

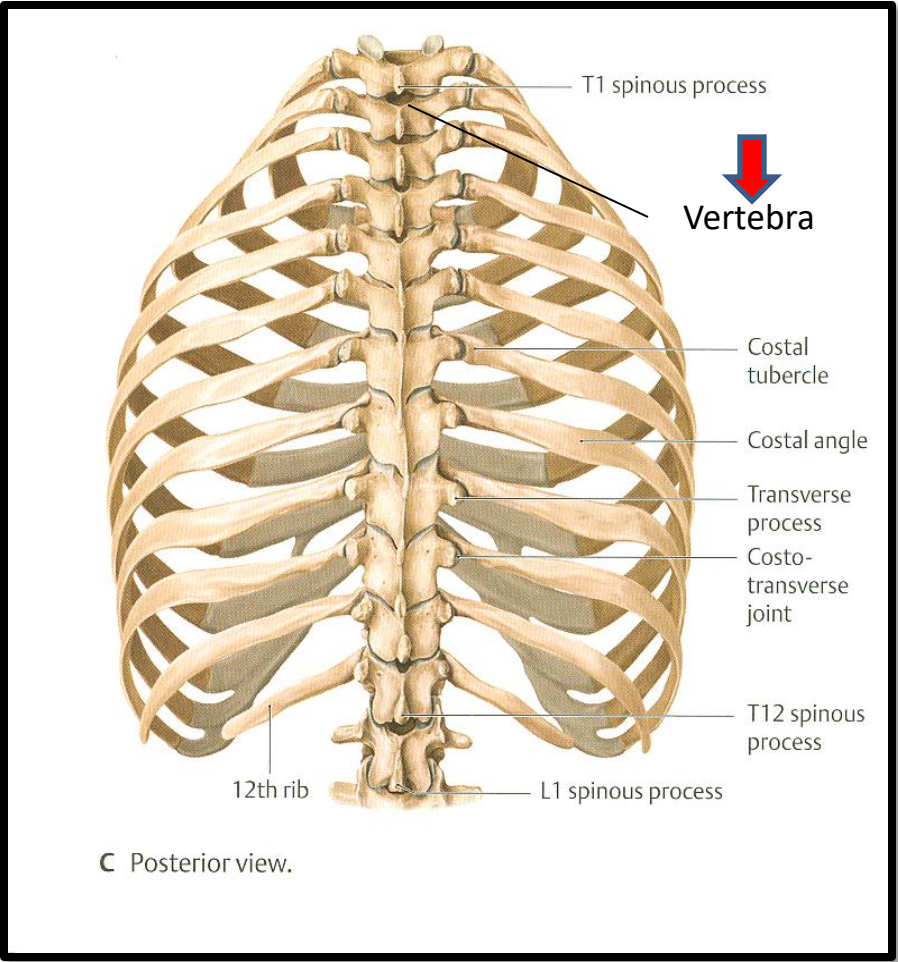
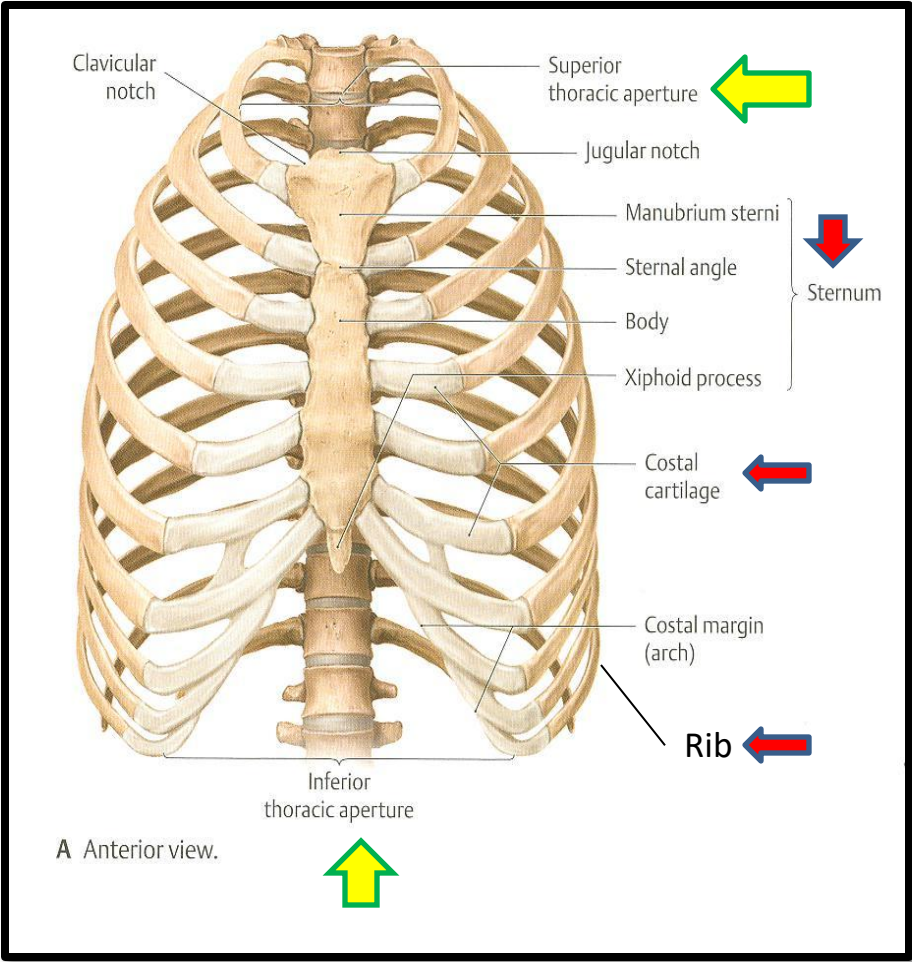
MUSCLES INVOLVED IN RESPIRATION

