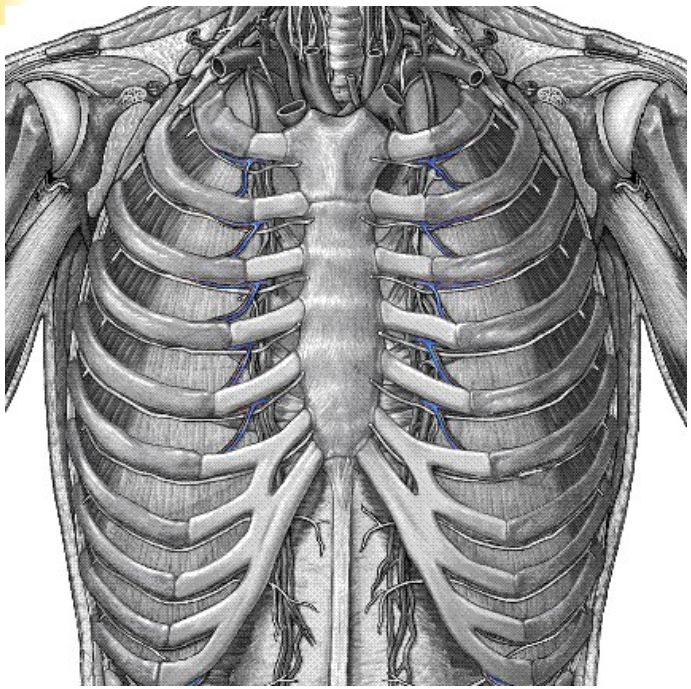
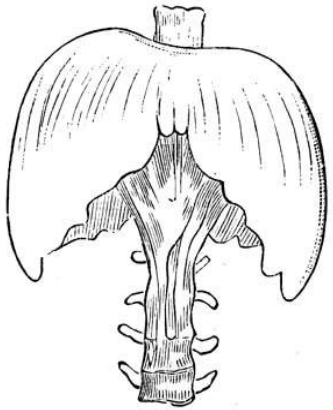
Anatomy of chest wall and diaphragm

Dr Vivek Nagaraja



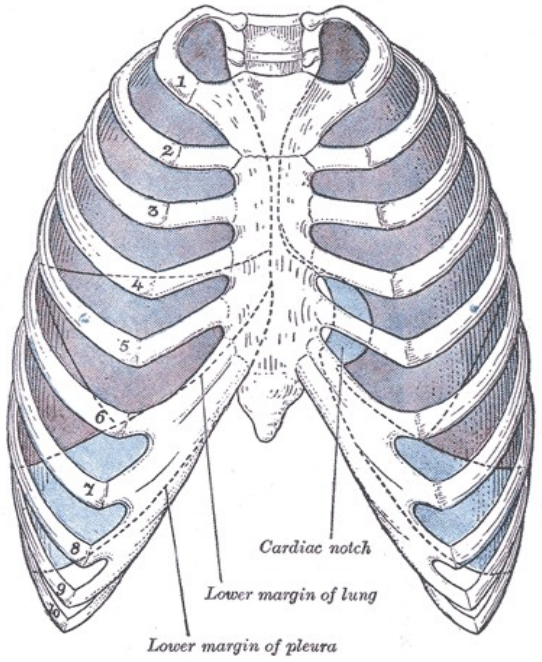


Contents

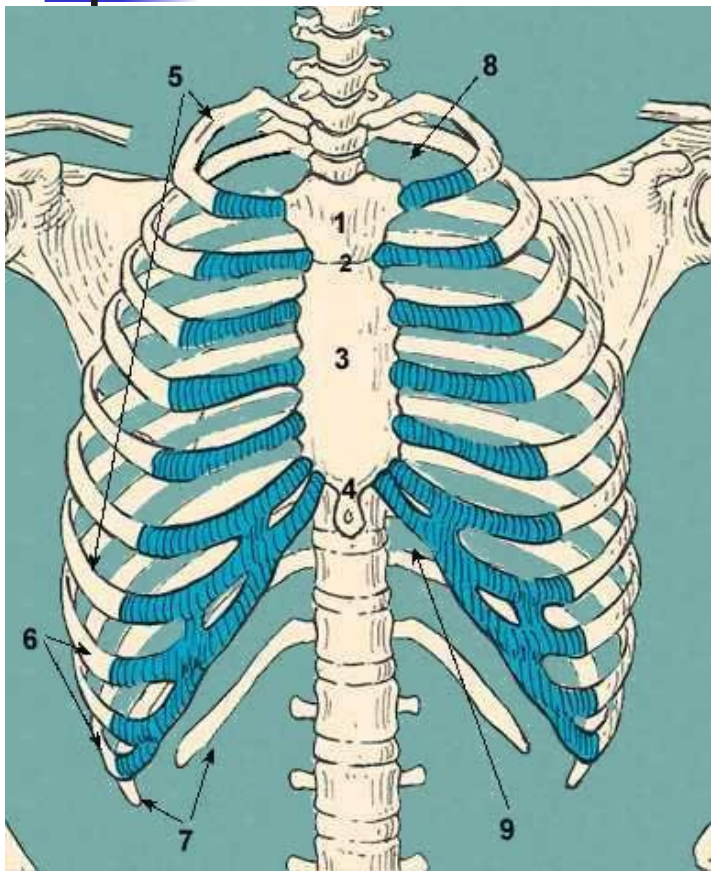
- Introduction
- Bony boundaries
- Bones of thorax
- Articulations of bony thorax
- Muscles of thorax
- Diaphragm
- Blood supply and nerve supply
- Applied anatomy

General Information

- Primary function
  - Respiration
- Secondary functions
  - Venous return
  - Protection of organs

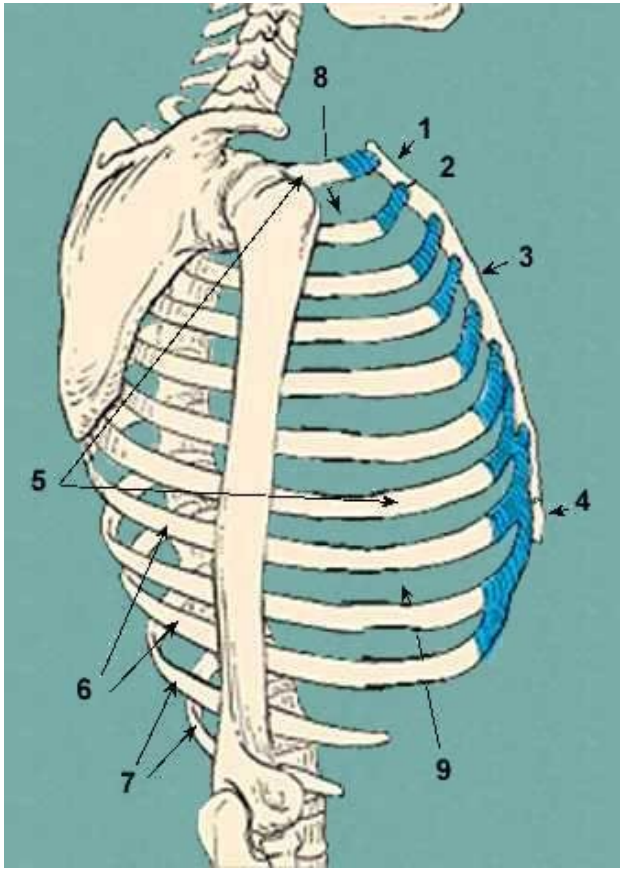


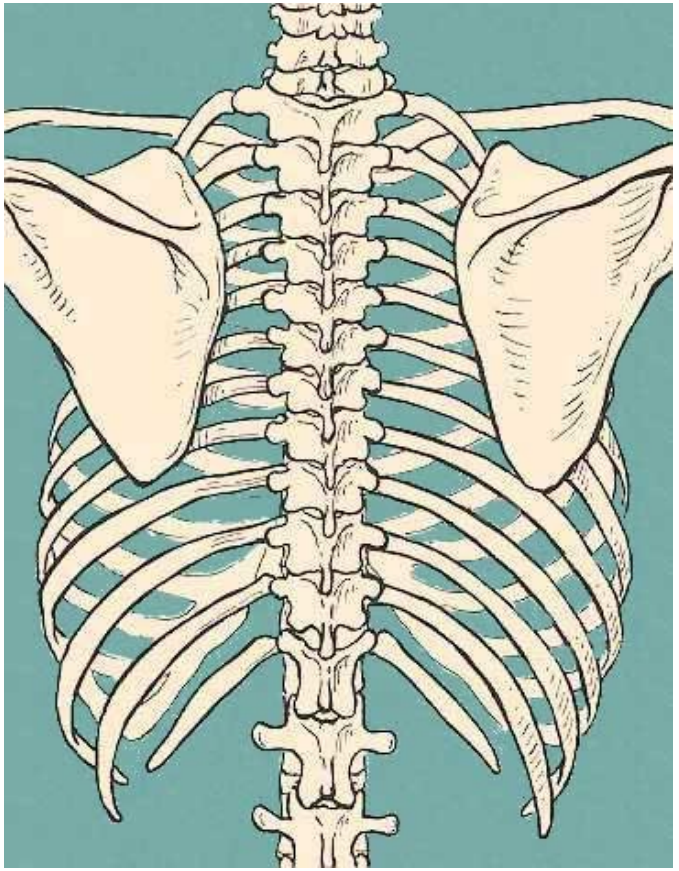
Bony boundaries



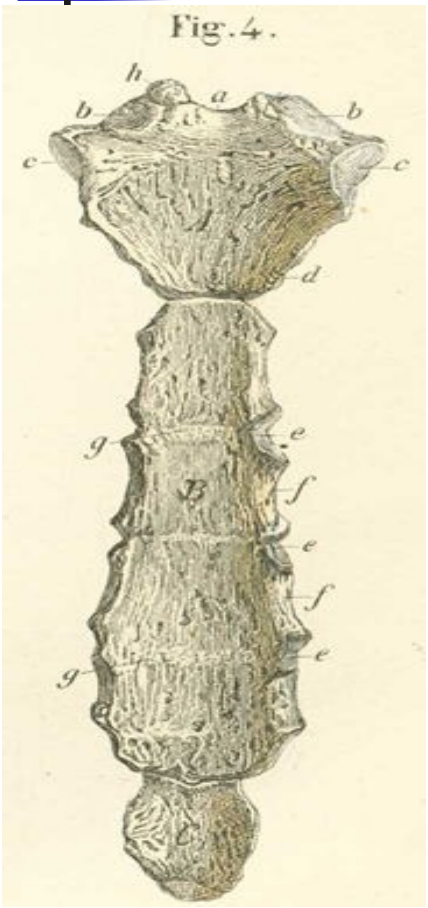
- sternum
  - manubrium (1)
  - sternal angle (2)
  - body (3)
  - xiphoid process (4)
- 12 pairs of ribs
  - 6 or 7 pairs of true ribs (5)
  - 3 or 4 pairs of false ribs (6)
  - 2 pairs of floating ribs (7)
- thoracic vertebrae, posteriorly

