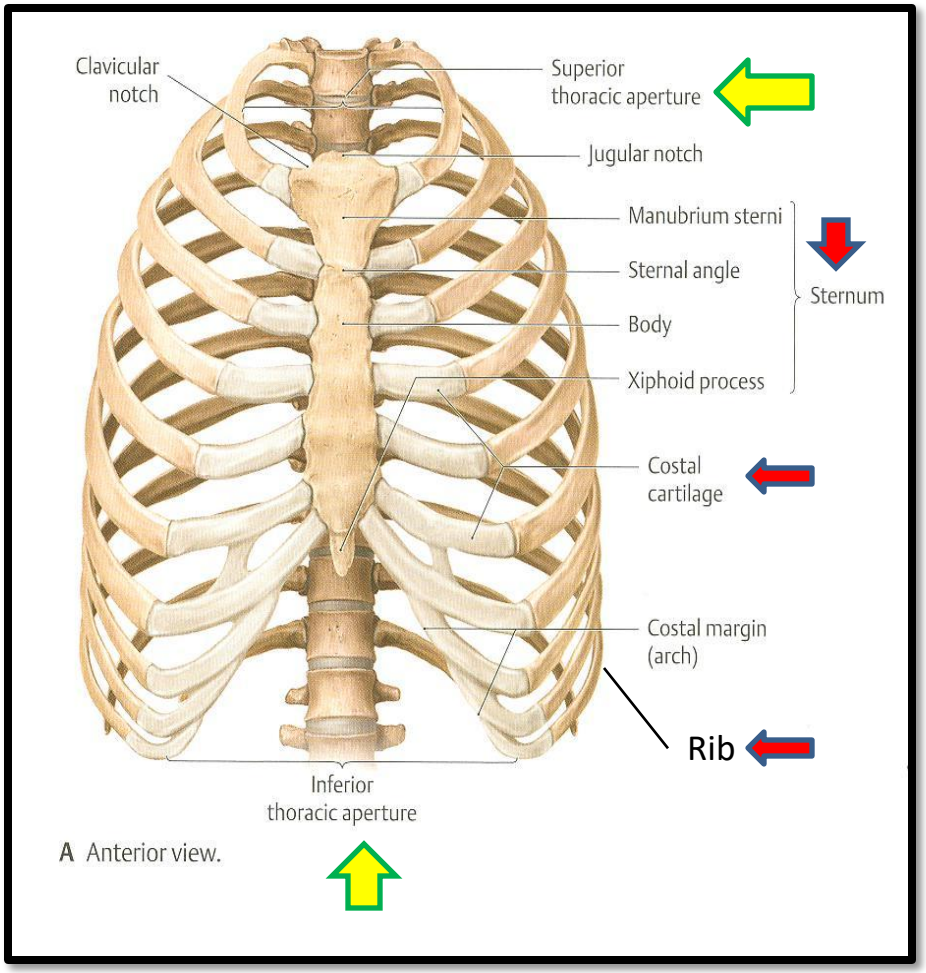
MUSCLES INVOLVED IN RESPIRATION

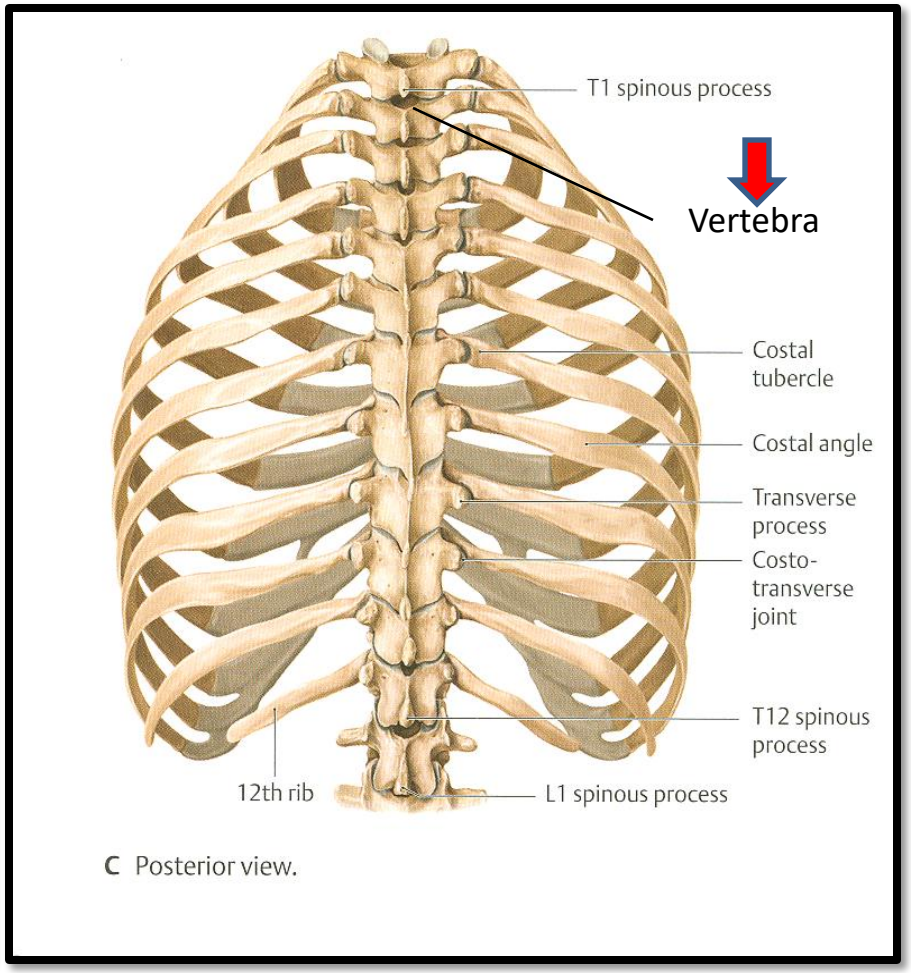
OBJECTIVES

At the end of the lecture, students should:

- ***Describe the components of the thoracic cage and their articulations.***
- ***Describe in brief the respiratory movements.***
- ***List the muscles involved in inspiration and in expiration.***
- ***Describe the attachments of each muscle to the thoracic cage and its nerve supply.***
- ***Describe the origin, insertion, nerve supply of diaphragm.***