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

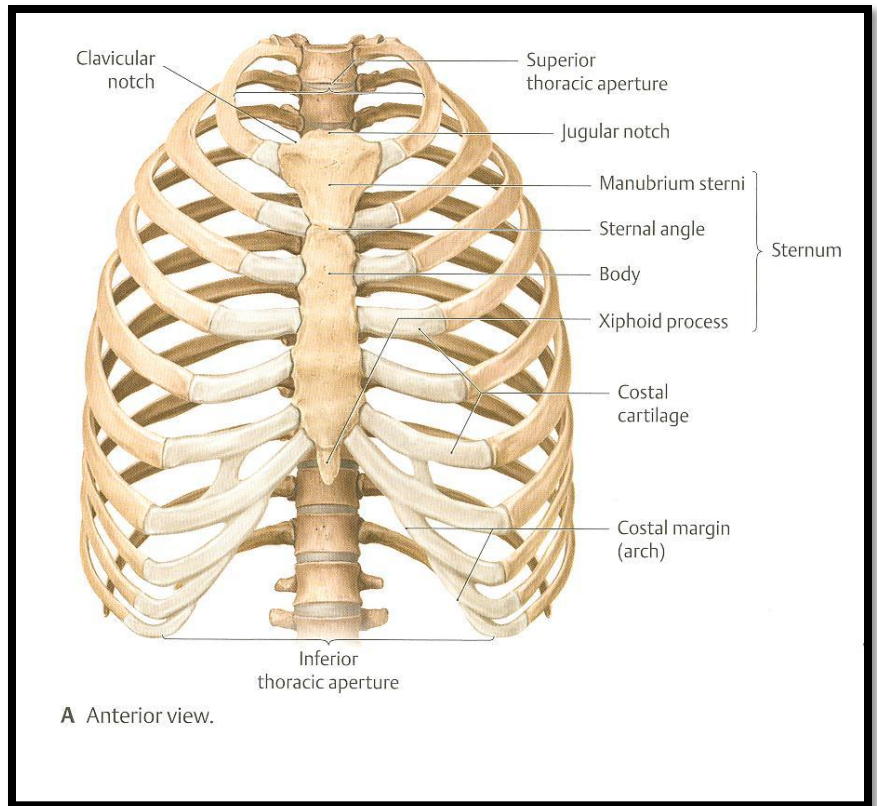
❑ Conical in shape

❑ Formed by

1-Sternum and costal cartilages **anteriorly**

2-Ribs & intercostal spaces **laterally**

3- *Thoracic vertebrae* **posteriorly**



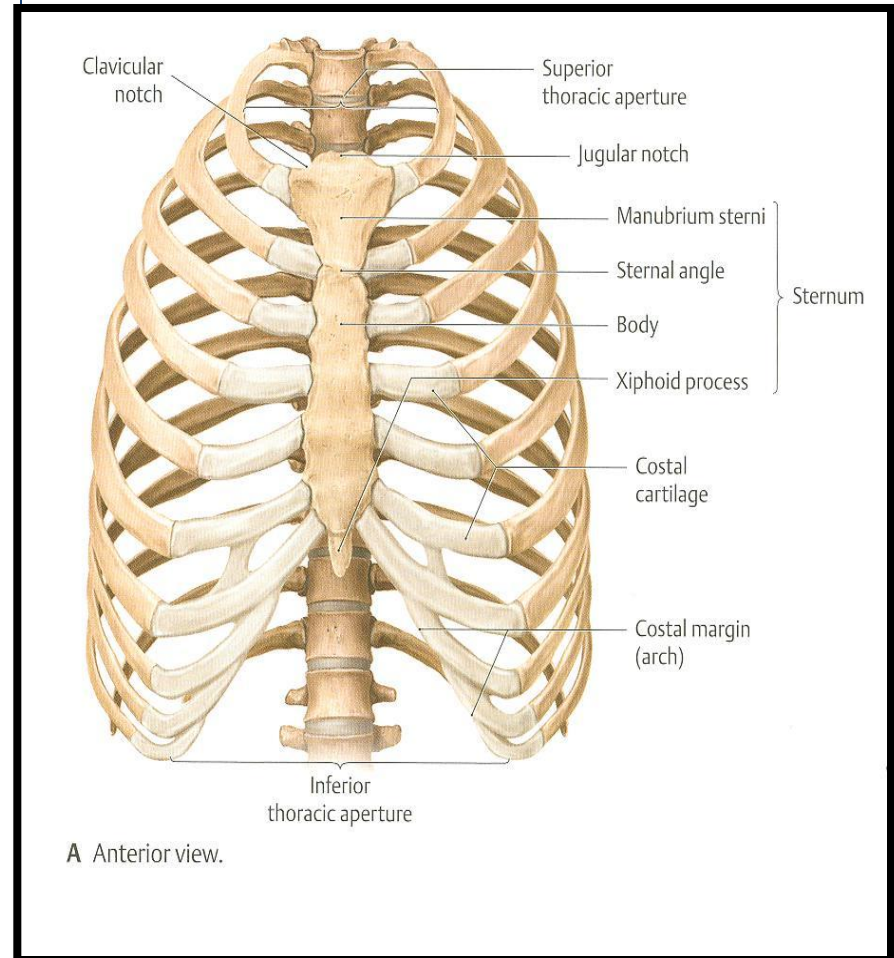
THORACIC CAGE

❑ Has 2 apertures (openings):

1- Superior opening (*thoracic outlet*): narrow, open, continuous with neck, obliquely 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***

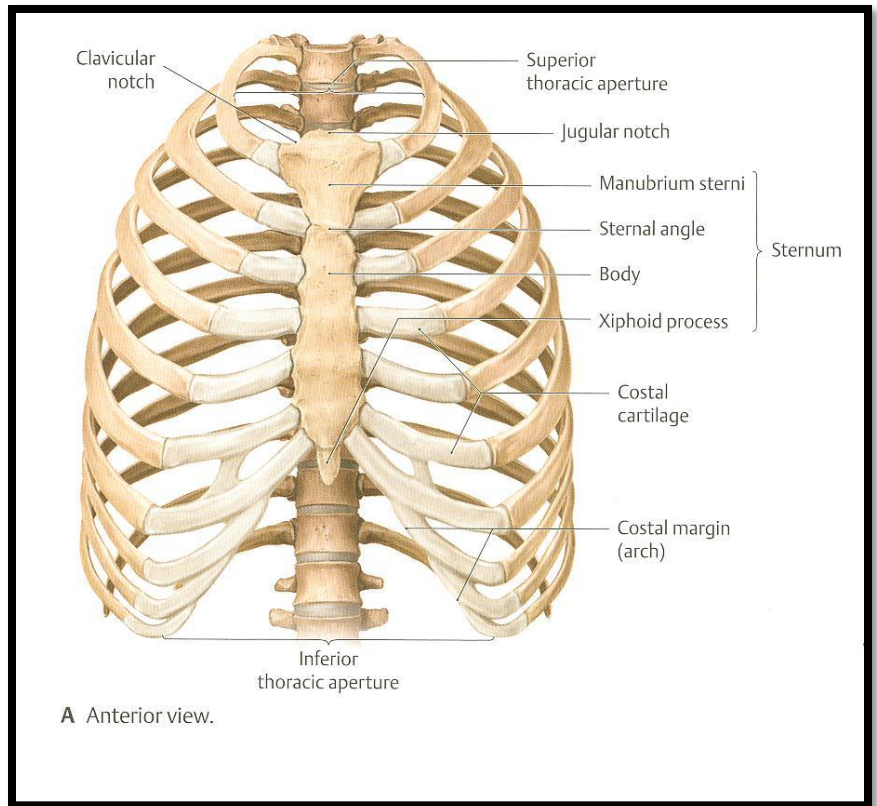


THORACIC CAGE

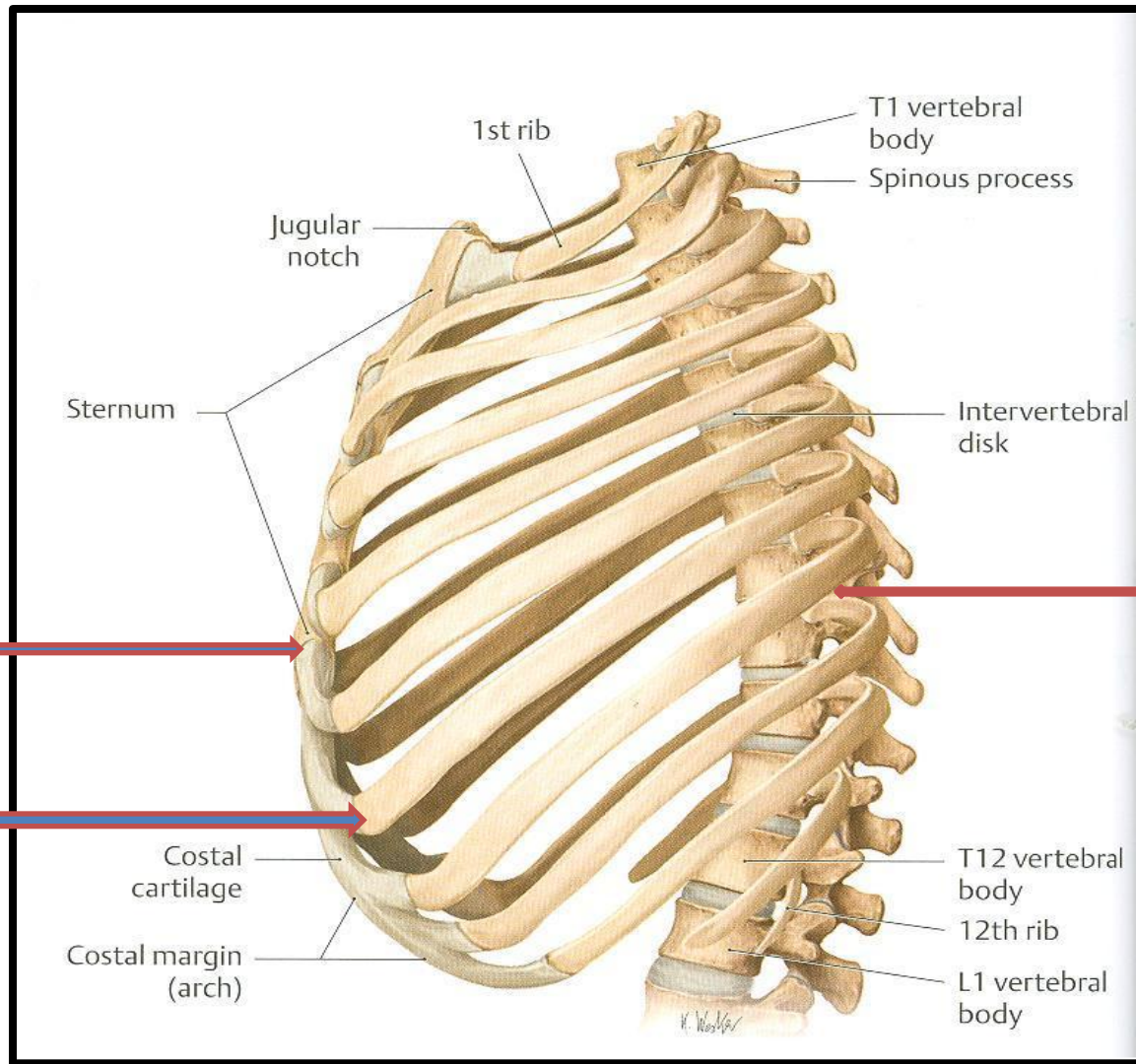
2- Inferior opening: wide, closed by diaphragm