Bony boundaries



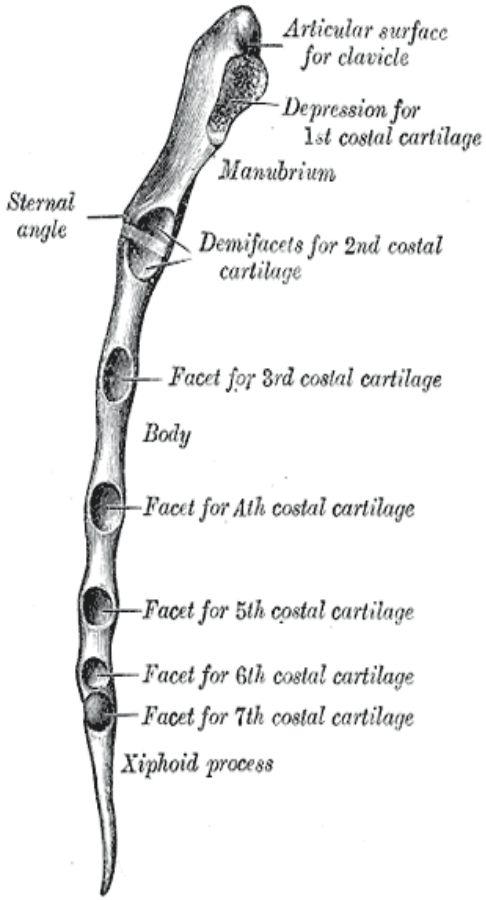


Bones of thorax- Sternum

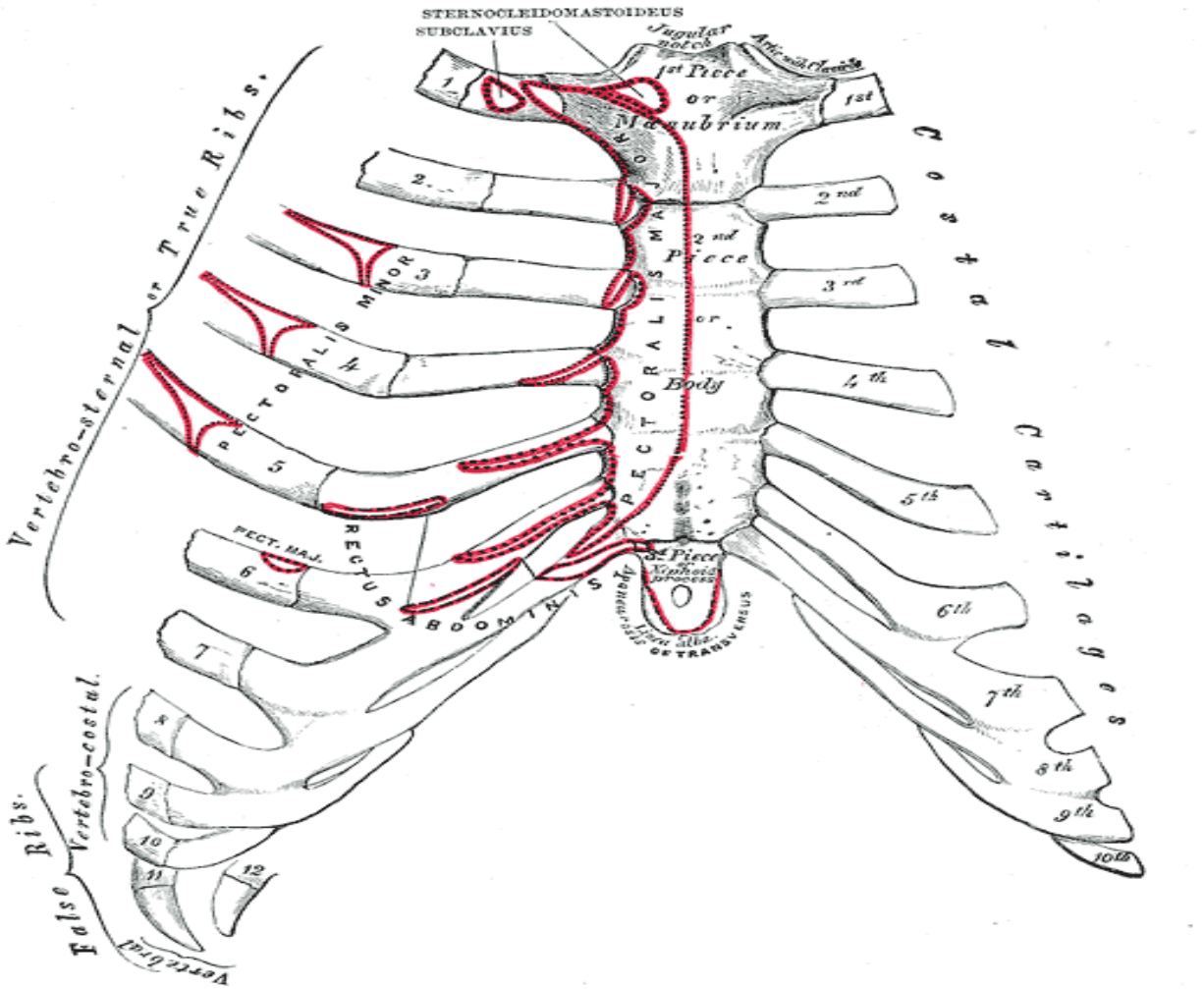


- A) Manubrium- 2 surfaces, 3 borders
- B) Body- 2 surafces, 2 borders
- C) Xiphoid (ensiform) process- 2 surfaces, 2 borders

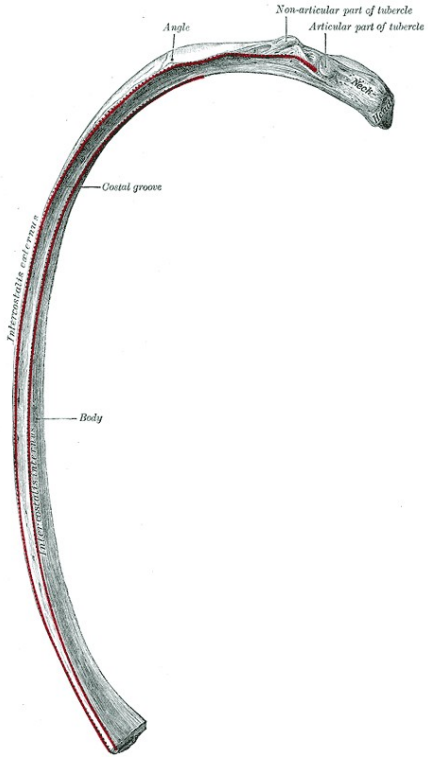
- a- Sternal notch
- b- Clavicular notch
- c- Notch for 1st rib
- d- Notch for 2nd rib
- e- Costal notches
- f- Lateral semilunar notches
- g- Transverse line



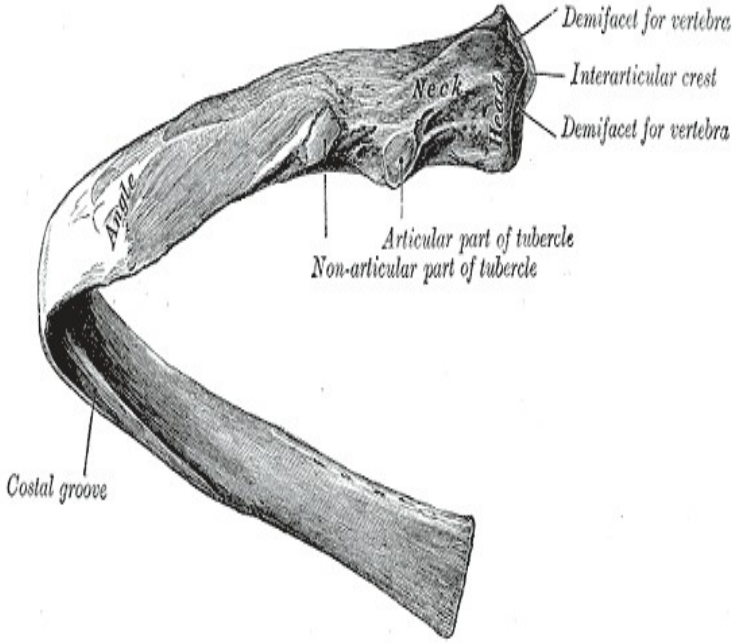
Bones of thorax- Sternum



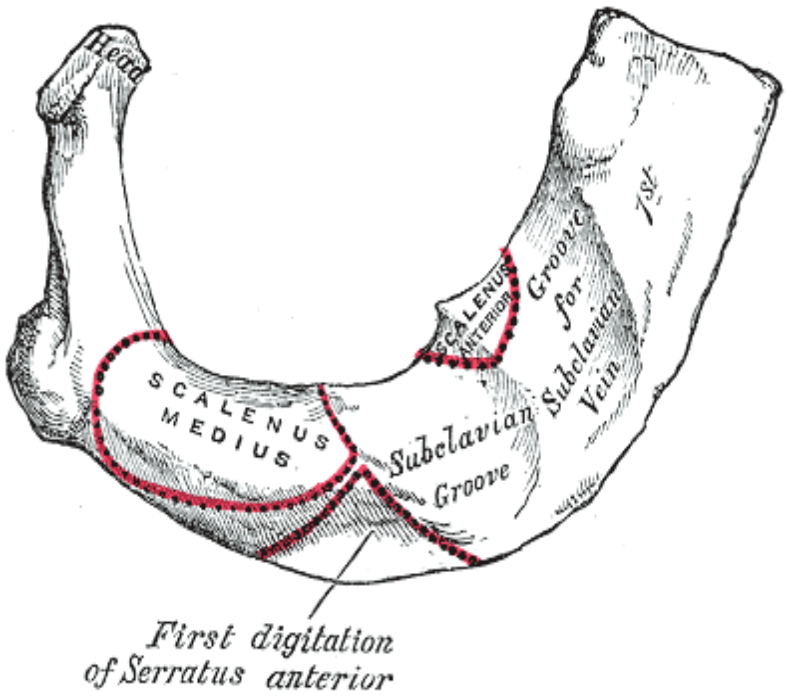
Bones of thorax- Ribs



- **Head** - articulates with bodies of vertebrae
- **Neck**
- **Tubercle** - articulates with transverse processes
- **Body or shaft**
- **Angle** - a point just lateral to the tubercle where the shaft bends forward
- **Costal groove** - lodges intercostal vessels and nerves