THORACIC CAGE





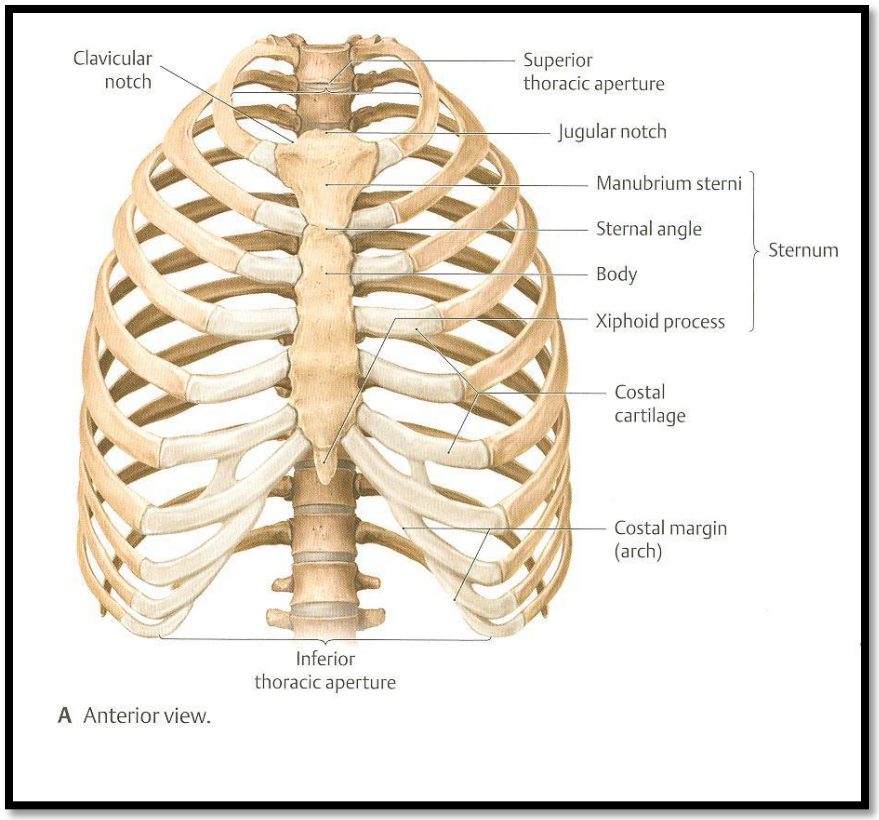
THORACIC CAGE

- ❑ **Conical in shape**
- ❑ **Formed by**

1-Sternum and costal cartilages anteriorly

2-Ribs& intercostal spaces laterally

3- *Thoracic vertebrae* posteriorly



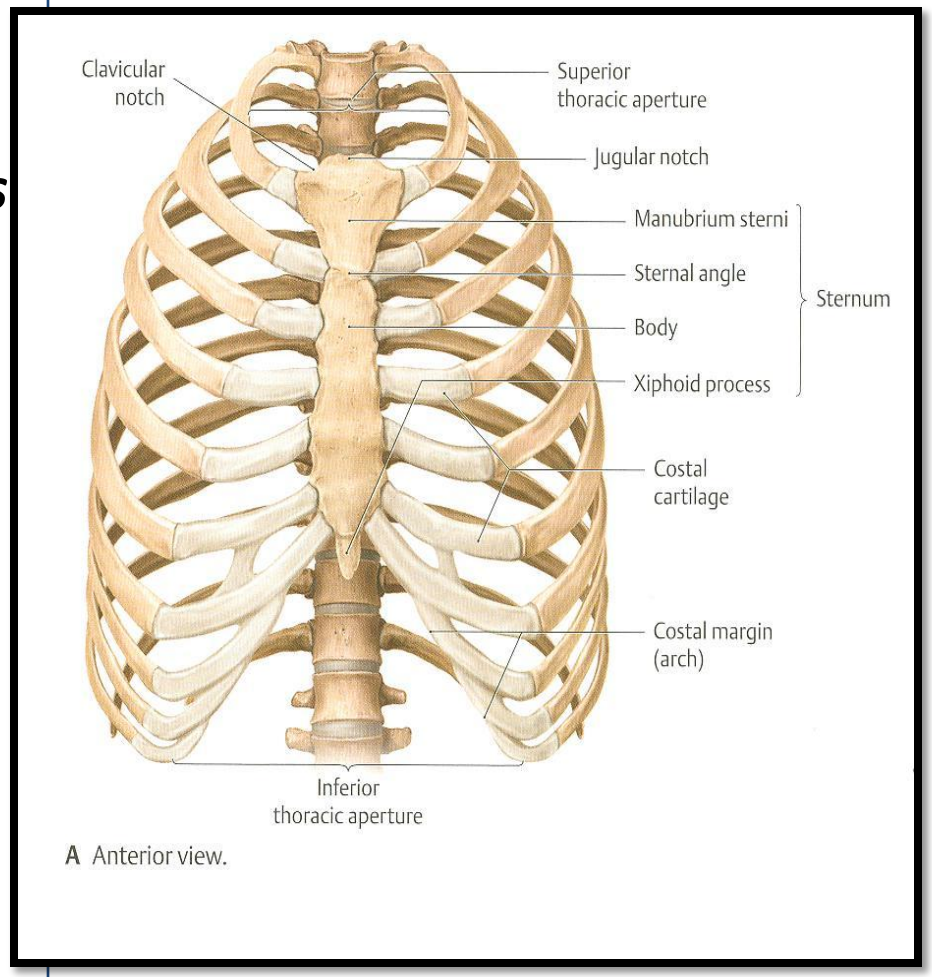
THORACIC CAGE

❑ **Has 2 apertures (openings):**

1- Superior opening *(thoracic outlet):* *narrow, open, continuous with neck, obliquly placed facing upward and forward*

Bounded by:

1. ***Superior border of the manubrium sterni anteriorly***
2. ***Medial borders of first rib laterally***
3. ***First thoracic vertebrae posteriorly***

