

# Muscles involved in normal respiration

Respiratory Block - Lecture 1

Color index:

**Important**

In male's slides only

In female's slides only

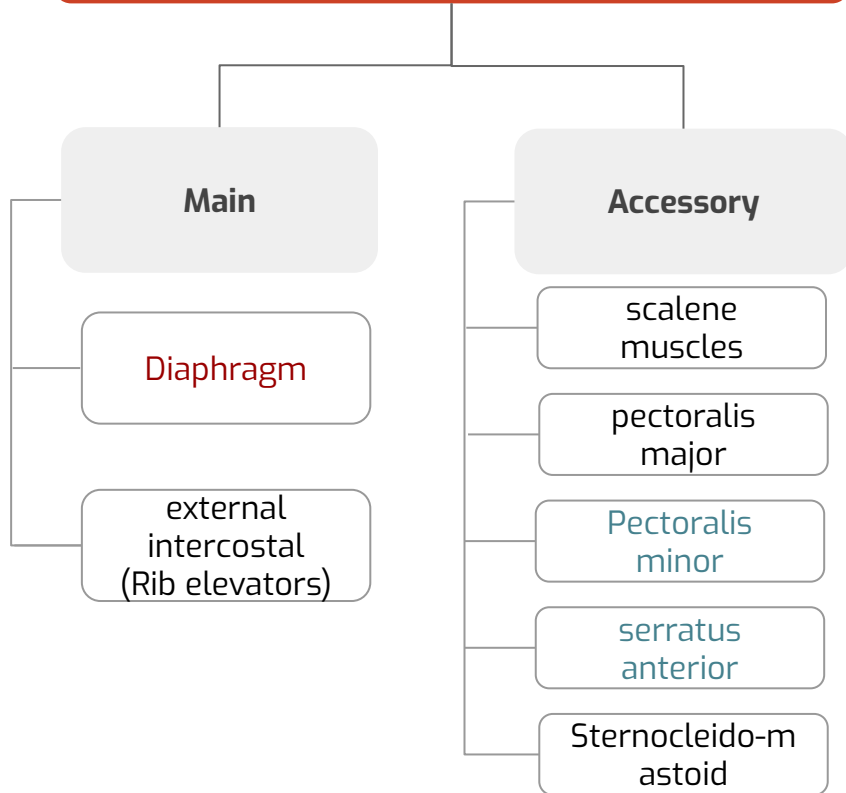
Extra information, explanation

Doctors notes

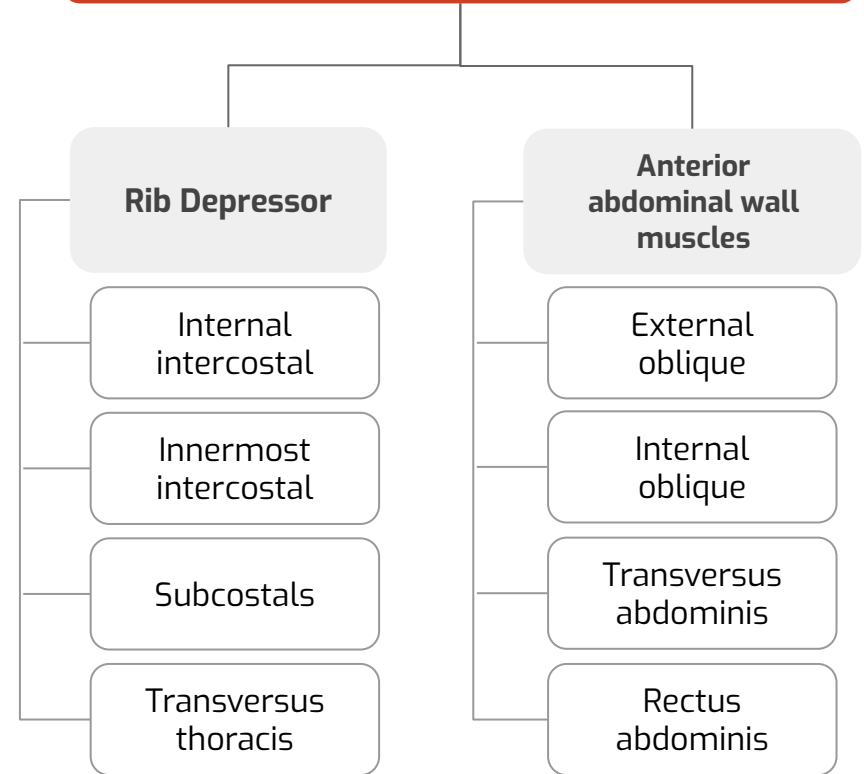
# Objectives:

- 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.

