MUSCLES INVOLVED IN RESPIRATION

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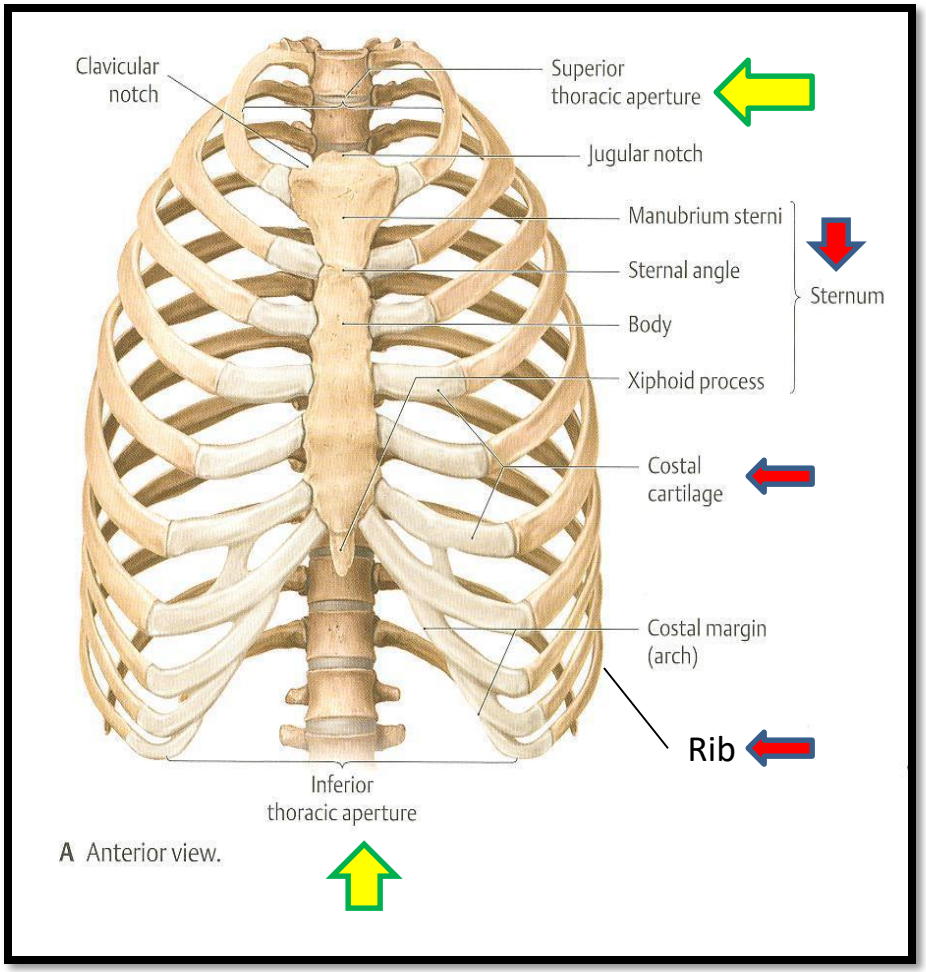
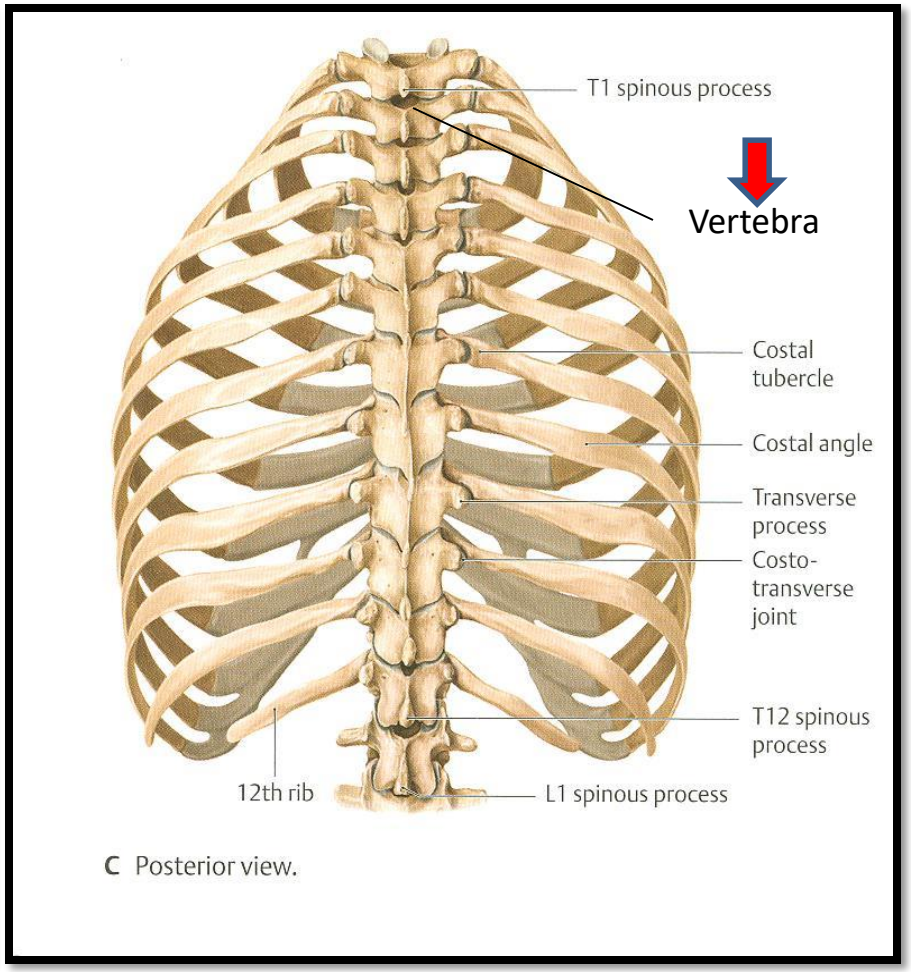
OBJECTIVES

