



# Anatomy of the Anterior Thoracic Wall and Diaphragm

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# **Anatomy of the thoracic wall**

## **Reference books:**

- **Oxford handbook of Medical Sciences 2011, pp: 356-359.**
- **Integrated Medical Sciences 2007, pp:1-14.**
- **Lippincott Illustrated Reviews: Integrated Systems (2015), pp: 208-252.**
- **Kaplan (2021), pp: 35-38.**

- **By end of the lecture the student will be able to Knowledge:**

**A1- Describe shape and outline of thoracic cage including inlet and outlet.**

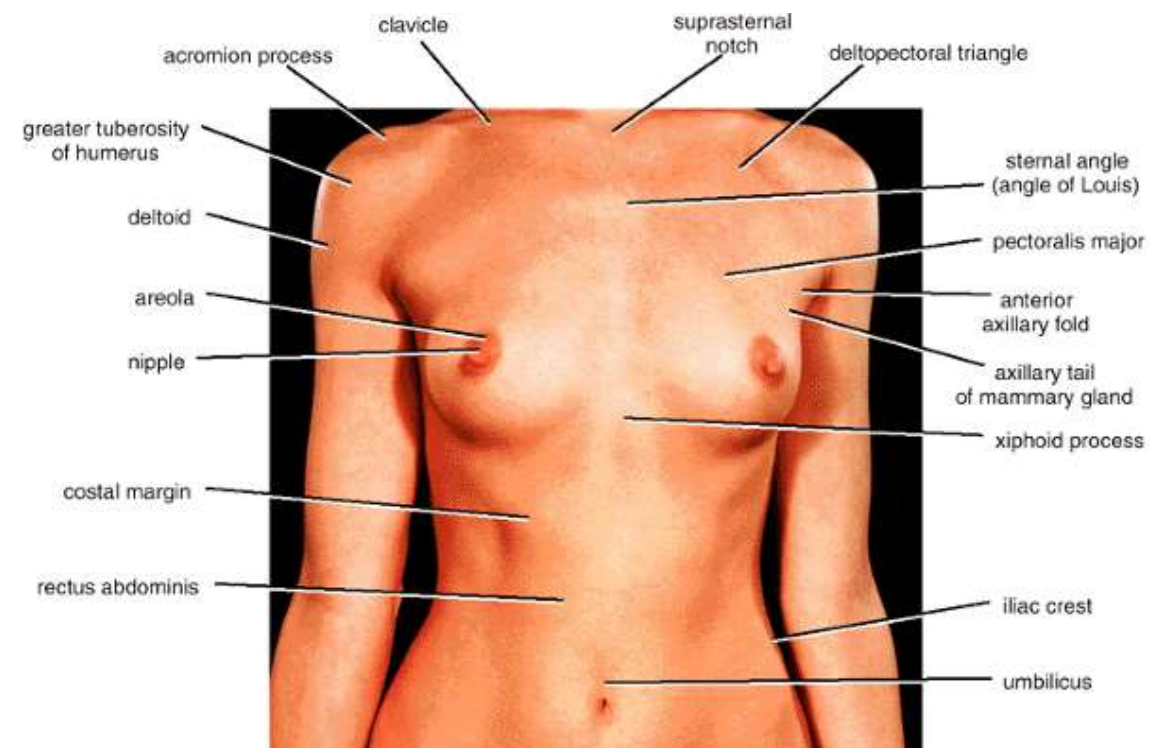
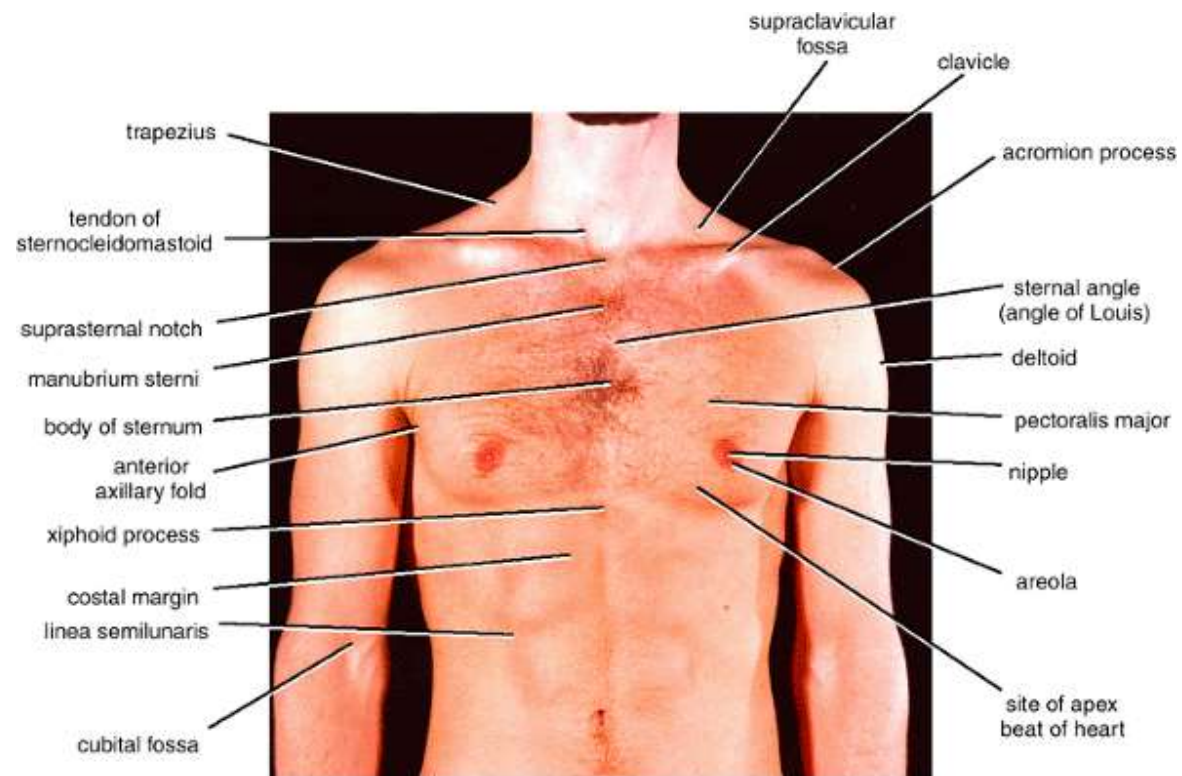
**A2- Describe the anatomical landmarks of the anterior chest wall.**

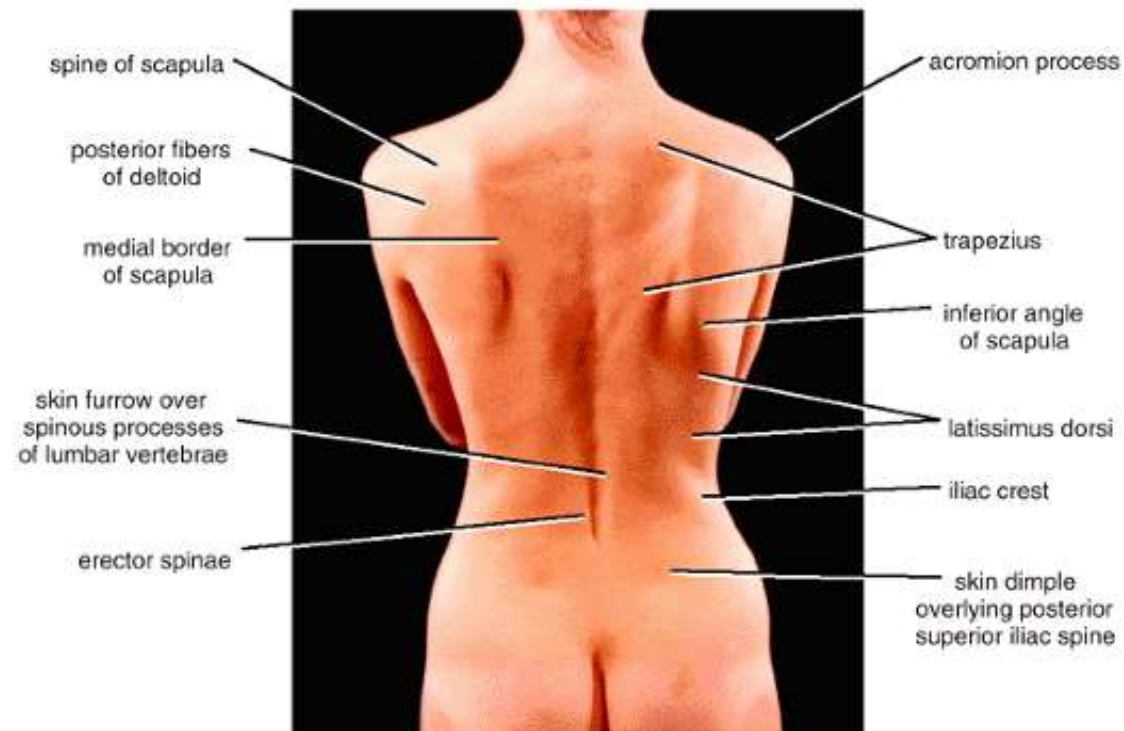
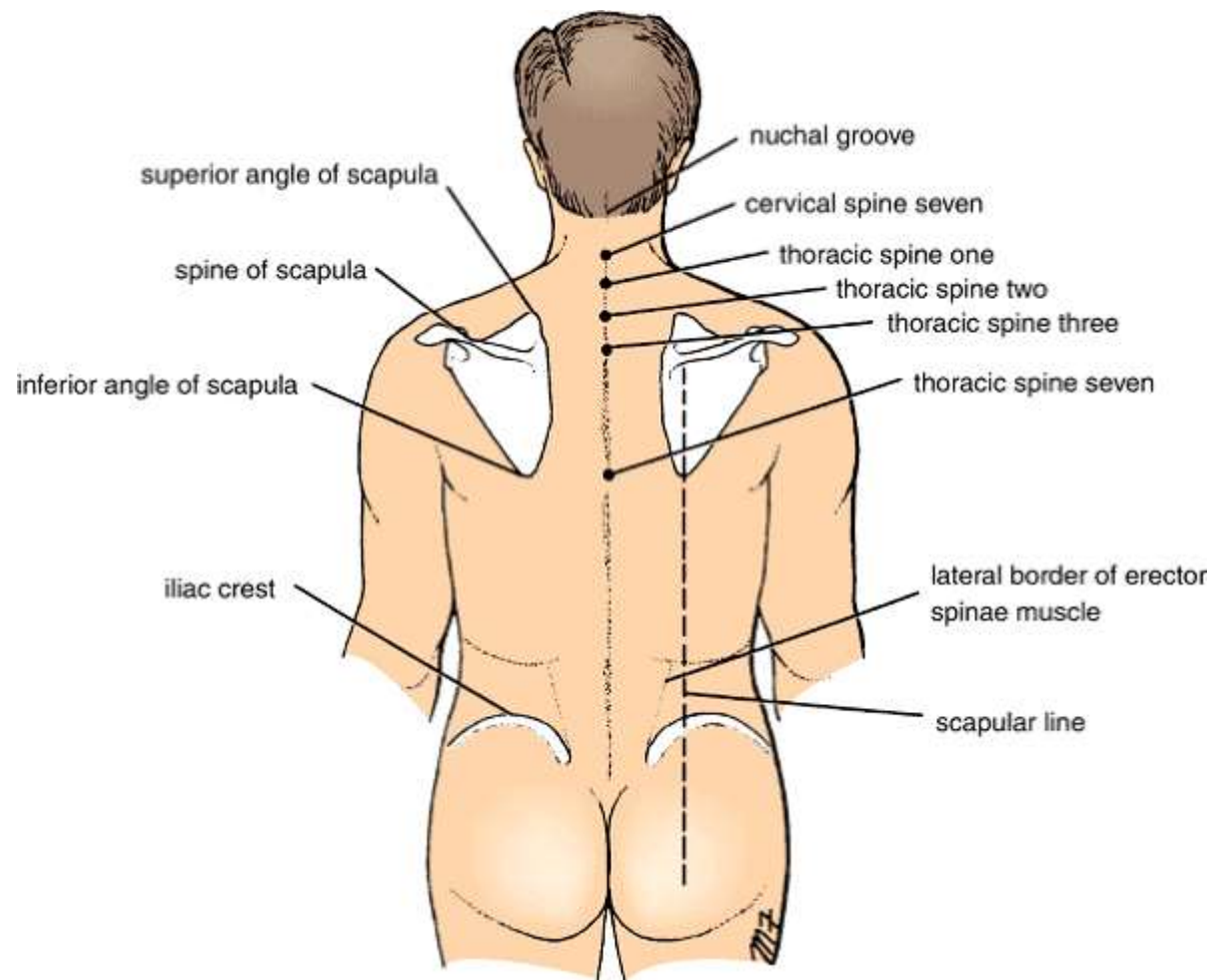
**A3- List various structures making the thoracic wall.**