□ Bounded by:

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



ARTICULATIONS



Sternocostal

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

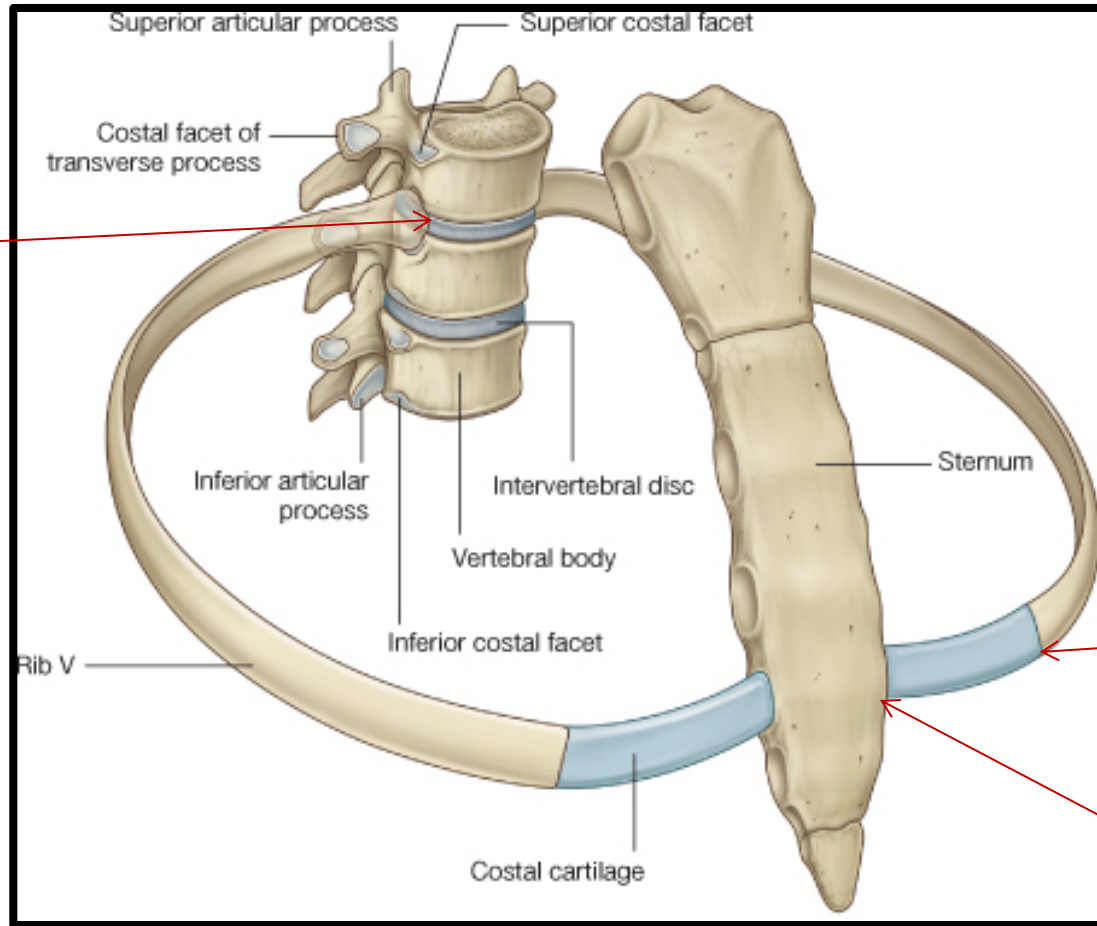
Costochondral

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

Costovertebral

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

ARTICULATIONS



Costovertebral

Plane synovial j.

Costochondral

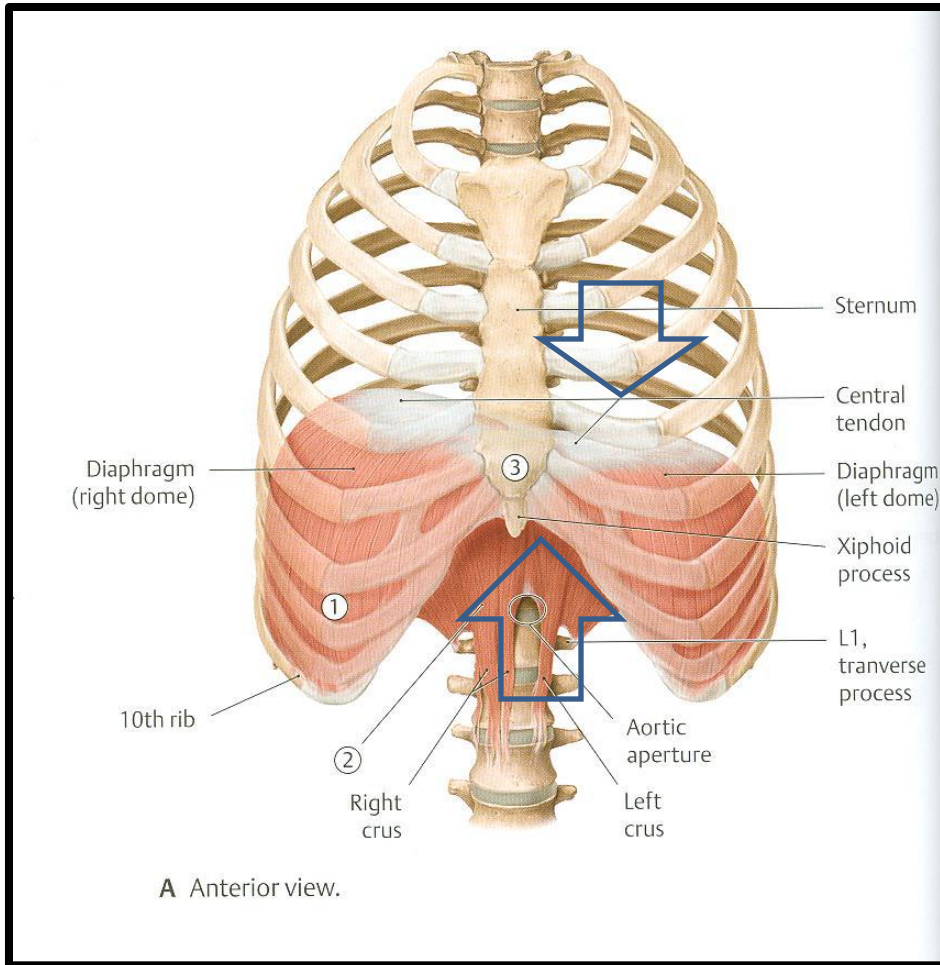
Cartilagenous j.

Sternocostal

Plane synovial j.

