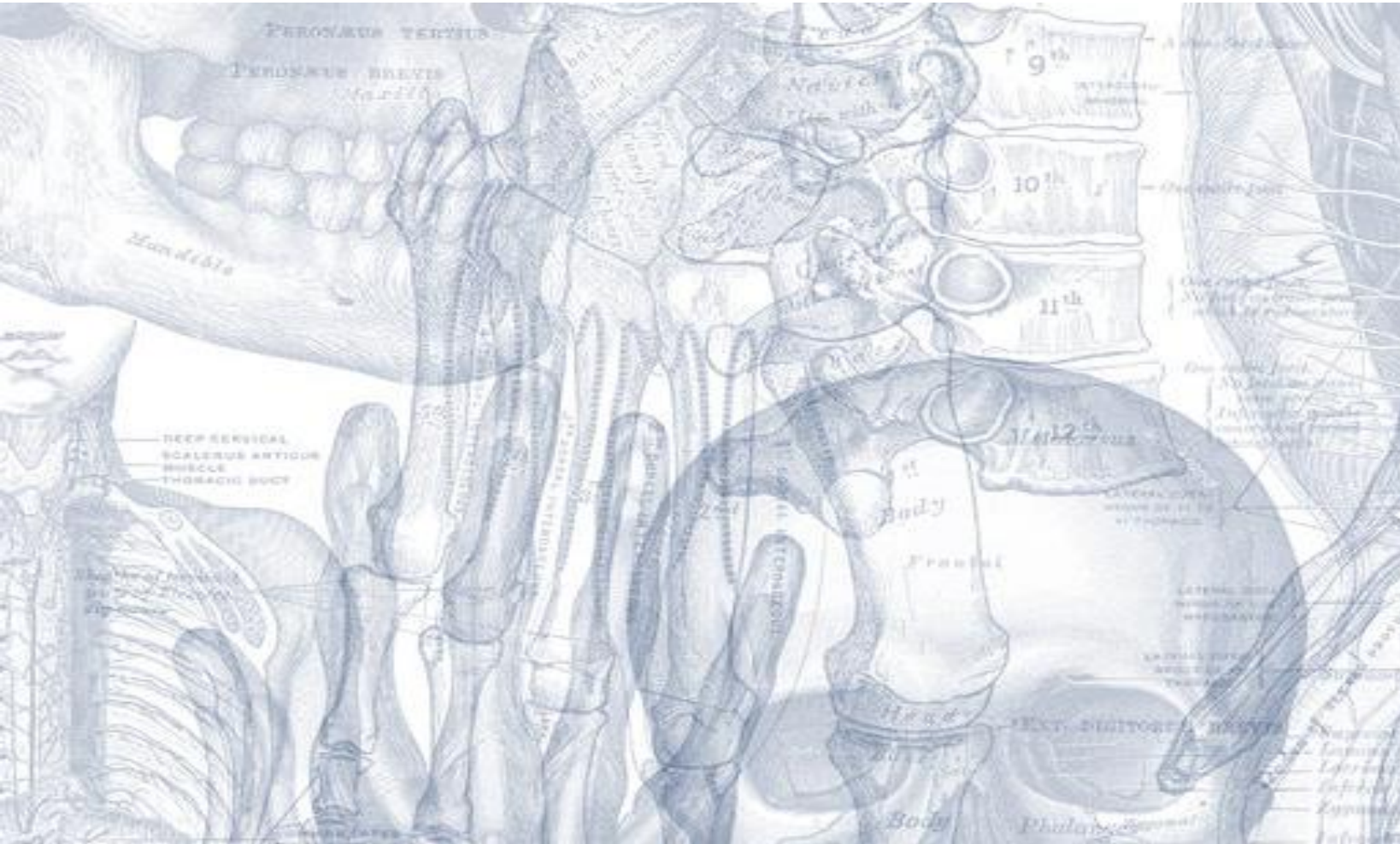


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



# Muscles involved in Respiration

Please view our [Editing File](#) before studying this lecture to check for any changes.

## Color Code

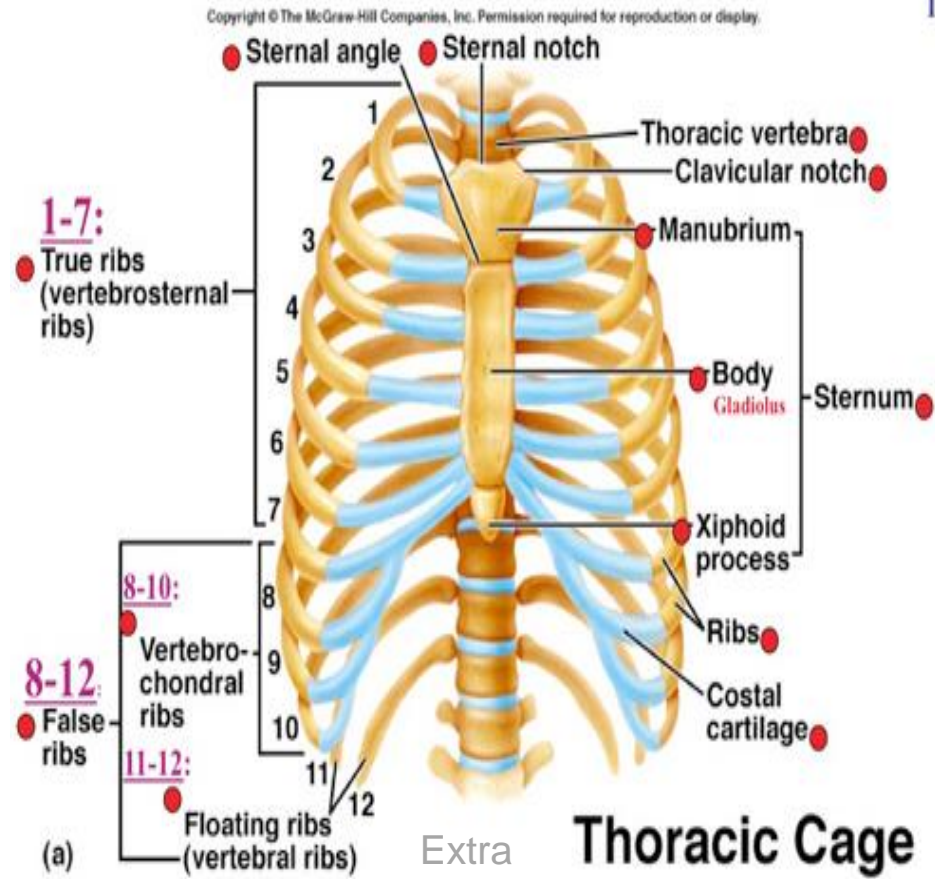
- **Important**
- **Doctors Notes**
- **Notes/Extra explanation**