**A4- Make a list of muscles of the thoracic wall including their nerve and blood supply and their actions.**

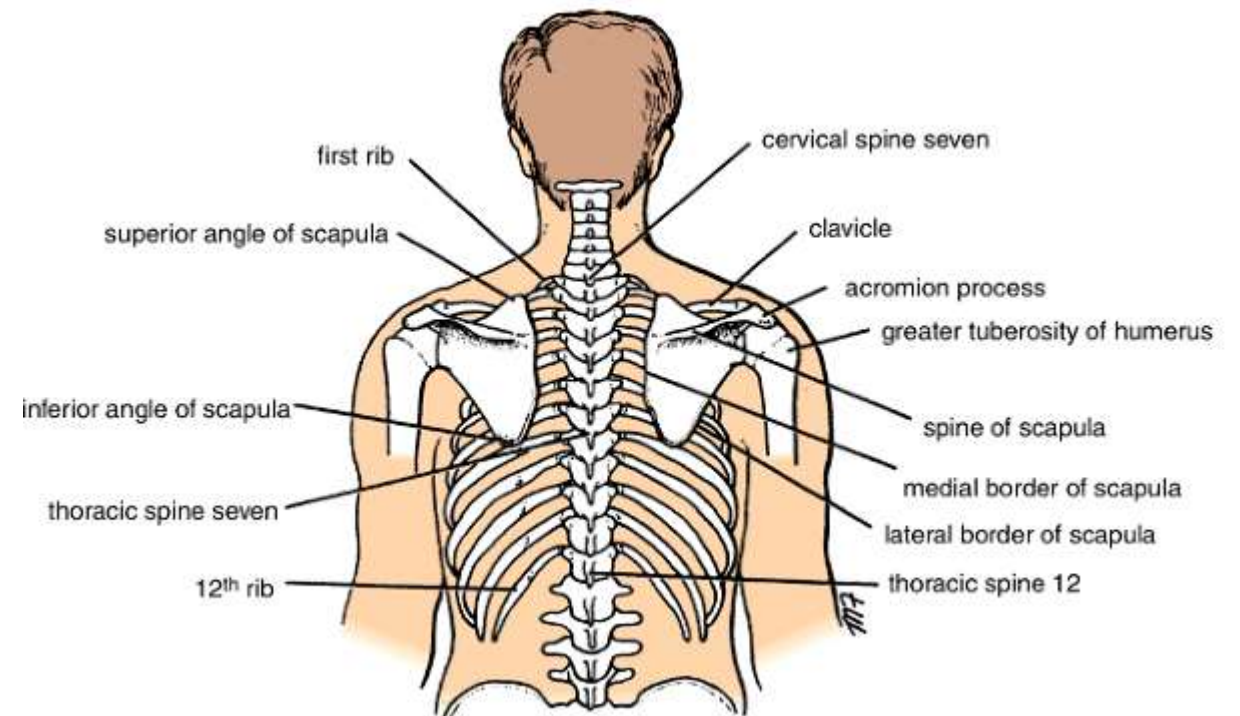
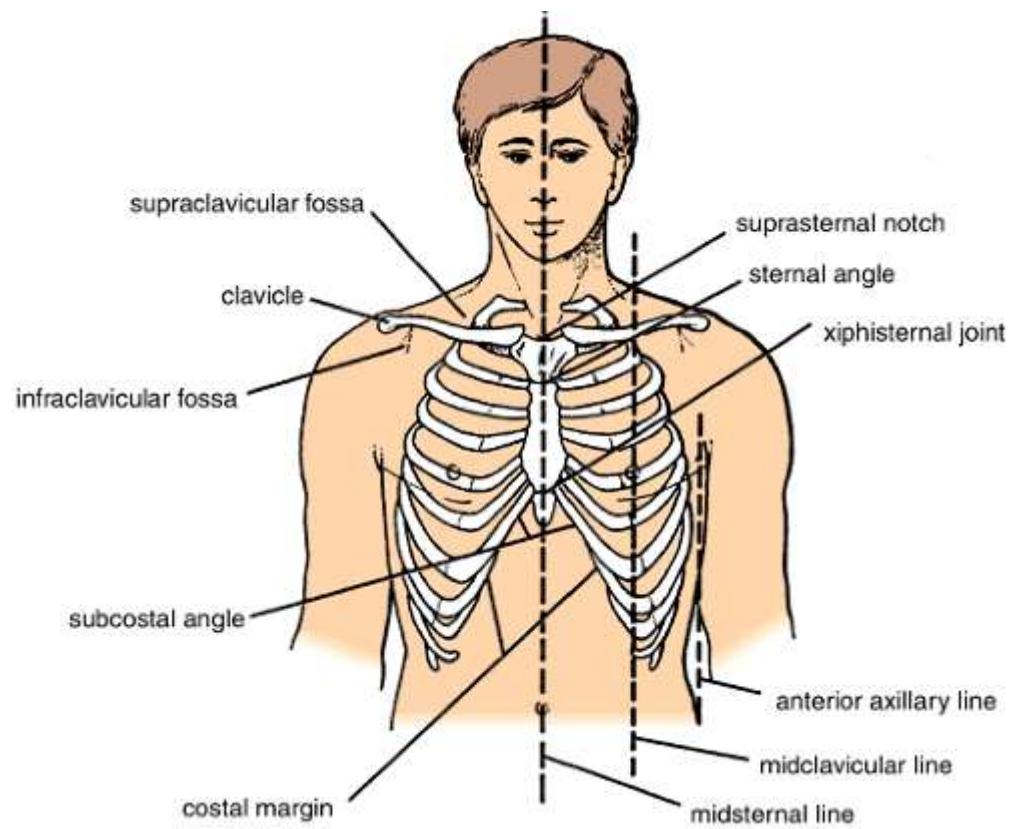
**A5- Define intercostal spaces and discuss their various components including intercostal muscles.**

**A6- Describe diaphragm; origin, insertion, function, nerve and blood supply. Study openings in diaphragm and structures passing through.**





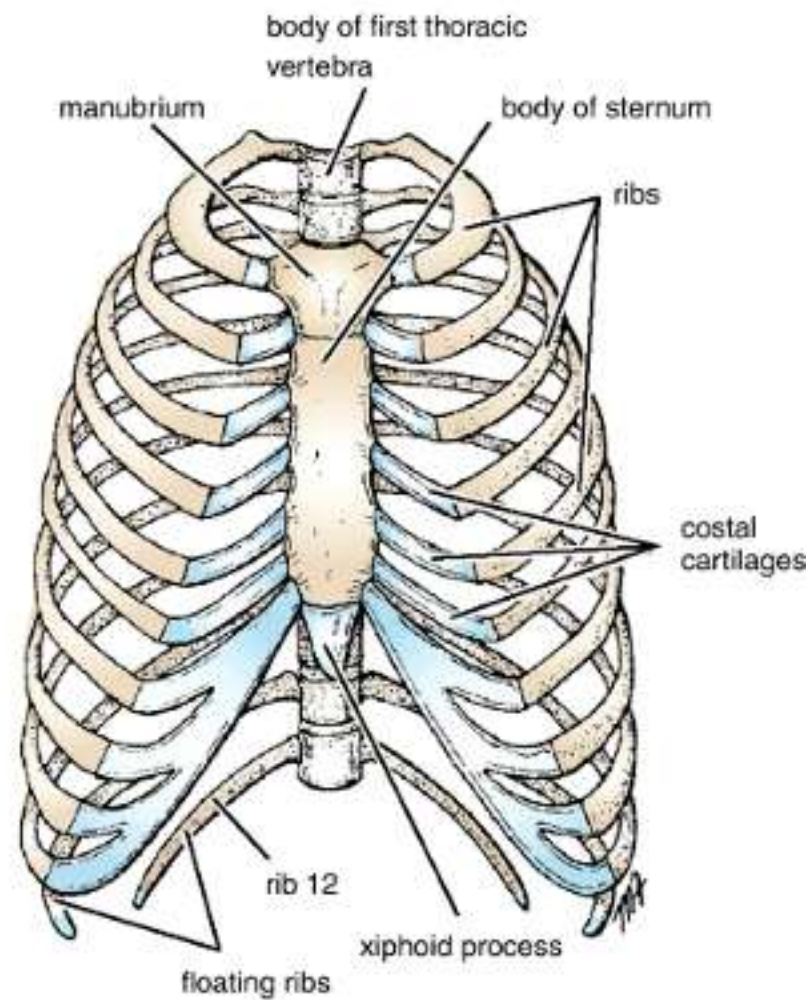
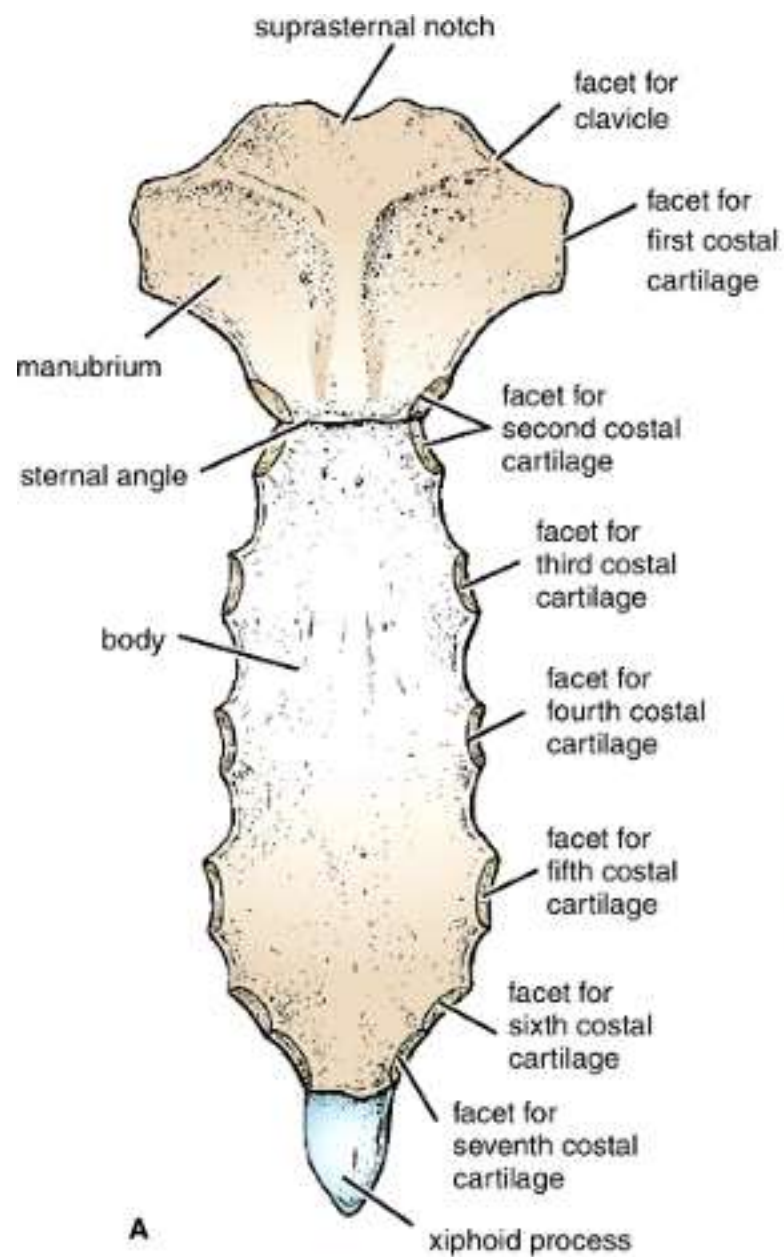