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

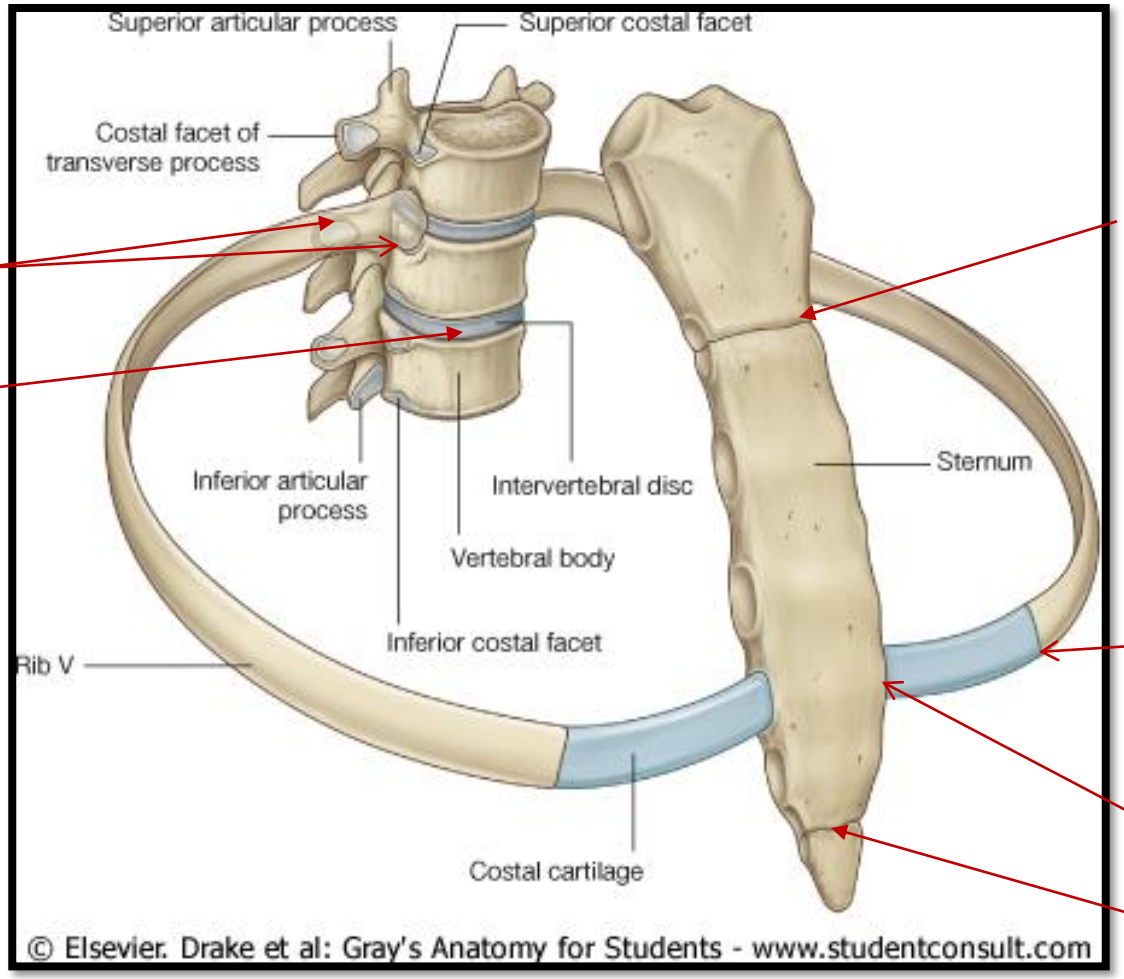
- **Conical** in shape
- Has 2 apertures (openings):

1. **Superior** ***(thoracic outlet):*** narrow, open, continuous with neck
2. **Inferior:** wide, closed by diaphragm

- Formed of:

1. **Sternum & costal cartilages:** ***anteriorly***
2. **Twelve pairs of ribs:** ***laterally***
3. **Twelve thoracic vertebrae:** ***posteriorly***

ARTICULATIONS



Costovertebral

Intervertebral disc

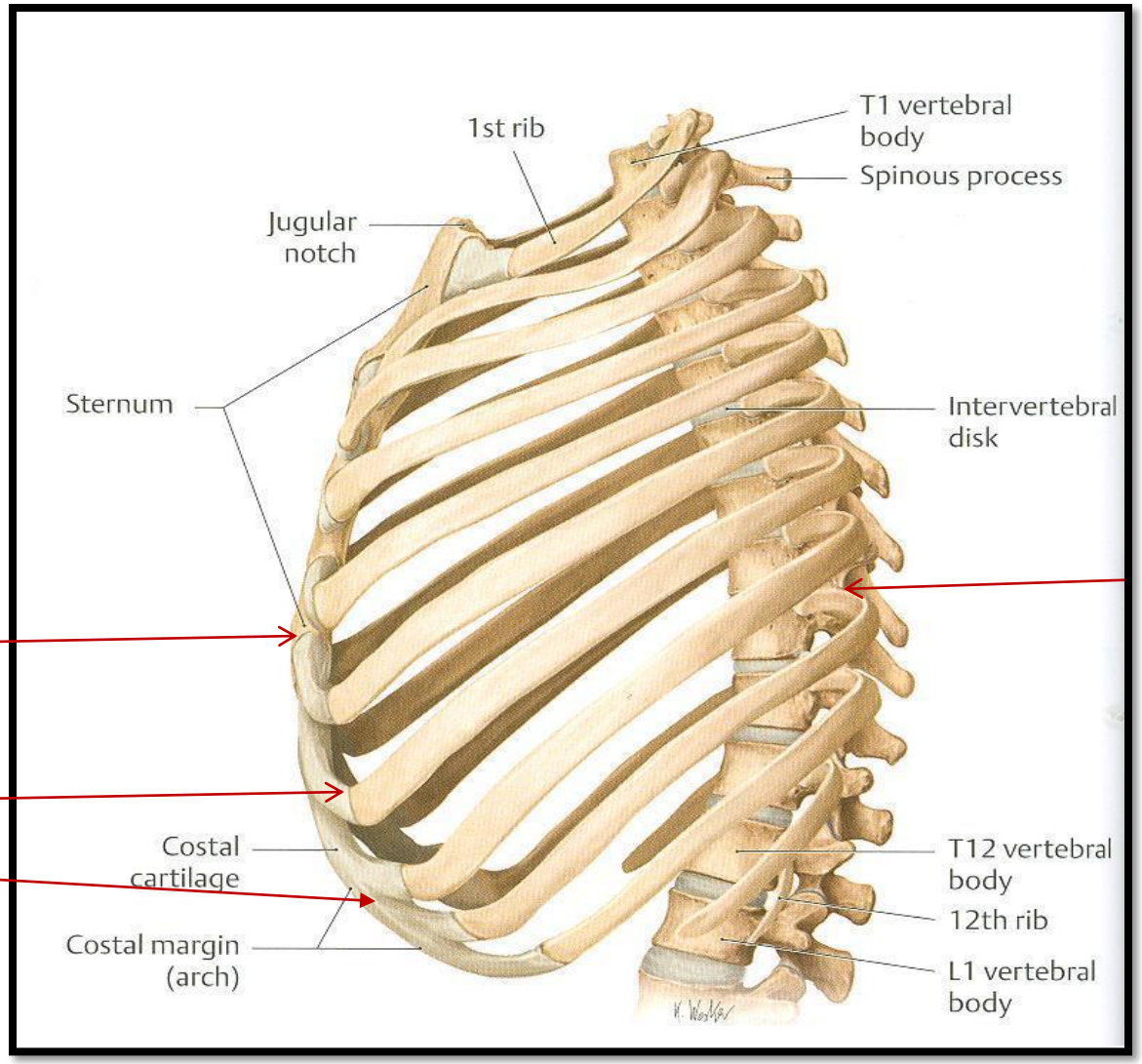
Manubriosternal

Costochondral

Sternocostal

Xiphisternal

ARTICULATIONS



Sternocostal

Costochondral

Interchondral

Costovertebral

ARTICULATIONS

- **Secondary cartilaginous:** Manubriosternal joint, Xiphisternal joint and Intervertebral discs.
- **Primary cartilaginous:** 1st Sternocostal joint, Costochondral joints and Interchondral joints.
- **Plane synovial joints:** Costovertebral joints and the rest of Sternocostal joints.