## *Objectives:*

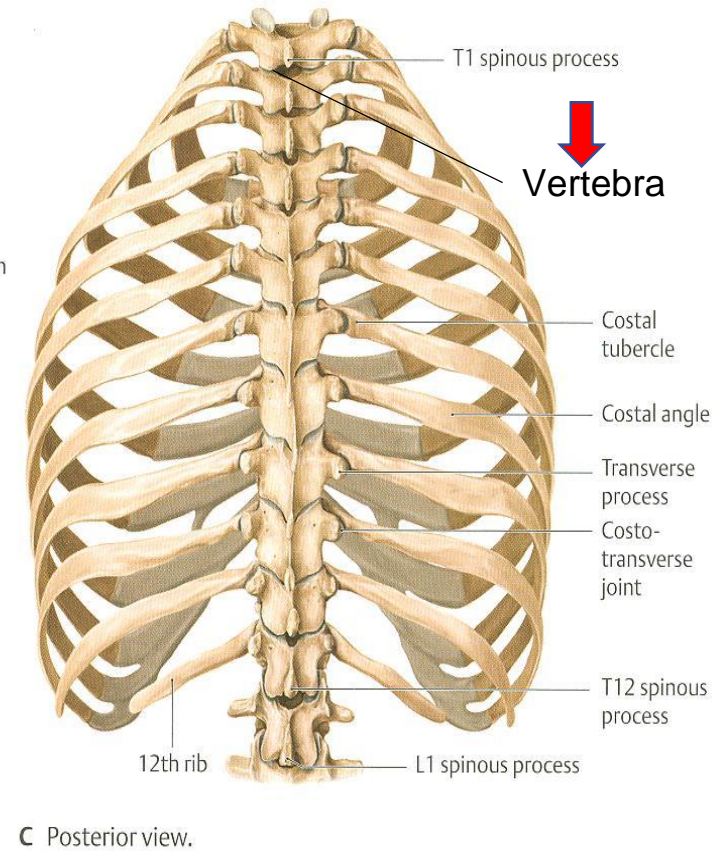
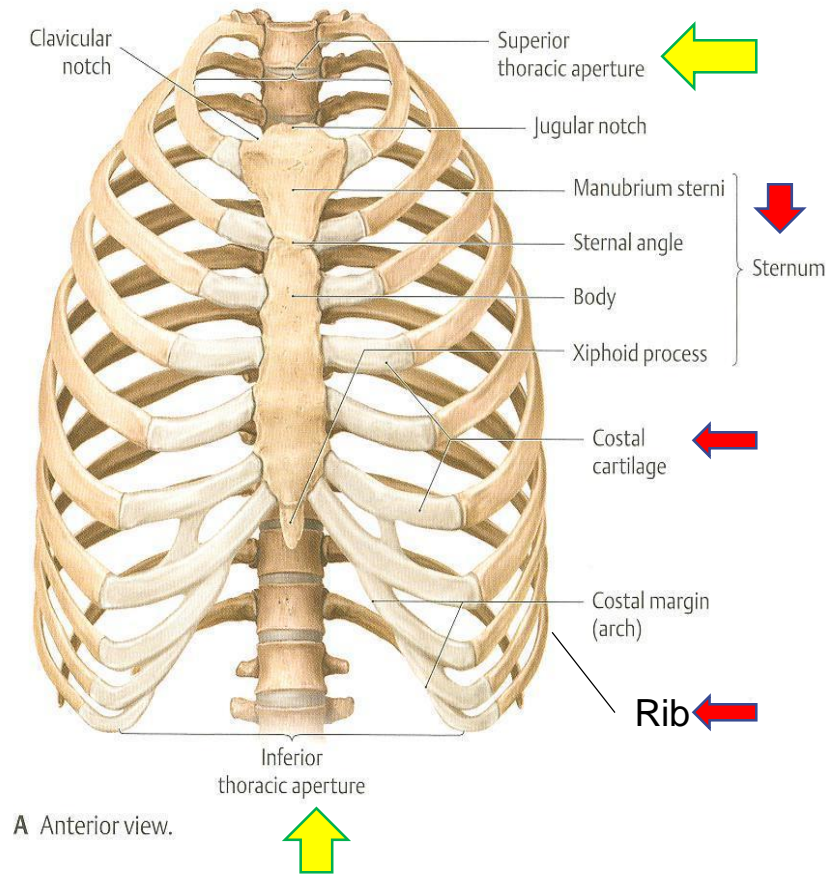
- ✓ Describe the **components** of the thoracic cage and their **articulations**.
- ✓ Describe in brief the respiratory movements.
- ✓ List the **muscles** involved in **inspiration** and in **expiration**.
- ✓ Describe the **attachments of each muscle** to the thoracic cage and its **nerve supply**.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