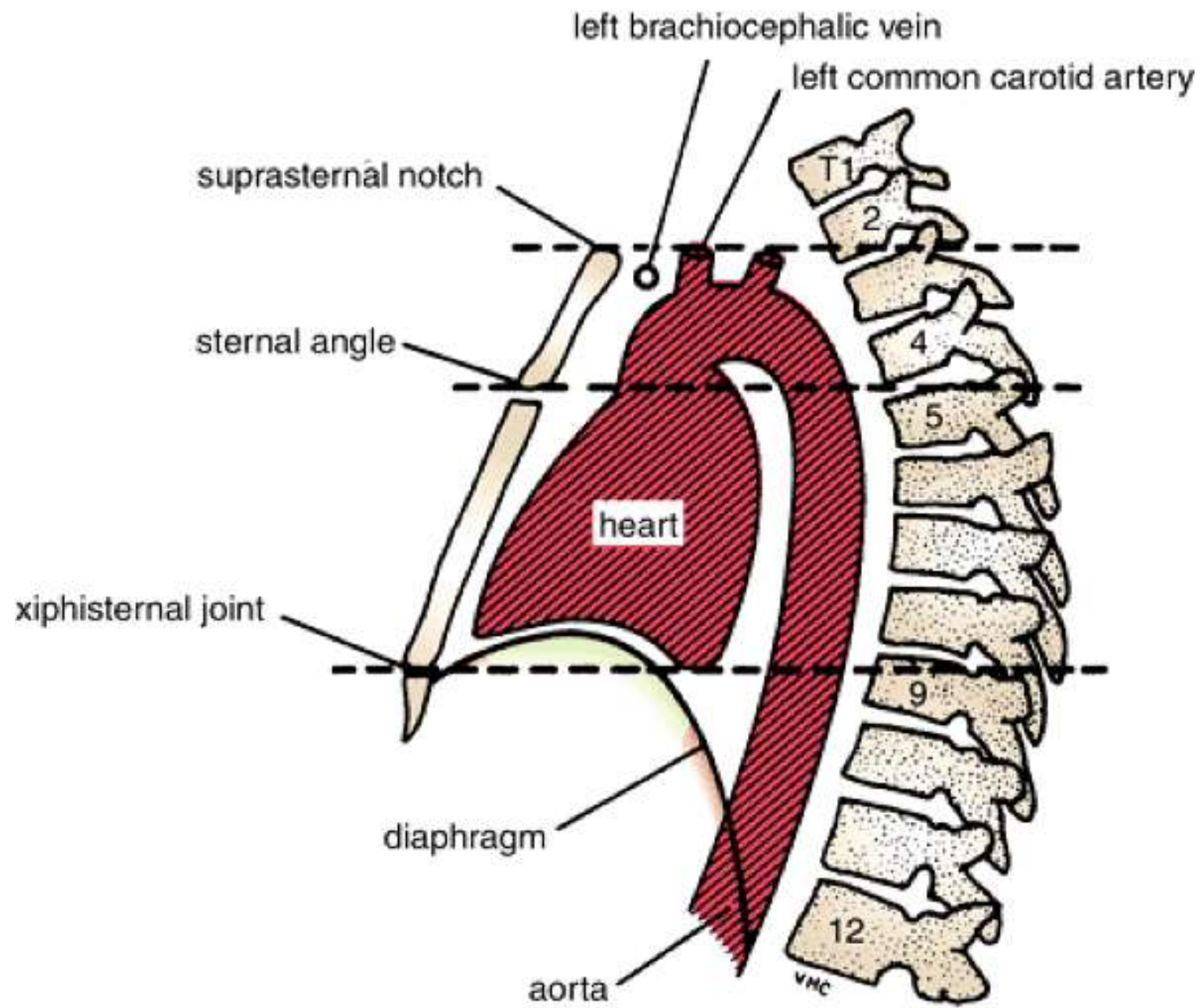
# Skeletal and soft tissue framework of the thorax

## Thorax is bounded by:

1. 12 pairs of ribs,
  2. Costal cartilages,
  3. Thoracic vertebrae,
  4. Intercostal muscles,
  5. Sternum
- Participate in ventilation as well as protecting the thoracic organs.
  - Together they form the thoracic cage.
6. Diaphragm: attached to inferior margins of thoracic cage and separates thoracic cavity from abdomen.