RESPIRATORY MOVEMENTS

A- MOVEMENTS OF DIAPHRAGM



Inspiration

**Contraction (descent)
of diaphragm**



**Increase of vertical diameter
of thoracic cavity**

Expiration

**Relaxation (ascent)
of diaphragm)**

RESPIRATORY MOVEMENTS

B- MOVEMENTS OF RIBS

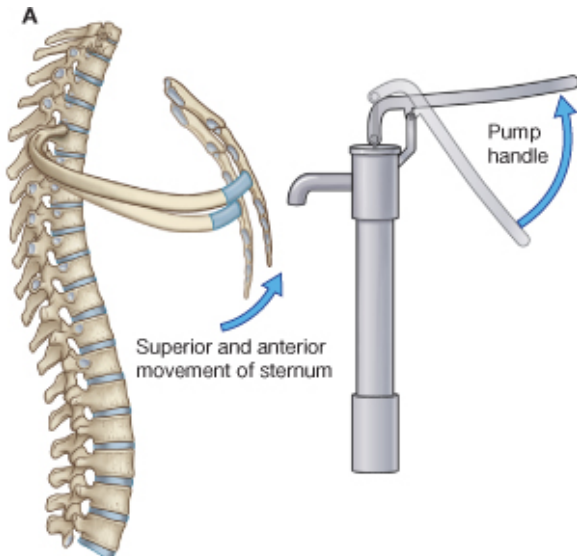
(In Normal Inspiration)

PUMP HANDLE MOVEMENT

Elevation of ribs



Increase in antero-posterior diameter of thoracic cavity

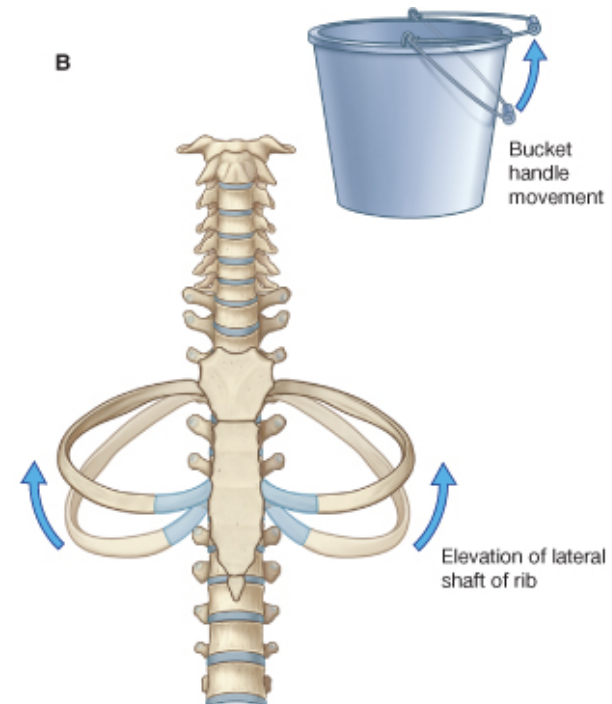


BUCKET HANDLE MOVEMENT

Elevation of ribs



Increase in lateral (transverse) diameter of thoracic cavity



INSPIRATORY MUSCLES

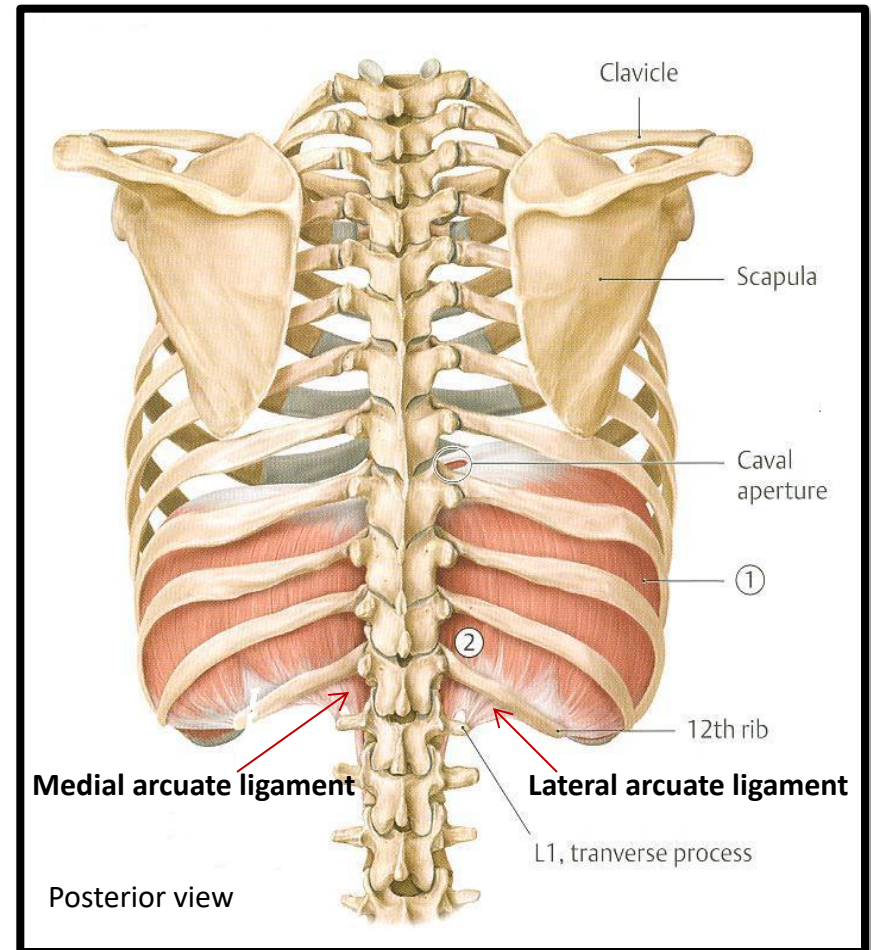
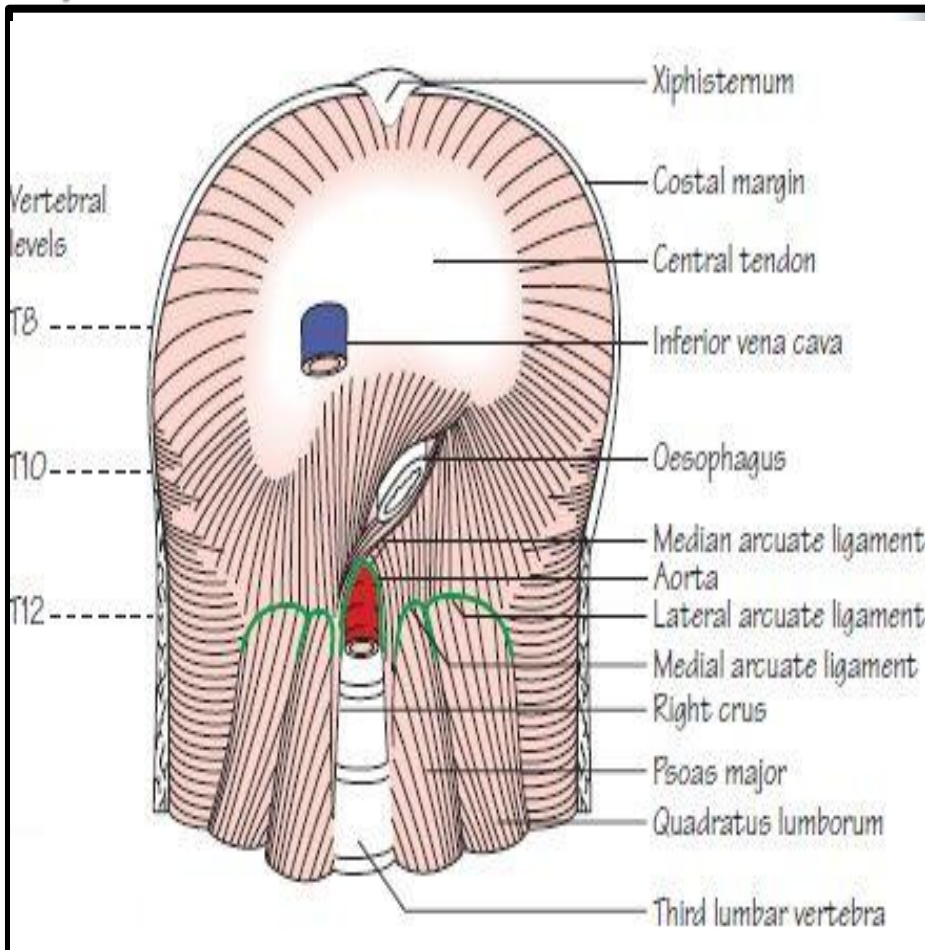
- ❑ Diaphragm (most important muscle)
- ❑ Rib elevators: external intercostal muscles
- ❑ Accessory muscles (only during forced inspiration) :
 1. Muscles attaching cervical vertebrae to first & second rib: **scalene muscles**
 2. Muscles attaching thoracic cage to upper limb: **pectoralis major.**
 3. **Sternocleidomastoid.**