# Thoracic Cage

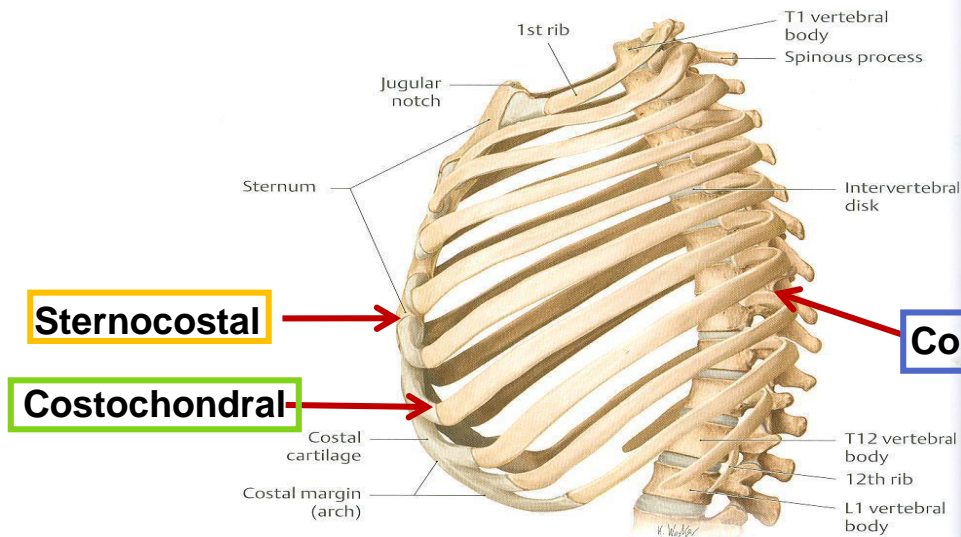


11



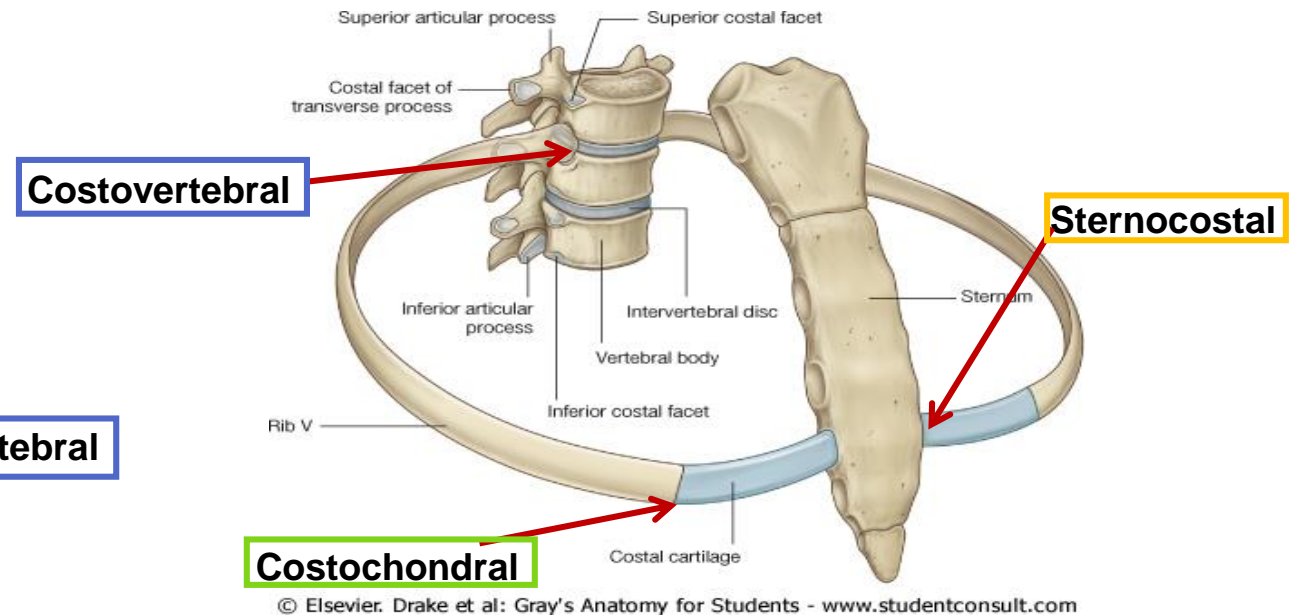
# Thoracic Cage

- Conical (مخروطي) 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

1. **Costochondral** (cartilaginous joint) is an articulation between the ribs and the costal cartilage.
2. **Sternocostal** (1<sup>st</sup> cartilage with manubrium by primary cartilaginous joint/ 2<sup>nd</sup> to 7<sup>th</sup> cartilages with sternum by synovial joint) is an articulation between the true ribs and the sternum.
3. **Costovertebral** (plane synovial joint) is an articulation between the thoracic vertebrae and the heads of ribs.





# Thoracic Cage

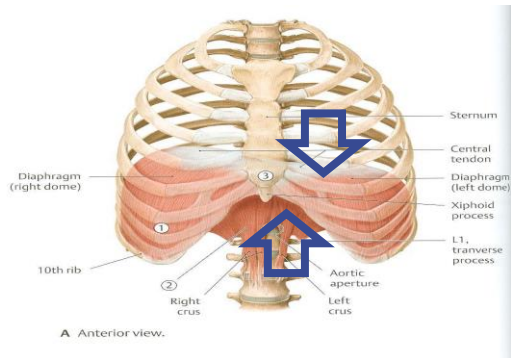
## Respiratory Movements

### A- MOVEMENTS OF DIAPHRAGM

#### Inspiration:

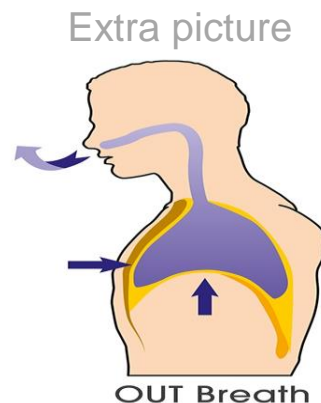
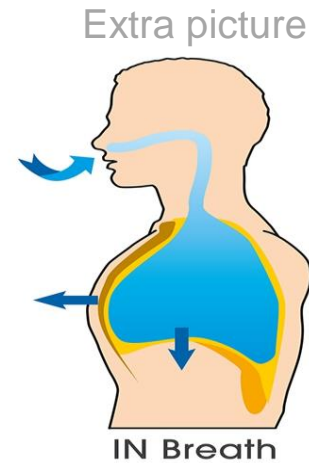
Contraction (descent) ↓ of diaphragm

Increase of **vertical diameter** of thoracic cavity



#### Expiration:

Relaxation (ascent) ↑ of diaphragm



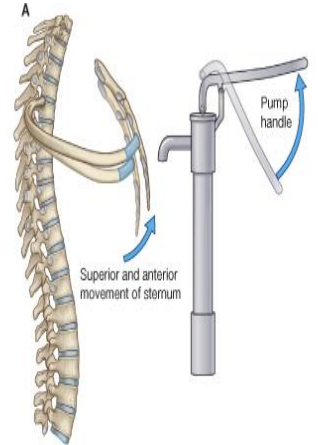
### B- MOVEMENTS OF RIBS (In Normal Inspiration)

#### 1-PUMP HANDLE MOVEMENT:

Elevation of ribs



Increase in **antero-posterior** diameter of thoracic cavity



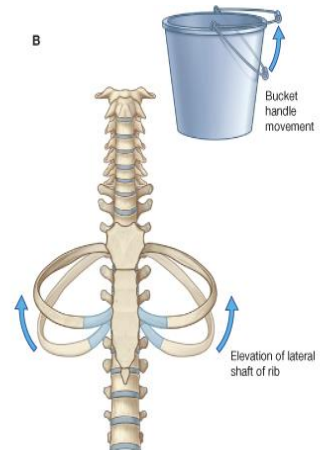
© Elsevier. Drake et al: Gray's Anatomy for Students - www.studentconsult.com

#### 2-BUCKET HANDLE MOVEMENT:

Elevation of ribs



Increase in **lateral (transverse)** diameter of thoracic cavity



© Elsevier. Drake et al: Gray's Anatomy for Students - www.studentconsult.com

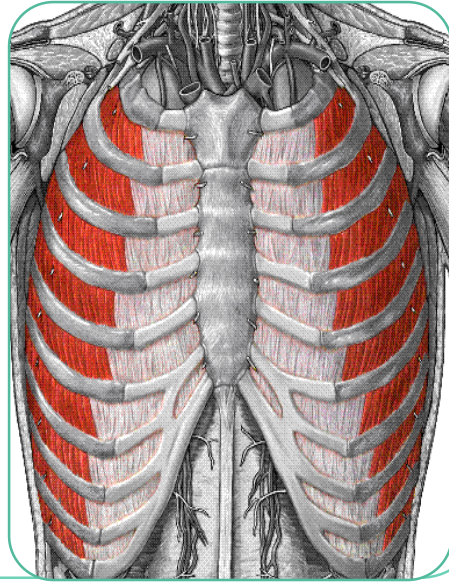
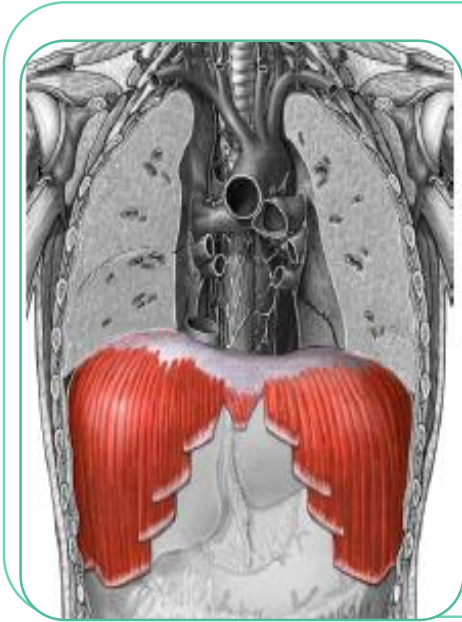
#Watch this helpful videos: (very short)

<https://www.youtube.com/watch?v=V45Jywr4nhA>

<https://www.youtube.com/watch?v=Ph9tlaUSfo>

# Inspiratory Muscles

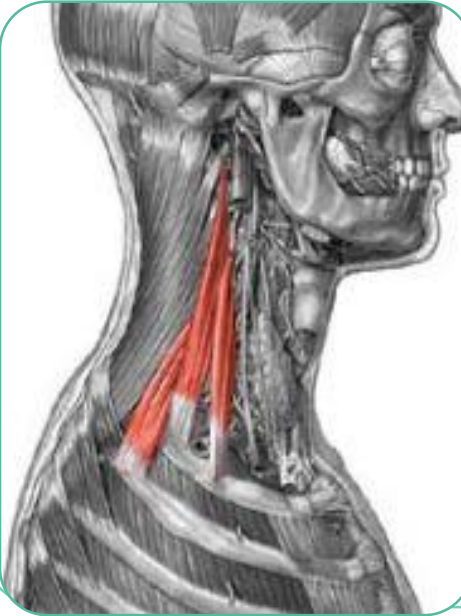
Muscles used in **rest** and **forced inspiration**