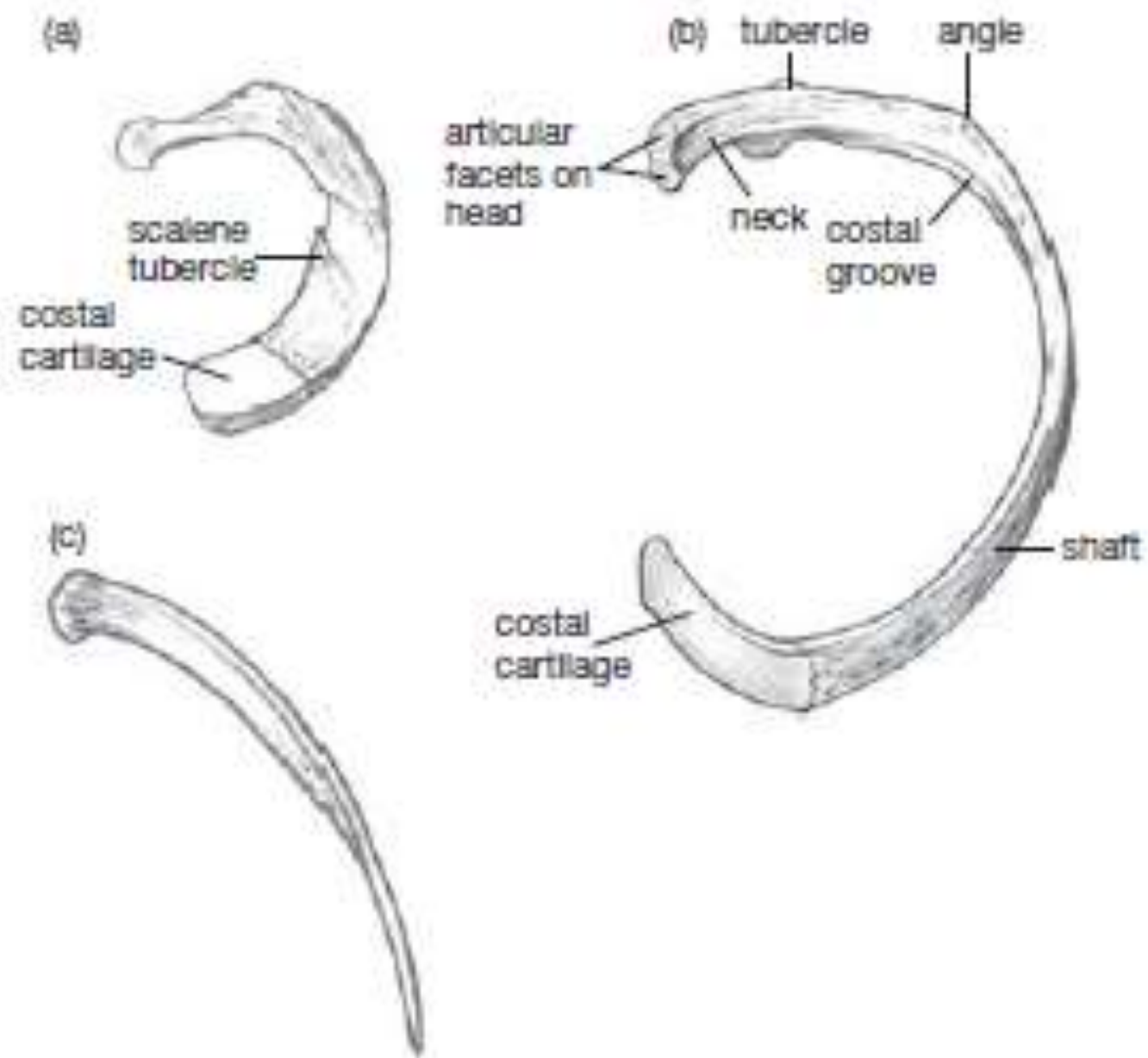


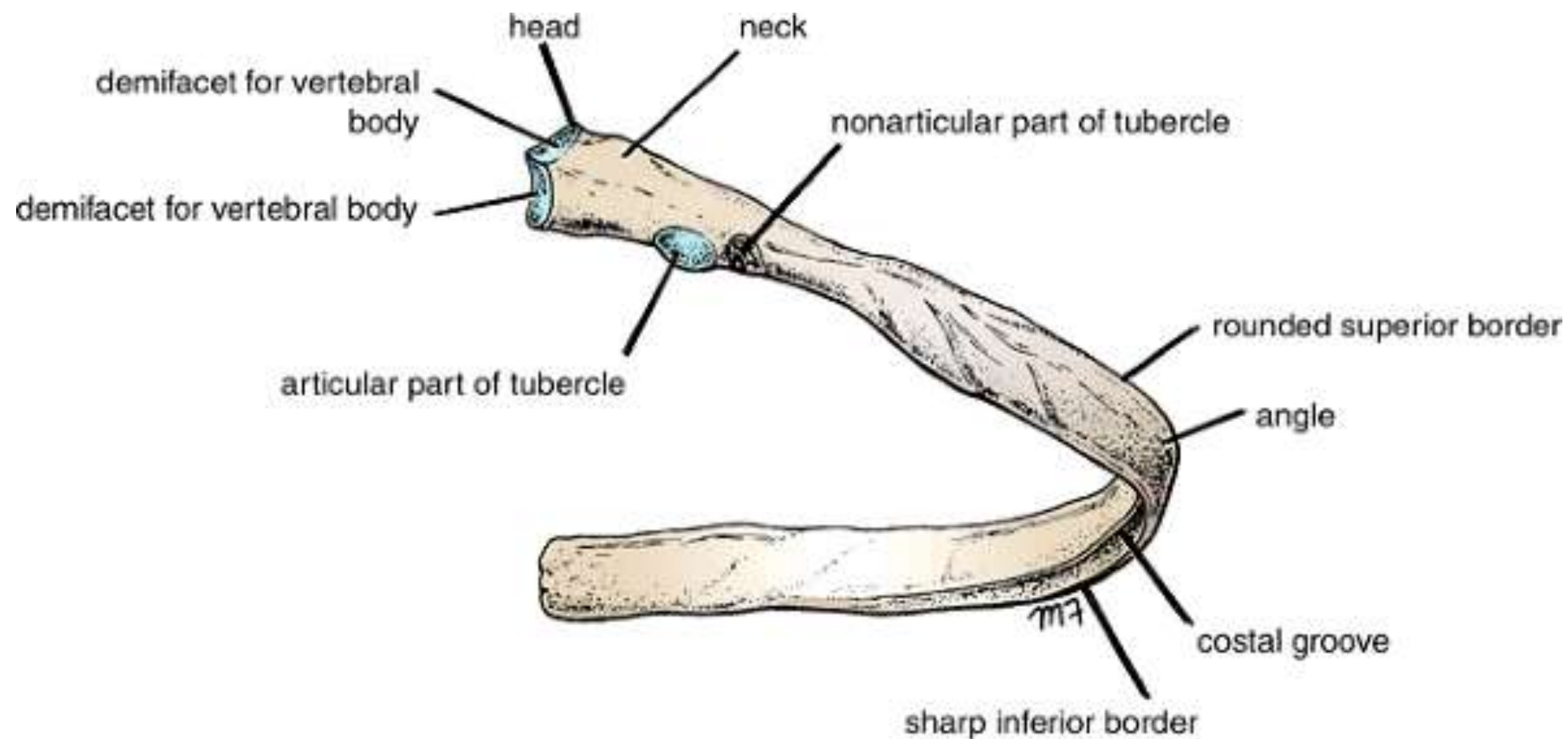


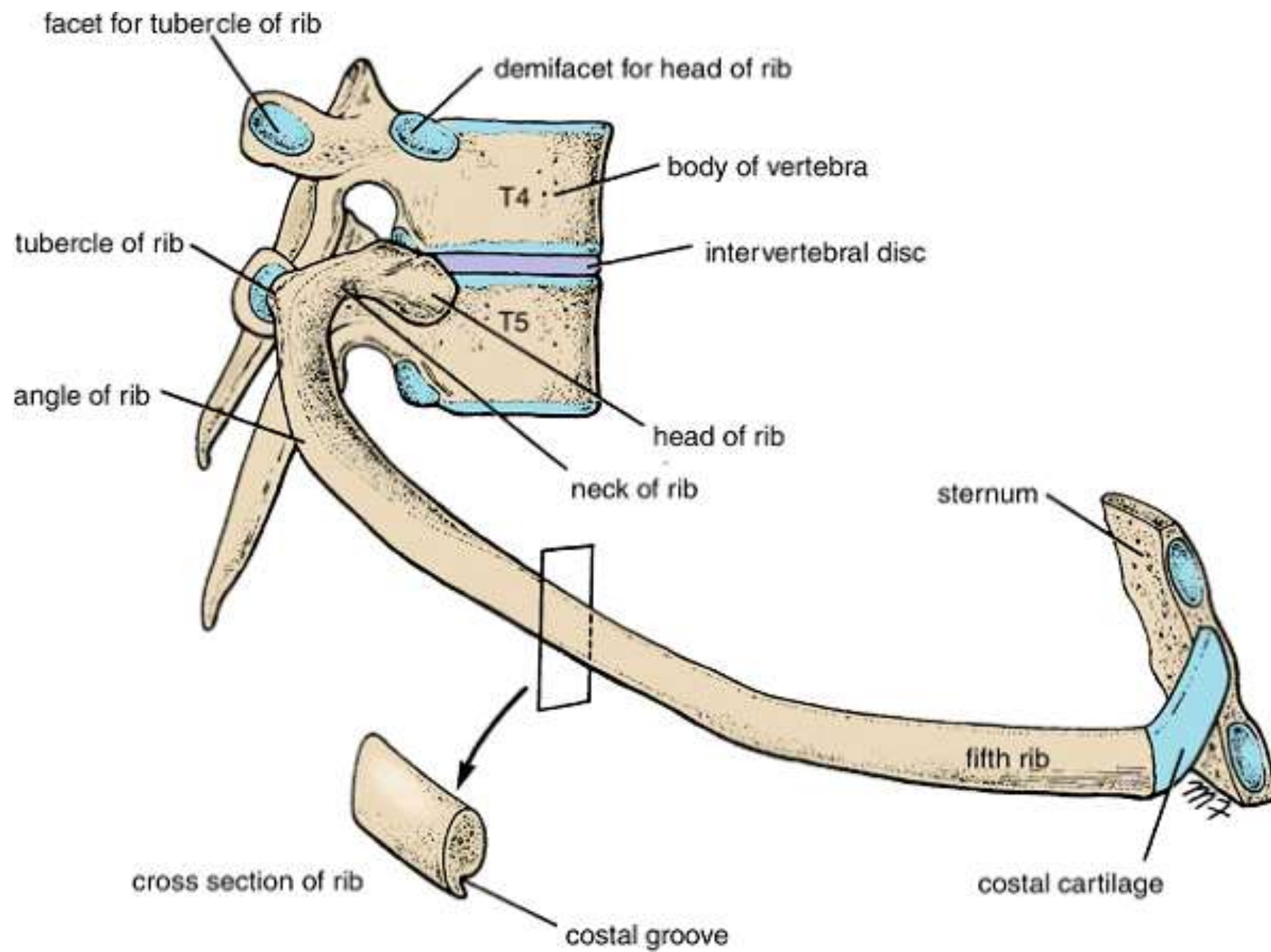
# The ribs

A typical rib comprises several distinct parts:

- **Head:** articulates with corresponding vertebra and one above.
- **Neck:** separates the head and the tubercle
- **Tubercle:** articulates with the transverse process of the corresponding vertebra
- **Angle of the rib:** divides the rib into two halves and is the weakest point of the rib
- **Shaft:** forms the flattened main portion of the rib







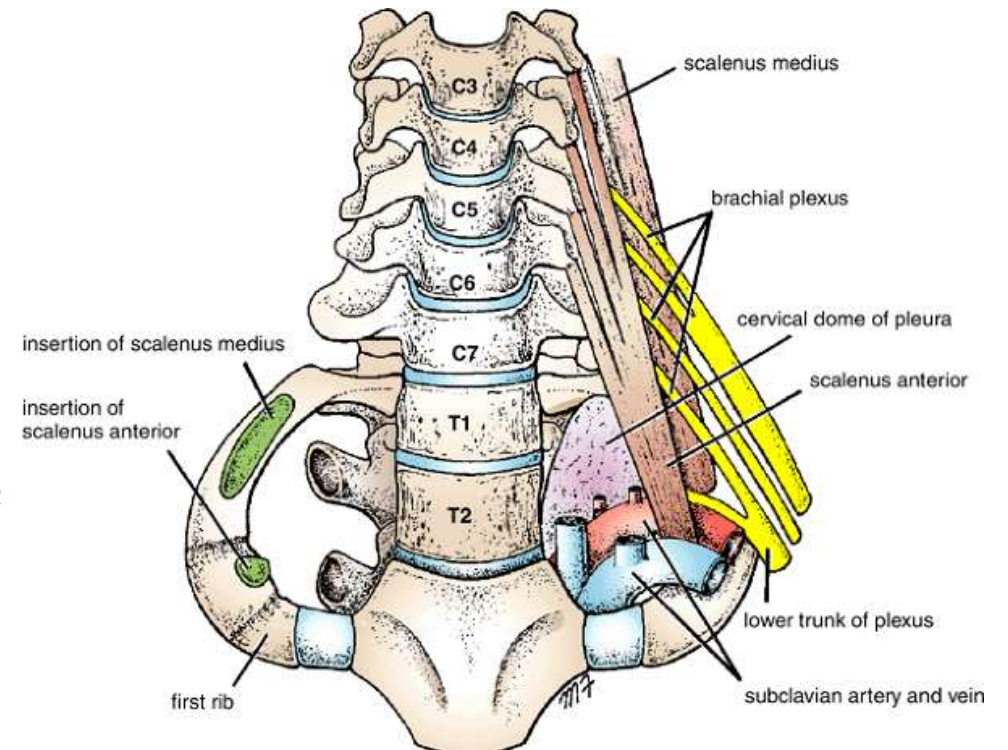


## The ribs (Cont.)

- Ribs 1–7 are true ribs (vertebrosternal ribs); the rib is fused anteriorly to the sternum via costal cartilage.
- Ribs 8–10 are false ribs (vertebrochondral ribs); the rib is fused to the costal cartilage of the above rib.
- Ribs 11 and 12 are floating ribs; the rib is not fused to sternum by any means).
- Costal cartilage increases elasticity of the thoracic cage, making it less fragile and liable to fracture following trivial trauma.

## The 1st rib

- **Owing to its superior location, it is associated with other structures and muscle attachments.**
- **The most curved rib.**
- **Scalenus medius attaches to its upper surface posteriorly.**
- **Scalenus anterior attaches to its tubercle on its upper medial side.**
- **Subclavian vein runs in front of this attachment, and subclavian artery and lowest branch of brachial plexus run behind attachment of scalenus anterior.**