ORIGIN OF DIAPHRAGM

1) Costal: lower 6 ribs and their costal cartilages

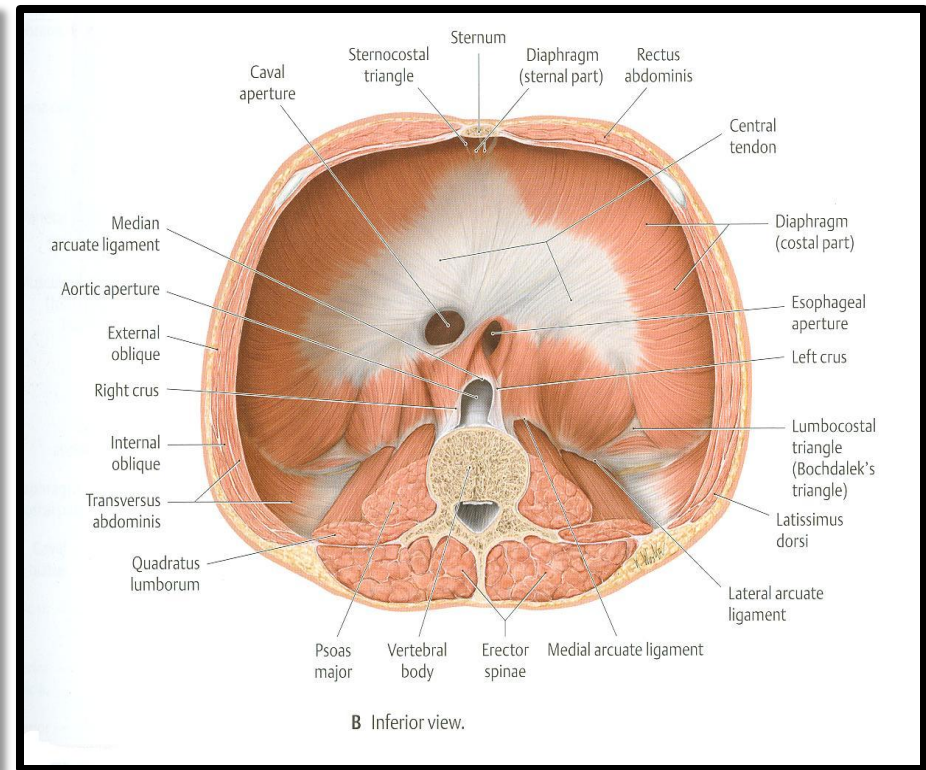
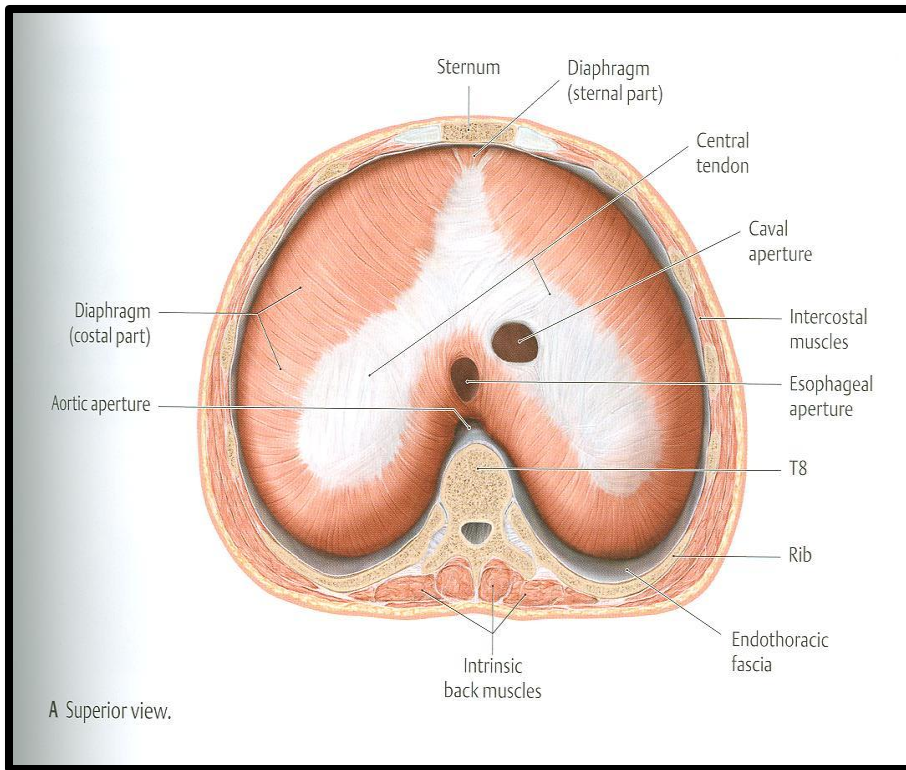
3) Sternal: xiphoid process of sternum

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



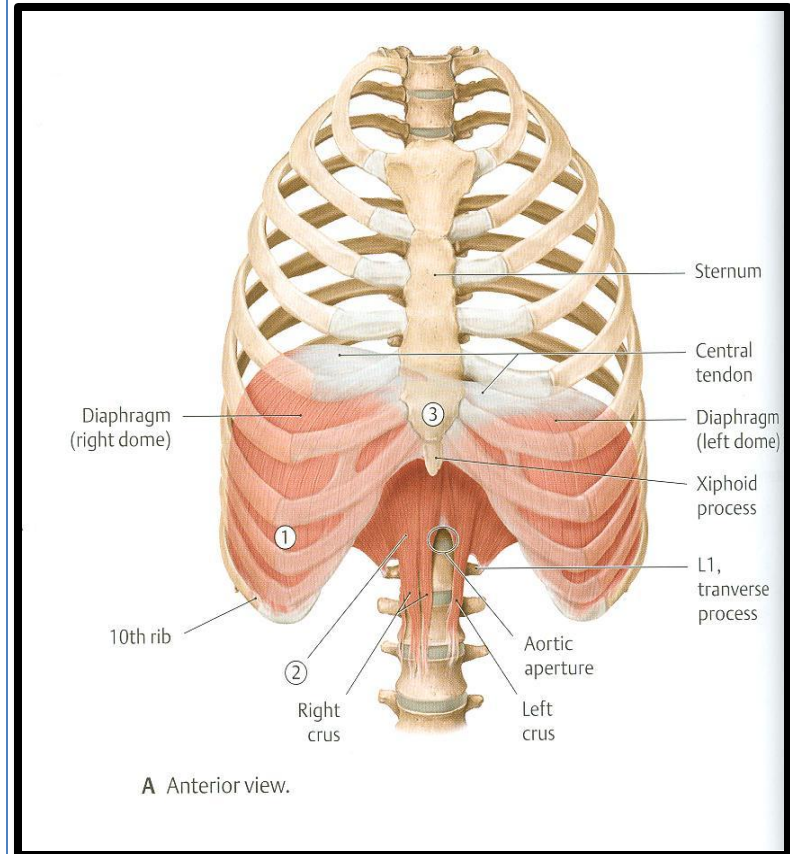
INSERTION OF DIAPHRAGM (CENTRAL TENDON)

➤ (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)