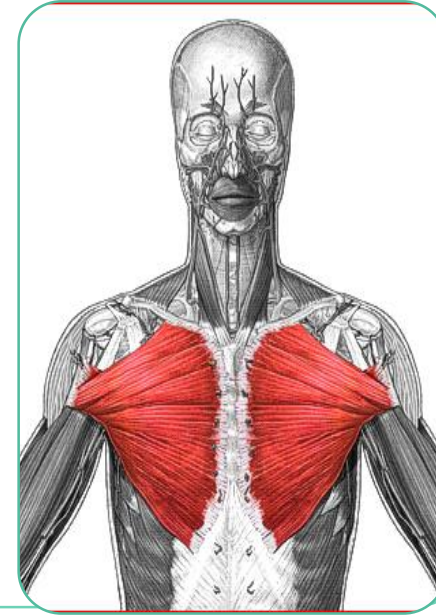
**Diaphragm** :  
most important  
muscle in  
inspiration

Rib elevators:  
**external  
intercostal  
muscles**

**Accessory muscles**  
(only during forced inspiration) :



Muscles attaching  
cervical vertebrae  
to first & second  
rib: **scalene  
muscles**



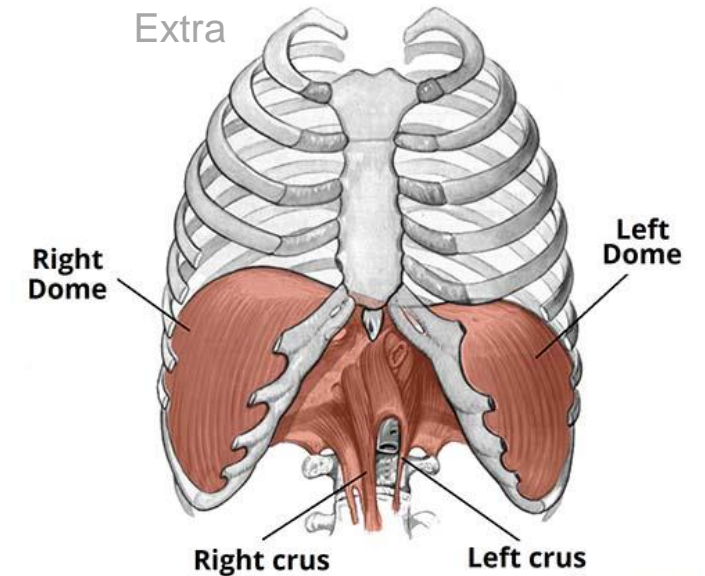
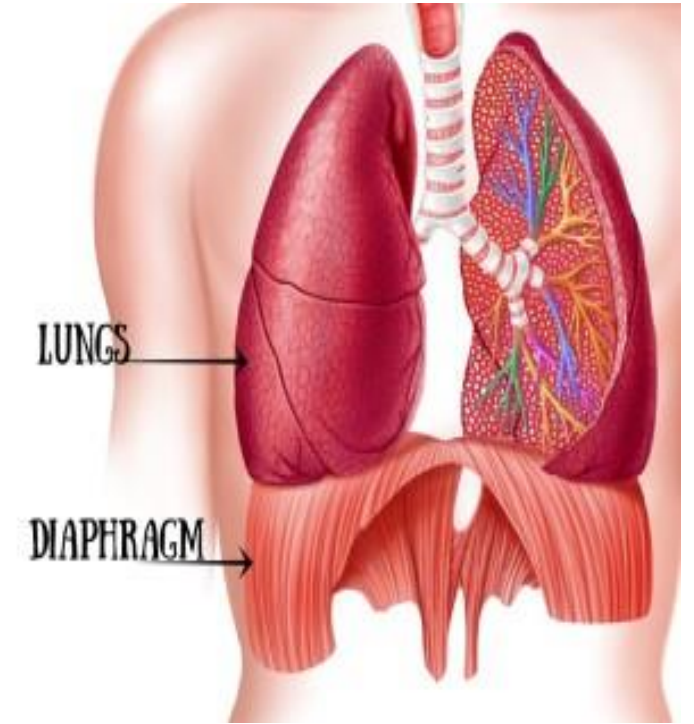
Muscles attaching  
thoracic cage to  
upper limb:  
**pectoralis major**

Note:  
Why are the  
accessory muscles  
listed in anatomy  
different from the  
ones in physiology?  
Because they are  
BOTH correct.  
**Grey's Anatomy:**  
*"Any muscles  
attaching to the ribs  
can potentially  
move one rib  
relative to another  
and therefore act as  
accessory  
respiratory  
muscles."*

# Inspiratory Muscles

## 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 the **central tendon**.
- Nerve supply: **phrenic nerve (C3,4,5)**, penetrates (تخترق) diaphragm & innervates it from abdominal surface .
- Action: contraction (**descent**) of diaphragm **increase vertical diameter** of thoracic cavity essential for normal breathing .



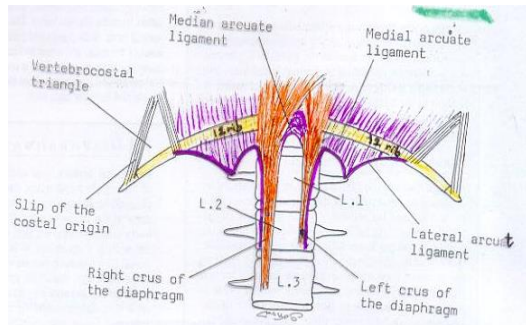
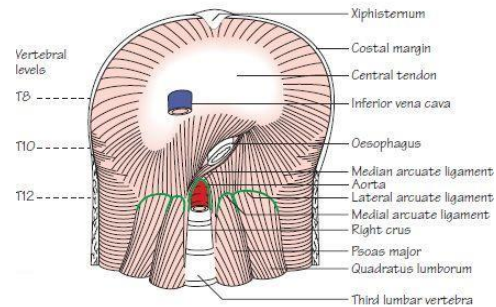
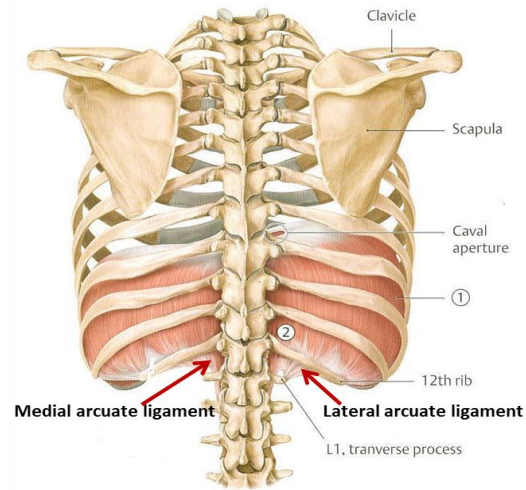
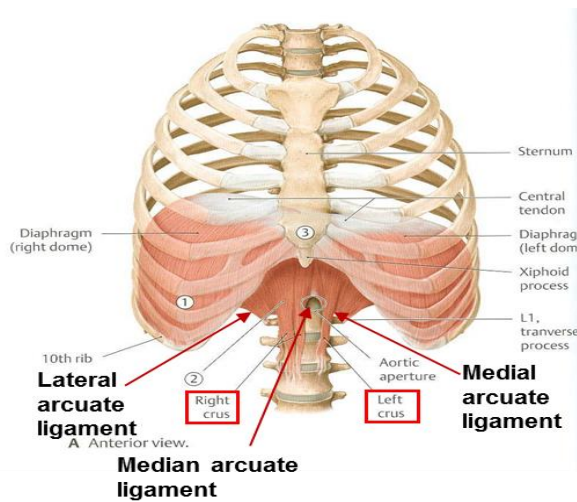