## **The 10th rib**

**The 10th rib only articulates with T10 and, hence, only has one articular facet.**

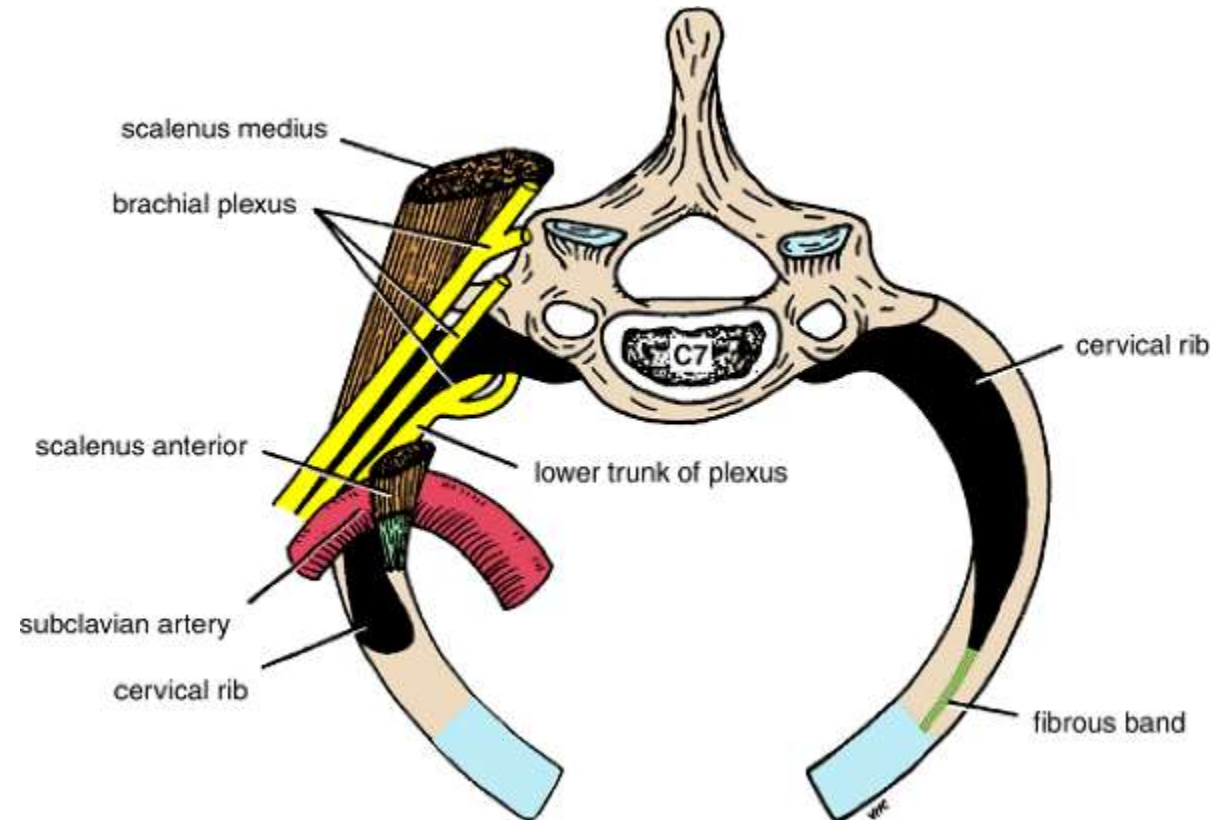
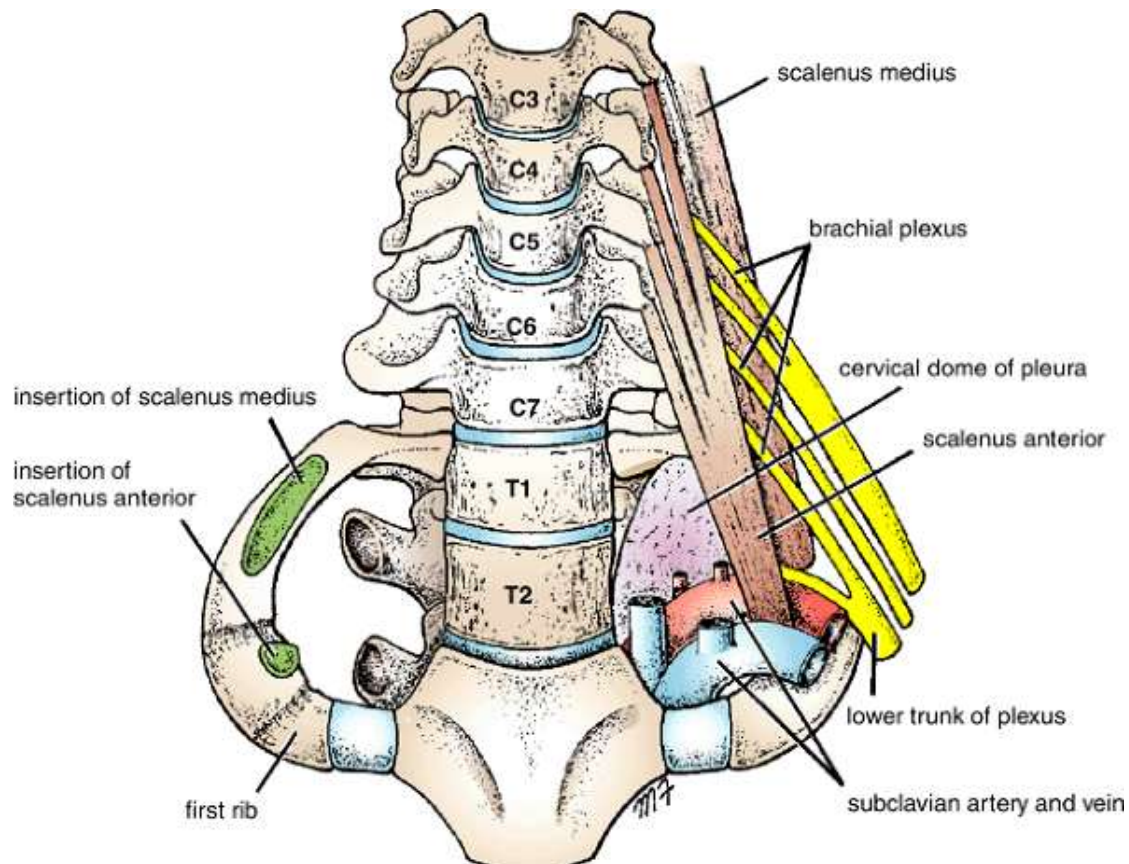
## **The 11th and 12th ribs**

**These two ribs are short, have no necks or tubercles, and only have one large facet that articulates with the corresponding vertebra.**



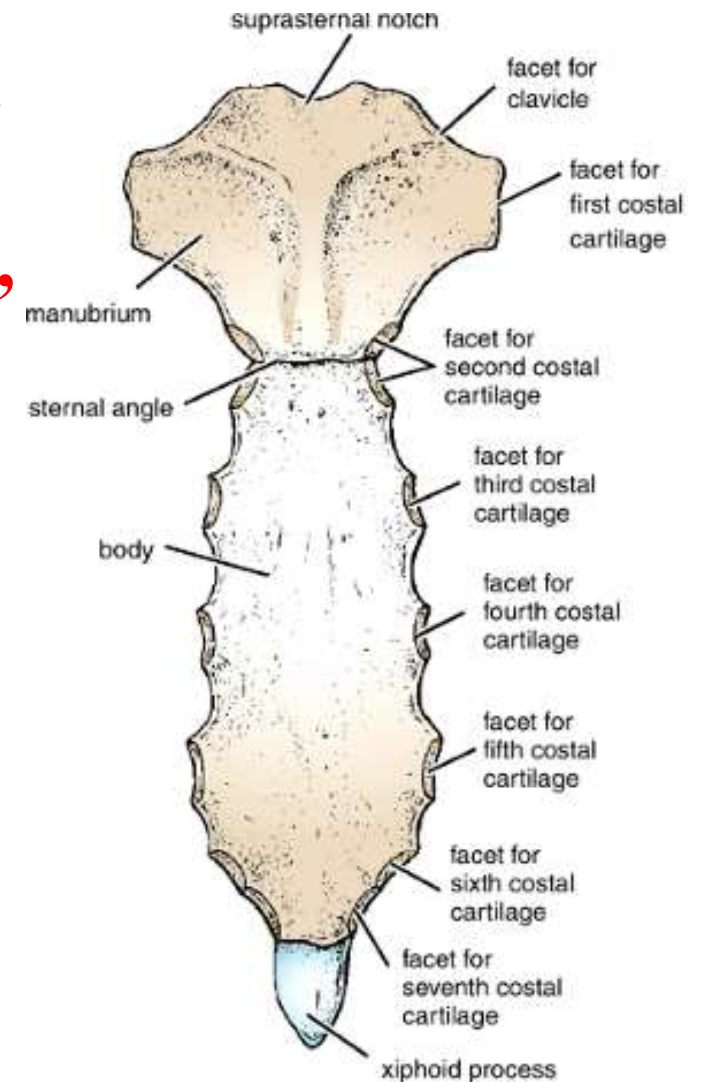
## Cervical and lumbar ribs

- An extra rib is found in 0.5% of the population, known as a cervical rib (since it articulates with the 7th cervical vertebra).
- Sometimes this can cause lower brachial plexus compression



## The sternum

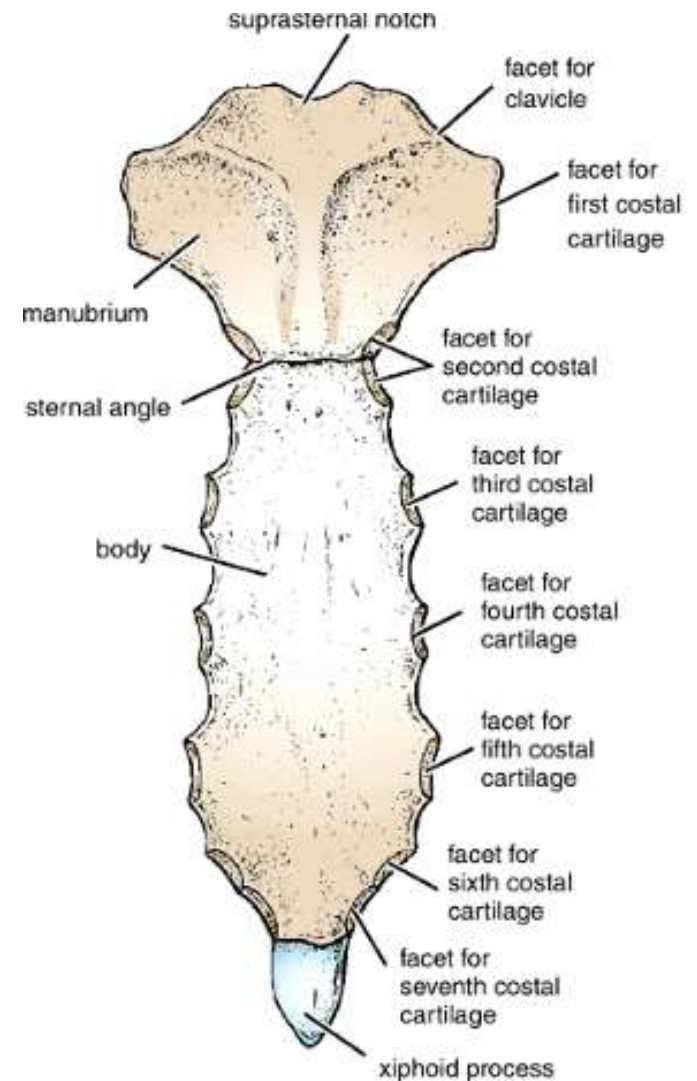
- Flat, long bone which articulates anteriorly with the ribs via costal cartilages.
- Comprises three fused bones (manubrium, body, xiphisternum).
- The manubrium is a flat, wide, and triangular-shaped bone, found at level of T3 and T4 vertebrae.
- It articulates with the clavicle and the first two ribs.
- At the superior end is found the suprasternal notch as well as two notches either side of this where head of the clavicle articulates.





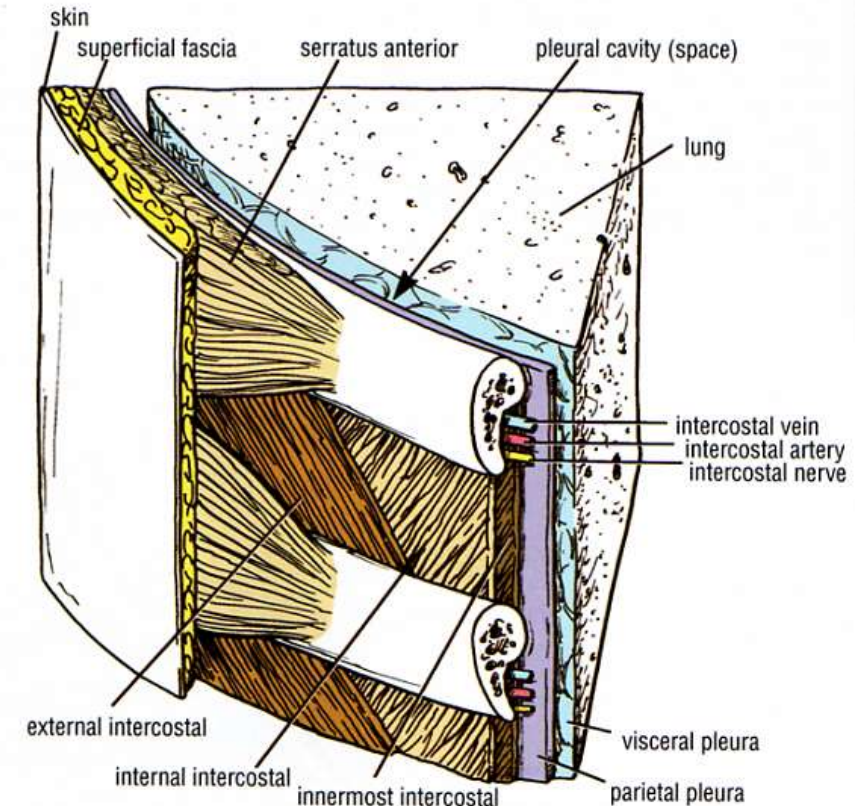
## The sternum (Cont.)