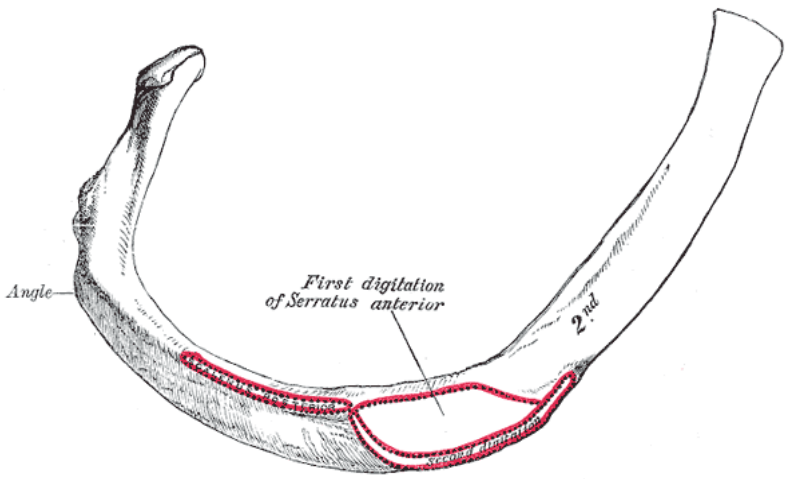


Bones of thorax- Atypical ribs (1st)



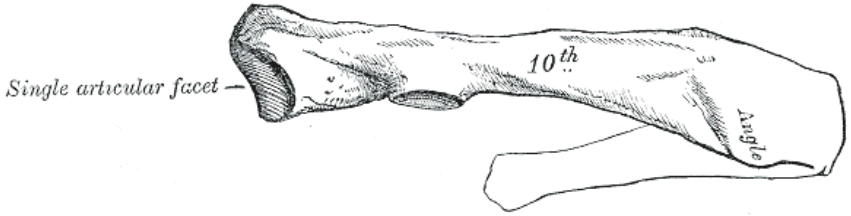
- Atypical
- Short and flat
- Head- One articular surface
- No angle and costal groove
- One tubercle- Origin of scalenus anterior
- Two grooves
  - Anterior (Subclavian vein)
  - Posterior (Subclavian artery + Brachial plexus)
- Function- Base attachment for intercostal muscles and ribs below

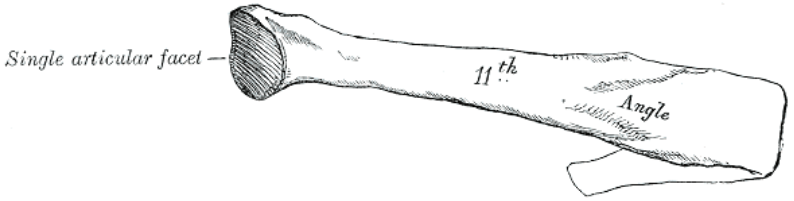
Bones of thorax- Atypical ribs (2nd)

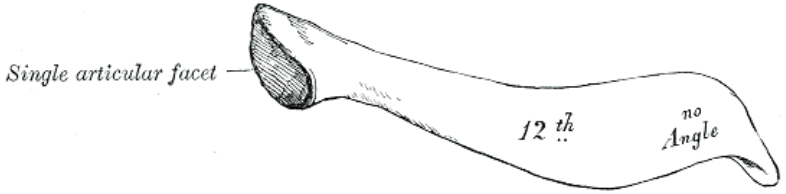


- Longer
- Slight angle
- Body is not twisted
- Rough eminence- origin of first and whole of second digitation of serratous anterior
- Short costal groove

Bones of thorax- Atypical ribs (10^{th}, 11^{th}, 12^{th})

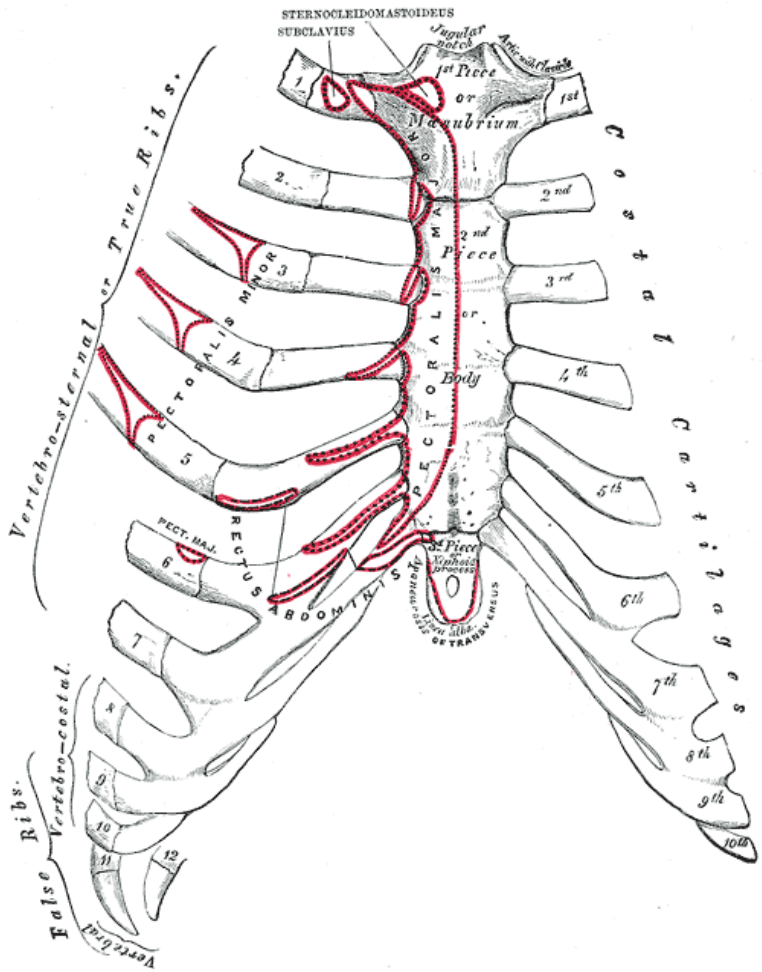






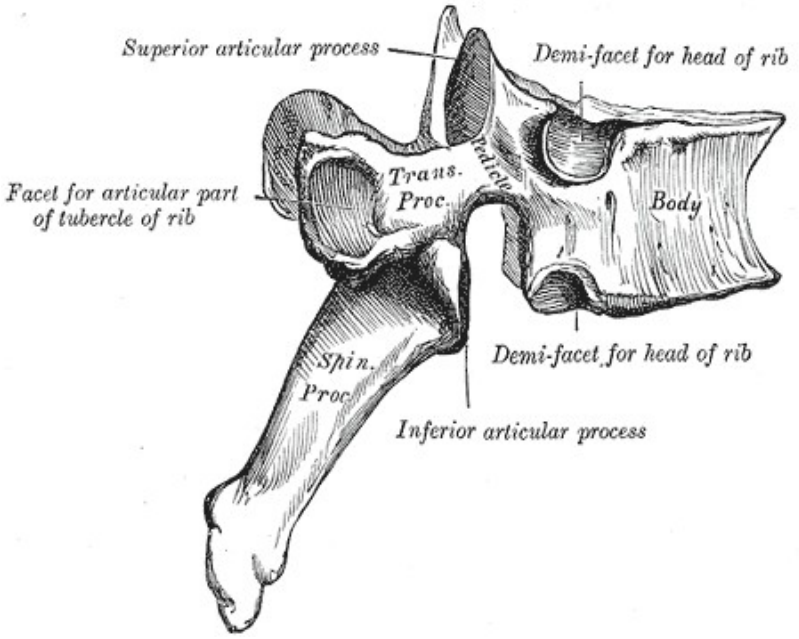
- 10^{th} rib- Single articular facet
- 11^{th} and 12^{th} ribs
  - Single large articular facets
  - No necks or tubercles
  - Pointed anteriorly
  - 11^{th}- slight angle and shallow groove
  - 12^{th}- no angle or groove

Costal cartilages



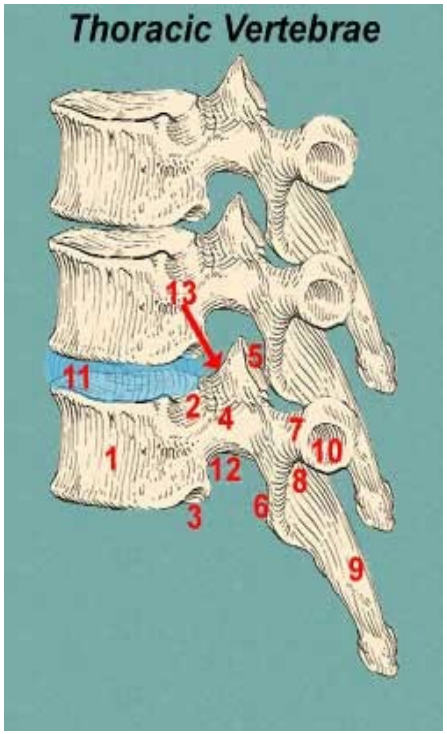
- Hyaline cartilage
- Surfaces
  - Anterior: 1st- sub-clavius and costoclavicular ligament, 1st- 6th pectoralis major
  - Posterior:1st-sternothyroid, 3rd-6th transversus thoracis, last 6 cartilages transversus abdominis and diaphragm
- Borders
  - Superior
  - Inferior:
    - attachment to internal intercostals
    - smooth oblong facets (6-9)