# Inspiratory Muscles

## Diaphragm

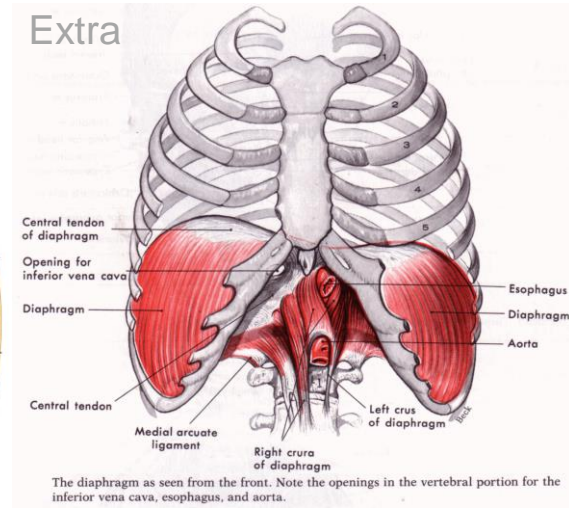
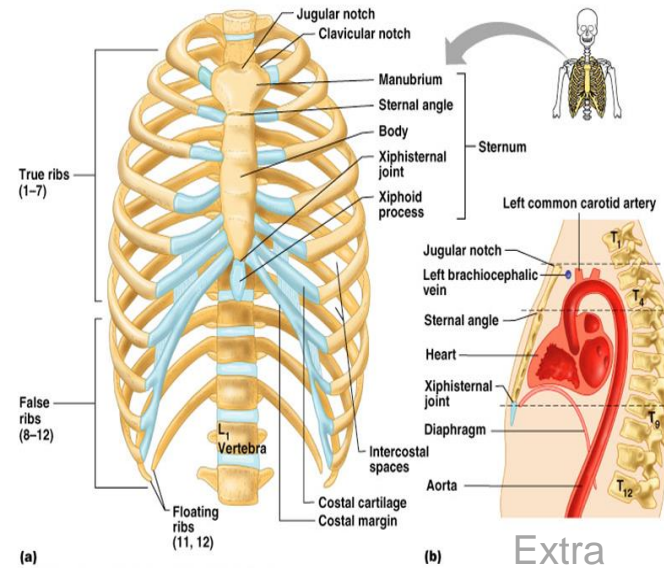
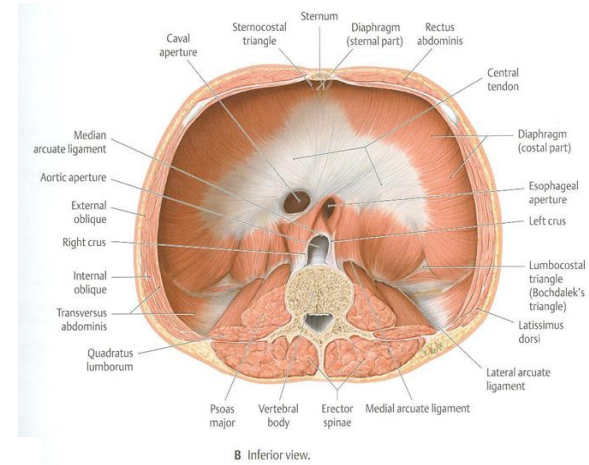
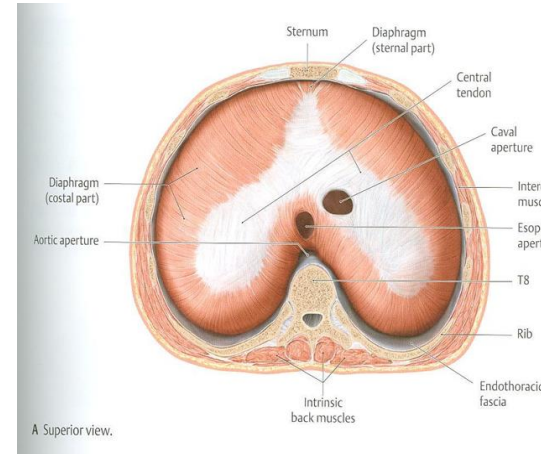
### Origin Of Diaphragm

- 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** : Lies at the level of xiphisternal joint , at **9<sup>th</sup> thoracic vertebra**

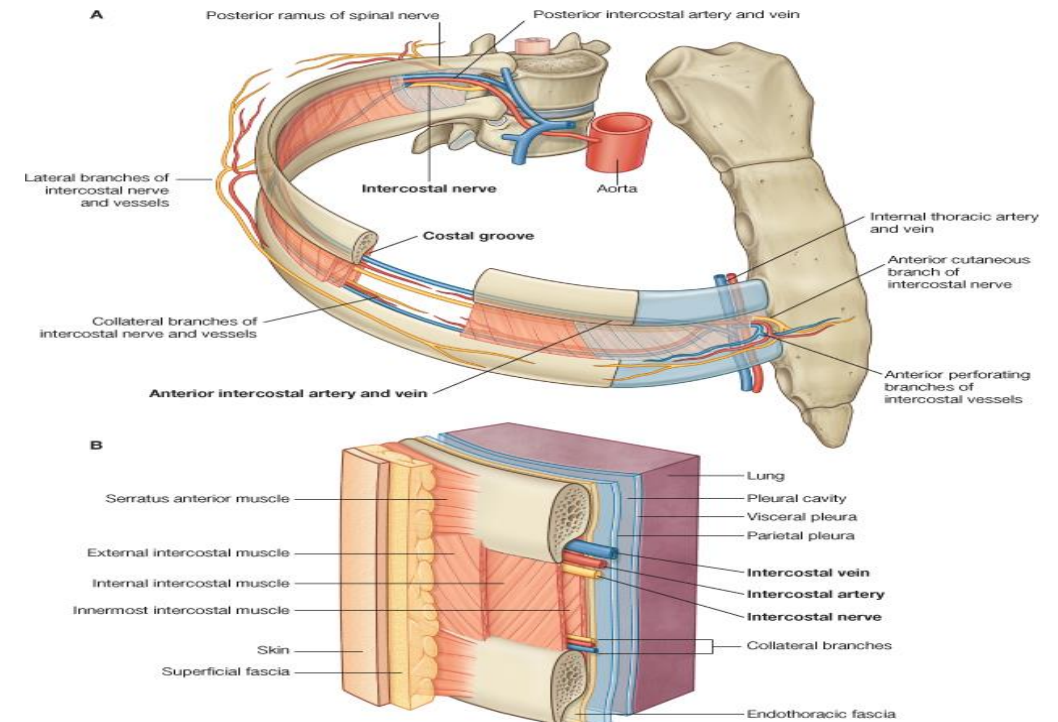
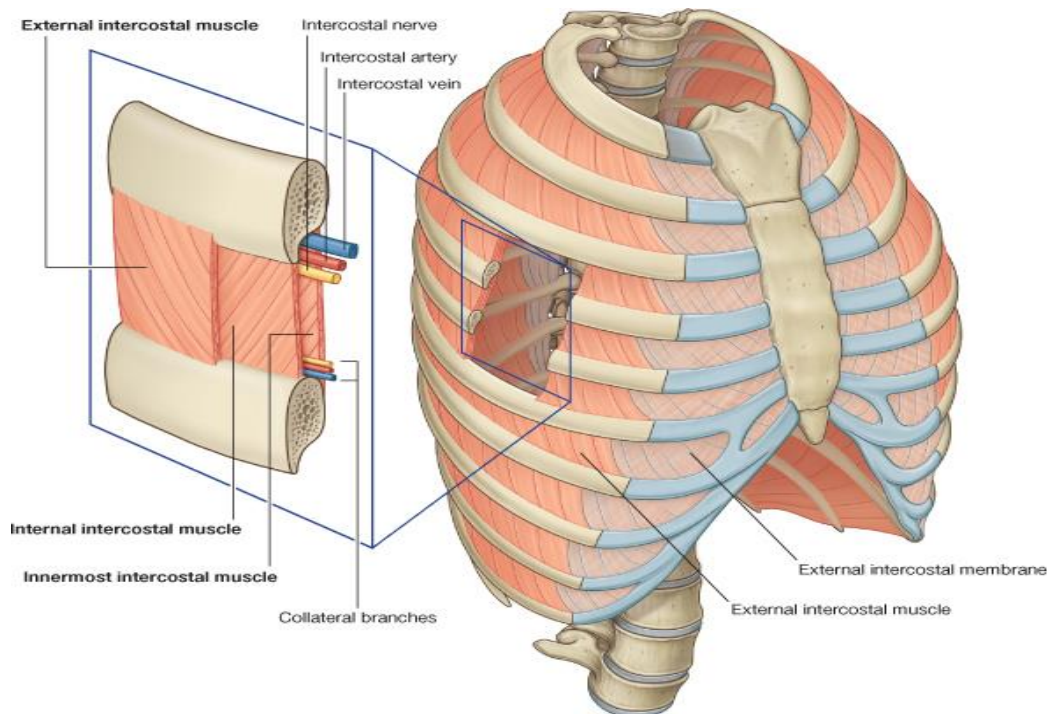