## INSPIRATORY MUSCLES

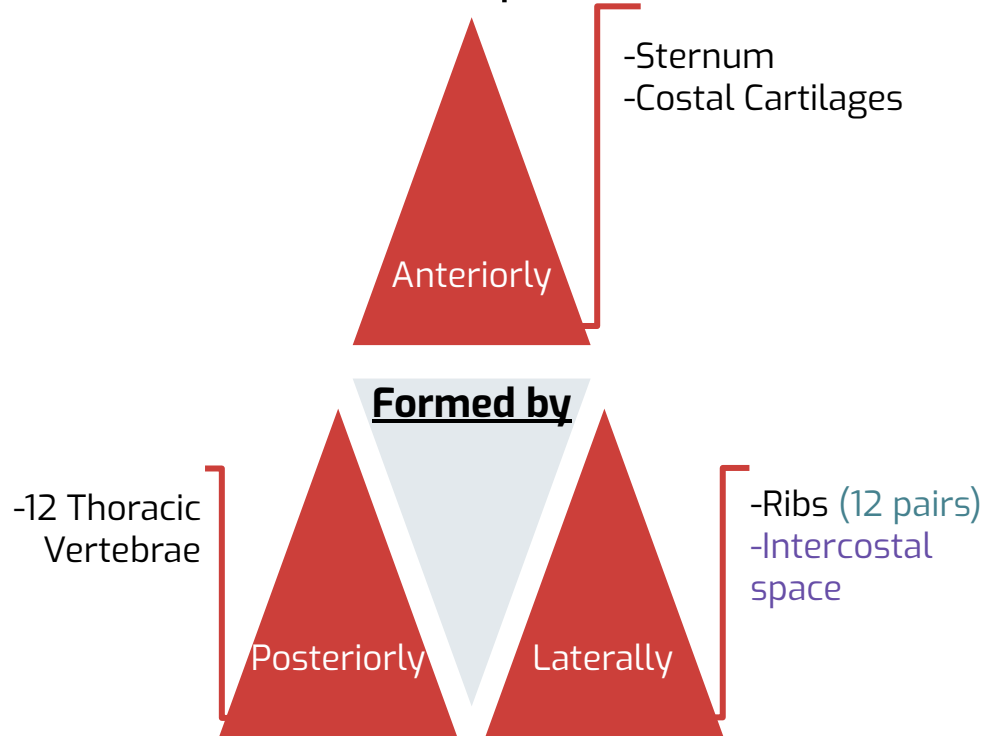


## EXPIRATORY MUSCLES



# THORACIC CAGE:

- Conical in shape



## Has 2 apertures (openings)

### Superior opening (thoracic outlet)

narrow, open, continuous with neck  
obliquely placed facing upward and forward

#### Bounded by:

**1-Anteriorly,**  
Superior border of the manubrium sterni  
**2-laterally,**  
Medial borders of first rib  
**3-posteriorly,**  
First(1rst) thoracic vertebrae

### Inferior opening (Inferior Thoracic aperture)

wide, closed by diaphragm

#### Bounded by:

**1-Anteriorly,**  
Xiphisternal joint  
**2-laterally,**  
Curving costal margin  
**3-posteriorly,**  
Twelfth(12th) thoracic vertebrae