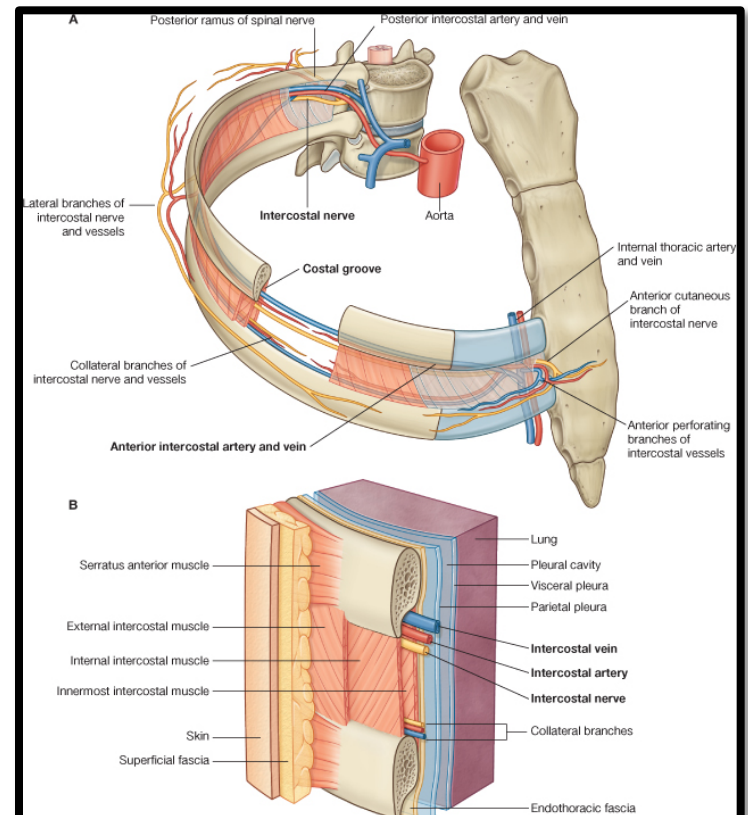
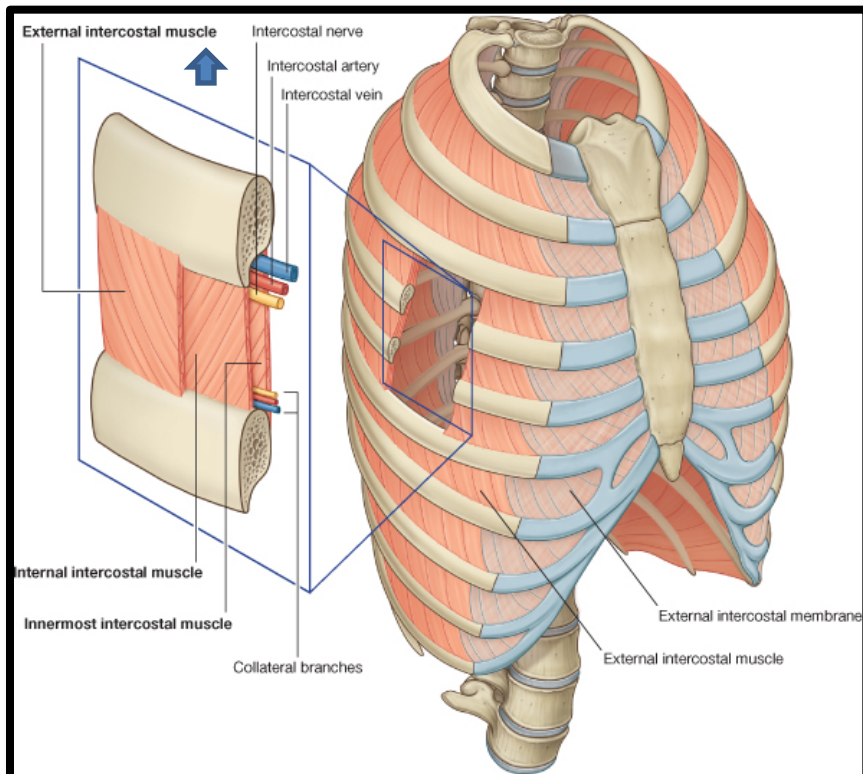


EXTERNAL INTERCOSTAL

(Inspiratory Muscle)

- **Attachments:** from lower border of rib above to upper border of rib below
- **Direction of fibers:** downward, forward & medially

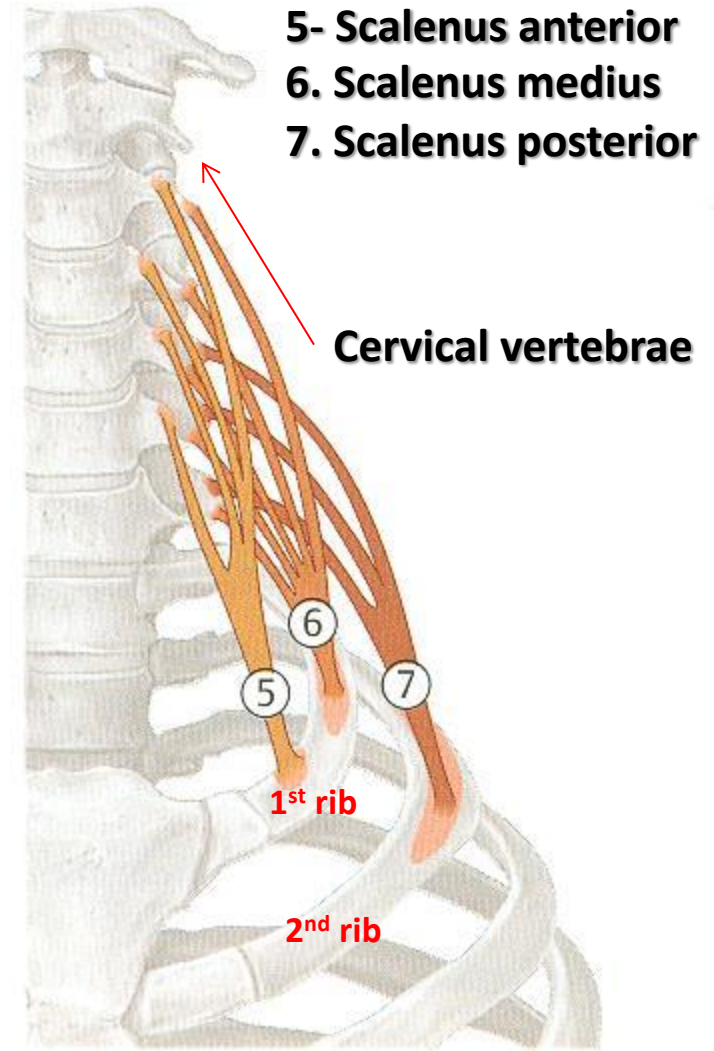
- **Nerve supply:** intercostal nerves
- **Action:** rib elevators (inspiratory)



SCALENE MUSCLES

(In Forced Inspiration)

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



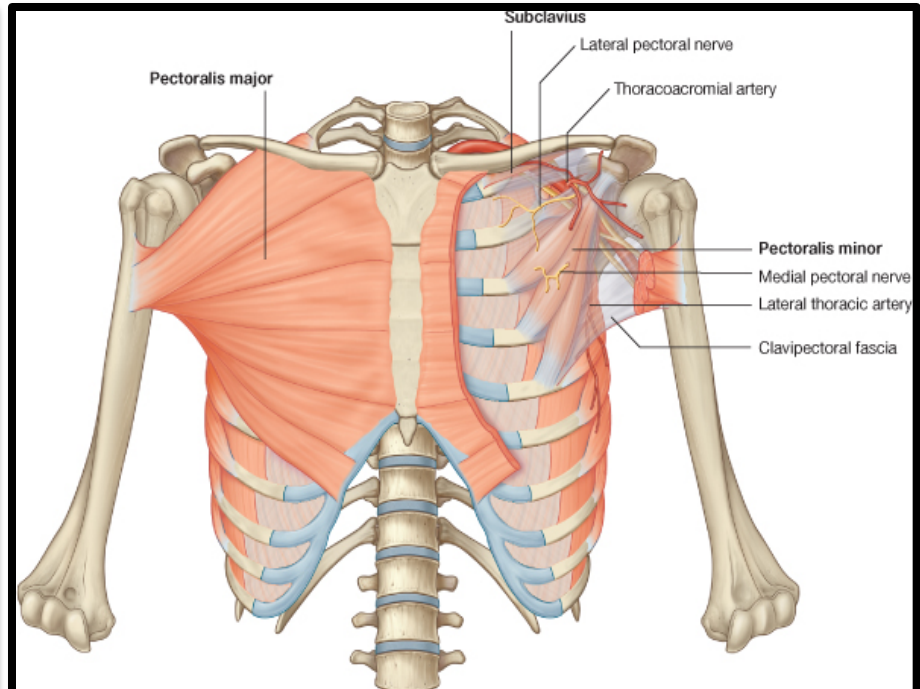
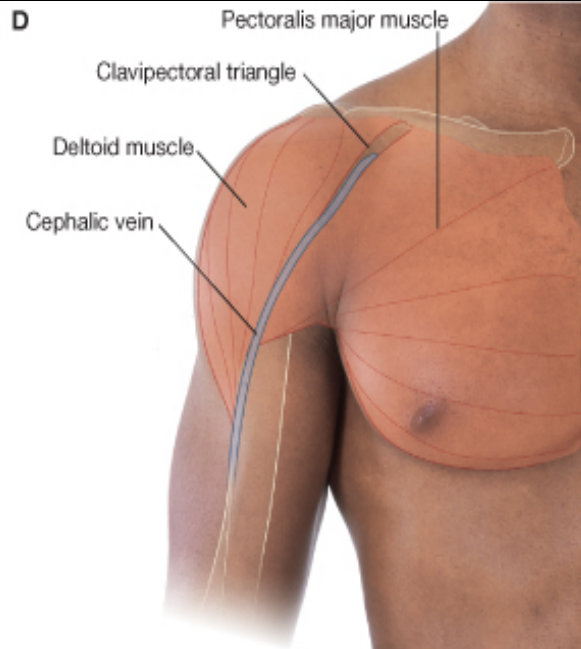
B Scalene muscles, anterior view.