Complete Respiration and the 3D Diaphragm

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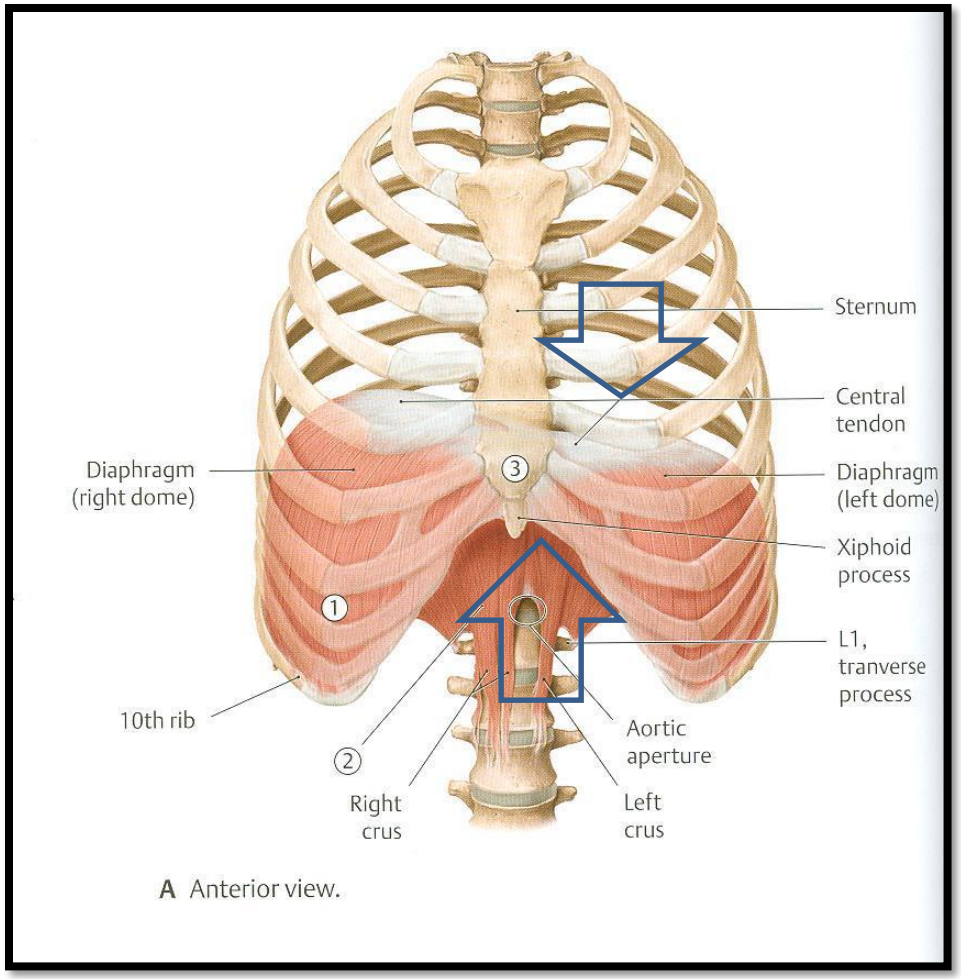
RESPIRATORY MOVEMENTS

A- MOVEMENTS OF DIAPHRAGM



A Anterior view.

Inspiration

Contraction (descent) of diaphragm

Increase of vertical diameter of thoracic cavity

Relaxation (ascent) of diaphragm)

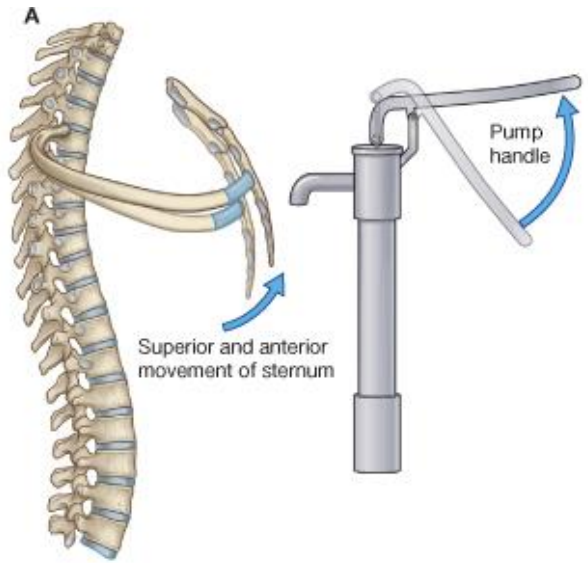
Expiration

RESPIRATORY MOVEMENTS
B- MOVEMENTS OF RIBS

PUMP HANDLE MOVEMENT

Elevation of ribs

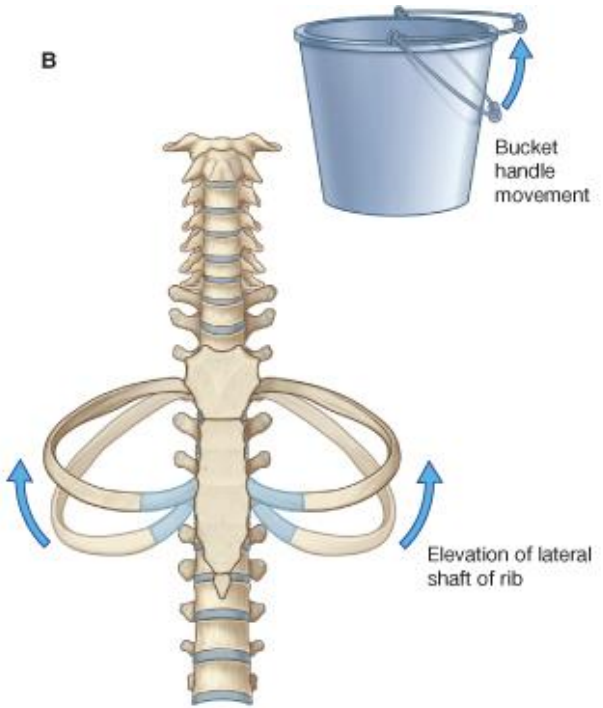
Increase in antero-posterior diameter of thoracic cavity



BUCKET HANDLE MOVEMENT

Elevation of ribs

Increase in lateral diameter of thoracic cavity



INSPIRATORY MUSCLES

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

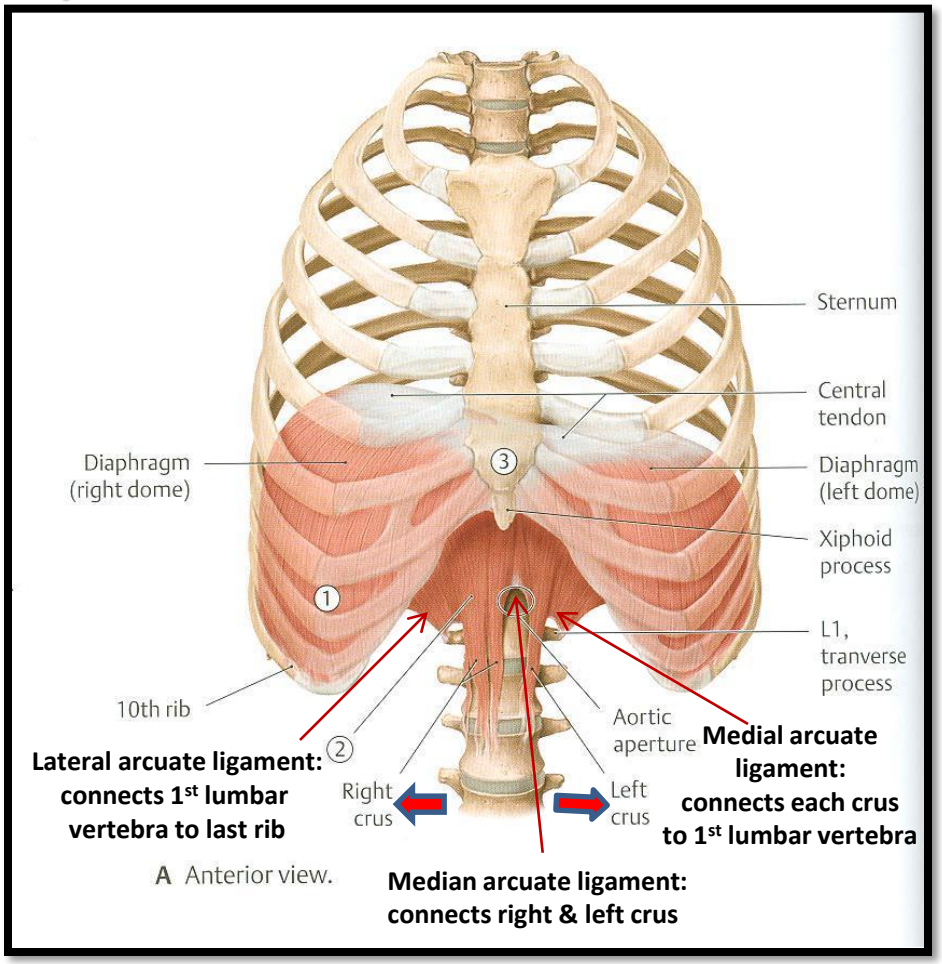
1. Muscles attaching cervical vertebrae to first & second rib: scalene muscles
2. Muscles attaching thoracic cage to upper limb: pectoralis major