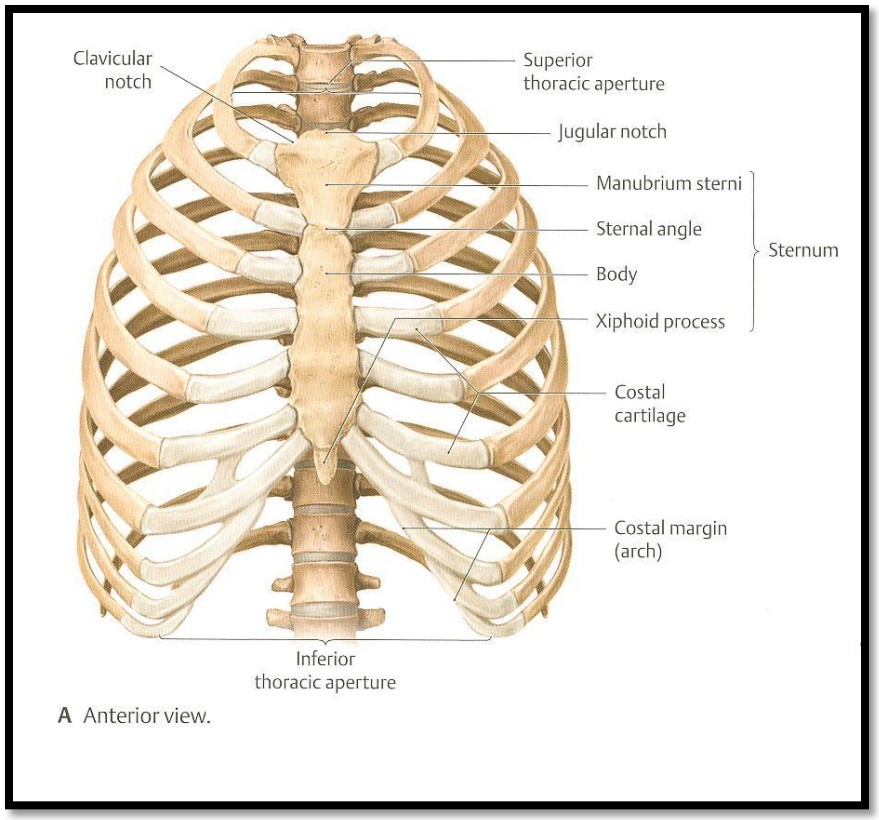


THORACIC CAGE

2- Inferior opening: ***wide, closed by diaphragm***

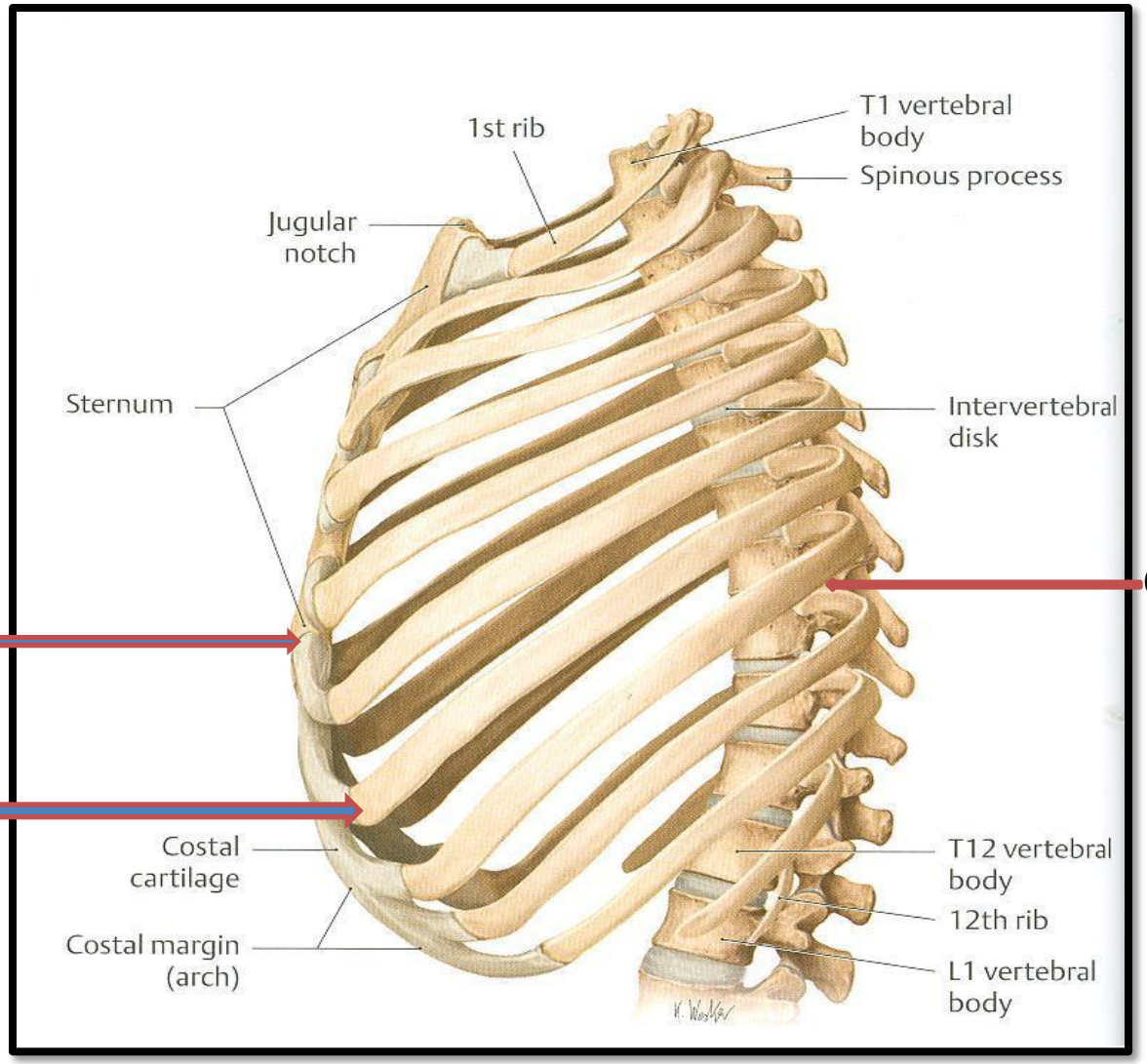
- ❑ **Bounded by:**

1. ***Xiphisternal joint: anteriorly***
2. ***Curving costal margin laterally***
3. ***Twelve thoracic vertebrae: posteriorly***



A Anterior view.

ARTICULATIONS



Sternocostal

- 1st costal cartilage: articulates with manubrium by a primary cartilaginous j.
- From 2nd to 7th cartilages articulate with sternum by synovial js.

Costochondral

- Between the costal cartilage and the ribs
- Cartilagenous j.

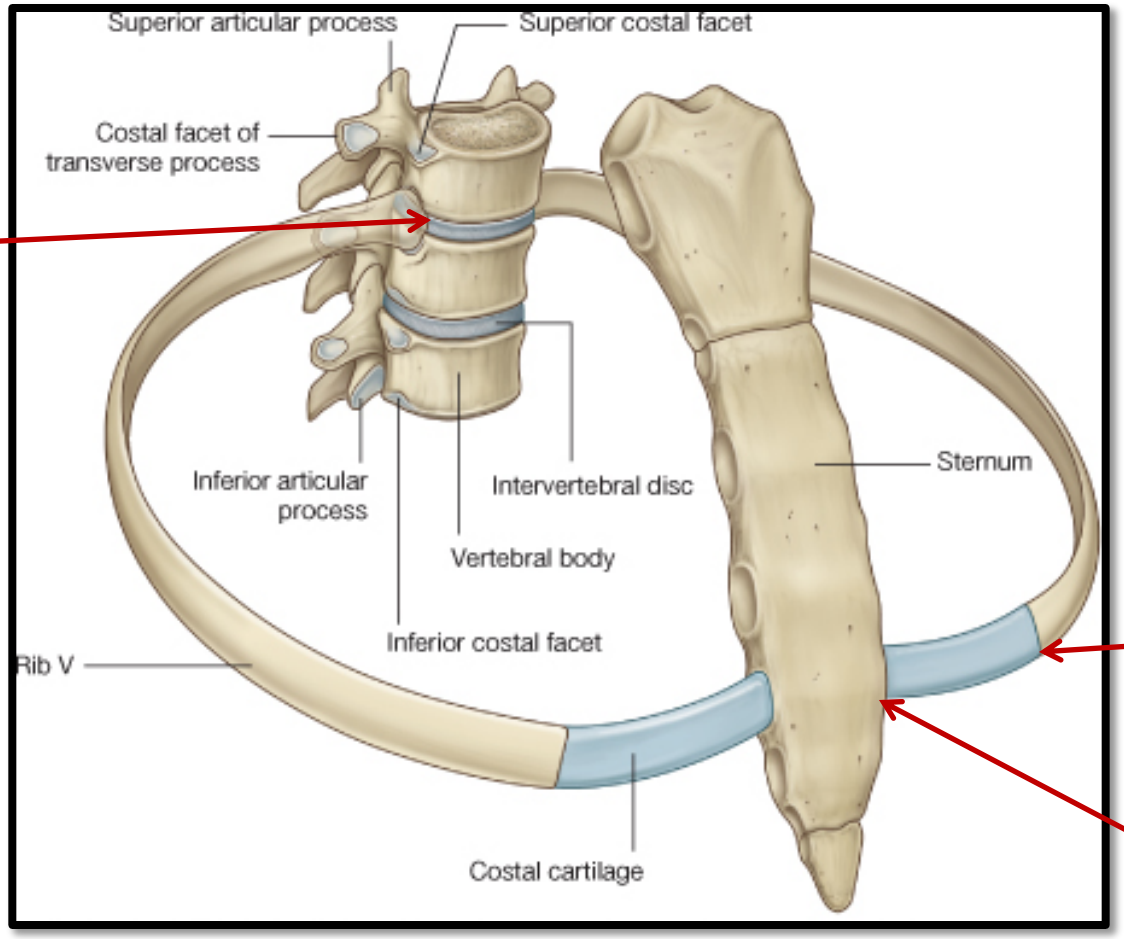
Costovertebral

- These are plane synovial joints.
- Between heads of ribs & thoracic vertebrae.

ARTICULATIONS

Costovertebral

Plane synovial j.



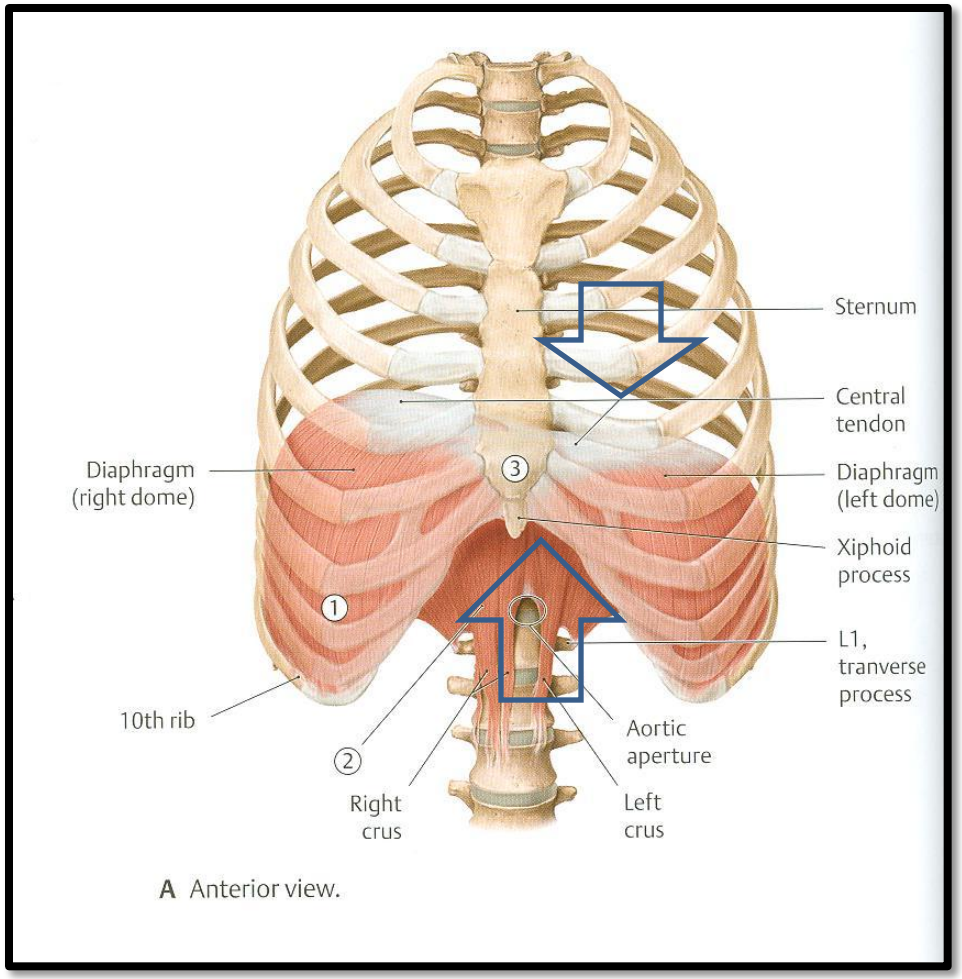
Costochondral

Cartilegenous j.

Sternocostal

Plane synovial j.

RESPIRATORY MOVEMENTS
A- MOVEMENTS OF DIAPHRAGM



A Anterior view.