Bones of thorax- Vertebrae

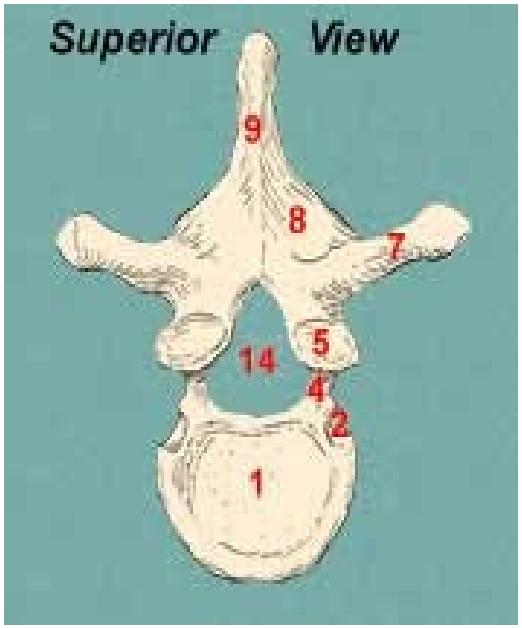


- Twelve thoracic vertebrae
- Increase in size from above downwards
- Facets on the body
- Inferior vertebral notches- larger and deeper

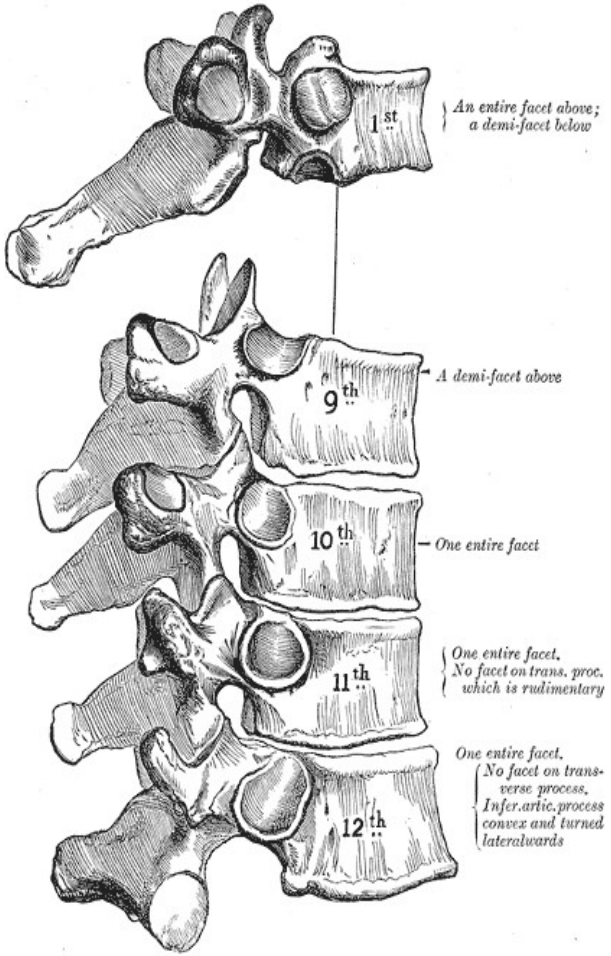
Bones of thorax- Vertebrae



- body (1)
- superior and inferior demifacets (2,3)
- pedicle (4)
- superior and inferior articular processes (5, 6)
- transverse process (with an articular process) (7,10)
- lamina (8)
- spinous process (9)
- superior and inferior notches (13,12)
- vertebral canal(14)
- intervertebral disk (11)

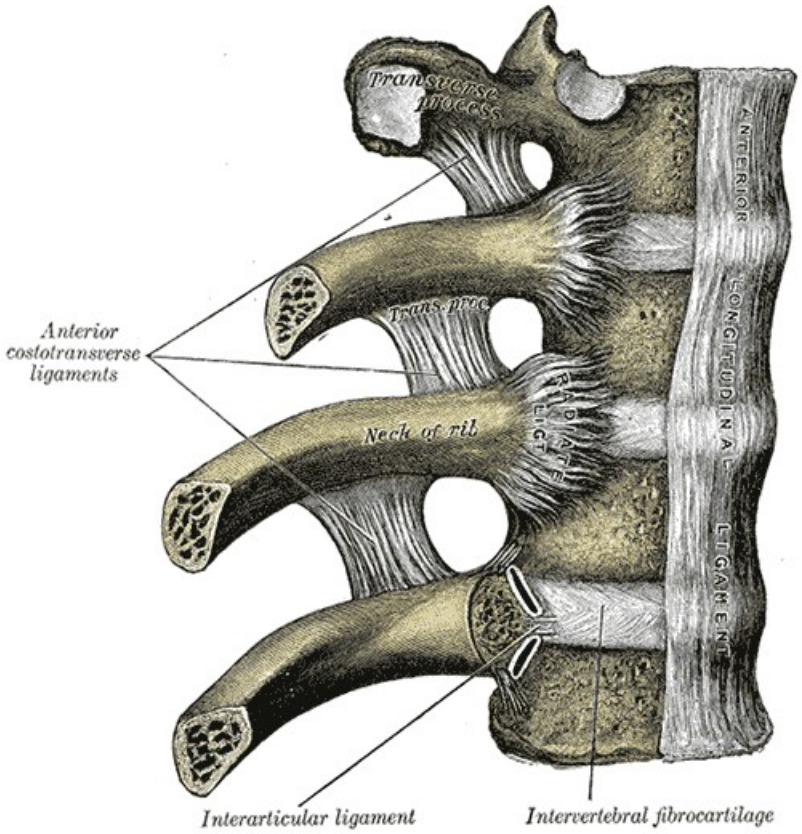


Bones of thorax- Peculiar Vertebrae



- 1st vertebra
  - Entire articular facet + demi-facet
  - Body like cervical vertebrae
  - Spinous process longer
- 9th vertebra- No demi-facets below
- 10th vertebra- Single articular facet
- 11th and 12th vertebrae
  - Single large articular facets
  - Body like lumbar vertebrae
  - Short spinous process
  - Thicker and stronger pedicles

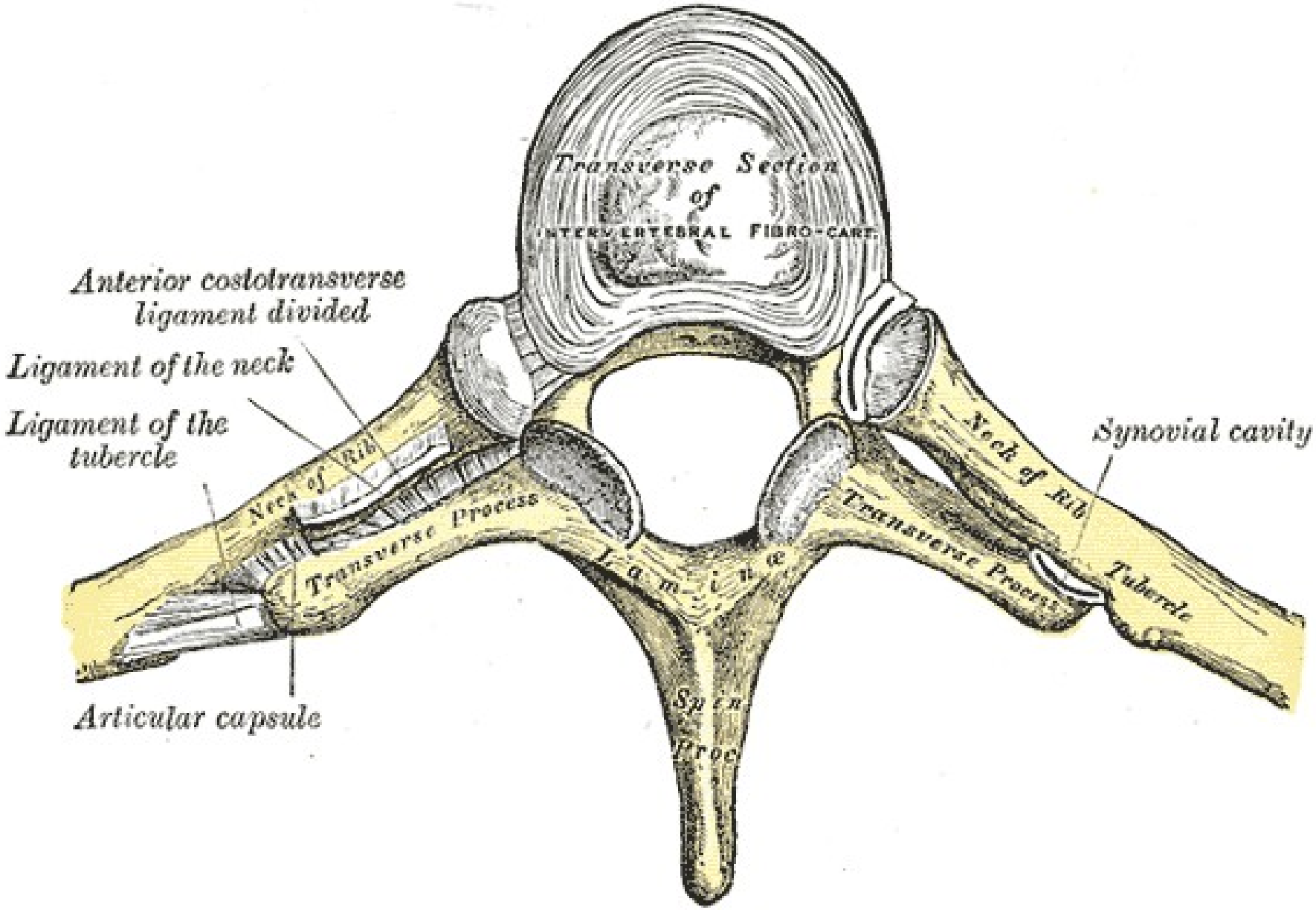
Articulations of bony thorax (Costo-vertebral)