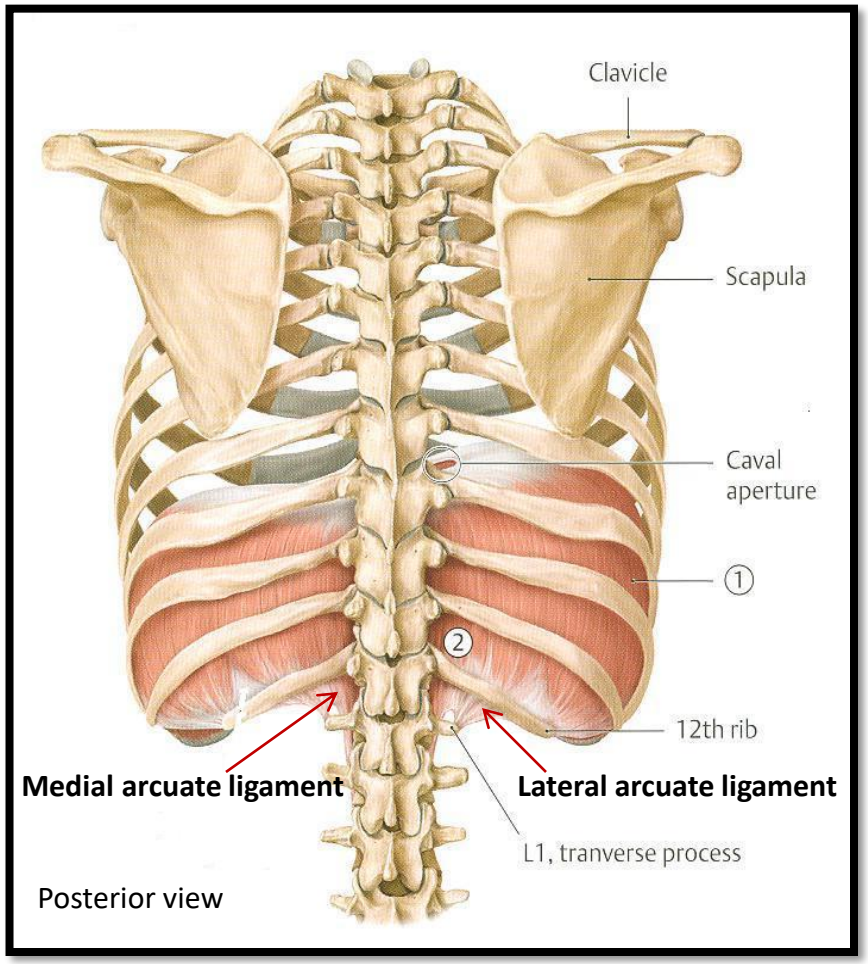
ORIGIN OF DIAPHRAGM

1) Costal: lower 6 costal cartilages

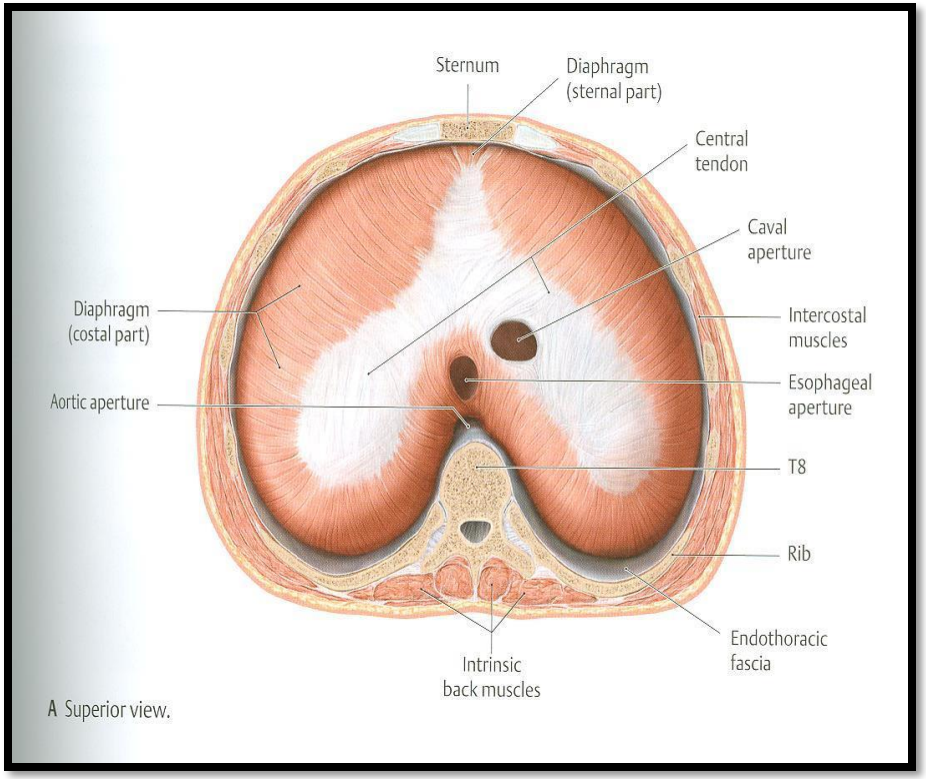
2) Vertebral: upper 3 lumbar vertebrae (right & left crus + arcuate ligaments)