Inspiration

Contraction (descent) of diaphragm

Increase of vertical diameter of thoracic cavity

Expiration

Relaxation (ascent) of diaphragm)

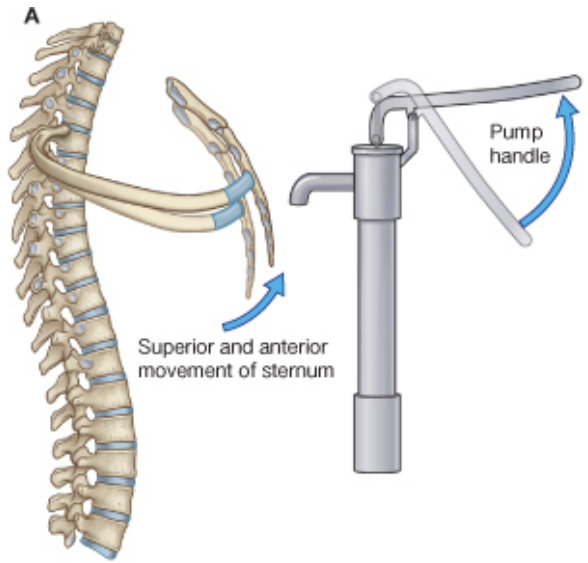
RESPIRATORY MOVEMENTS
B- MOVEMENTS OF RIBS

(In Normal Inspiration)

PUMP HANDLE MOVEMENT

Elevation of ribs

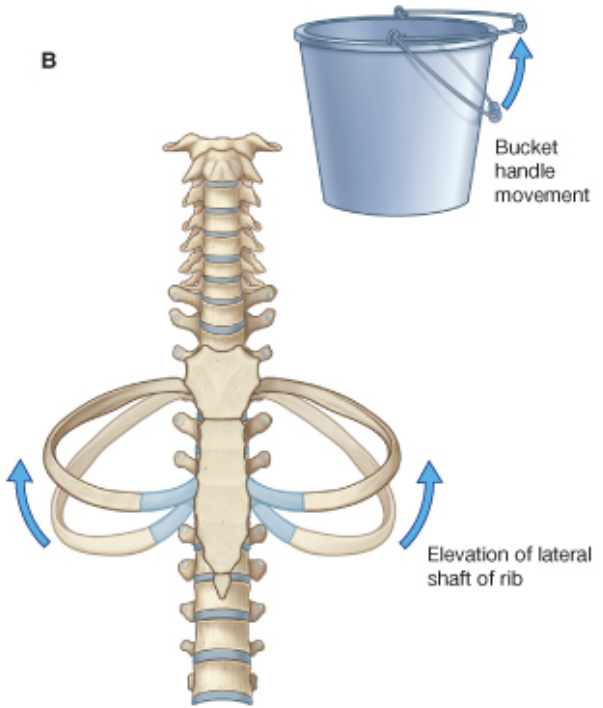
Increase in antero-posterior diameter of thoracic cavity



BUCKET HANDLE MOVEMENT

Elevation of ribs

Increase in lateral (transverse) diameter of thoracic cavity



INSPIRATORY MUSCLES

- ❑ Diaphragm (most important muscle)
- ❑ Rib elevators: external intercostal muscles
- ❑ Accessory muscles (only during forced inspiration) :

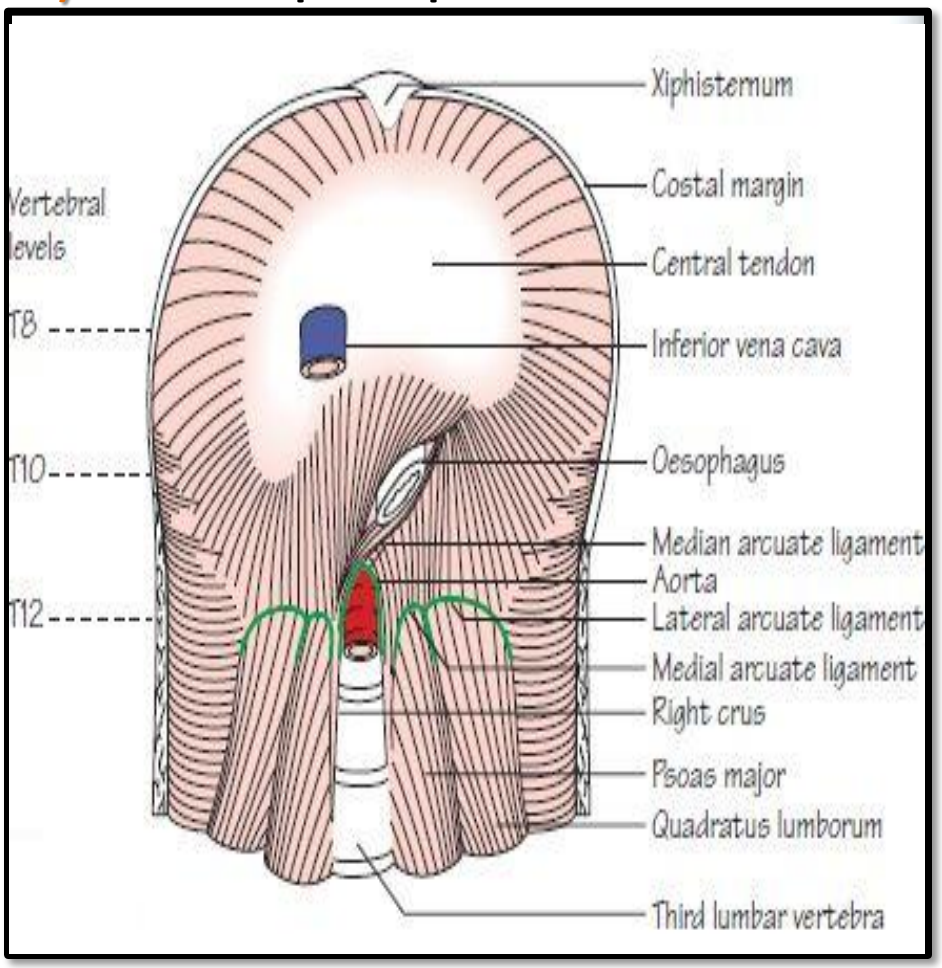
1. Muscles attaching cervical vertebrae to first & second rib: scalene muscles
2. Muscles attaching thoracic cage to upper limb: pectoralis major.

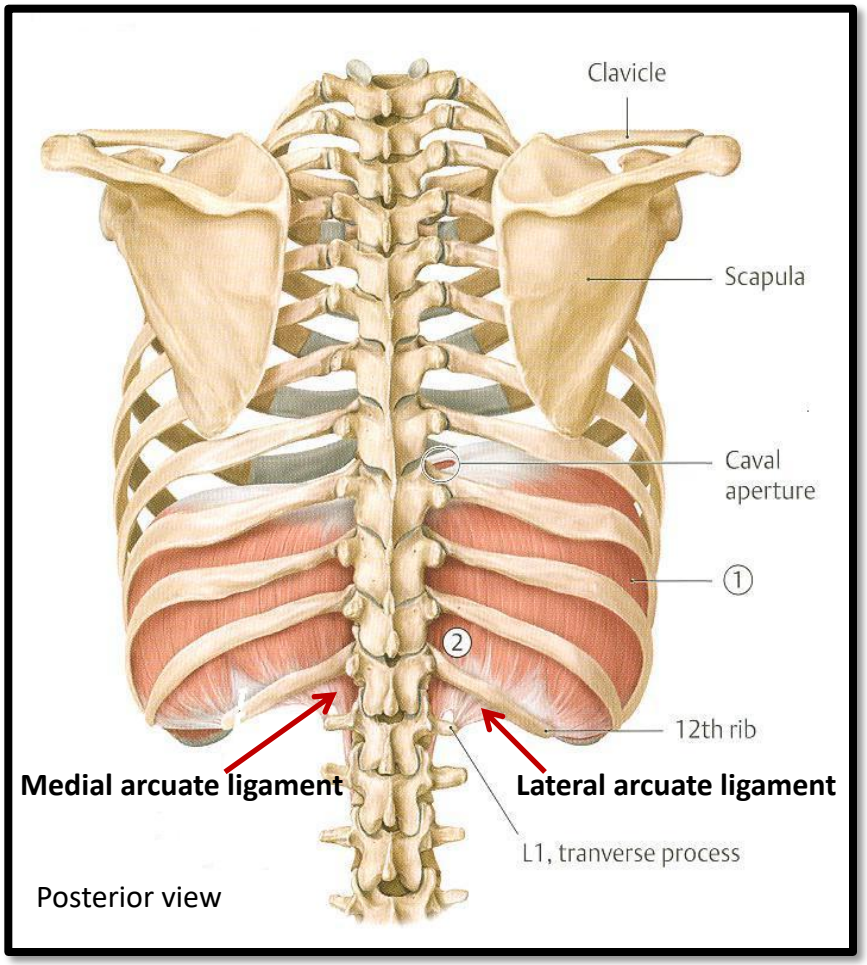
ORIGIN OF DIAPHRAGM

1) Costal: lower 6 ribs and their costal cartilages

2) Vertebral: upper 3 lumbar vertebrae (right & left crus + arcuate ligaments)