# Articulations

## Main joints found (details were in girls slides only)

### Sternocostal

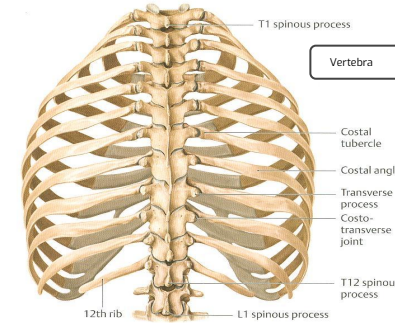
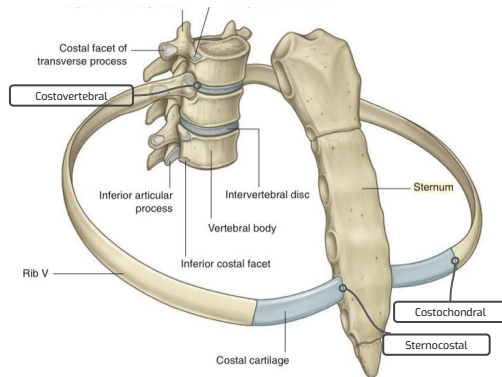
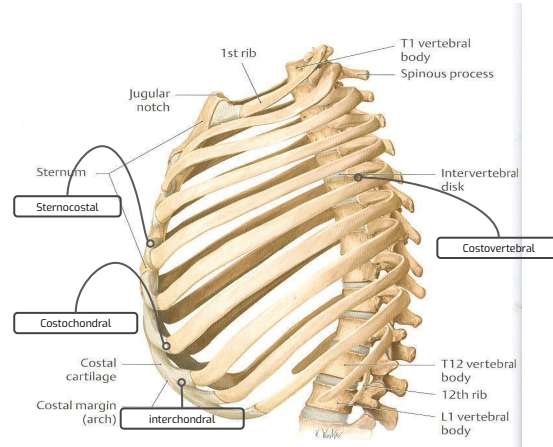
- Plane synovial joint mainly.
- 1st costal cartilage:  
articulates with manubrium  
by a **primary cartilaginous  
joint**
- 2nd to 7th cartilages  
articulate with sternum by  
**synovial joints**

### Costovertebral

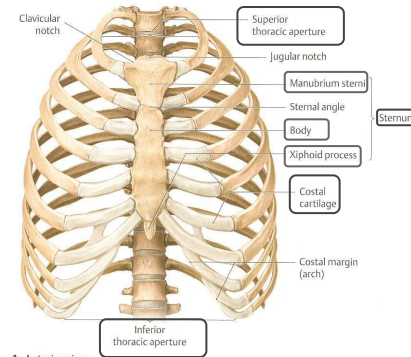
- Plane synovial joint
- Between heads of ribs &  
thoracic vertebrae.

### Costochondral

- Cartilaginous joint
- Between the costal cartilage  
and the ribs



C Posterior view.



A Anterior view.

## Based on the types of joints (in boys slides)

### 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.

# RESPIRATORY MOVEMENTS

## MOVEMENTS OF DIAPHRAGM

### Inspiration

Contraction (descent) of diaphragm



Increase of vertical diameter of thoracic cavity

**MED438 Notes:** Both Normal and forced Inspiration are active (needs muscles action)

### Expiration

Relaxation (ascent) of diaphragm

**MED438 Notes:**

-Normal Expiration is **Passive**

1. Elastic recoil of lung 2. Relaxation of diaphragm & external intercostal (No muscles action)

-Forced Expiration is active (needs muscles action)

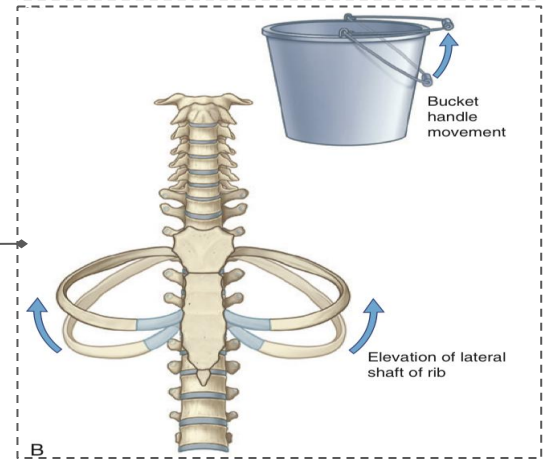
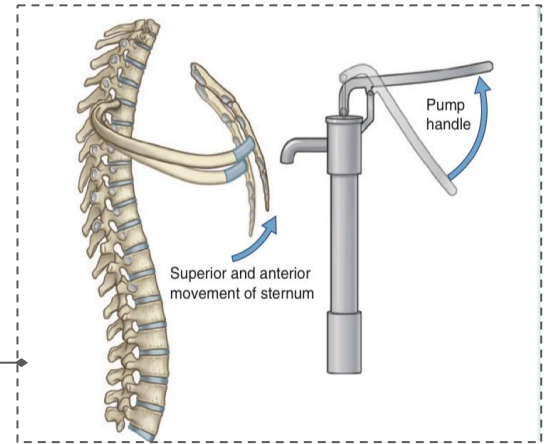
## MOVEMENTS OF RIBS (During Normal Inspiration)