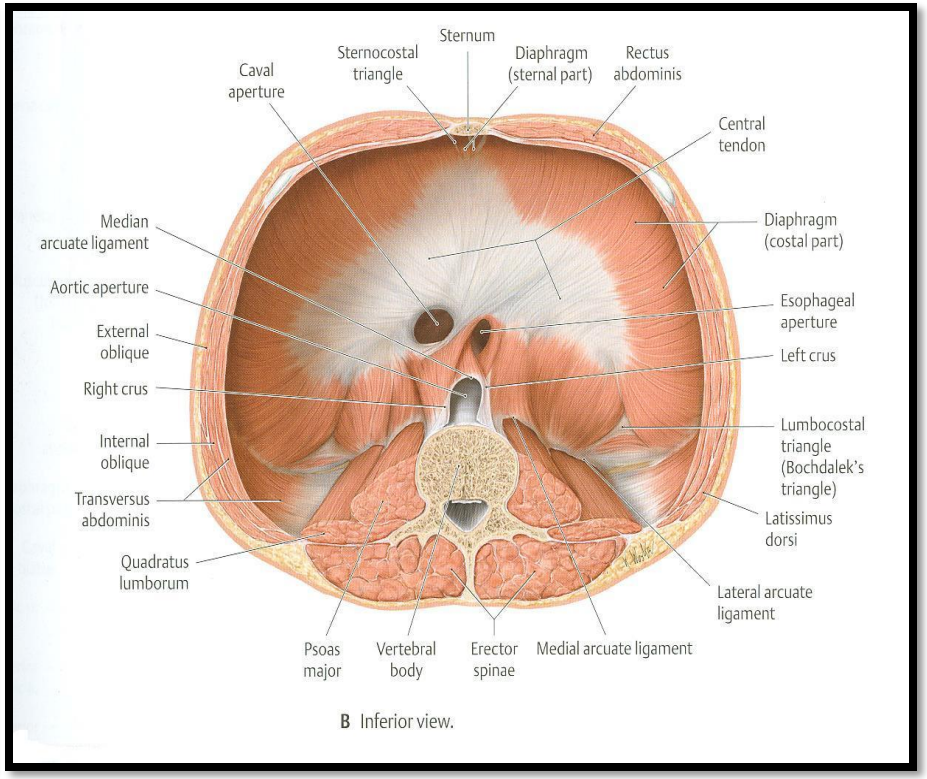
3) Sternal: xiphoid process of sternum





INSERTION OF DIAPHRAGM (CENTRAL TENDON)



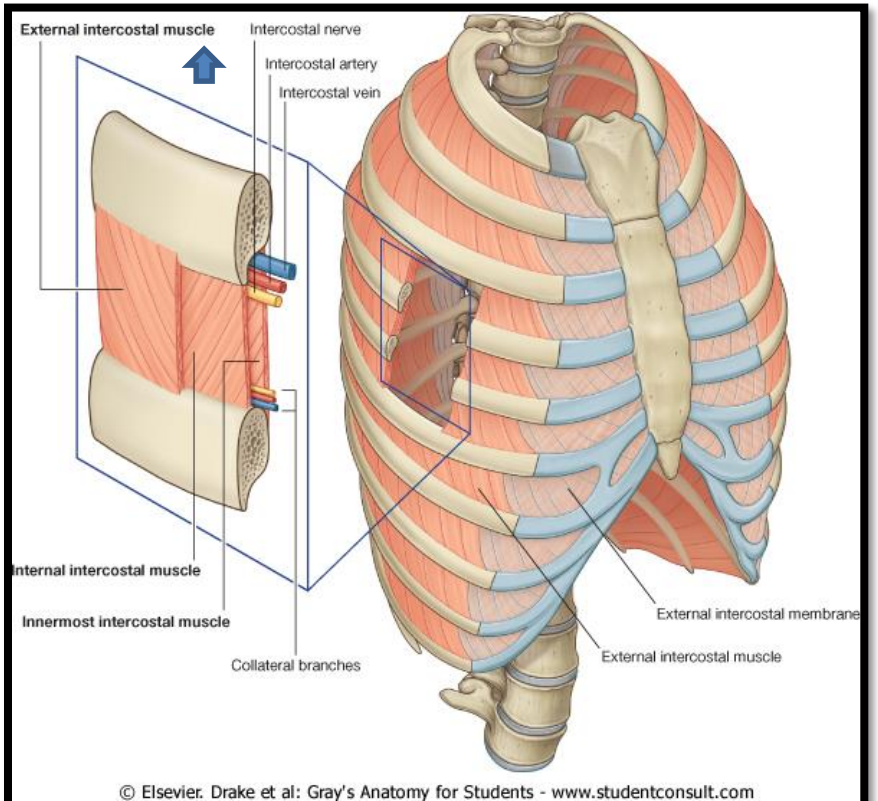


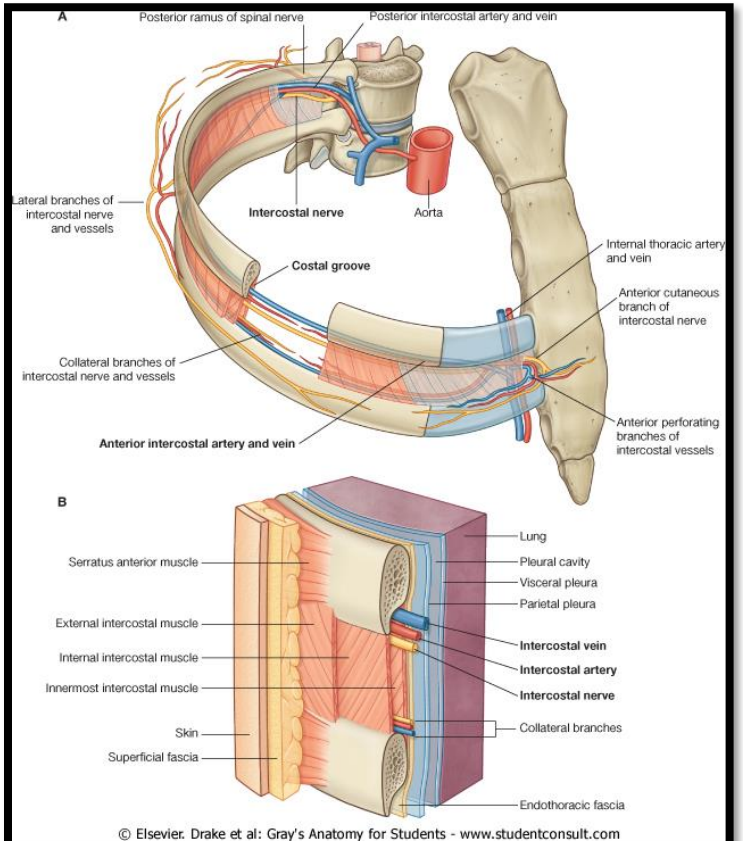
DIAPHRAGM

- **A musculotendinous partition** between thoracic & abdominal cavity.
- **Convex** toward thoracic & **concave** toward abdominal cavity.
- **Attached to:** sternum, costal cartilages, 12^{th} rib & lumbar vertebrae.
- Fibers converge to join 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