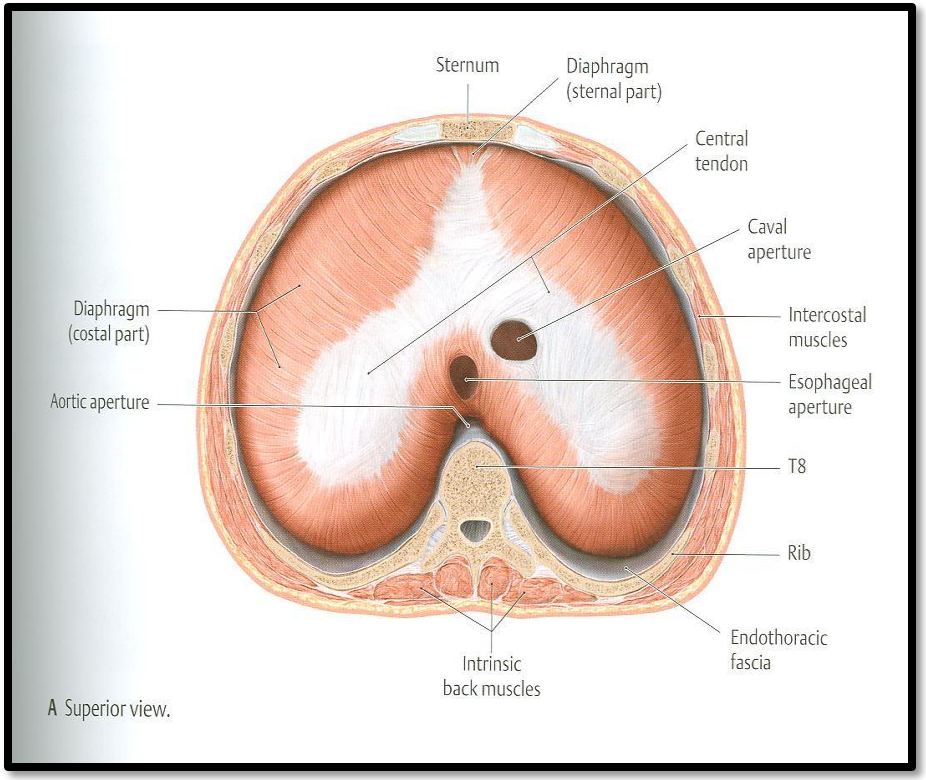
3) Sternal: xiphoid process of sternum

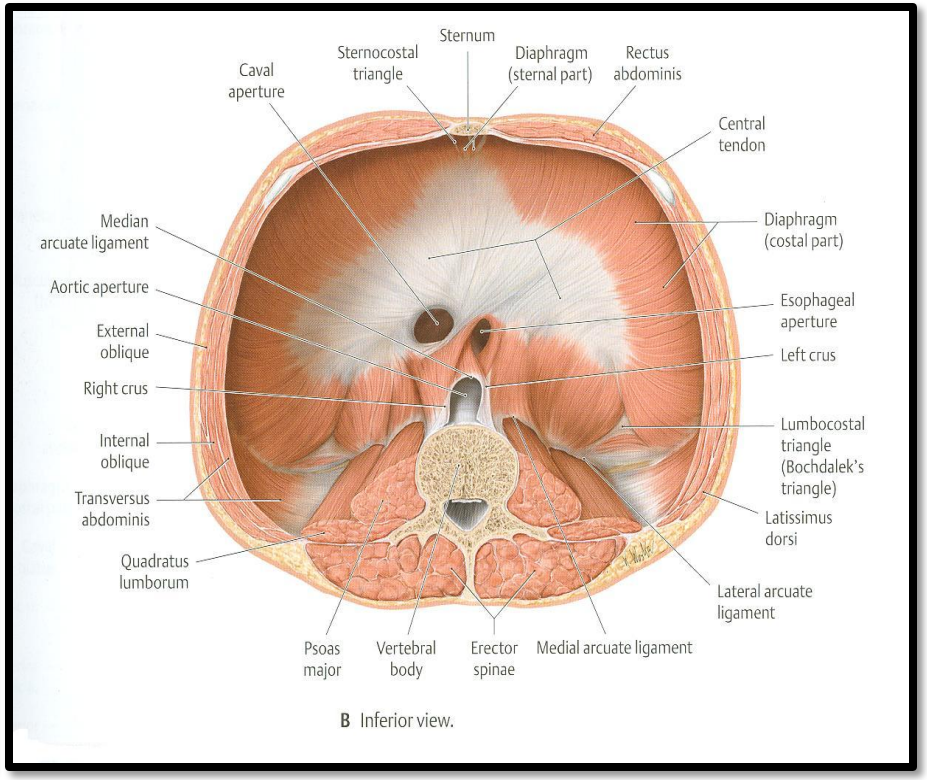




INSERTION OF DIAPHRAGM (CENTRAL TENDON)

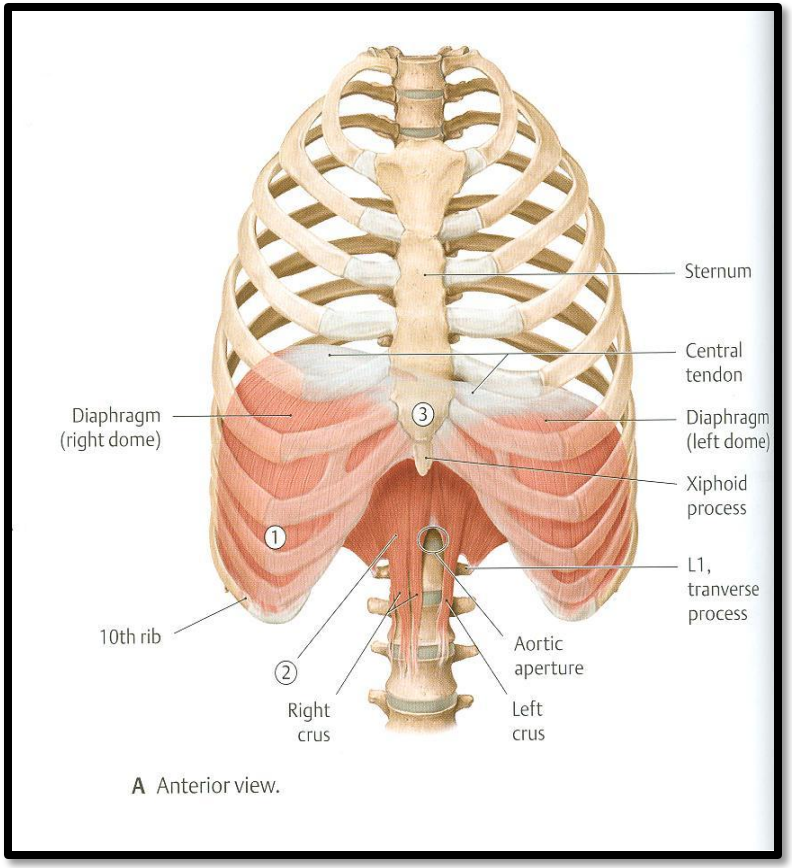
- **(lies at the level of xiphisternal joint, at 9th thoracic Vertebra)**





DIAPHRAGM

- **A musculotendinous partition** between thoracic & abdominal cavity
- **Convex** toward thoracic & **concave** toward abdominal cavity
- **Attached to:** sternum, costal cartilages,12th rib & lumbar vertebrae
- **Fibers converge to join and inserted into** the central tendon
- **Nerve supply:** phrenic nerve (C3,4,5), penetrates diaphragm & innervates it from abdominal surface
- **Action:** contraction (descent) of diaphragm increase vertical diameter of thoracic cavity (essential for normal breathing)