- The sternal angle (or angle of Louis) defines the point where the manubrium fuses with the body of the sternum.
- The body is the largest part of the sternum and comprises four fused segments.
- It extends from T5 to T9 and articulates with the cartilage of ribs 2–7.
- The xiphisternum is found inferiorly and is the smallest sternal bone.



## Musculature of the thorax

- The intercostal muscles are located between neighboring ribs.
- They comprise three layers of muscle, from inside to outside:
- Innermost intercostal muscles are separated incompletely from the middle intercostal muscles by neurovascular bundle.
- This layer may cross more than one rib, forming incomplete fibrous layer
- Middle or internal intercostal muscles run obliquely away from the sternum.
- External intercostal muscles run obliquely towards the sternum



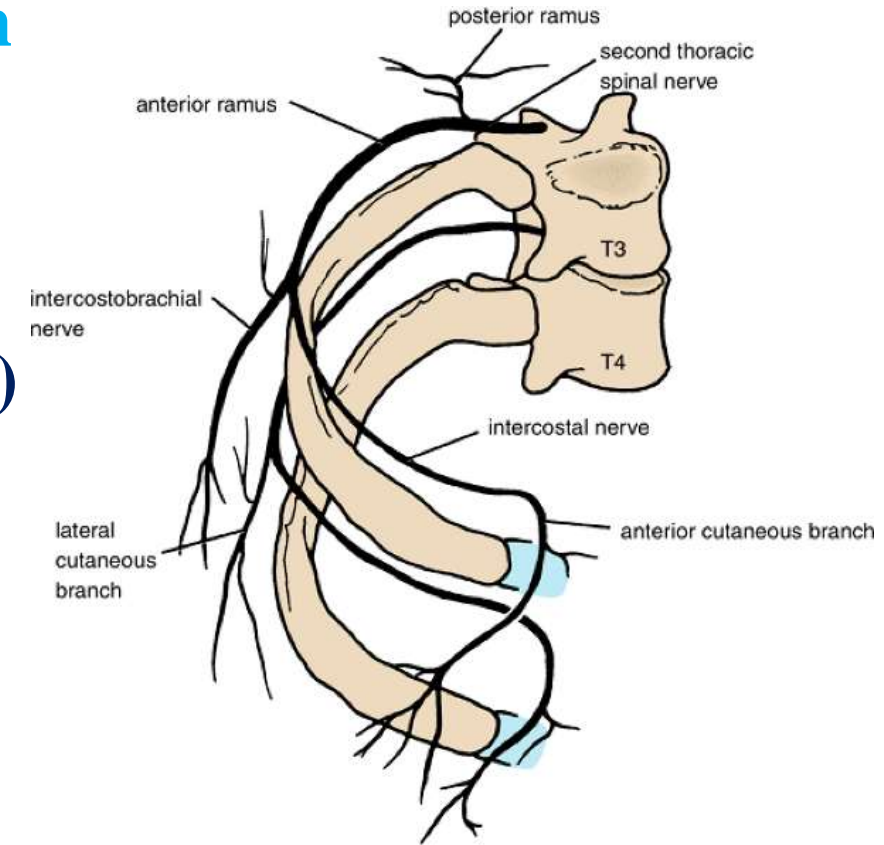
**Note:**

**Several other muscles attach to the thoracic cage, including the accessory muscles of respiration such as:**

- 1. Sternocleidomastoid muscles**
- 2. Scalene muscles**

## Nerve supply of the thoracic cage

- Each thoracic spinal nerve (associated with corresponding rib) gives two nerve branches on leaving intervertebral foramina.
- **Dorsal rami supply muscles, bones, joints, and skin of the back.**
- **Anterior rami form intercostal nerves (T1–T11) and subcostal nerve (T12).**
- **Intercostal nerves give muscular branches and two cutaneous branches (lateral and anterior branches) and supply muscular walls of the thorax and abdomen and corresponding cutaneous area of skin (dermatome).**
- **Intercostal muscles are supplied by branches of the intercostal nerves called collateral nerves.**

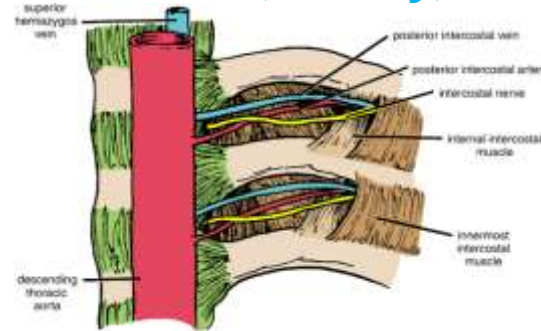




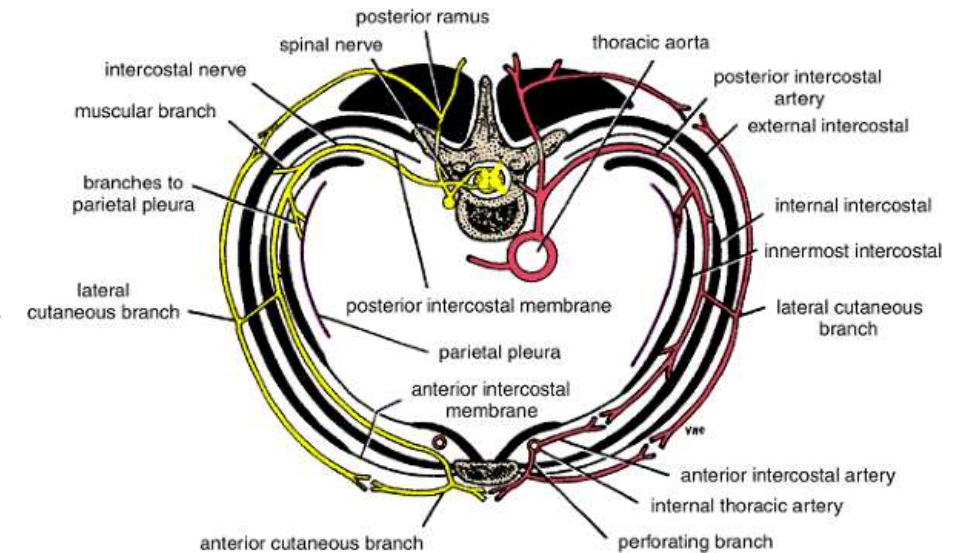
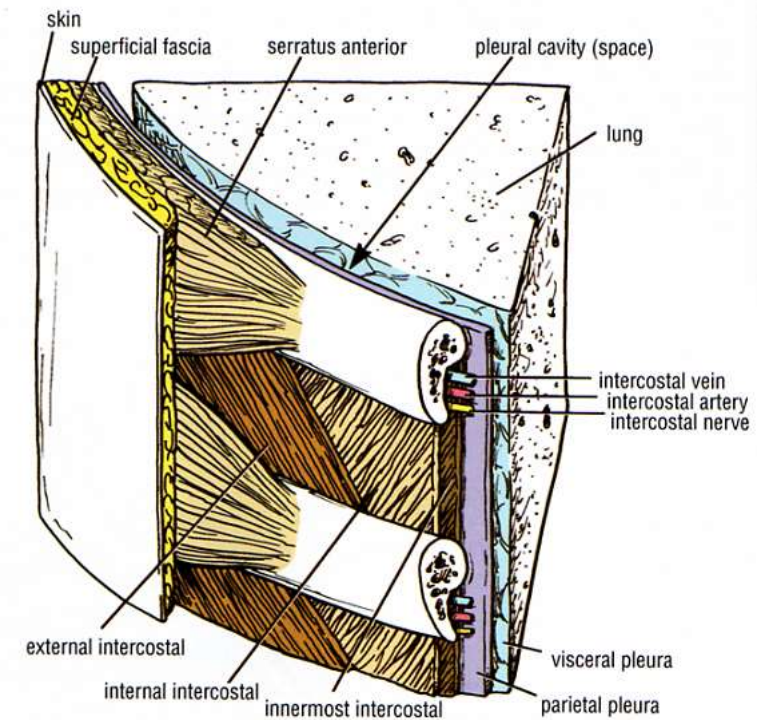
## Neurovascular bundle (intercostal bundle):

Consists of anterior and posterior intercostal vessels (**arteries** and **veins**) and intercostal **nerves**.

- Intercostal bundle runs below the corresponding rib and includes, from top to bottom: vein, artery, and nerve (**VAN**)



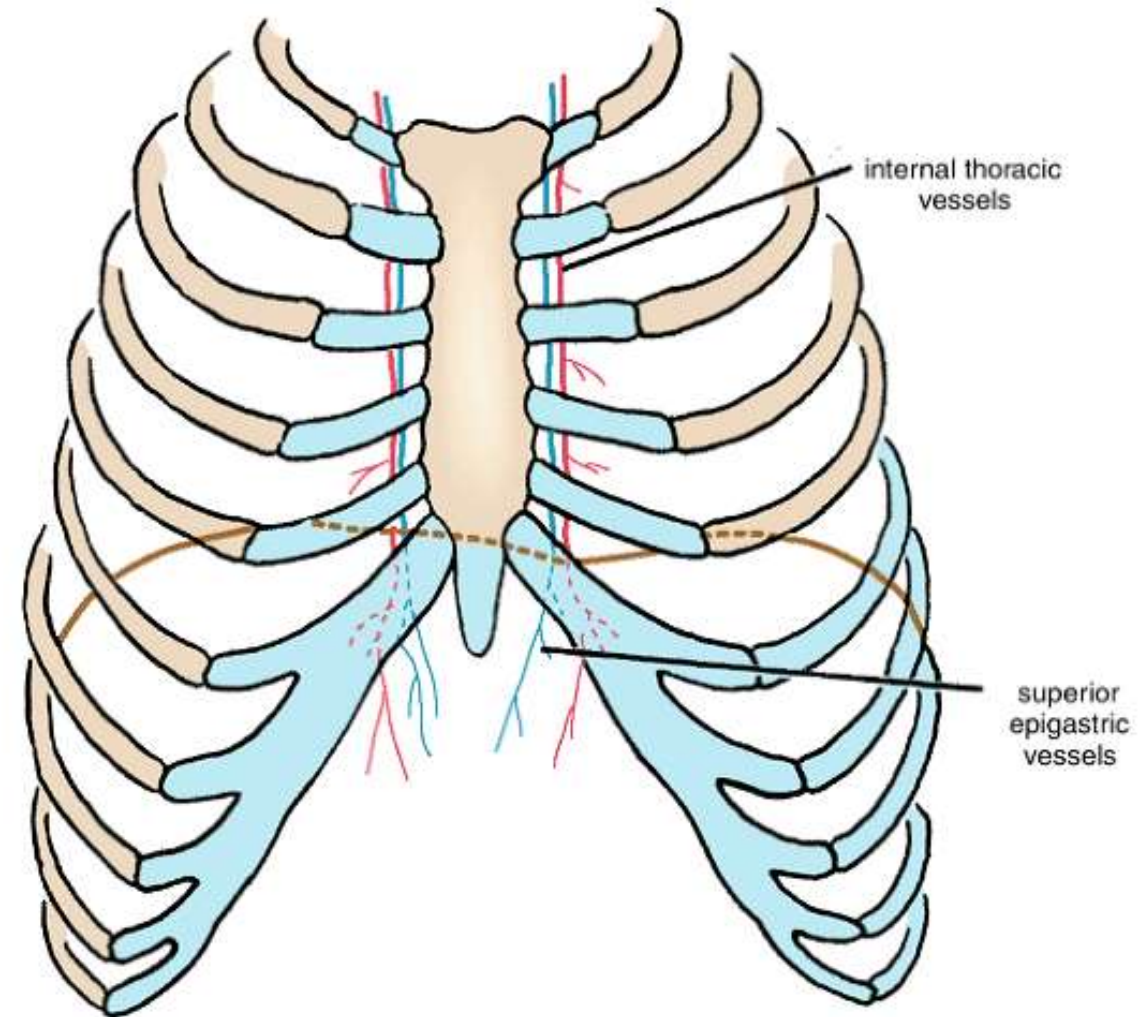
- They enter intercostal space between pleura and internal intercostal membrane posteriorly.
- Initially, neurovascular bundle runs in middle of the intercostal space, along internal surface of internal intercostal membrane.
- This neurovascular bundle runs under the rib in the costal groove at angle of the rib where it gives *collateral branch*.
- Anterior cutaneous branch runs on inner surface of internal intercostal muscle and ends anteriorly near the sternum as *anterior cutaneous branches*.