### 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



B

# INSPIRATORY MUSCLES

## ORIGIN OF DIAPHRAGM:

- It has three origins:

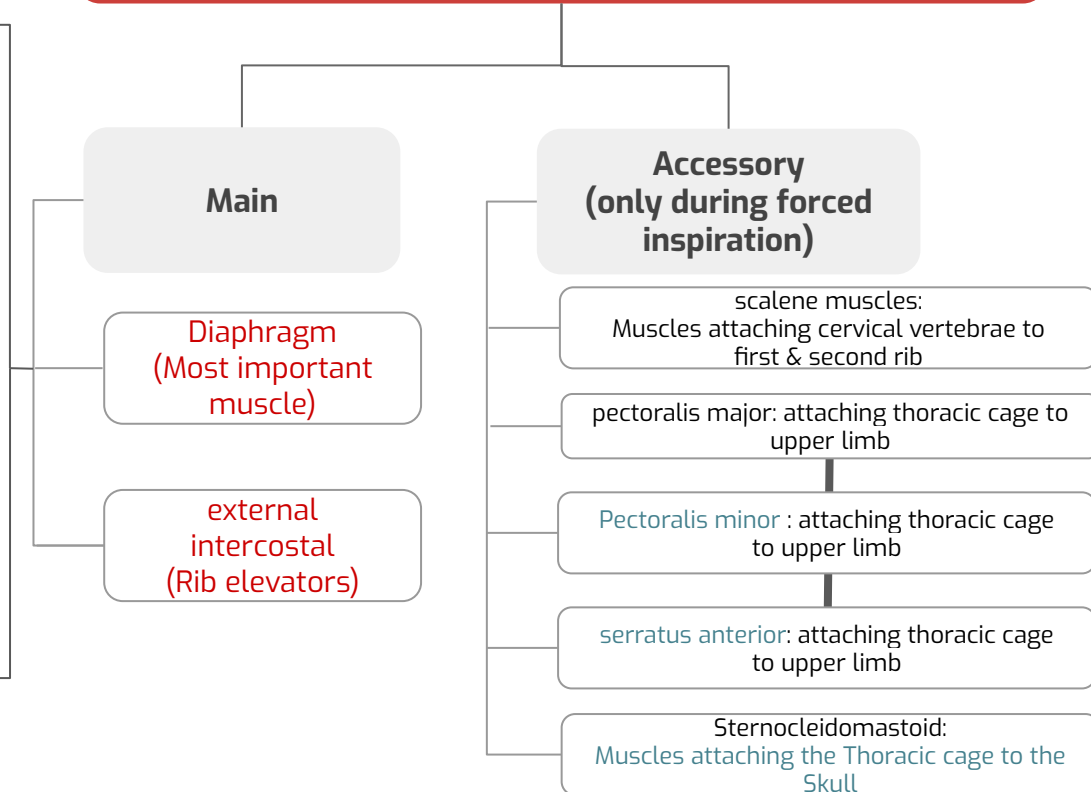
1- **Costal:** lower 6 ribs and their costal cartilages

2- **Sternal:** xiphoid process of sternum

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

## INSERTION OF DIAPHRAGM

- The Central Tendon
- **Lies at:** the level of xiphisternal joint, at 9<sup>th</sup> thoracic Vertebra