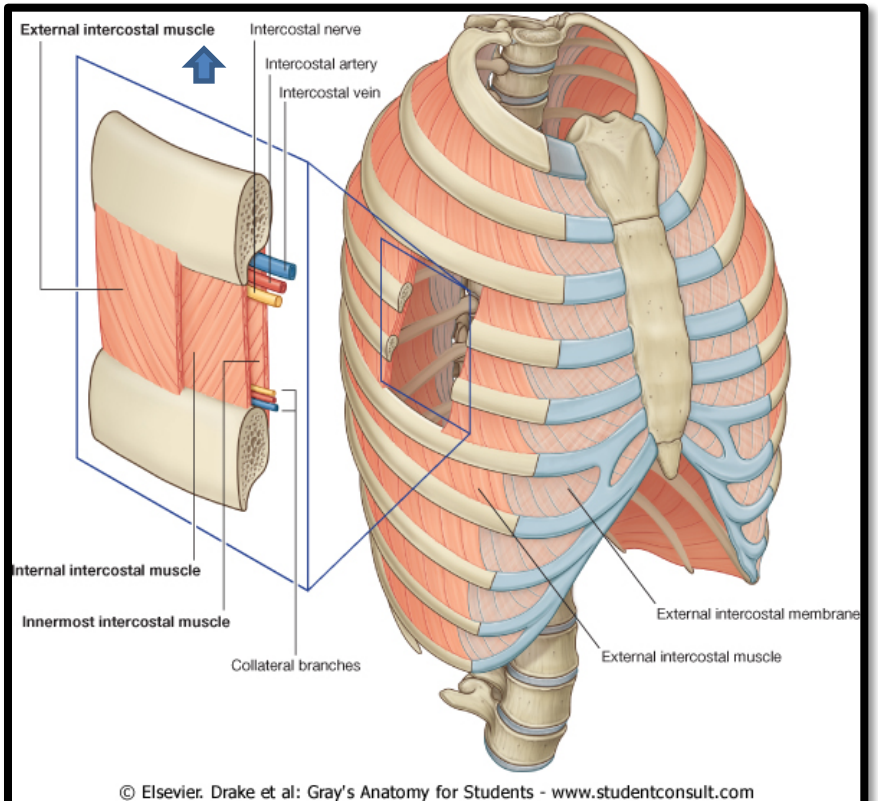


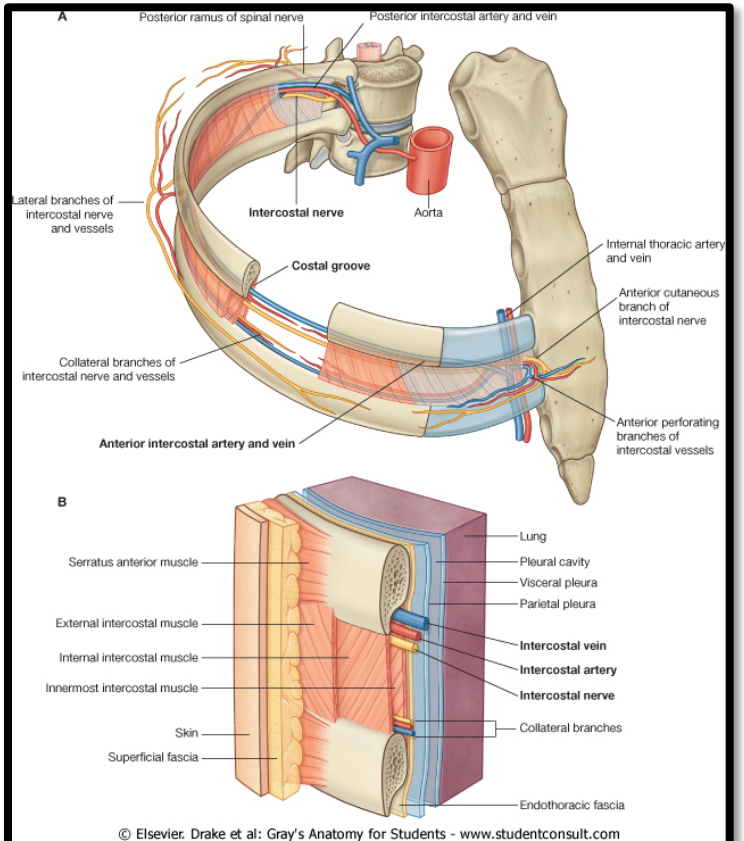
A Anterior view.

EXTERNAL INTERCOSTAL

(Inspiratory Muscle)

- **Attachments:** from lower border of rib above to upper border of rib below
- **Direction of fibers:** downward ,forward & medially
- **Nerve supply:** intercostal nerves
- **Action:** rib elevators (inspiratory)

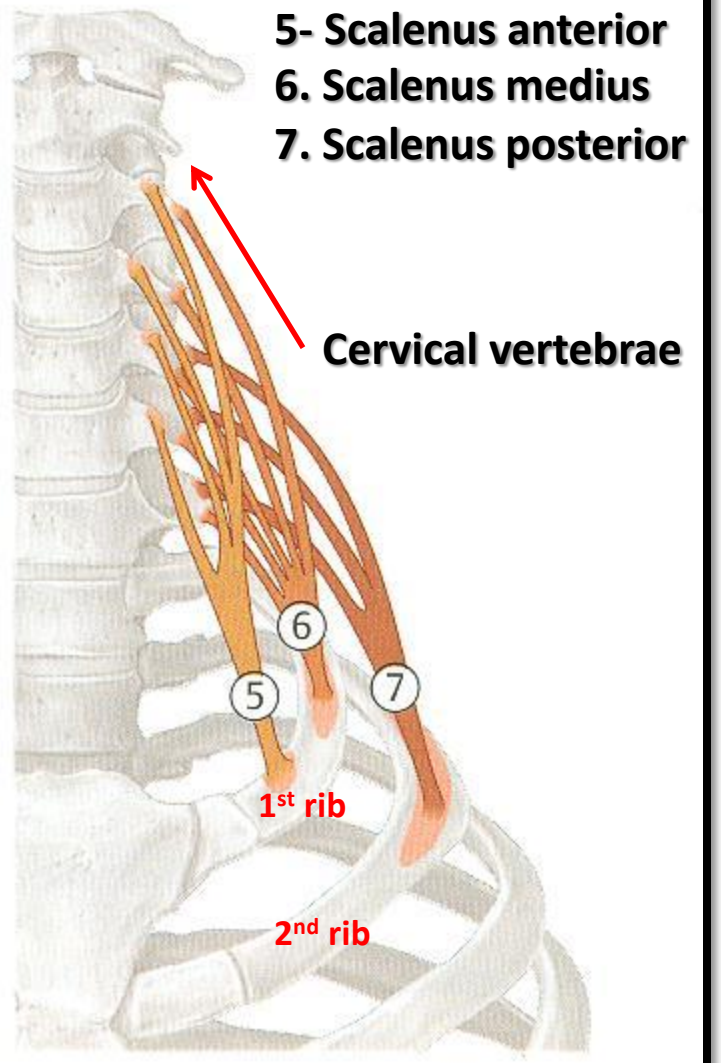




SCALENE MUSCLES

(In Forced Inspiration)

- **Origin:** cervical vertebrae
- **Insertion:** 1st & 2nd ribs
- **Action:** elevates 1st & 2nd ribs (inspiratory)