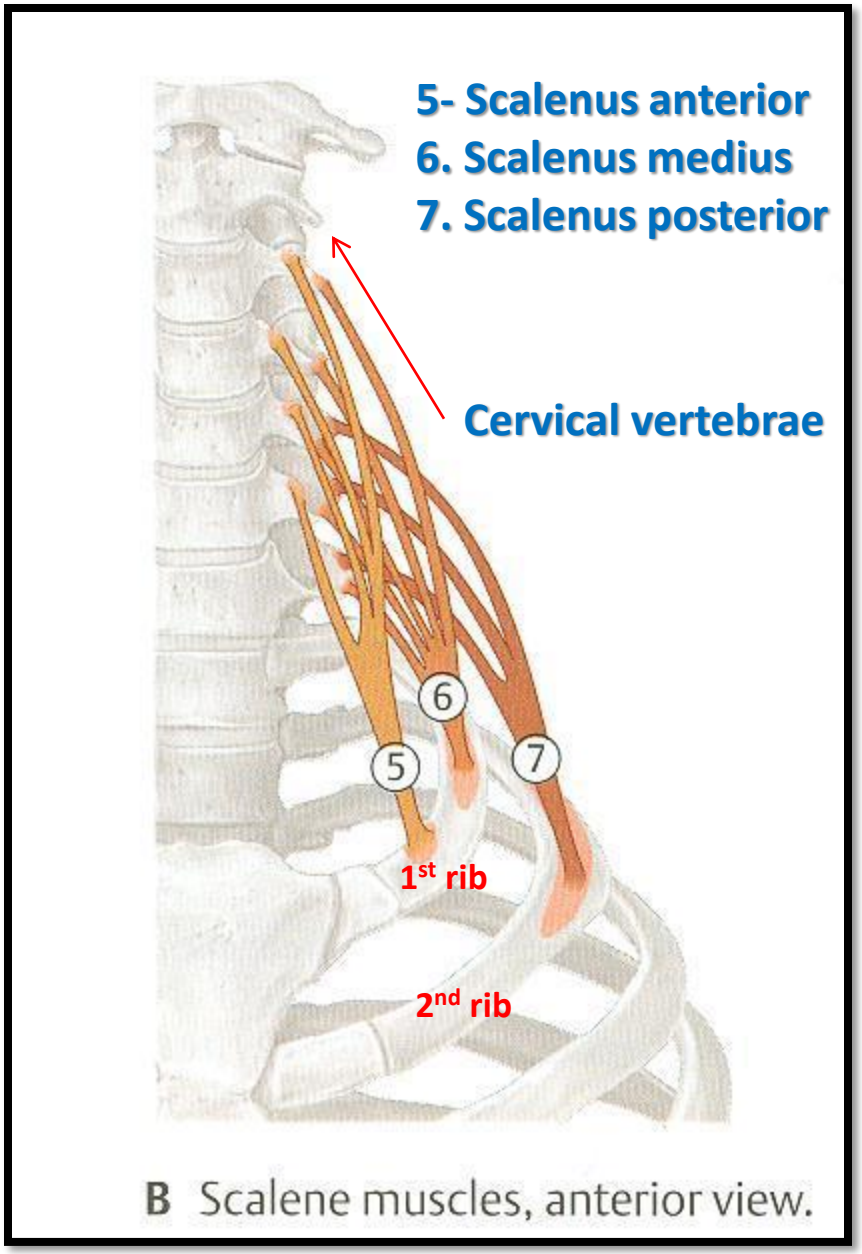
- **Attachments:** from lower border of rib above to upper border of rib below
- **Direction of fibers:** downward & medially
- **Nerve supply:** intercostal nerves
- **Action:** rib elevators (inspiratory)





SCALENE MUSCLES

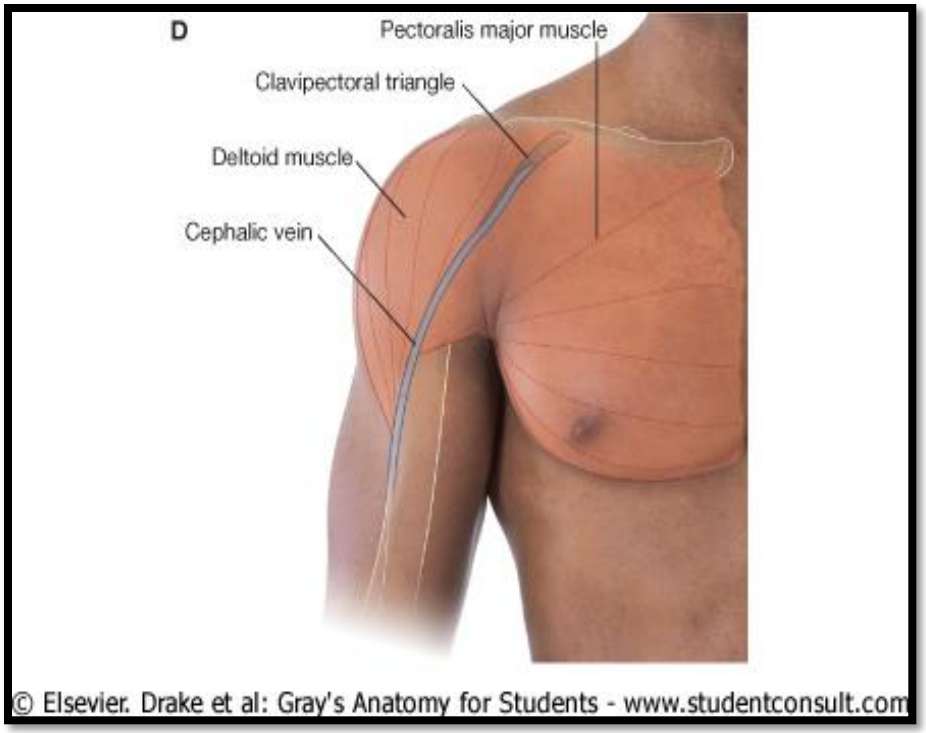
- **Origins:** cervical vertebrae
- **Insertions:** 1st rib (scalenus anterior and medius) & 2nd rib (scalenus posterior)
- **Action:** elevate 1st & 2nd ribs (inspiratory)

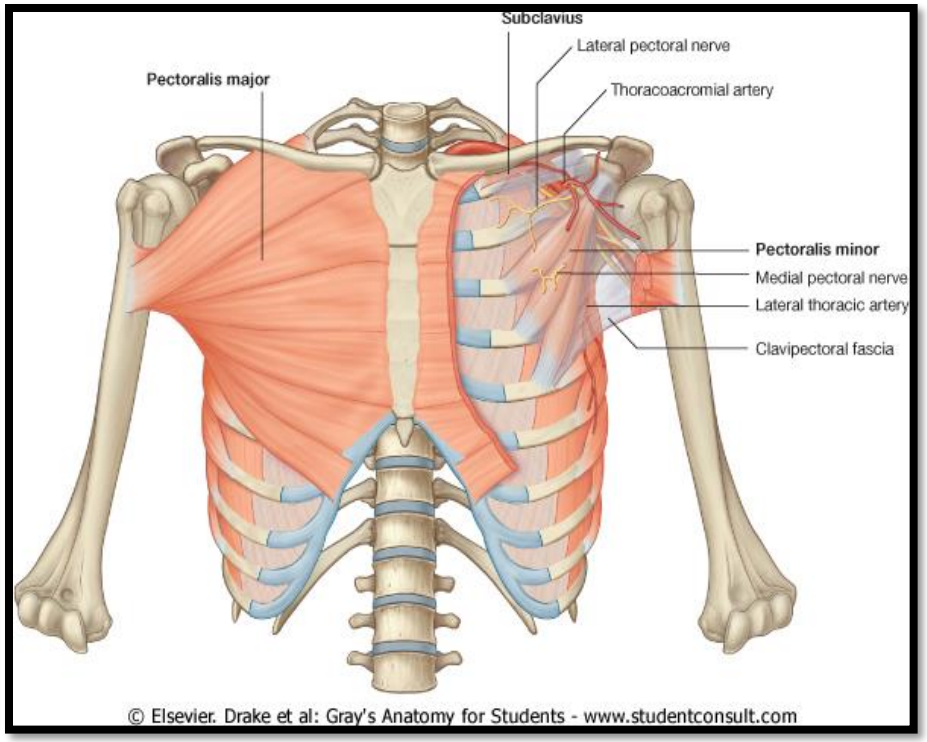


B Scalene muscles, anterior view.