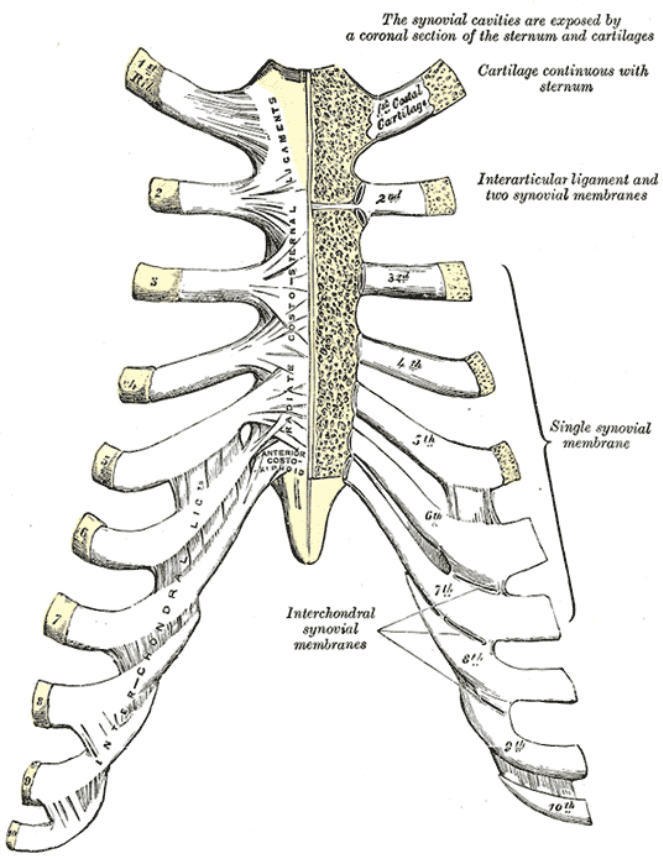
- Plane joint
- Head of the ribs articulate with the body of vertebrae
- Articular capsule
- Radiate ligament (Stellate lig)
  - Connect the anterior part of head with the sides of either vertebrae
- Inter-articular ligament
  - Situated in the interior of the joint
  - Connects crest separating the articular surfaces in the head of the rib to intervertebral disc
  - Divides the joint into two cavities

Articulations of bony thorax (Costo-transverse)

- Plane joint
- Articular surface of tubercle of rib articulates with transverse process of vertebra
- Articular capsule
- **Anterior costo-transverse ligament**
  - Attached below to the neck of the rib and above to the lower border of the transverse process
- Posterior costo-transverse ligament- Feeble band
- **Ligament of the neck of the rib**
  - connects the back of the neck of the rib with the anterior surface of the adjacent transverse process
- **Ligament of the tubercle of the rib**
  - Connects the apex of transverse process to the rough non-articular portion of the tubercle of the rib

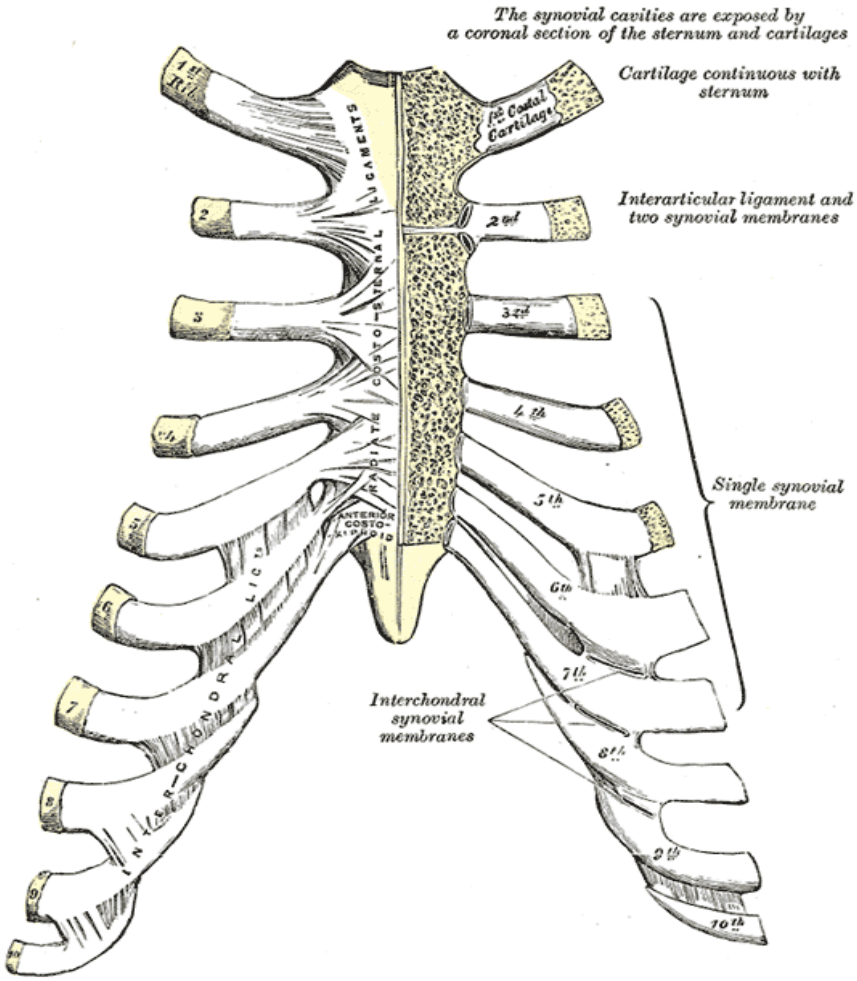

Transverse Section of
INTERVERTEBRAL FIBRO-CART.
Anterior costotransverse ligament divided
Ligament of the neck
Ligament of the tubercle
Articular capsule
Neck of Rib
Transverse Process
Lamina
Spin. Proc.
Transverse Process
Neck of Rib
Synovial cavity
Tubercle

Articulations of bony thorax (Sternocostal articulation)



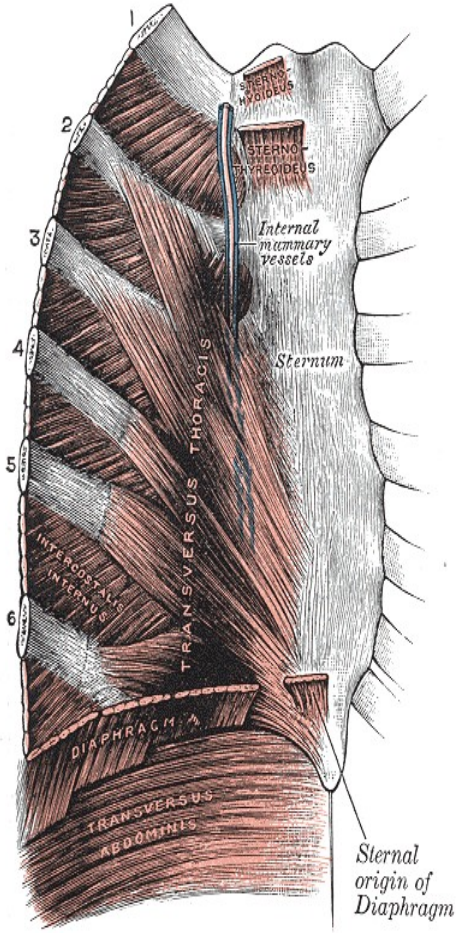
- Plain joints
- Articulations of cartilages of true ribs with the sternum (exc. 1st rib)
- Articular capsule
- **Radiate sternocostal ligaments**
  - Radiate from the front and back of the sternal ends of the cartilages of the true ribs to the anterior and posterior surfaces of the sternum
- **Interarticular sternocostal ligament**
  - Between second costal cartilage and sternum
- Costoxiphoid ligaments

Articulations of bony thorax (Sternocostal articulation)

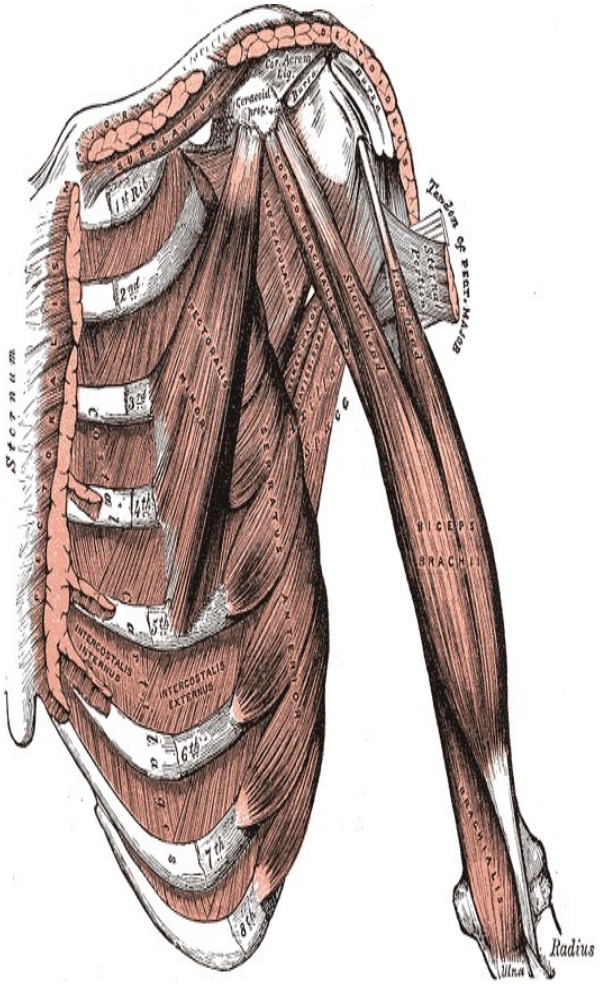


- Inter-chondral articulations
- Costo-chondral articulations

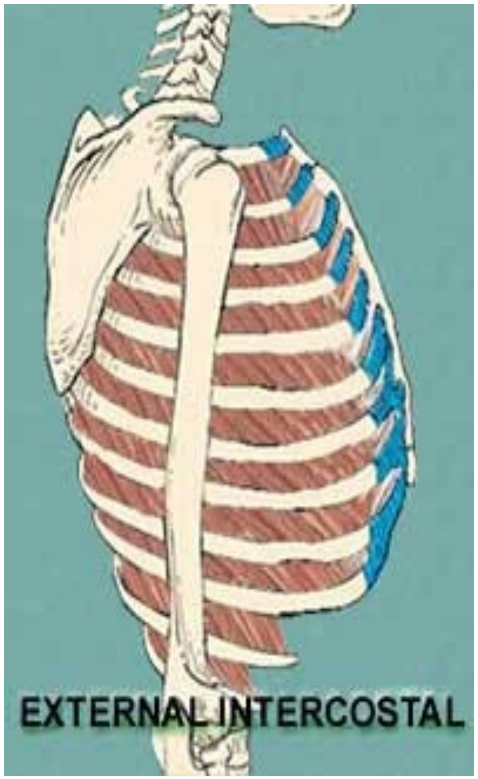
Muscles of thorax



- Outer layer- External intercostals, serratous posterior superior, serratous posterior inferior
- Middle layer- Inner intercostals
- Inner layer- Subcostal, Innermost intercostal, Transversus thoracis
- DIAPHRAGM