# Inspiratory Muscles

## External Intercostal

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

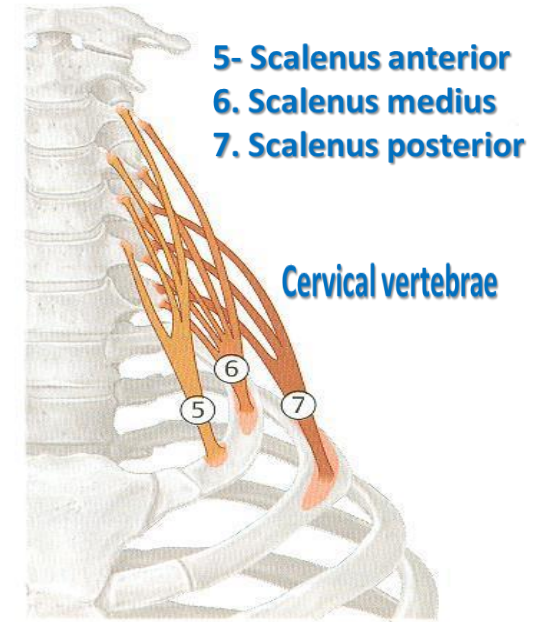


# Inspiratory Muscles

Accessory Muscles (in forced inspiration)

## Scalene Muscles

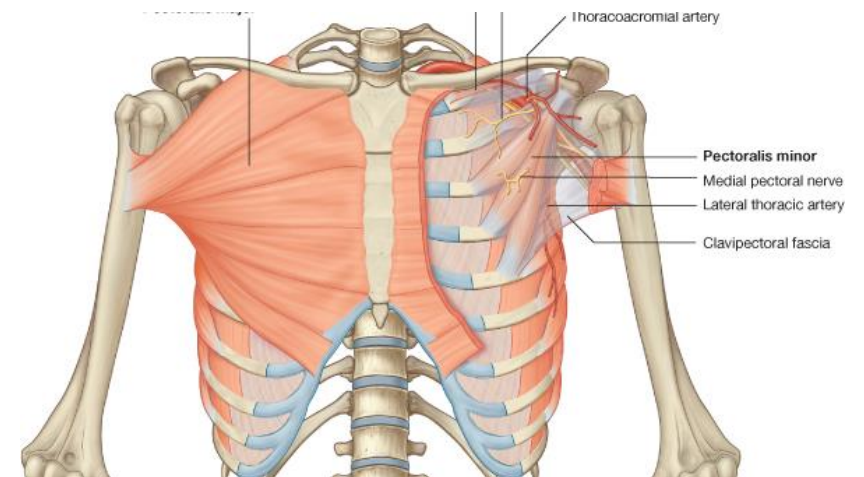
1. Origin: **cervical vertebrae**
2. Insertion: **1st & 2nd ribs**
3. Action: **elevates 1st & 2nd ribs (inspiratory)**



B Scalene muscles, anterior view.

## Pectoralis Major

1. Origin: **sternum + costal cartilages**
2. Insertion: **humerus** (Bicipital groove)
3. 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