PECTORALIS MAJOR

- **Origin:** clavicle + 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:**

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

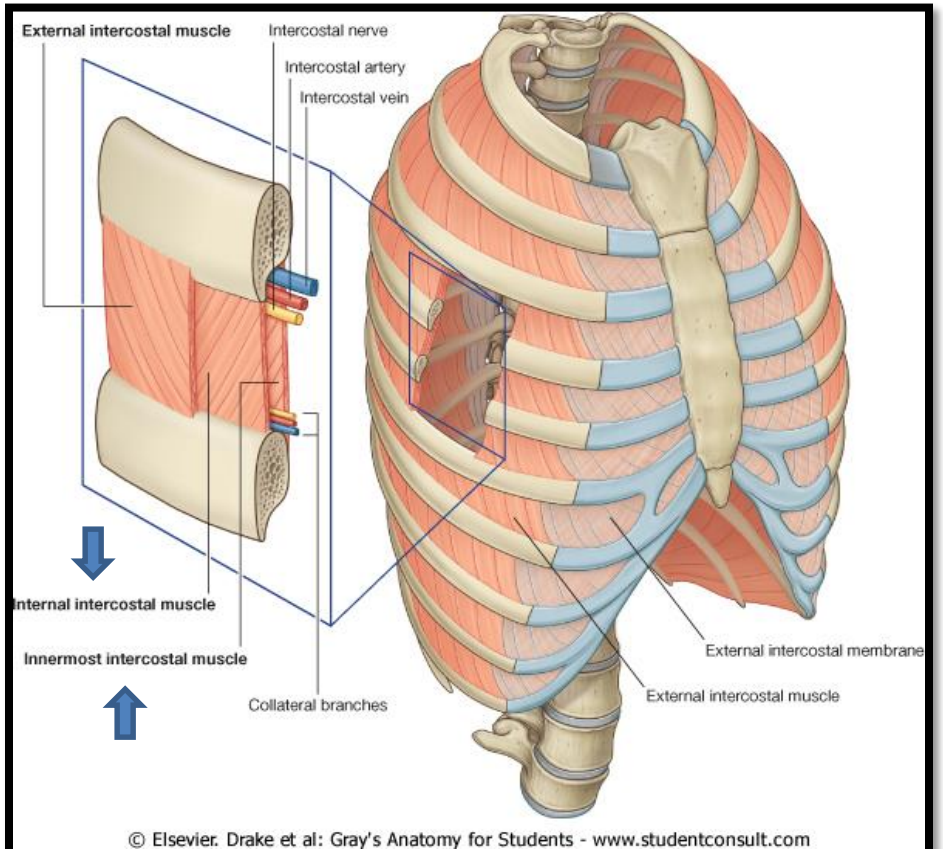
RIB DEPRESSORS: REST OF INTERCOSTAL MUSCLES

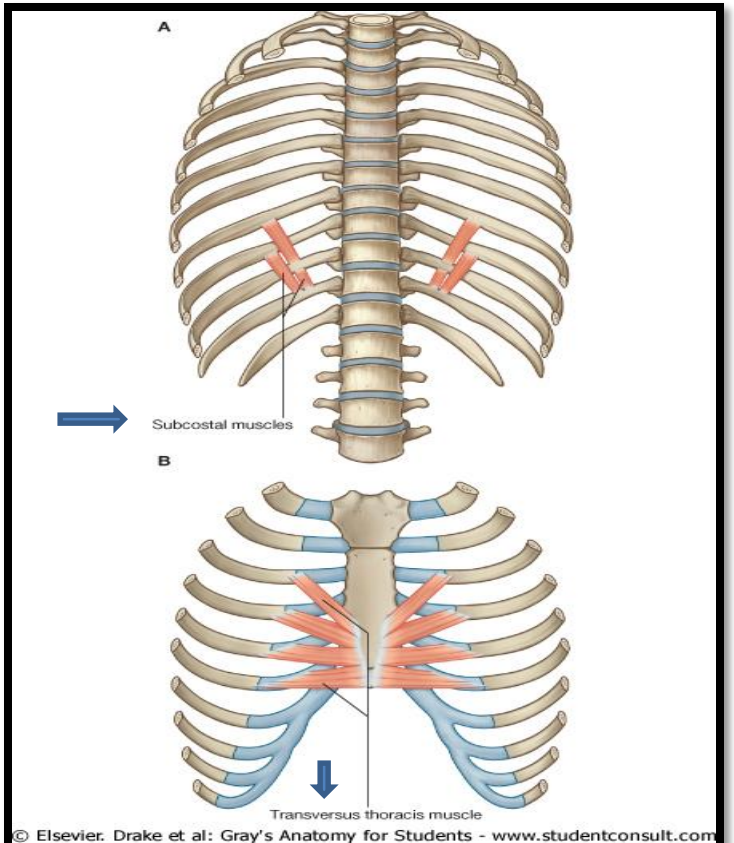
1. Internal intercostal
2. Innermost intercostal