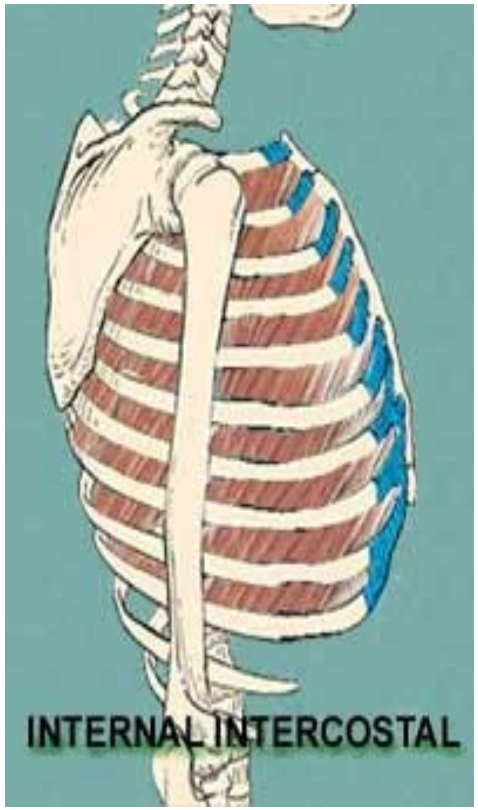


Muscles of thorax- Outer layer



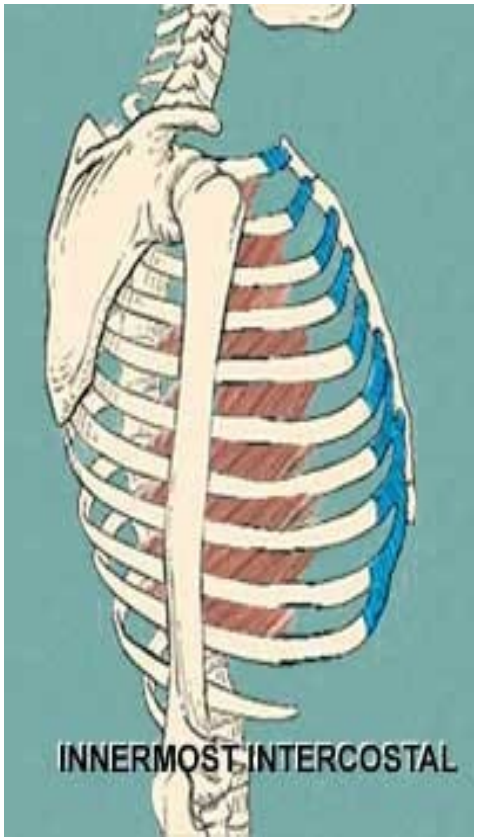
- External intercostal (11 in number)
  - extend from the tubercles of the ribs behind, to the cartilages of the ribs in front
  - arises from the lower border of a rib, and is inserted into the upper border of the rib below
  - Fibres pass obliquely downwards and forwards
- Weak muscles of respiration
  - Serratous posterior superior
  - Serratous posterior inferior

Muscles of thorax- Middle layer



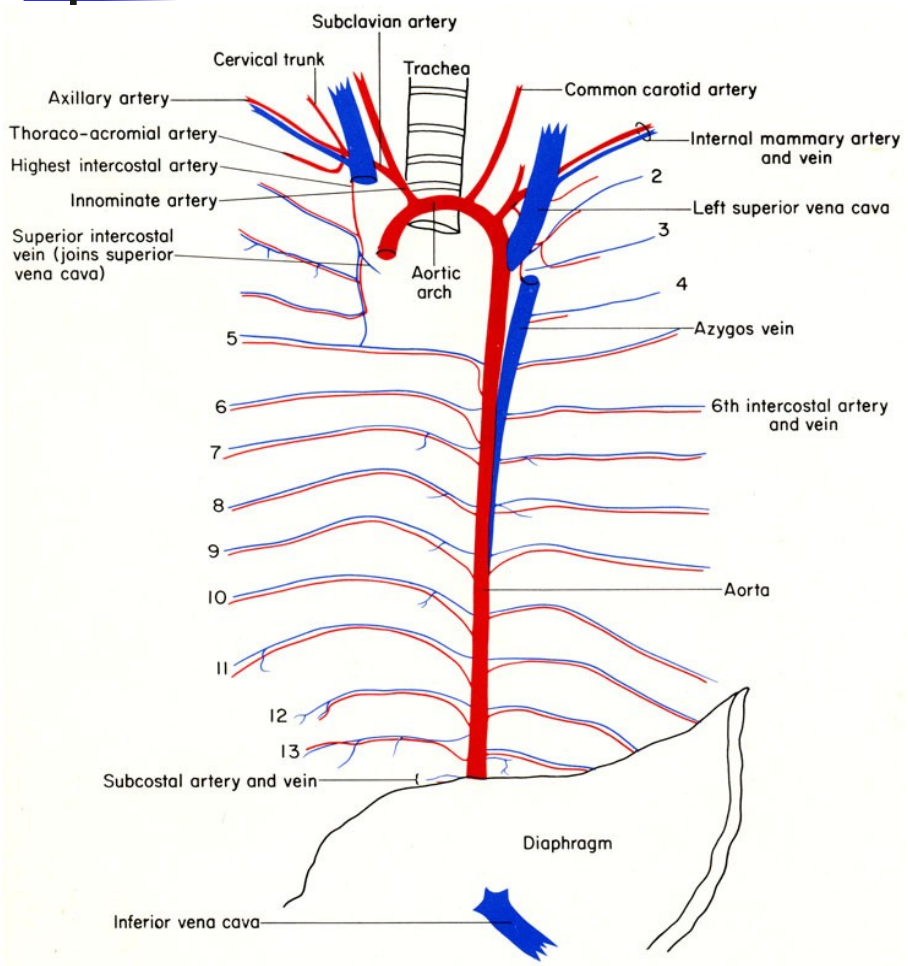
- Internal intercostals (11 in number)
  - commence anteriorly at the sternum and extend backward as far as the angles of the ribs
  - arises from the ridge on the inner surface of a rib, as well as from the corresponding costal cartilage, and is inserted into the upper border of the rib below