# THE DIAPHRAGM

## What is it?

A musculotendinous partition between thoracic & abdominal cavity

## Structure

Convex toward thoracic & concave toward abdominal cavity

## Attached to:

-sternum, costal cartilages, 12th rib & lumbar vertebrae (origin)

-Fibers converge to join and inserted into the central tendon (insertion)

## Nerve supply

phrenic nerve (C3,4,5), penetrates diaphragm & innervates it from abdominal surface

## Action

contraction (descent) of diaphragm increase the **vertical diameter** of the thoracic cavity (essential for normal breathing)

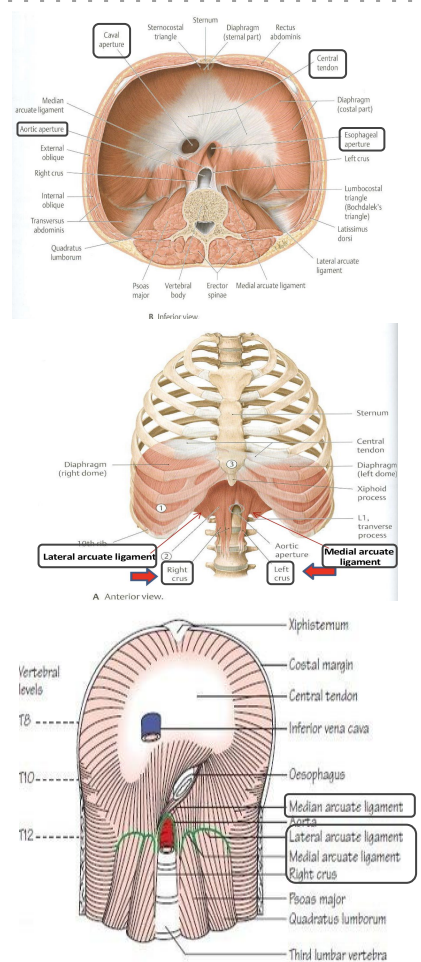
## Openings

(Not in the slides but mentioned by the girls doctor cuz it's important for the MCQ)

**Caval aperture**  
the **inferior vena cava** (the largest vein) passes at approximately vertebra **T 8**

**Esophageal aperture**  
The **esophagus** passes through it, at the level of vertebra **T 10**.

**Aortic aperture**  
The **aorta** (largest artery) passes posteriorly, at the lower level of vertebra **T 12**.





## External intercostal (inspiratory muscle )

### **Attachment :**

from lower border of superior (upper) rib to upper border of inferior (lower) rib

### **Direction of fibers :**

-Downward,forward and medially.

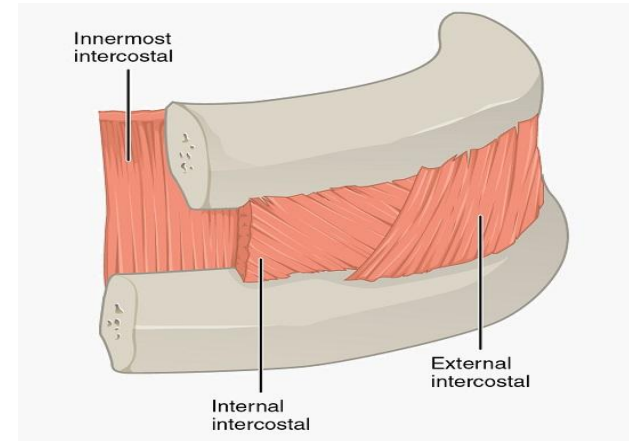
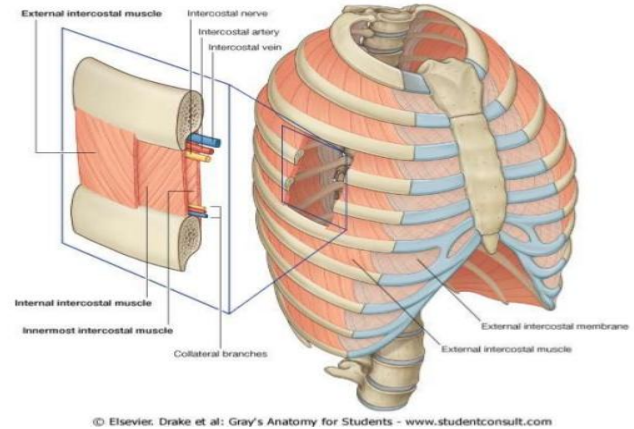
### **Nerve supply:**

-Intercostal nerves.