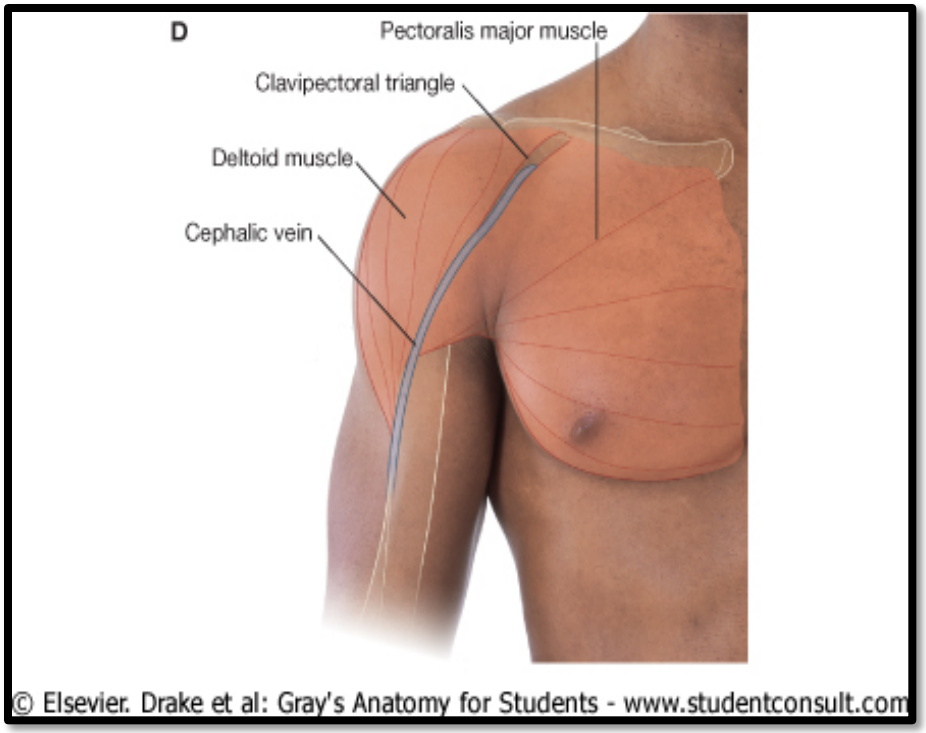


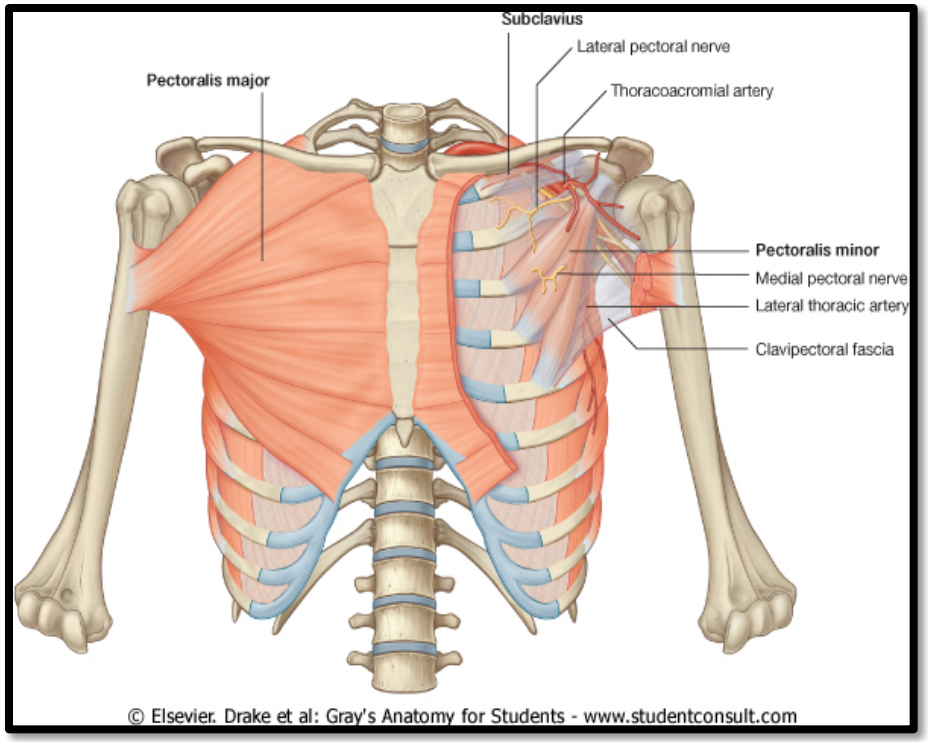
B Scalene muscles, anterior view.

PECTORALIS MAJOR

(In Forced Inspiration)

- **Origin:** sternum + costal cartilages
- **Insertion:** humerus
- **Action:** increases antero-posterior diameter of thoracic cavity, when arm is fixed (inspiratory)





EXPIRATORY MUSCLES

❑Act only during forced expiration

- **Rib depressors:**

1. Internal intercostal
2. Innermost intercostal
3. Subcostals
4. Transversus thoracis

- **Anterior abdominal wall muscles:**

(Compression of abdominal viscera to help in ascent of diaphragm).

1. External oblique
2. Internal oblique
3. Transversus abdominis
4. Rectus abdominis

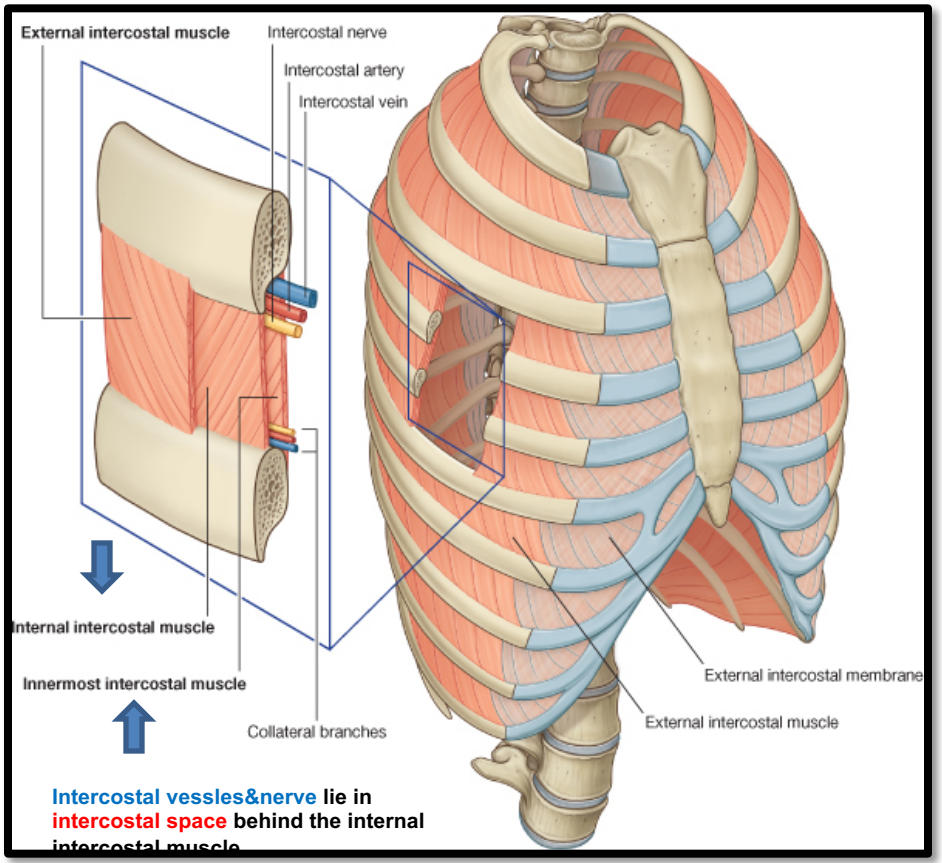
RIB DEPRESSORS: REST OF INTERCOSTAL MUSCLES

1. Internal intercostal
2. Innermost intercostal

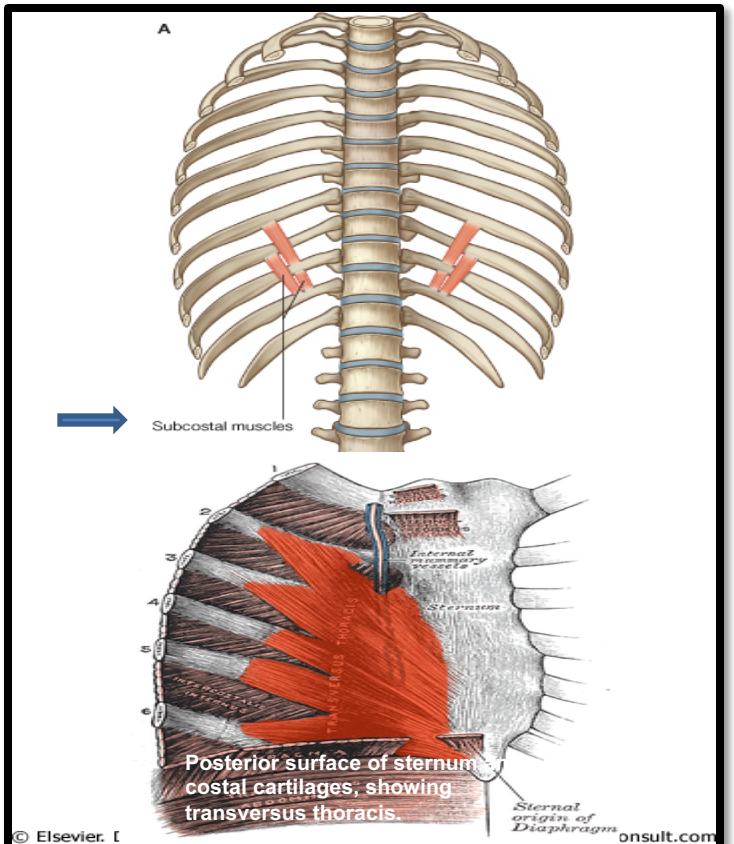
Direction: downward, backword &laterally

3. Subcostal
4. Transversus thoracis

Nerve supply: intercostal nerves (ventral rami of T1-T11)



Intercostal vessles&nerve lie in intercostal space behind the internal intercostal muscle