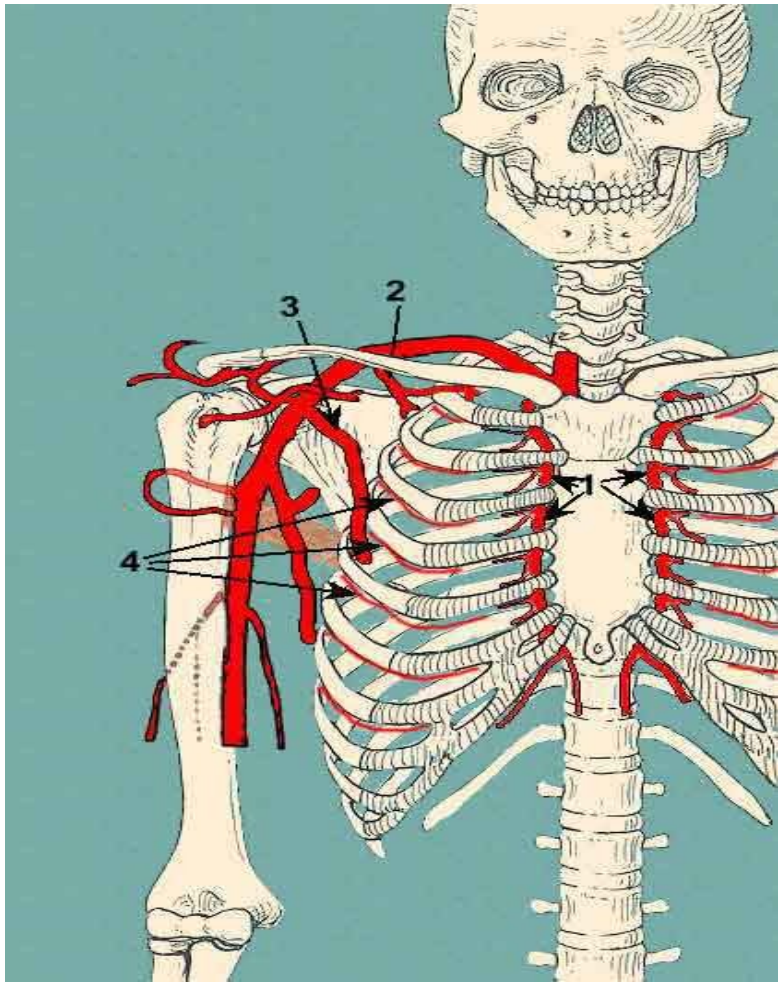
Muscles of thorax- Inner layer



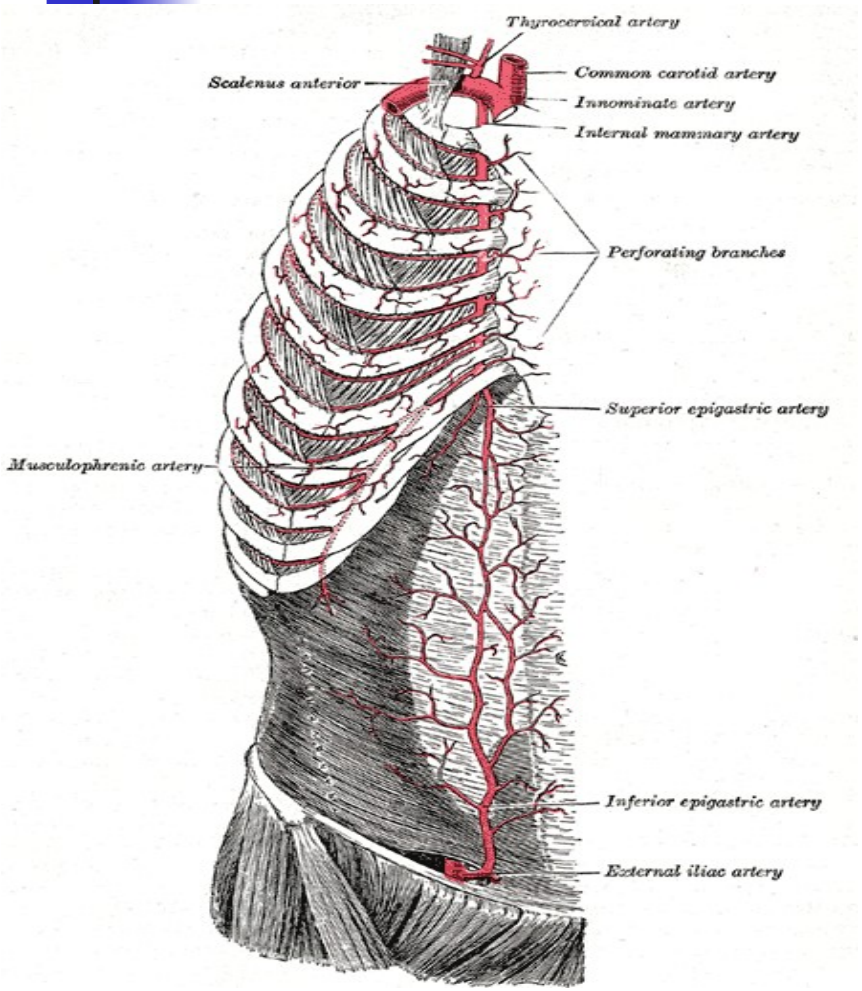
- Sub-costals
  - In the para-vertebral gutter attached to the inner surface of the ribs
- Innermost intercostals
  - Attached to the inner surface of the ribs on the lateral part of thoracic wall
- Transversus thoracis
  - Arises from the posterior surface of the lower part of sternum and attached to second to sixth costal cartilages through digitations

Intercostal arteries



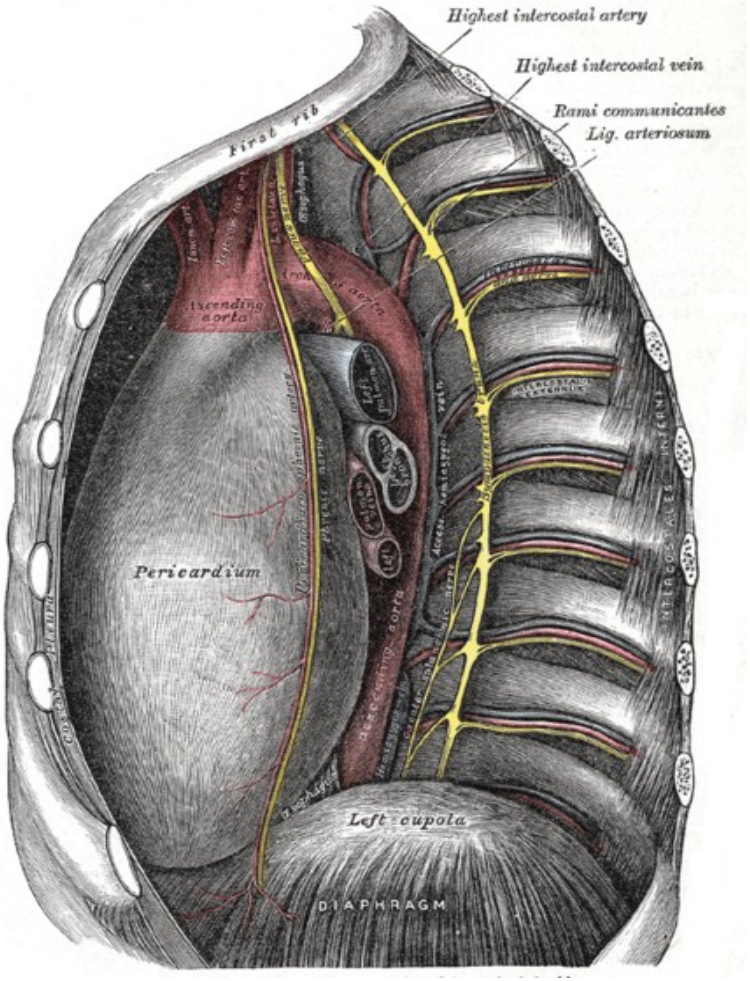


Internal Thoracic Artery



- Internal thoracic A- Anterior intercostal A, first 6 spaces
- Musculophrenic A- Anterior intercostal A, next 3 spaces
- Last 2 spaces- no Anterior intercostal A

