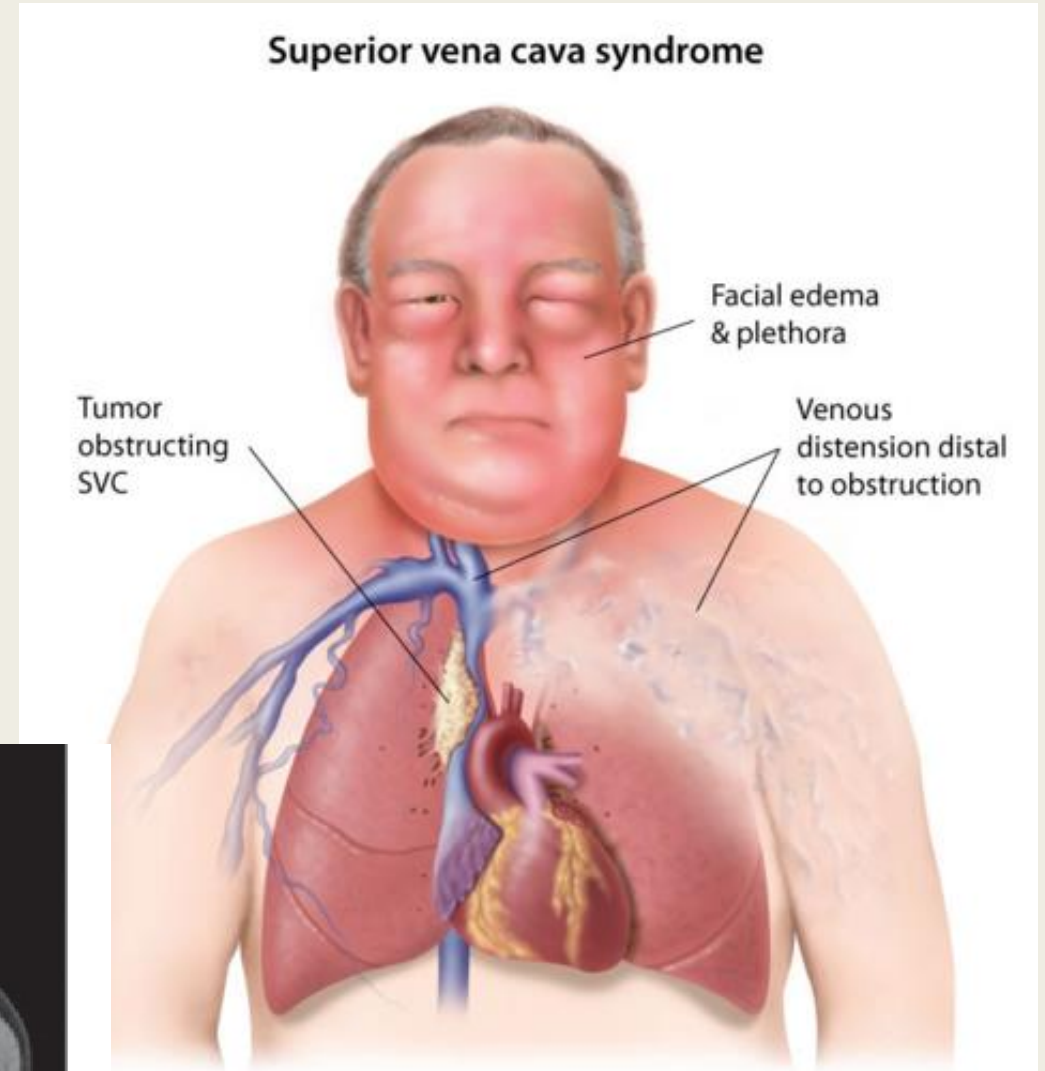
in the **left brachiocephalic vein**.



From anatomy to differential diagnosis



Vein occlusion and infiltration...



axial computed tomography without a contrast agent, in the mediastinal window (right) and with a contrast agent in the