### **Action:**

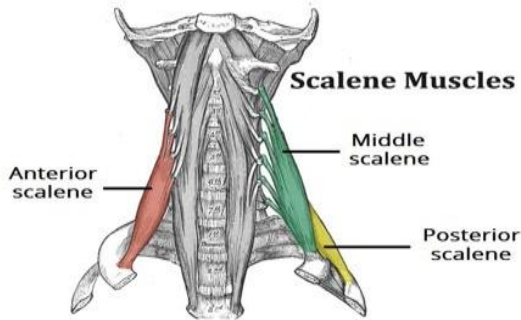
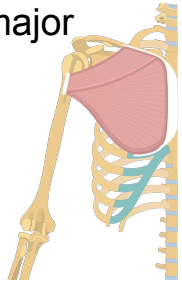
-Rib elevator (inspiratory)

**Note:** The External intercostal muscle is the most superficial layer .



**Accessory inspiration muscles  
(Forced inspiration)**

Pectoralis major



<b>Muscle</b>	<b>Scalene Muscles (In forced inspiration)</b>	<b>Pectoralis Major (In forced inspiration)</b>
<b>Origin</b>	Transverse process of Cervical vertebrae	1-sternum 2-costal cartilages 3-clavicle
<b>Insertion</b>	1st rib (Scalenus anterior&medius) and 2nd rib(Scalenus posterior)	Lateral lip of Bicipital groove of <b>humerus</b>
<b>Action</b>	Elevate <b>1st</b> and <b>2nd</b> ribs	Increases antero-posterior diameter of thoracic cavity , when arm is fixed

# Sternocleidomastoid (Inspiratory muscles)

## Origin:

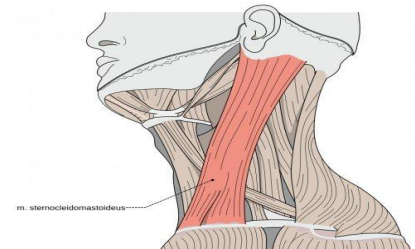
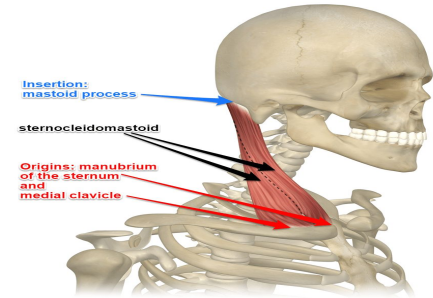
- Sternal head:** front of manubrium sterni
- Clavicular head:** medial third of clavicle.

## Insertion:

- Mastoid process** of the temporal bone and nuchal lines of occipital bone.

## Action:

- Elevation of the manubrium
- Elevation of the sternum and assists in forced inspiration.
- Assists two muscles flex the neck.
- Assists one muscle rotates the head of opposite side.



# Expiratory muscles

- Two groups: 1-Rib depressors . 2- Anterior abdominal wall muscles .
- Act only during forced expiration. (Normal Expiration is Passive)

## 1-Rib depressors

<b>Muscles</b>	Internal intercostal	Innermost intercostal	Subcostal	Transversus thoracis
<b>Direction</b>	Downward, Backward & laterally		-	-
<b>Nerve</b>	Intercostal nerves (ventral rami of T1-T11)			
<b>Action</b>	Depression of the ribs .			
<b>Picture</b>				

## Expiratory muscles

# Anterior abdominal wall(AAW)

-Is formed of 3 layers of muscle 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)**.