Intercostal Veins

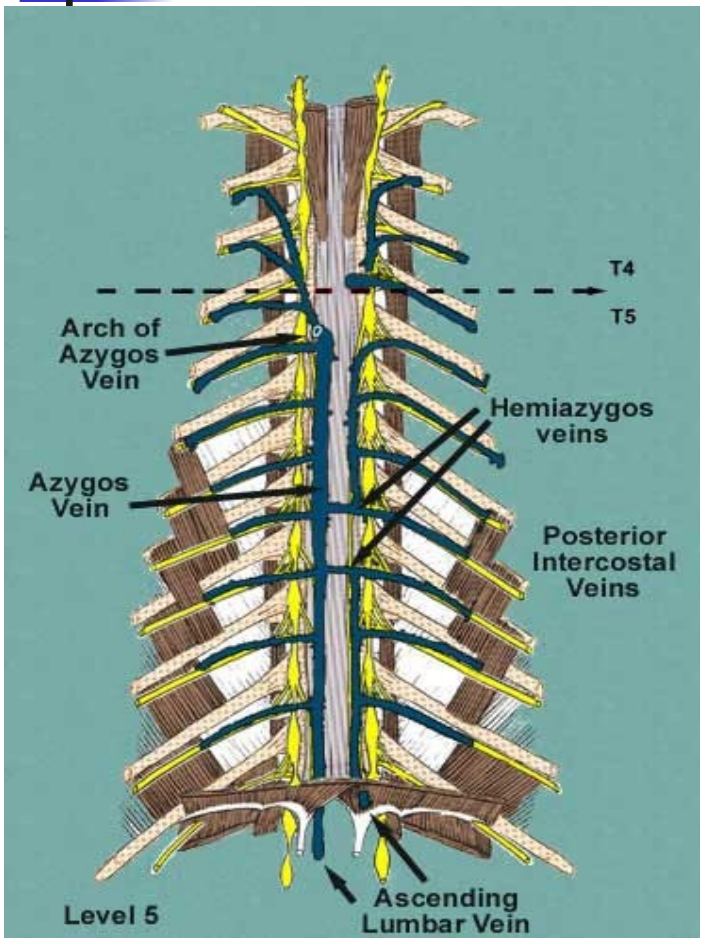


Anterior veins drain into

Internal thoracic V and

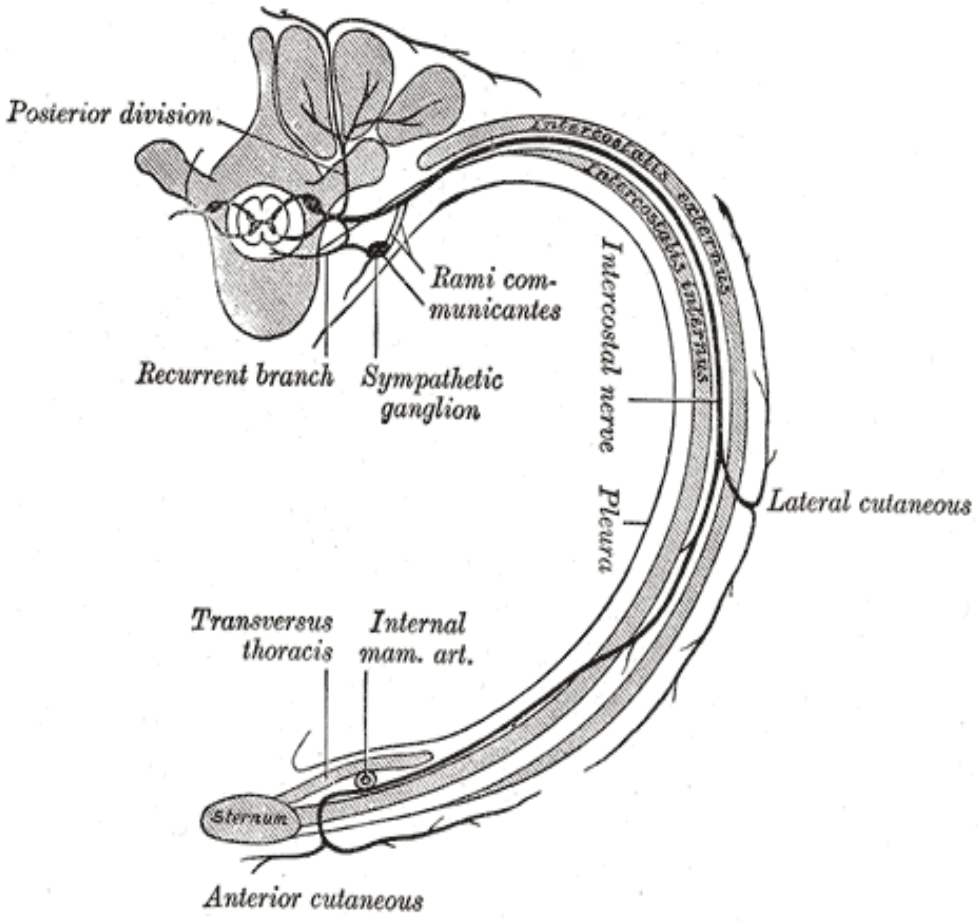
Musculophrenic V

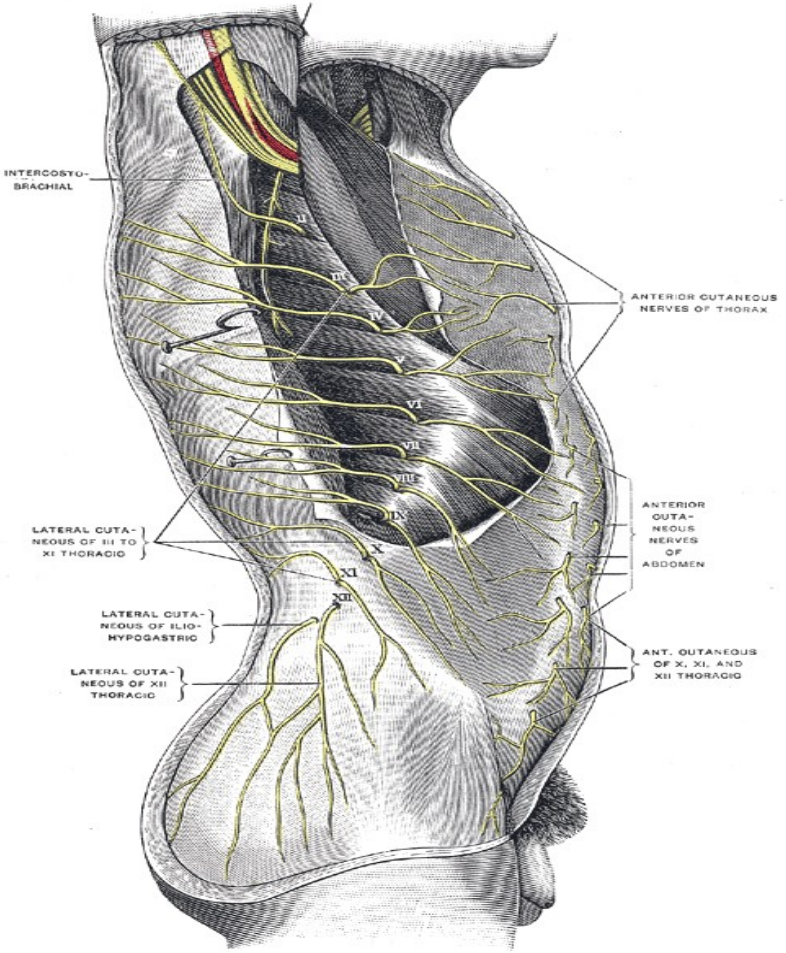
Intercostal Veins



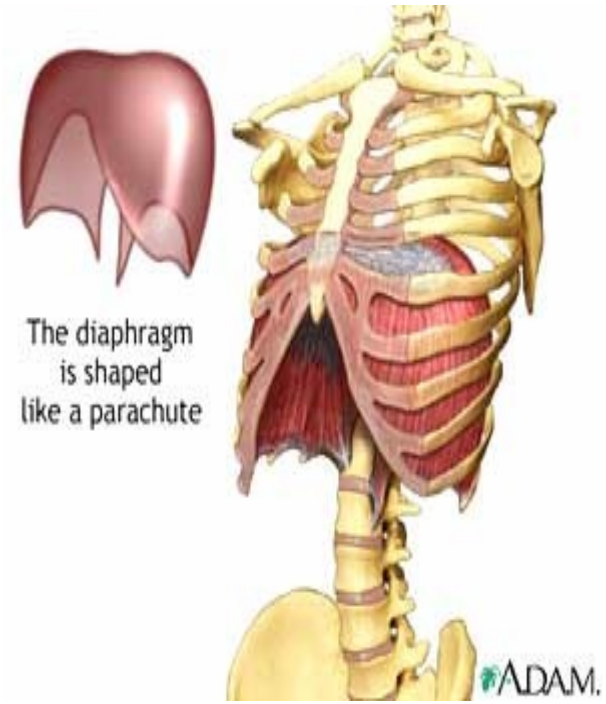
- 1st posterior intercostal V- into Vertebral V / Brachiocephalic V
- 2nd and 3rd form Superior intercostal V- drains into Azygous V (Rt), Brachicephalic V (Lt)
- Posterior intercostal V- Last eight spaces, into Azygous V (Rt), Hemi-azygous V (Lt)

Intercostal Nerve



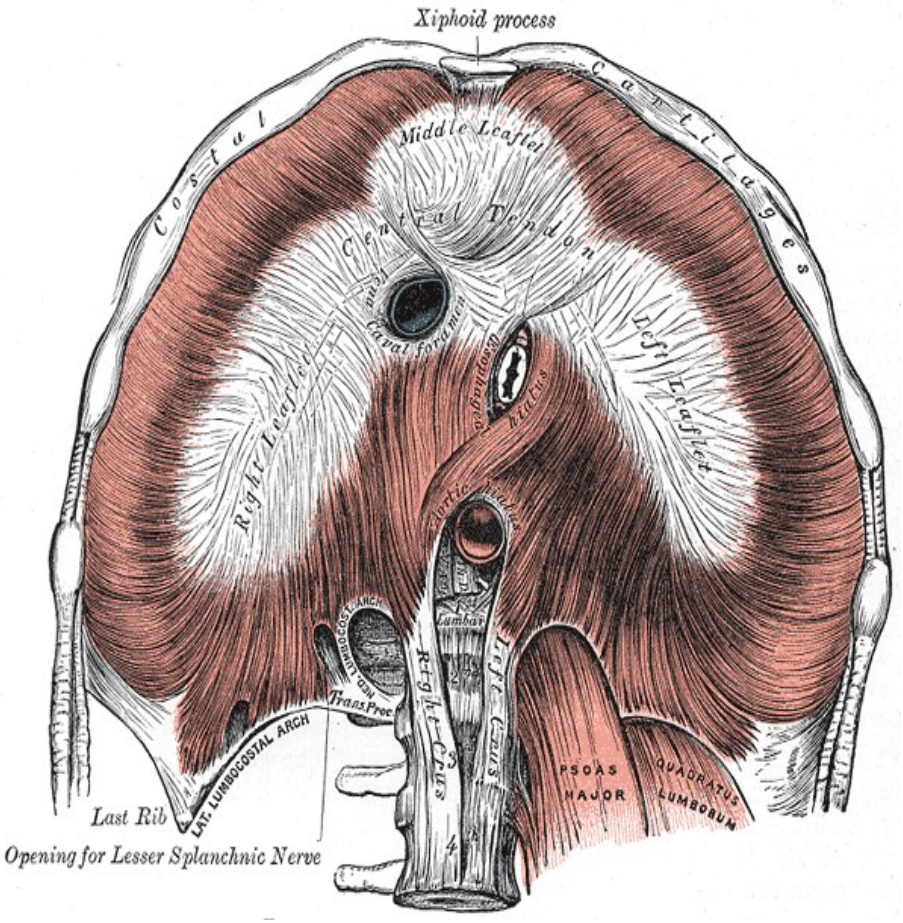


Diaphragm



- Chief muscles of inspiration
- Dome-shaped
- Musculofibrous septum

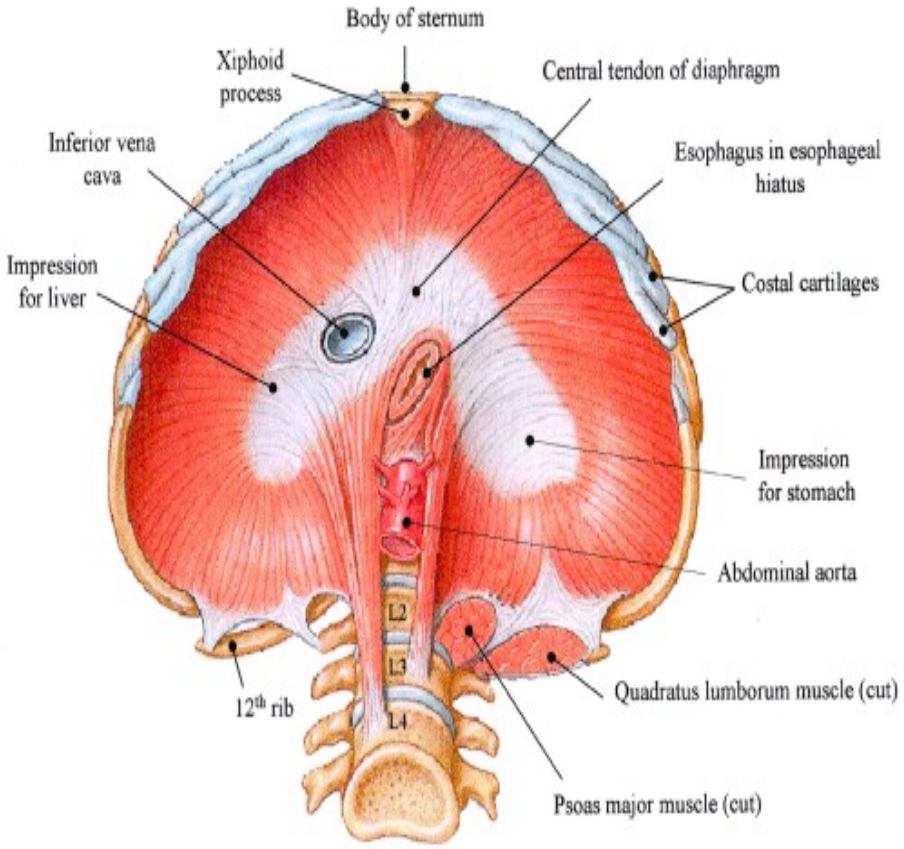
Origins of diaphragm



- Sternal part
- Costal part
- Lumbar part
  - Medial lumbocostal arch
  - Lateral lumbocostal arch
  - Crura

- **Inserted into central tendon**

Openings of diaphragm



- Aortic opening (T12)- aorta, azygous vein, thoracic duct
- Oesophageal opening (T10) Oesophagus, vagus nerve, oesophageal arteries
- Venacaval opening (T8-T9) IVC, branches of right phrenic nerve
- Lesser apertures

Blood supply

- Costal margin of diaphragm- Lower five intercostal and sub-costal arteries
- Main mass from crura- Inferior phrenic arteries
- Small contributions- pericardiophrenic and musculophrenic arteries

Nerve supply

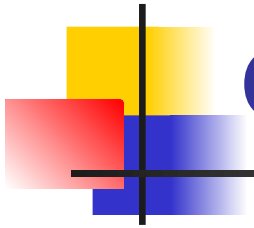
- Motor supply- Phrenic nerve (C3, C4, C5)
- Each half of diaphragm supplied by its own phrenic nerve
- Lower intercostal nerves- proprioceptive supply to periphery
- Phrenic nerve- proprioceptive supply to central part

Applied anatomy

- Thoracotomy
  - Anterolateral or Posterolateral
  - Median sternotomy
  - Thoracoabdominal incision
- Pleural tap

Summary

- The thoracic wall is mainly formed by sternum, ribs, costal cartilages, vertebrae and their articulations
- Diaphragm is the principal muscle of respiration
- The intercostals help in stiffening the ribs and prevent paradoxical movements during respiration
- Diaphragm has multiple origins and single central insertion
- It has three large openings and multiple small apertures
- Arterial supply to the thoracic wall is mainly from branches of descending thoracic aorta and internal thoracic artery



QUESTIONS?