## Blood supply of the thoracic cage

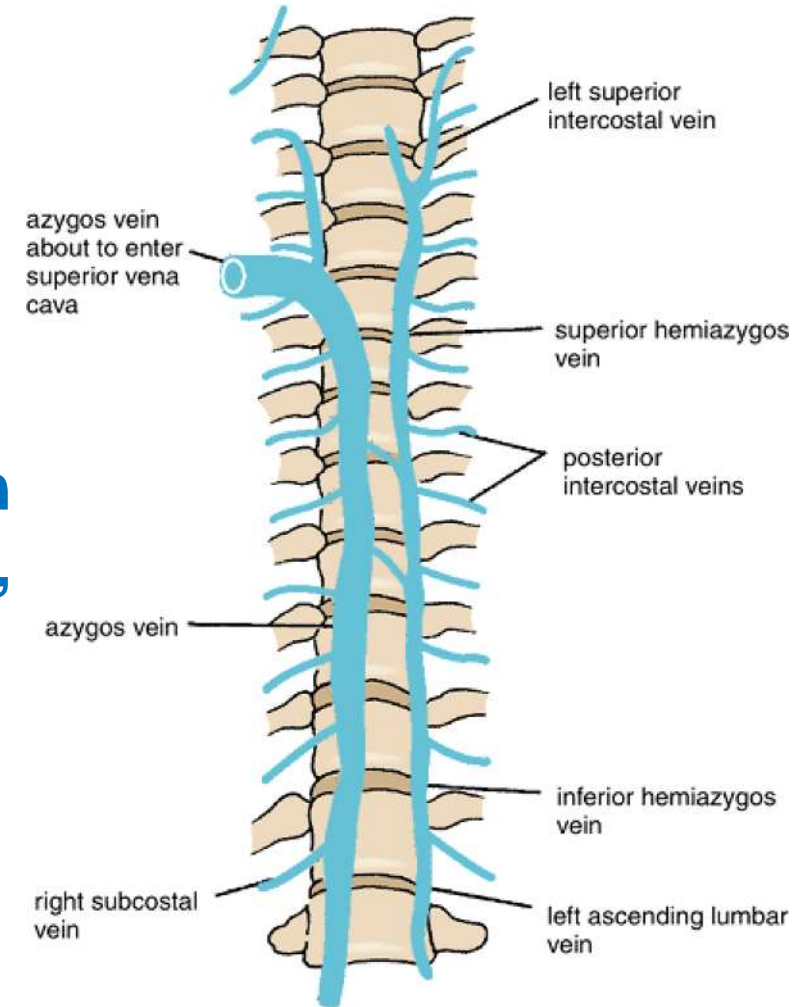
- **Thoracic cage is supplied by anterior and posterior intercostal arteries.**
- **1st–6th anterior intercostal arteries are branches from internal thoracic artery (1<sup>st</sup> part of subclavian artery).**
- **7th–9th anterior intercostal arteries are supplied by musculo-phrenic artery (internal thoracic artery).**
- **10<sup>th</sup> and 11th intercostal muscles only have a posterior supply.**



- 1st and 2nd posterior intercostal arteries are supplied by superior intercostal arteries (costocervical trunk; branch from 2<sup>nd</sup> part of subclavian artery).
- 3<sup>rd</sup>–11<sup>th</sup> posterior intercostal arteries are supplied by descending thoracic aorta.
- Branches of posterior intercostal arteries supply skin, muscles, and spinal cord.
- All posterior intercostal arteries run forwards and anastomose with corresponding anterior intercostal arteries.
- Anterior abdominal wall is supplied by subcostal artery (branch of descending thoracic aorta).

# Venous drainage of the thoracic cage

- Veins follow the course of corresponding arteries.
- 11 intercostal veins and 1 subcostal vein on each side of thorax.
- Generally, anterior and posterior intercostal veins anastomose to drain into internal thoracic and then azygous vein, which drains into superior vena cava, back to the heart.
- 1st posterior intercostal vein drains into left brachiocephalic or vertebral vein.
- Left 2nd and 3rd intercostal veins drain into superior intercostal vein; crosses the aorta to drain into left brachiocephalic vein.



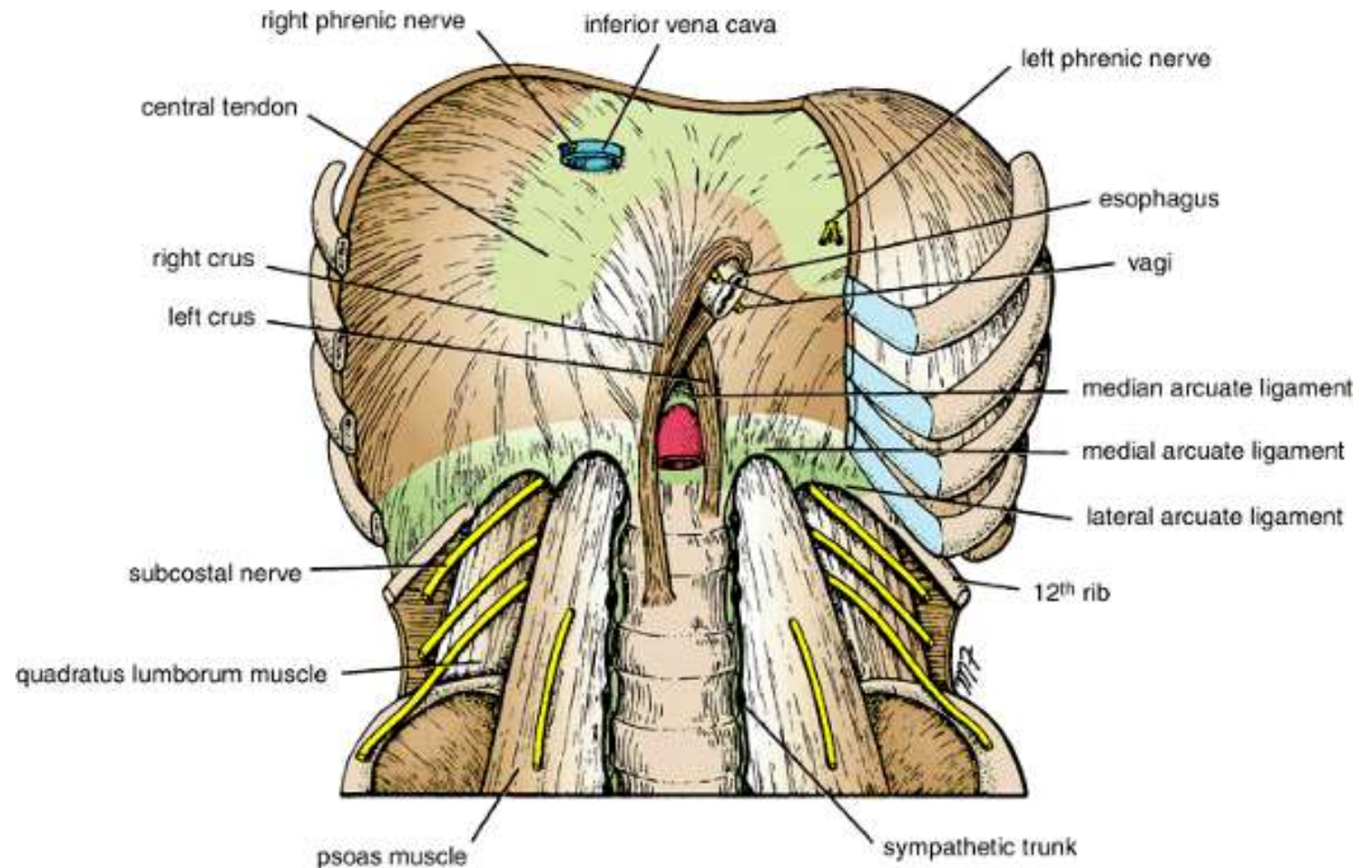
# Diaphragm

# Diaphragm

- **Muscular, dome-like structure which separates abdominal contents from the thorax.**
- **Involved in ventilation of the lungs.**