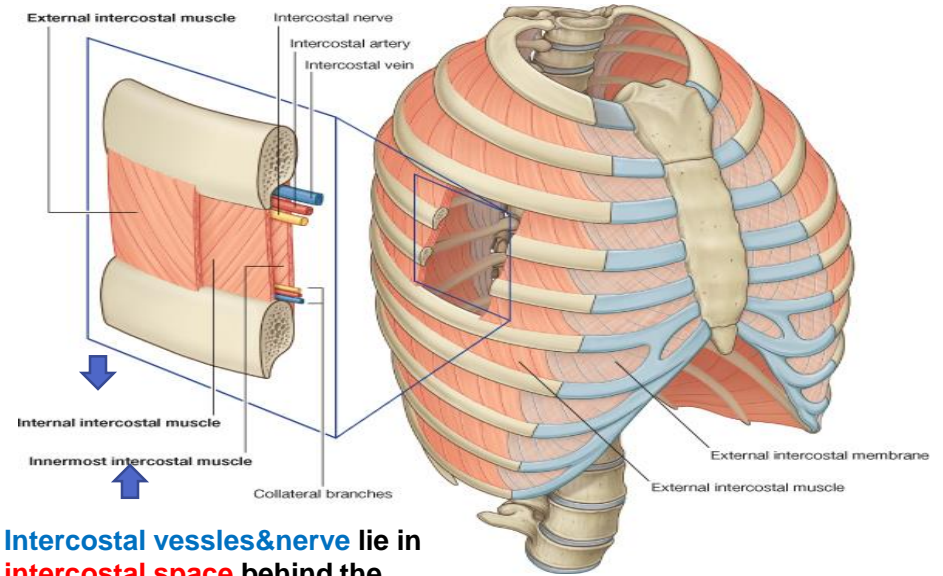
Direction:  
**upward & medially**

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

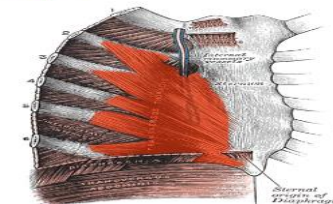
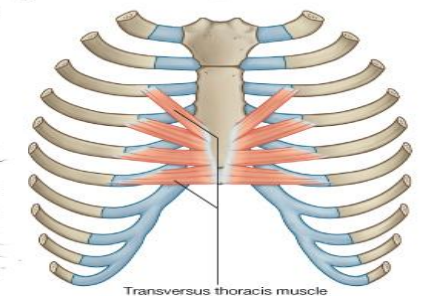
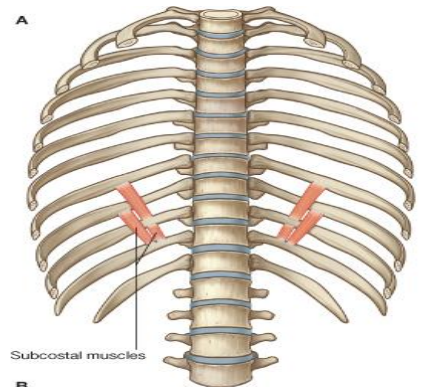
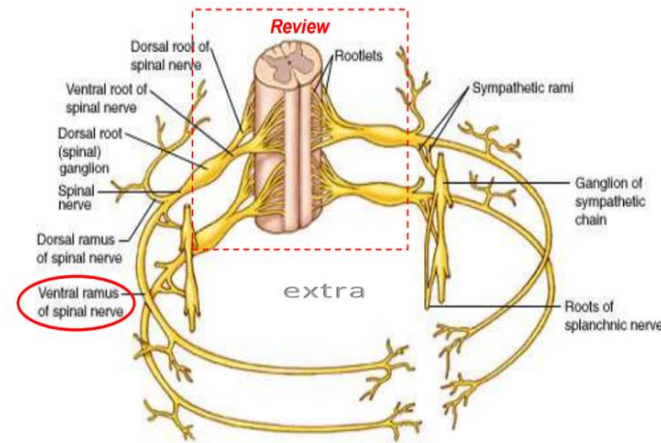
■ **Anterior abdominal wall muscles:**

**FUNCTION: Compression of abdominal viscera to help in ascent of diaphragm**

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



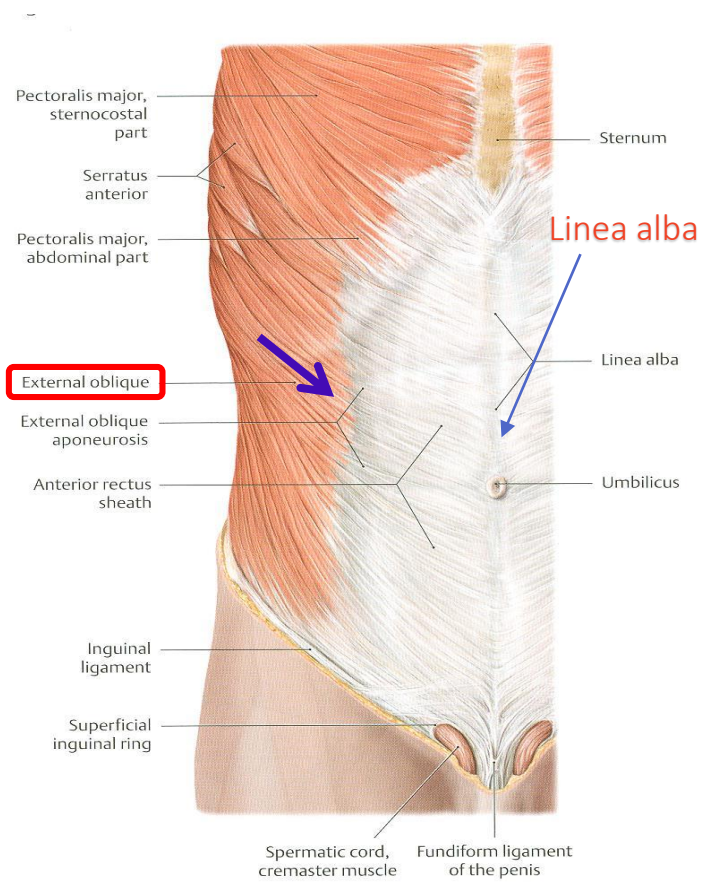
**Intercostal vessels & nerve lie in intercostal space behind the internal intercostal muscle.**



# Expiratory Muscles

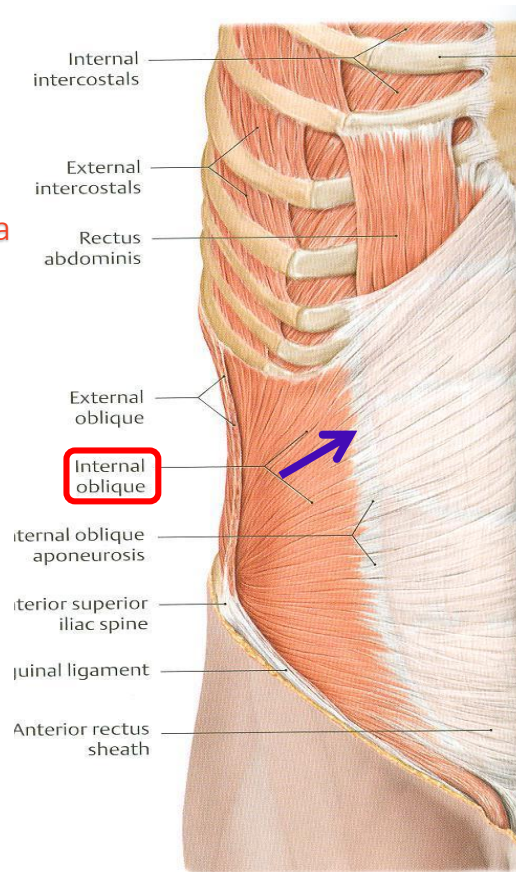
## Anterior Abdominal Wall

The **linea alba** is a fibrous structure that runs down the midline of the abdomen in humans and other vertebrates. In humans linea alba runs from the xiphoid process to the pubic symphysis.



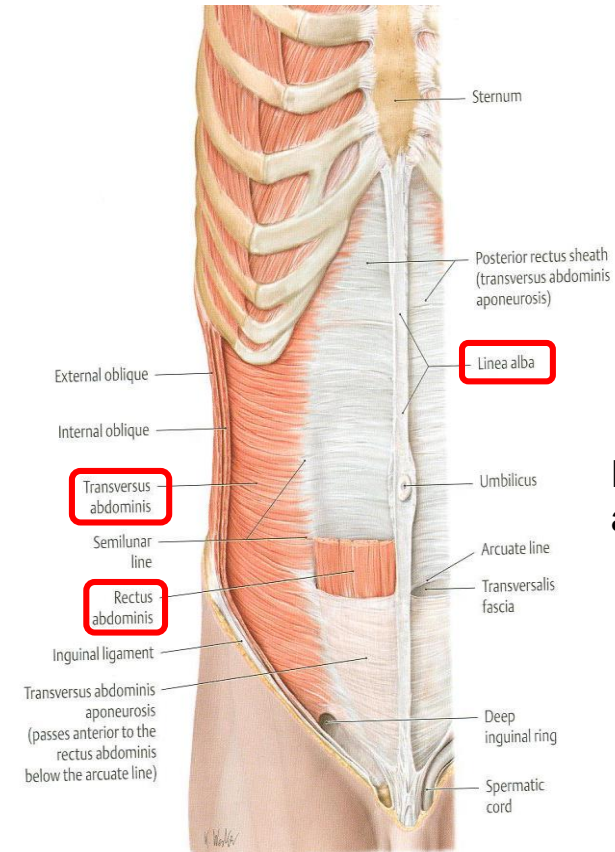
**External oblique**  
(outer layer)