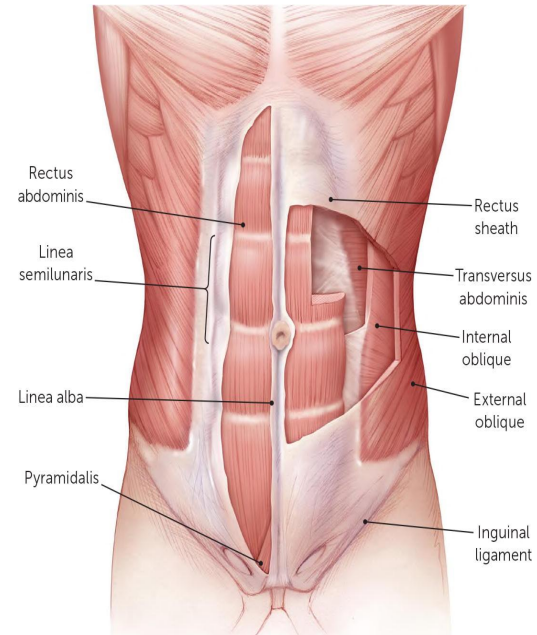
-Muscles are attached to: Sternum, costal cartilages, ribs and hip bones.

-The aponeurosis of the 3 muscles on both sides fuse in the midline to form **linea alba** .

-Extra notes :

-The AAW forms the anterior limit of the **abdominal** viscera.

-It runs, superiorly from xiphoid process and costal cartilages of 7th,8th,9th and 10th ribs to iliac crest, inguinal ligament, anterior superior iliac spine, pubic tubercle, pubic crest and pubic symphysis inferiorly.



important note  
"not related to the slide"

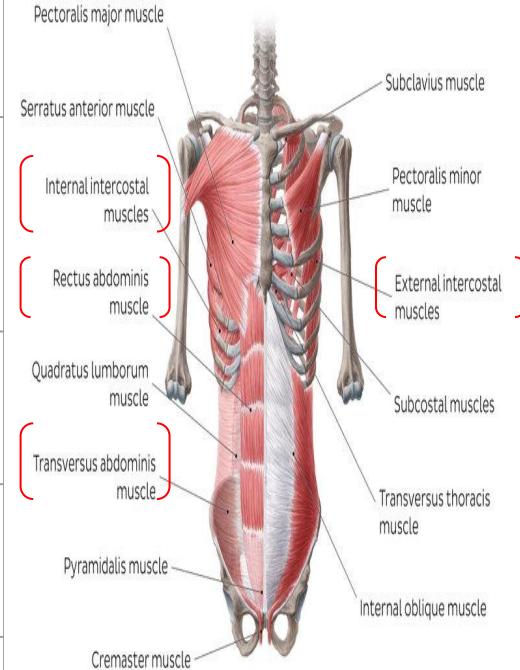
**the median arcuate ligament  
attaches the right and left crus**

# Expiratory muscles

## 2-Anterior abdominal wall muscles

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

<b>Muscle</b>	External oblique (Outer layer)	Internal Oblique (Middle layer)	Transversus abdominis (Inner layer)	Rectus abdominis
<b>Direction</b>	Downward & medially	Upward & medially	Transvers	Vertical
<b>Nerve</b>	lower 5 intercostal nerves (T7 – T11), subcostal nerve (T12) and first lumbar nerve (L1).			
<b>Action</b>	(during forced expiration) Compression of abdominal viscera to help in ascent of diaphragm			



# MCQ

**Q1:** which one of the following best describes the Thoracic cage shape:

- A. Conical
- B. Cylindrical
- C. Triangular
- D. Irregular

**Q4:** Which ONE of the following muscles is the **outer** layer of Anterior abdominal wall muscles ?

- A. External oblique muscle
- B. Internal oblique muscle
- C. Transversus abdominis muscle
- D. Rectus abdominis muscle

**Q2:** Which ONE of the following muscles depress the ribs ?

- A. Scalene
- B. Pectoralis major
- C. Internal intercostal
- D. Transversus abdominis

**Q5:** What is the nerve supply of rib depressors muscles ?

- A. Intercostal nerve
- B. Subscapular nerve
- C. Femoral nerve
- D. Median nerve

**Q3:** Which one of the following muscles used in forced inspiration?

- A. External intercostal
- B. Deltoid
- C. Pectoralis major
- D. Transversus abdominis