Direction: backward & laterally

3. Subcostal
4. Transversus thoracis

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

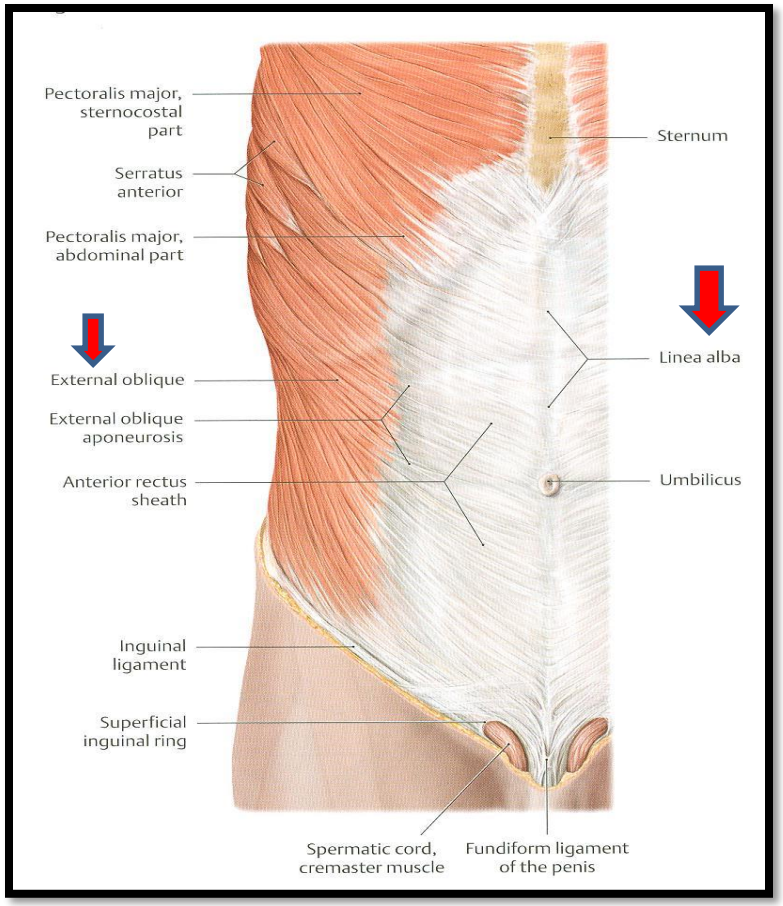




ANTERIOR ABDOMINAL WALL

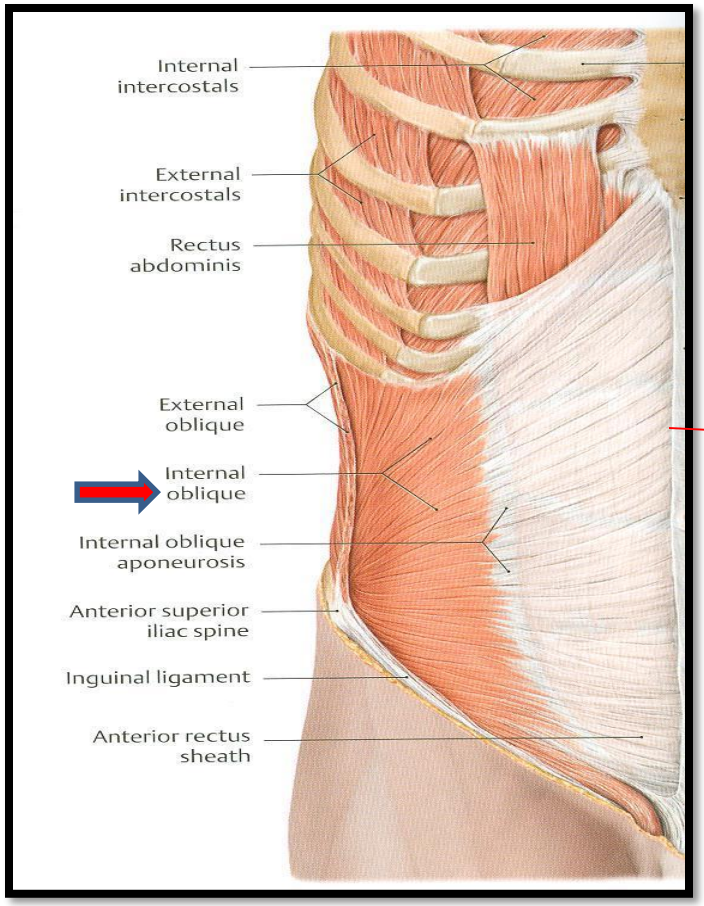
External oblique (outer layer)

- **Direction:** downward & medially



Internal oblique (middle layer)

- **Direction:** upward & medially



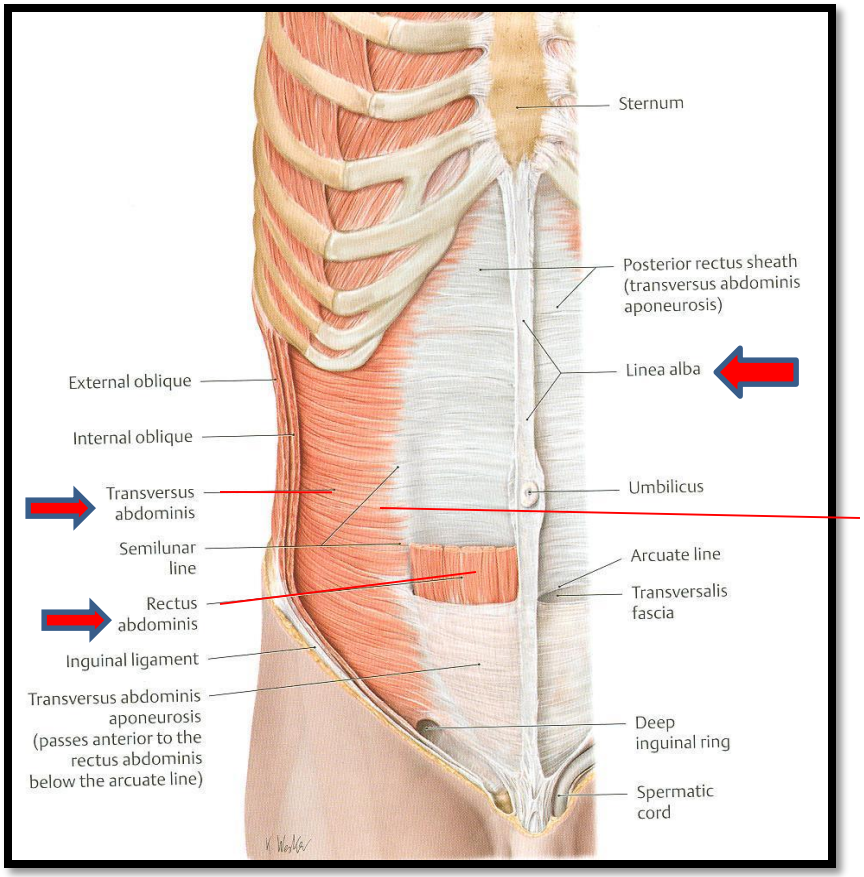
ANTERIOR ABDOMINAL WALL

Transversus abdominis (inner layer)

- **Direction:** transverse

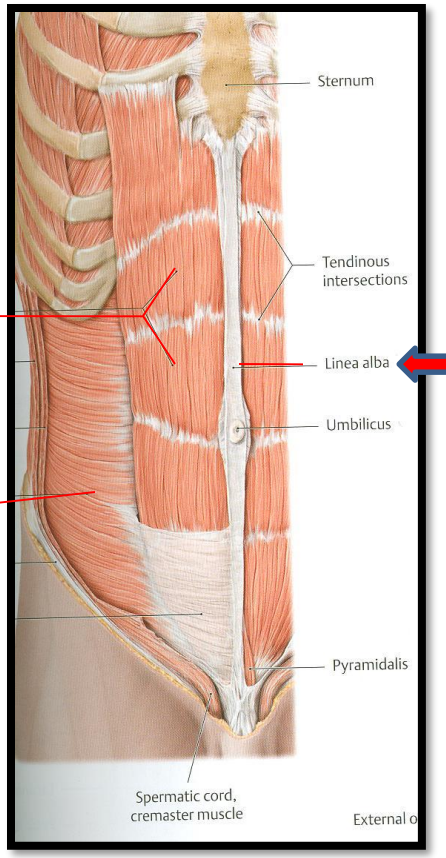
Rectus abdominis

- **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 muscles 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 (during forced expiration)
- Nerve supply: lower 5 intercostal nerves (T7 – T11), subcostal nerve (T12) and first lumbar nerve.

SUMMARY OF RESPIRATORY MOVEMENTS

Inspiration

- **Quiet Inspiration (active)**

Contraction (Descent) of diaphragm

Increase in **vertical** diameter

Elevation of ribs (external intercostal)

Increase in:
- **anteroposterior** diameter
- **lateral** diameter

- **Forced Inspiration (active)**

Accessory muscles of inspiration:
1. Pectoralis major
2. Scalene muscles

Expiration

- **Quiet Expiration (passive)**

1. Elastic recoil of lung
2. Relaxation of diaphragm & external intercostal

- **Forced Expiration (active):**

Contraction of anterior abdominal wall muscles

Compression of abdominal viscera

Ascent of diaphragm

Depression of ribs (rest of intercostal muscles)

QUESTIONS

- **Are the following muscles have a respiratory role? If yes, what is it?**

1. **Levatores costarum.**
2. **Serratus posterior superior.**
3. **Serratus posterior inferior.**
4. **Pectoralis minor.**
5. **Serratus anterior.**
6. **Latissimus dorsi.**
7. **Quadratus lumborum.**

- **Why diaphragm is supplied by cervical nerves?**
- **Why right crus of diaphragm is larger than left crus?**


THANK YOU