PECTORALIS MAJOR

(In Forced Inspiration)

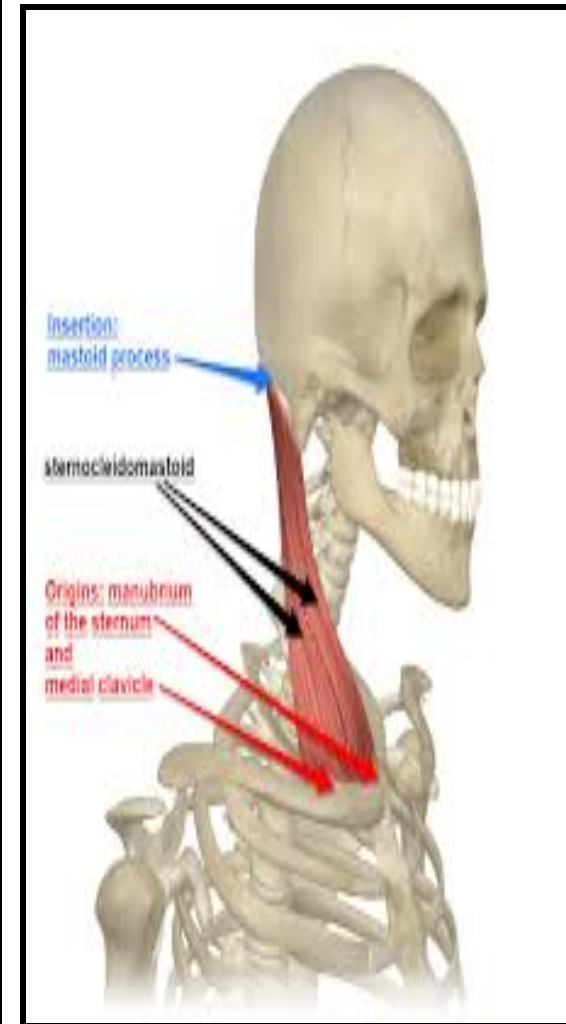
- **Origin:** sternum + costal cartilages
- **Insertion:** humerus

- **Action:** increases antero-posterior diameter of thoracic cavity, when arm is fixed (inspiratory)



Sternocleidomastoid

- **Origin:** Manubrium sterni and medial third of clavicle
- **Insertion:** Mastoid process of the temporal bone occipital bone
- **Action:** Elevation of the sternum and assists in forced inspiration+ two muscles flex the neck + one muscle rotates the head to the opposite side.



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

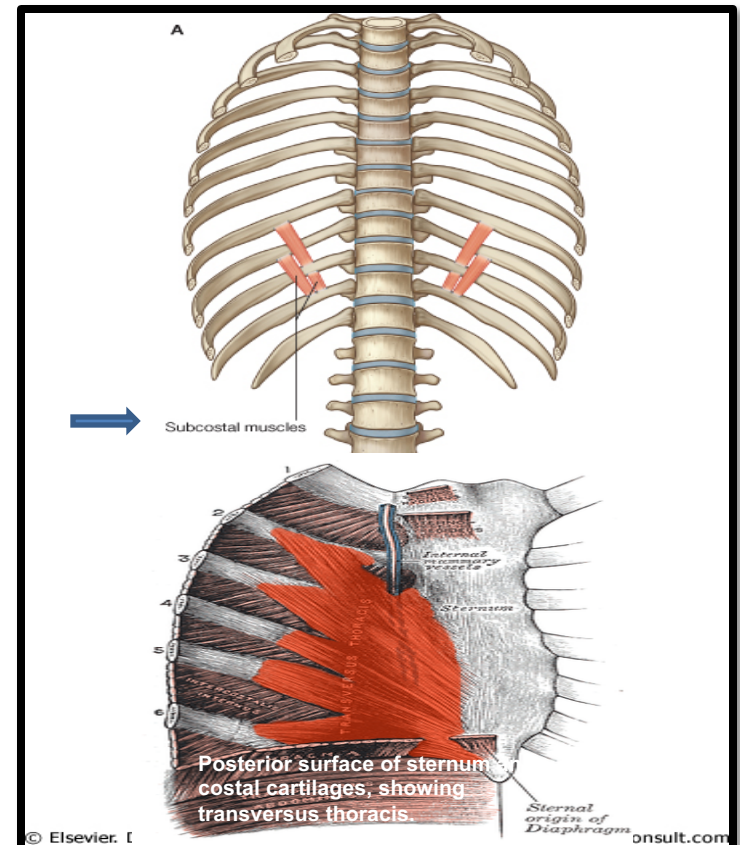
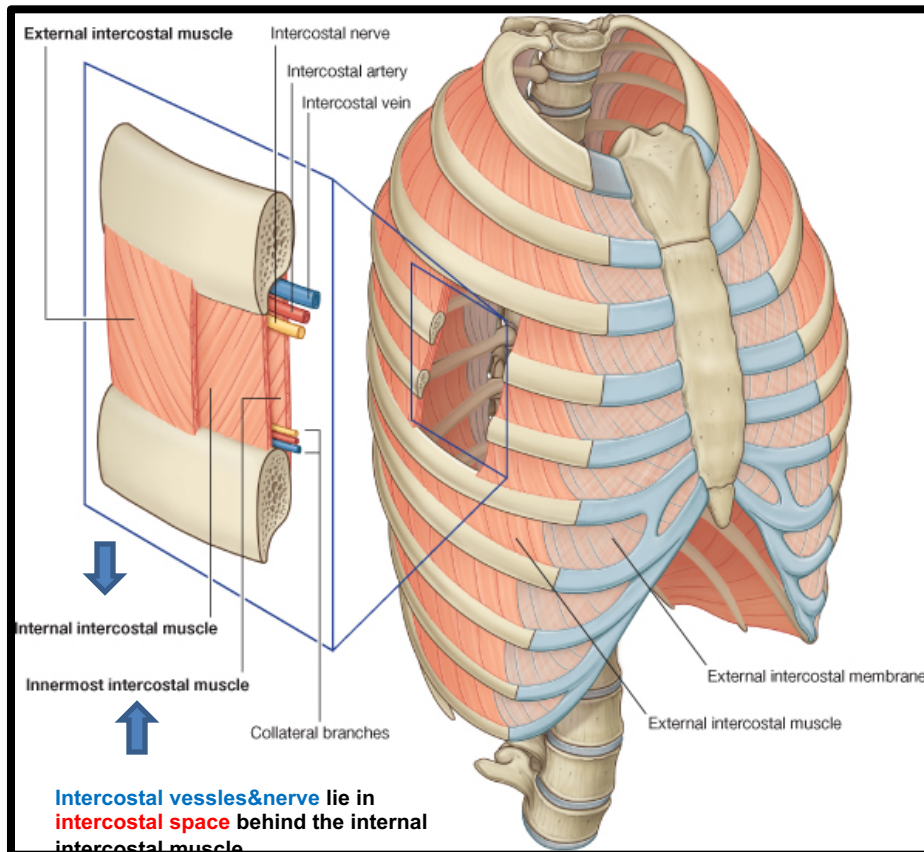
1. Internal intercostal
2. Innermost intercostal