Direction: **downward & medially**



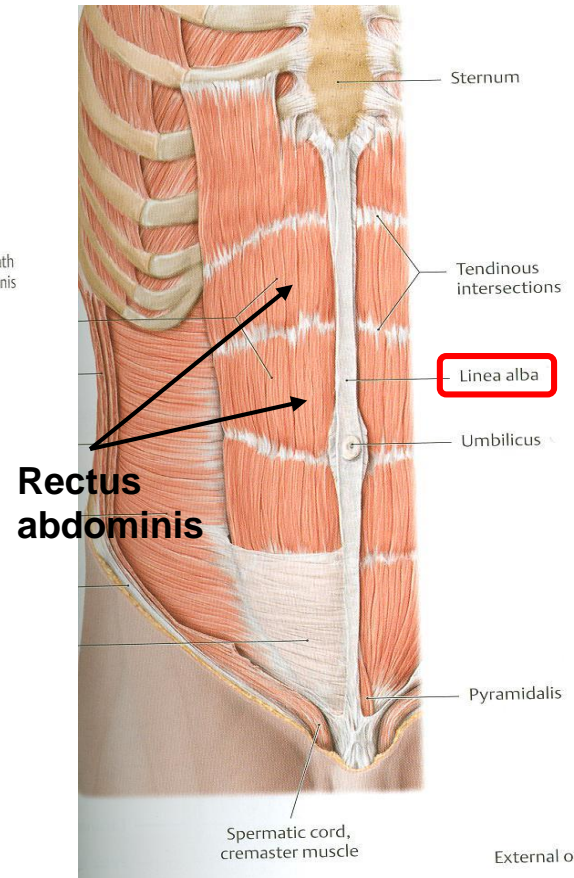
**Internal oblique**  
(middle layer)

Direction: **upward & medially**



**Transversus abdominis**  
(inner layer)

Direction : **transverse**



**Rectus abdominis**

**Rectus abdominis**

Direction: **vertical**



# Expiratory Muscles

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

Note: there are no muscles directly in charge of regular/relaxed expiration. This is because expiration is a passive movement depending on the natural recoil of the lungs, and relaxation of the diaphragm

# Summary

**Inspiration: -Quiet(Active):** 1-Contraction (Descent) diaphragm

2-Elevation of ribs **By external intercostal**

**-Forced(Active):** Accessory muscles of inspiration:

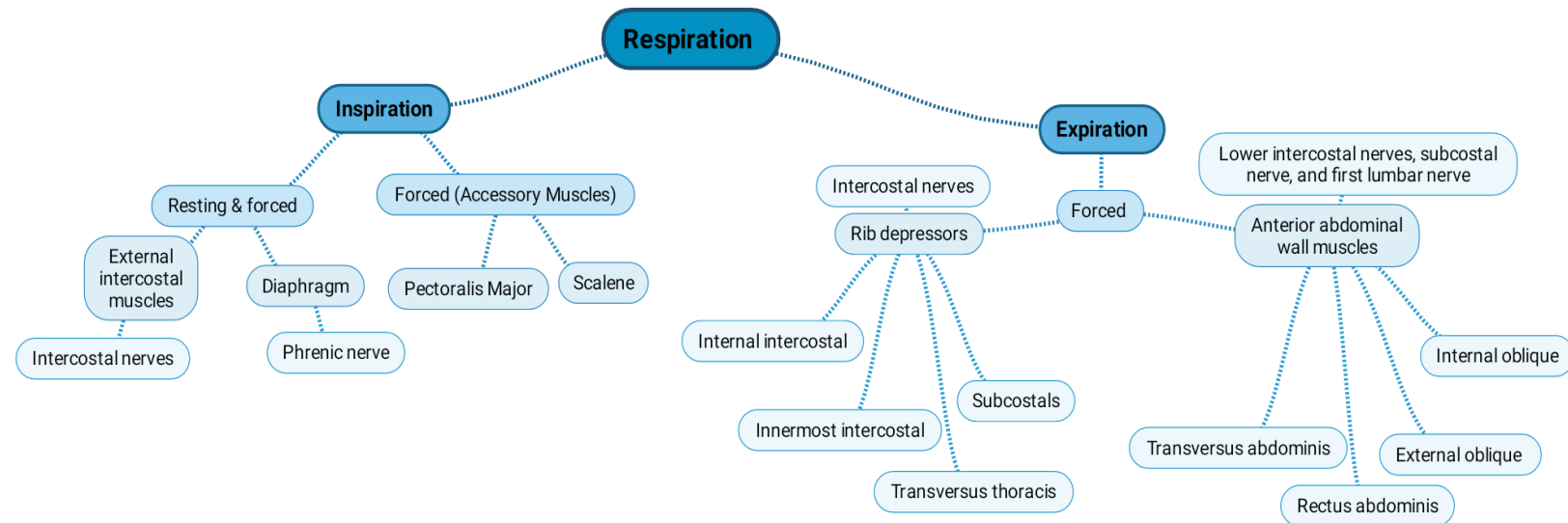
1-Pectoralis major 2-Scalene muscles

**Expiration:-Quiet(Passive):** 1-Elastic recoil of lung

2-Relaxation of **diaphragm & external intercostal**

**-Forced(Active):** 1-Contraction of **anterior abdominal wall muscles**

2- Depression of ribs (**Rest of intercostal muscles +Subcostals and transversus thoracis**)



The thoracic spinal levels at which the three major structures pass through the diaphragm can be remembered by the number of letters contained in each structure:

Vena Cava (8 letters) – Passes through the diaphragm at T8.

Oesophagus (10 letters) – Passes through the diaphragm at T10.

Aortic Hiatus (12 letters) – "Passes" through the diaphragm at T12

**\*THE RIGHT CRUS IS LARGER THAN THE LEFT BECAUSE OF THE POSITION OF THE LIVER.**



# MCQ

1. Which one of the following muscles is involved in expiration?

- A. external intercostal
- B. internal intercostal
- C. transversus thoracis
- D. Answers B AND C

2. The expiratory muscles act only during:

- A. Forced expiration.
- B. Deep inspiration.
- C. Deep expiration.
- D. Normal expiration.

3. The diaphragm is supplied by which nerve:

- A. Vagus
- B. Phrenic
- C. Intercostal nerves
- D. Long thoracic

4. The phrenic nerve's root value is?:

- A. C4,C5,C6
- B. C3,C4,C5
- C. C5,C6,C7
- D. C2,C3,C4

5. The most important muscle in respiration ?

- A. External intercostal
- B. scalene muscle
- C. Pectoralis major
- D. Diaphragm

6. Which one of the following is an articulation between the cartilages of true ribs and the sternum ?

- A- sternocostal
- B- costochondral
- C- costovertebral
- D- sacroiliac

7. In the pump handle movement which of the following will increase?

- A- transverse diameter
- B- lateral diameter
- C- antero-posterior diameter
- D- antero-lateral diameter

ANSWERS:

- 1.D
- 2.A
- 3.B
- 4.B
- 5.D
- 6.A
- 7.C

# SAQ

- 1-What is the action of pectoralis major in forced inspiration?
- 2-what will happen to the diaphragm during respiration?
- 3-Describe diaphragm's shape?
- 4-What is the nerve supply of the anterior abdominal wall muscles?

## ANSWERS:

- 1- increases antero-posterior diameter of thoracic cavity, when arm is fixed (inspiratory)
- 2- (1) Inspiration:
  - Contraction (descent) of diaphragm.
  - Increase of vertical diameter of thoracic cavity.(2) Expiration:
  - Relaxation (ascent) of diaphragm
- 3-Convex toward thoracic & concave toward abdominal cavity .
- 4-lower intercostal (T7-T11), subcostal (T12), and first Lumbar nerve.