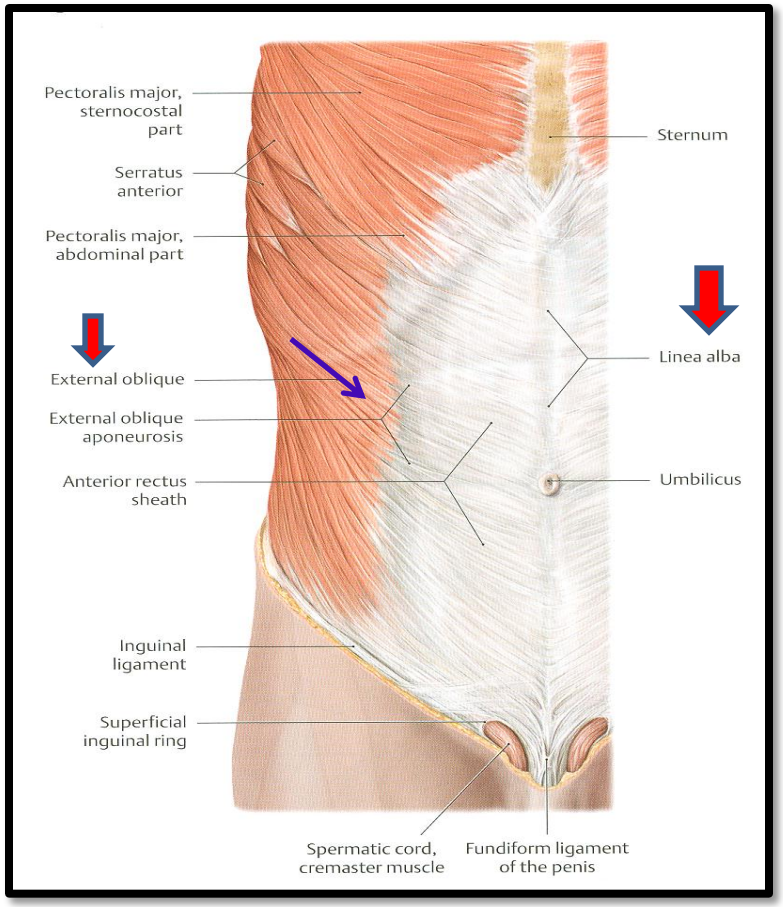
ANTERIOR ABDOMINAL WALL

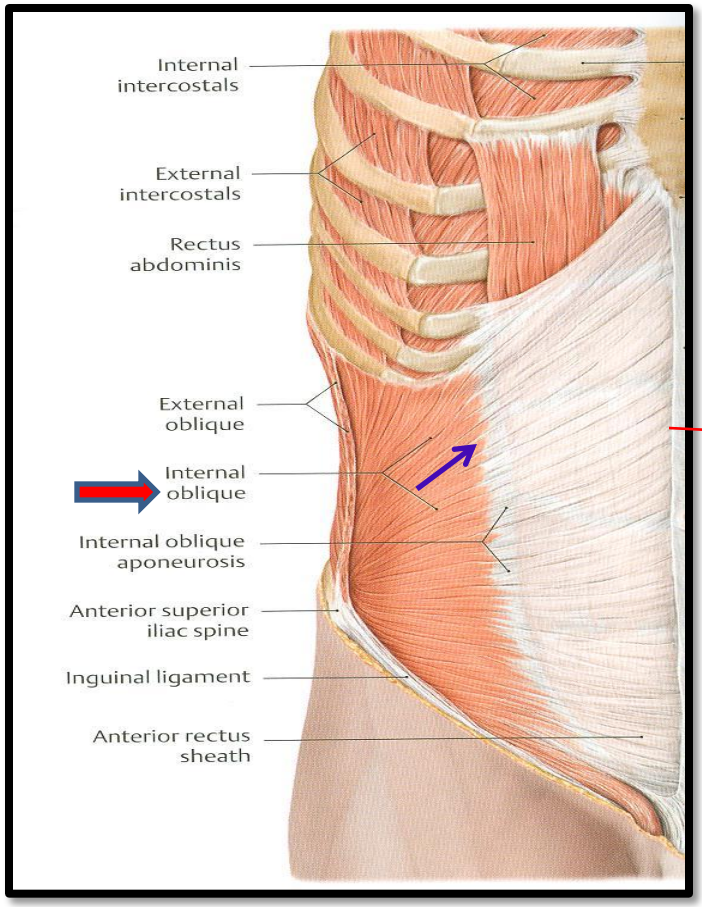
External oblique (outer layer)

- **Direction:** downward & medially

Internal oblique (middle layer)

- **Direction:** upward & medially





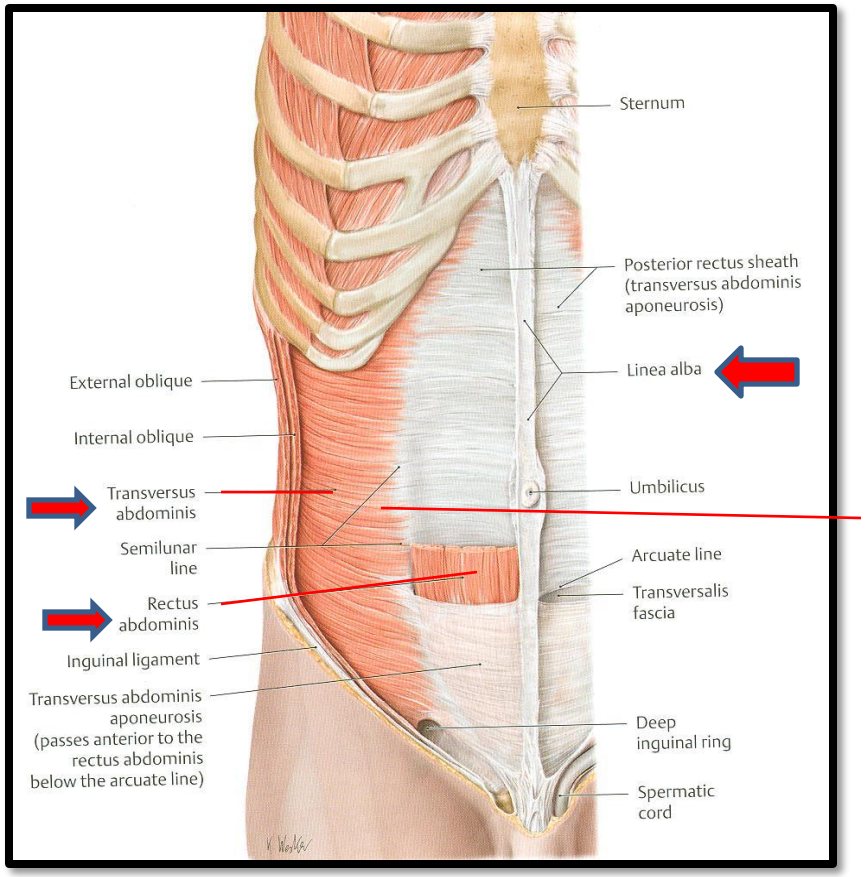
ANTERIOR ABDOMINAL WALL

Transversus abdominis (inner layer)

- **Direction:** transverse

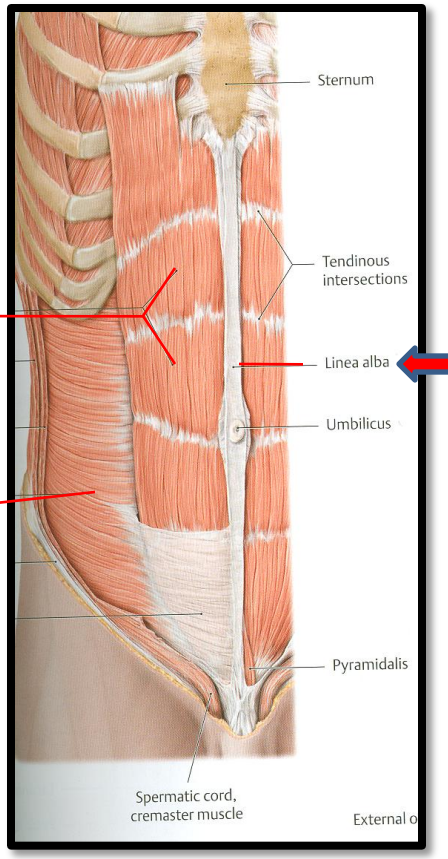
Rectus abdominis

- **Direction:** vertical



Rectus abdominis

Transversus abdominis



Anterior abdominal wall

- Is formed of 3 layers of muscles of fibers running in different directions (to increase strength of anterior abdominal wall)
- The 3 muscles form a sheath in which a fourth muscle lies (rectus abdominis)
- Muscles are attached to: sternum, costal cartilages and ribs + hip bones
- The aponeurosis of the 3 muscles on both sides fuse in the midline to form linea alba
- Action (during forced expiration): Compression of abdominal viscera to help in ascent of diaphragm
- Nerve supply: lower 5 intercostal nerves (T7 – T11), subcostal nerve (T12) and first lumbar nerve (L1).