## Two parts:

- **Peripheral muscular part and a central aponeurosis**

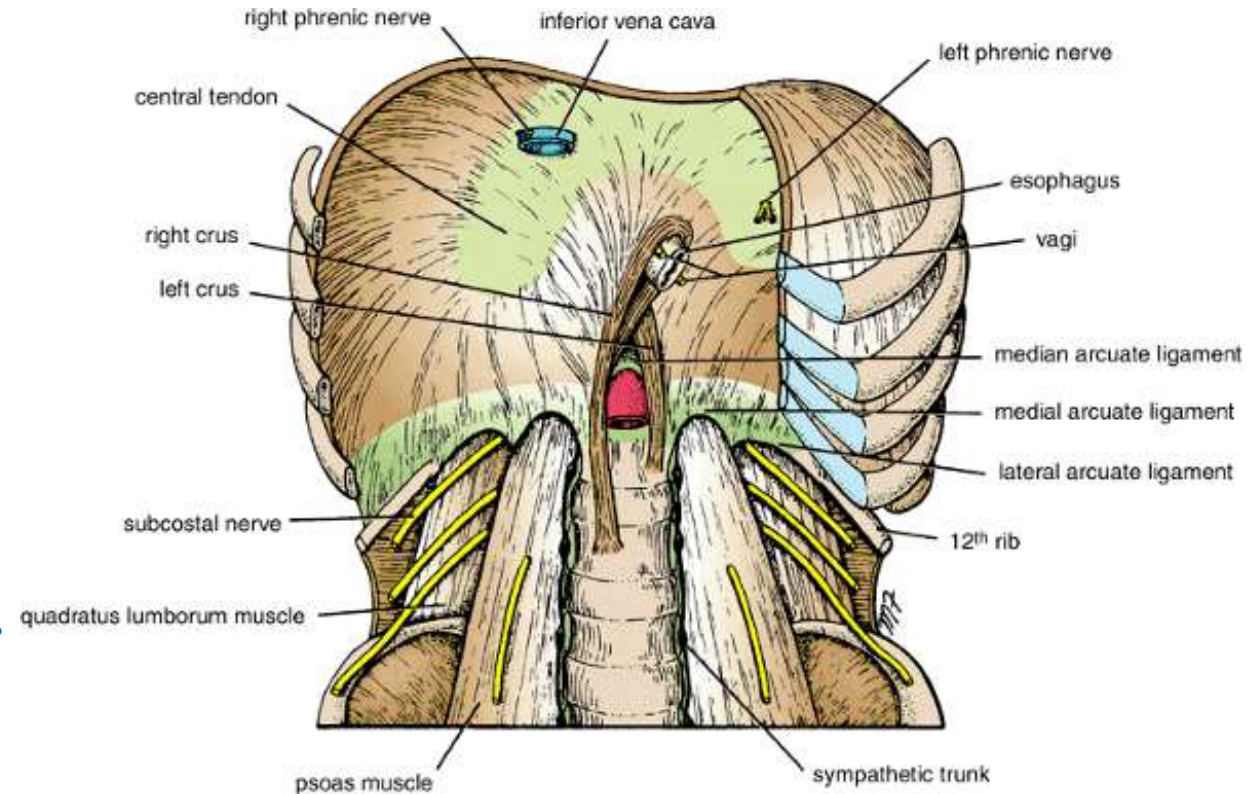




## Attachments of the diaphragm:

1. Costally; to inner sides of lower six costal cartilages and ribs.
2. Inside surface of xiphisternum.
3. Front of upper three lumbar vertebrae and intervertebral discs form attachment of the right crus.
4. 1st and 2nd lumbar vertebrae form attachment of the left crus.

Central tendon; Formed by insertions of muscular attachments of diaphragm (trefoil-shaped area which partially fuses with base of the pericardium).

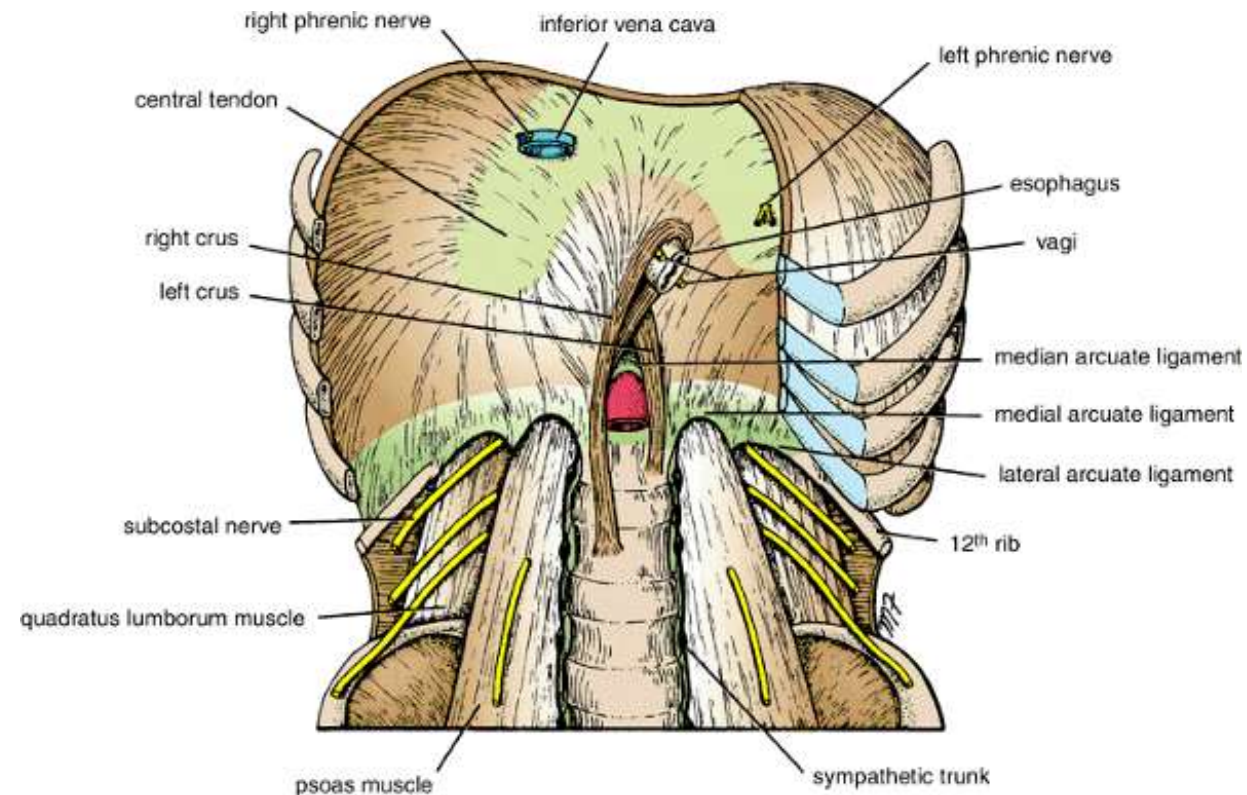
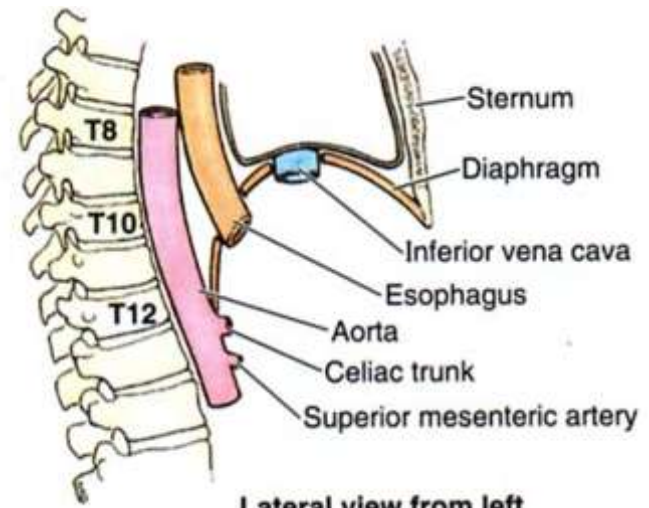


## Nerve Supply of diaphragm

- **Phrenic nerve from the cervical roots 3, 4, and 5.**
- **Since sensory innervation to central part of diaphragm is via the phrenic nerve, when diaphragm is inflamed, pain is referred to the shoulder tip which is the cutaneous portion of the phrenic nerve**
- **Peripheral part of diaphragm is by lower intercostal nerves**

## Openings of the diaphragm

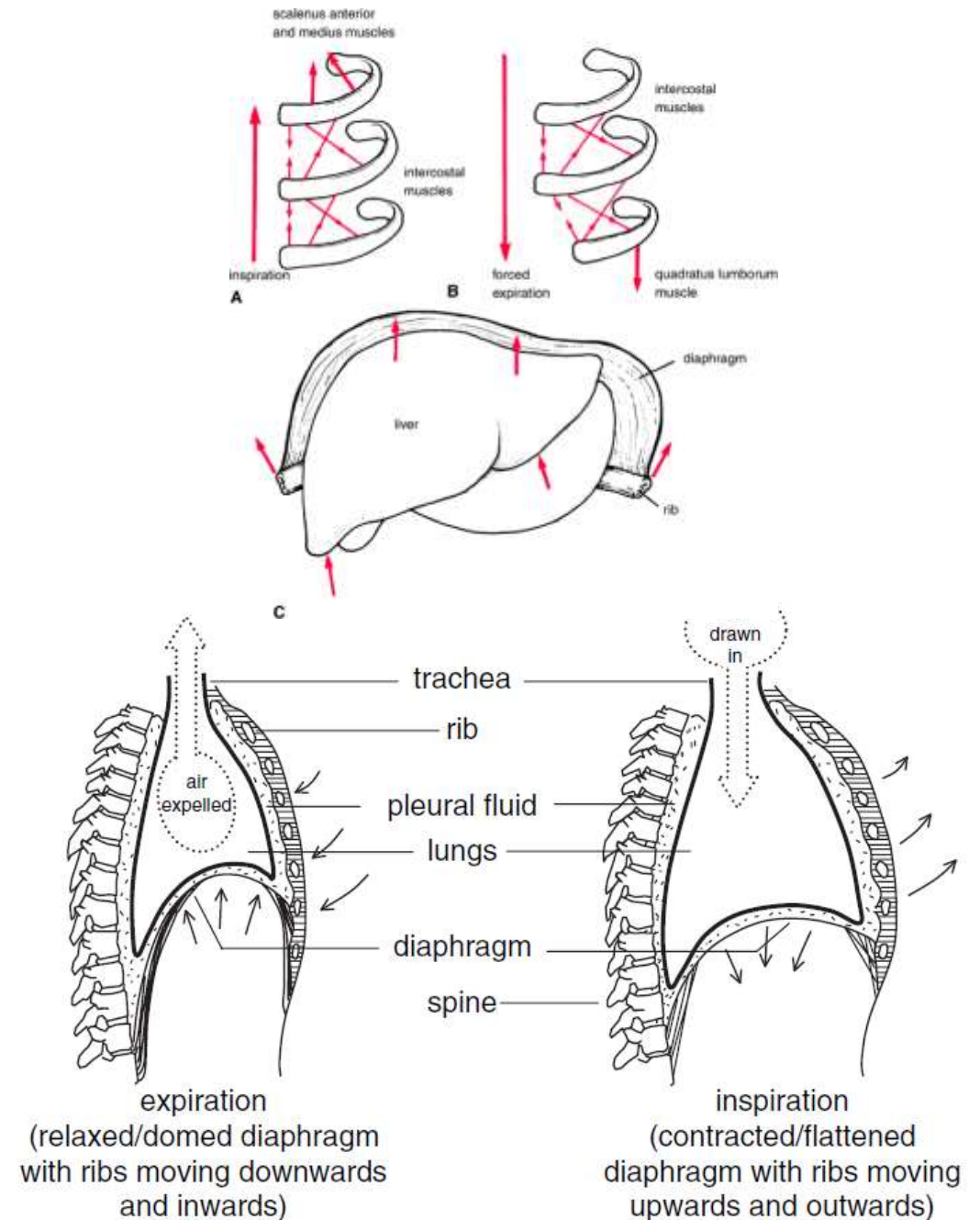
- Several important structures pass through the diaphragm between thorax and abdomen.
- Inferior vena cava and right phrenic nerve pierce diaphragm at level of the 8<sup>th</sup> thoracic vertebra.
- Oesophagus, left and right vagus nerves, and left gastric artery and vein pierce diaphragm at level of the 10<sup>th</sup> thoracic vertebra.
- Aorta, azygous vein, and thoracic duct pierce diaphragm at level of 12<sup>th</sup> thoracic vertebra.
- Also diaphragm is pierced by sympathetic chain and greater and lesser splanchnic nerves.





## Ventilatory movements

- During inspiration, the ribs move upwards and outwards like bucket handles lifting upwards.
- This increases the thoracic diameter in all directions
- During expiration, the thoracic cage shrinks as the bucket handle like motion of the ribs sinking reduces volume of the thoracic cage.
- The diaphragm moves downwards with inspiration by contraction at the central tendon, and upwards with expiration



**THANK YOU**