Direction: downward, backward & laterally

3. Subcostal

4. Transversus thoracis

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

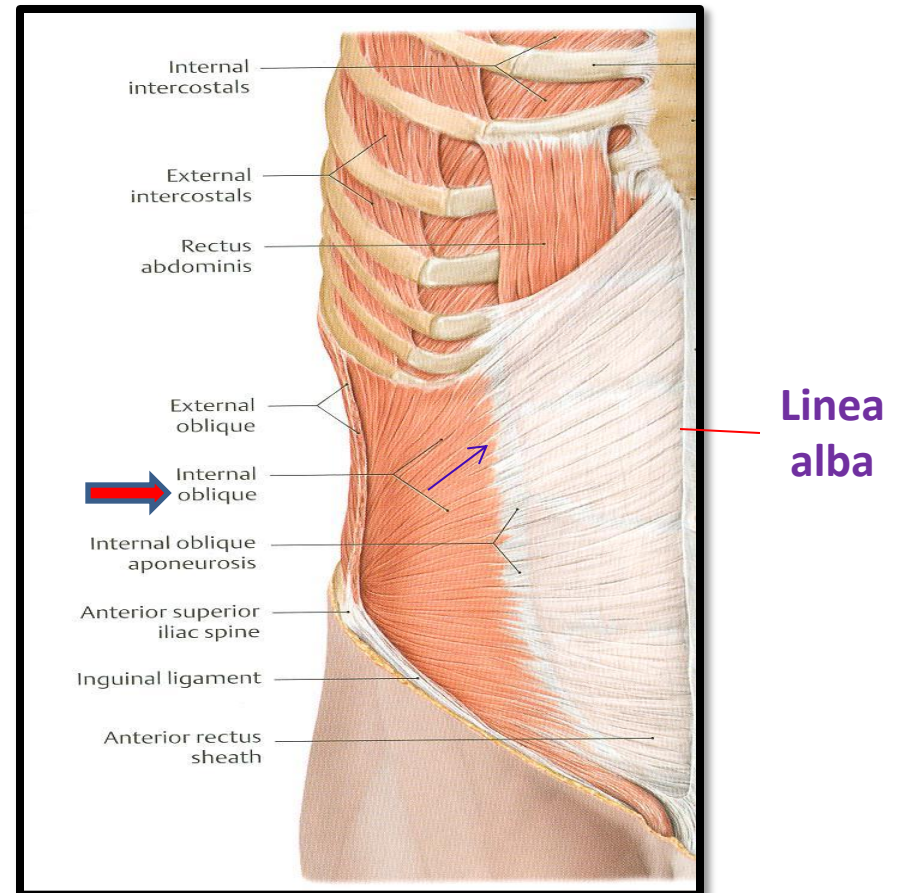
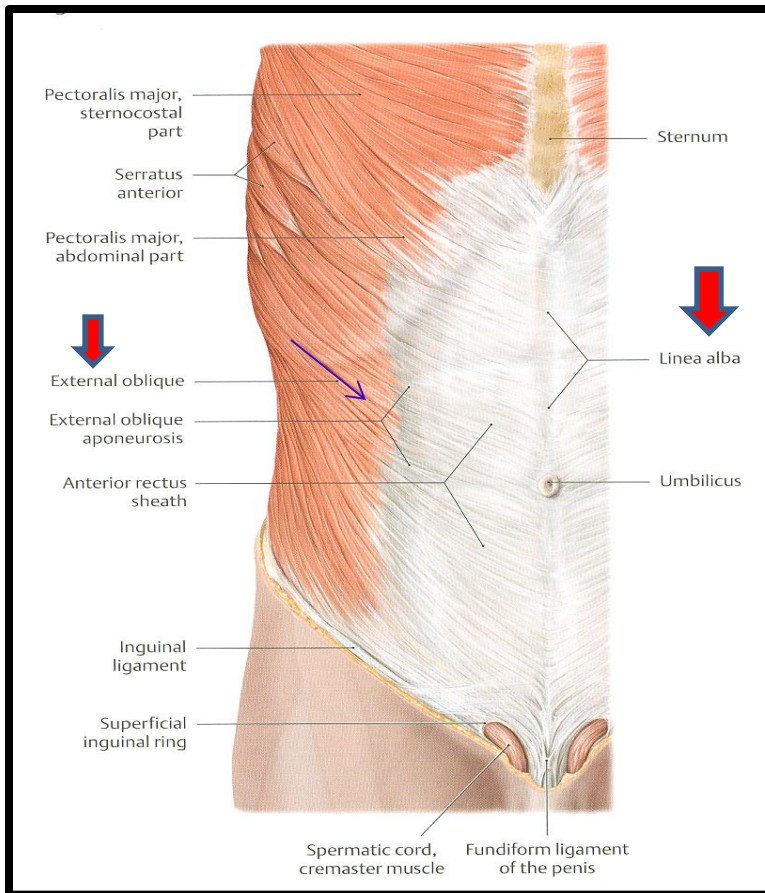


ANTERIOR ABDOMINAL WALL

External oblique (outer layer) Internal oblique (middle layer)

▪ **Direction:** downward & medially

▪ **Direction:** upward & medially



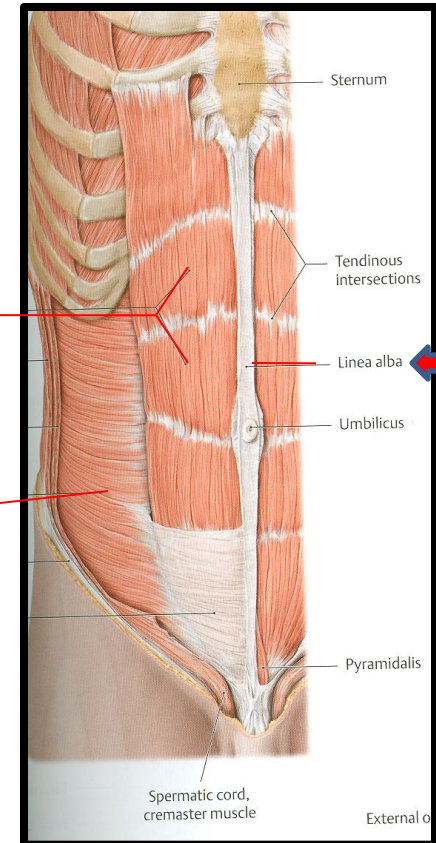
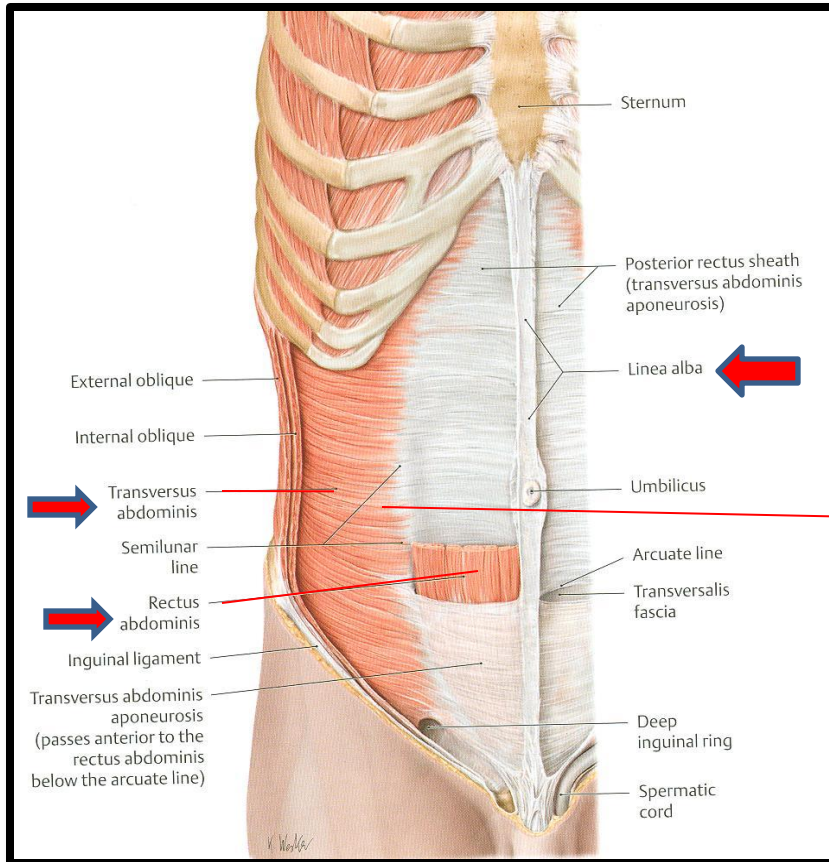
ANTERIOR ABDOMINAL WALL

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).