**Q6:** What is the action of subcostal muscle ?

- A. Rib depression
- B. Rib elevation
- C. Compression of abdominal viscera
- D. Increases antero-posterior diameter of thoracic cavity

answer key:  
1:A  
2:C  
3:C  
4:A  
5:A  
6:A

# MCQ

**Q7:** which one of the following forms the Thoracic cage anteriorly?

- A.** Sternum only
- B.** Sternum and costal cartilages
- C.** Ribs & intercostal spaces
- D.** Thoracic vertebrae

**Q10:** How is the Superior opening (thoracic outlet) bounded laterally?

- A.** First thoracic vertebrae
- B.** Second thoracic vertebrae
- C.** Medial borders of first rib
- D.** Superior border of the manubrium sterni

**Q8:** Which one is an accessory muscle of inspiration?

- A.** Tansversus thoracis
- B.** scalene muscle
- C.** External intercostal muscle
- D.** Internal intercostal muscle

**Q11:** How is the Inferior opening bounded anteriorly?

- A.** Xiphisternal joint
- B.** Curving costal margin
- C.** Twelve thoracic vertebrae
- D.** Sternocostal joints

**Q9:** Which nerve supplies the Diaphragm?

- A.** phrenic nerve
- B.** intercostal nerves
- C.** first lumbar nerve
- D.** subcostal nerve

**Q12:** Which one of the following joints involved in the thoracic cage articulation is a Plane synovial joints?

- A.** Manubriosternal joint
- B.** Costochondral joints
- C.** Xiphisternal joint
- D.** Costovertebral joints

answer key:  
7:B  
8:B  
9:A  
10:C  
11:A  
12:D



## SAQ :

**1** :Why Anterior abdominal wall is formed of 3 layers of muscle of fibers running in different directions?

**2** :What are the directions of internal and innermost intercostal muscles?

**3** :Describe the respiratory movement of the ribs during normal inspiration and how they change the Thoracic cavity diameter?

# SAQ :

4 :Why is the diaphragm supplied by the cervical nerves?

5 :Why is the right crus of the diaphragm larger than the left crus?

6 :Do 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

# SAQ Answers

1 :to increase strength of anterior abdominal wall

2 :Downward,Backward & laterally

3 :1-Pump Handle Movement, Elevation of ribs, Increase in antero-posterior diameter of thoracic cavity.

2- Bucket Handle Movement, Elevation of ribs, Increase in lateral (transverse) diameter of thoracic cavity.

# SAQ Answers

**4** :It is important for breathing, as it passes motor information to the diaphragm and receives sensory information from it. These nerves provide the only motor supply to the diaphragm as well as sensation to the central tendon.

**5** :The right crus lies at a higher level because of the large size of the right lobe of the liver.

**6** :**1.** Yes, The levatores costarum muscles are paired muscles of the posterior thorax. They number twelve on each side and attach to the transverse processes of C7 to T11 vertebrae and the ribs below, helping to elevate the ribs during respiration.

**2.** Yes, It helps to elevate the upper ribs during inhalation. Also it inversely, helps to draw the lower ribs downward and backward during exhalation.

**3.** Yes, The function of the serratus posterior inferior muscle is to pull down the lower ribs, assisting with forced exhaling

**4.** Yes, The pectoralis minor can be considered an accessory muscle in respiration when inspiration is deep and forced, as it will help raise the ribs during inspiration and aid in expanding the thoracic cavity

**5.** Yes, all 3 parts of the serratus anterior muscle work together to lift the ribs, assisting in respiration

**6.** Yes, the latissimus dorsi is active during deep inspiration and with forceful respiratory functions such as coughing and sneezing

**7.** Yes, It also helps support the core of the body when breathing.

# **Team leaders**

## **Abdullah Alsubaihi**

## **Abeer Awwad**

### Team Members :

- **Shayma Abdullah**
- **Sumo Abdulrahman**
- Fatimah Saad
- Shaden Alsaiedan
- Ghada Jedaie
- Alaa Alsulmi
- Sara alrashidi
- Joud alnujaidi
- Shahad almezel
- **Osama Alharbi**
- **Bassam Alasmari**
- Nawaf Al-Shahrani
- Bader Alrayes
- Nawaf Alsaadi
- Mohammed Akresh
- Ibrahim Alabdulkarim