MED437
KING SAUD UNIVERSITY

ANATOMY
Team 437

Muscles involved in respiration

Lecture 1

تمت المراجعة
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و
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Please check our Editing File.

هذا العمل لا يغني عن المصدر الأساسي للمذاكرة

Objectives

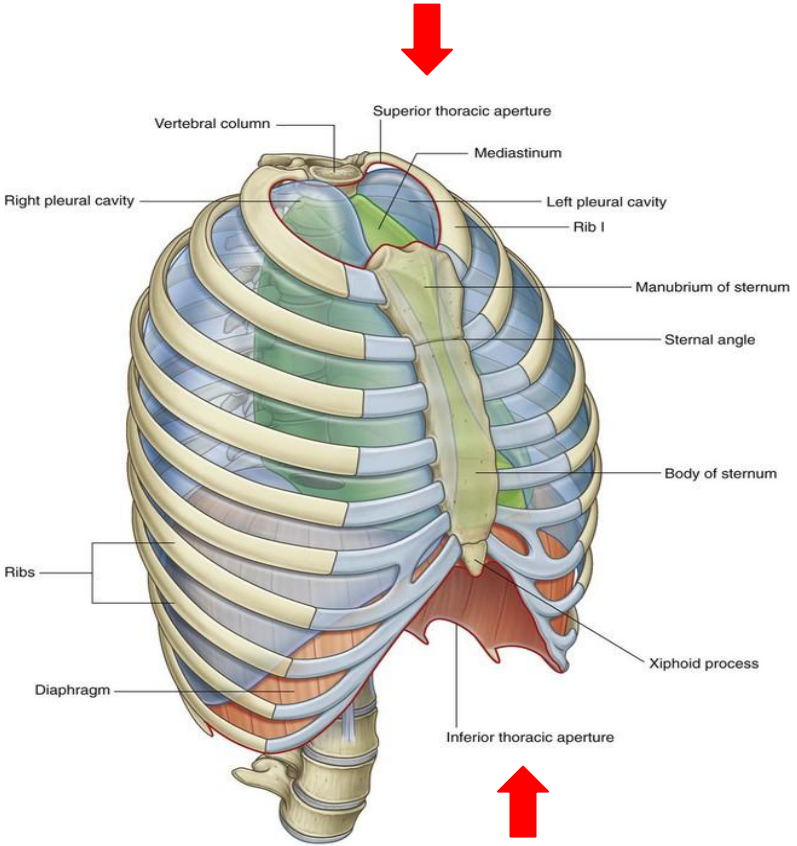
- Describe the components of the thoracic cage and their articulations.
- Describe in brief the respiratory movements.
- List the muscles involved in inspiration and in expiration.
- Describe the attachments of each muscle to the thoracic cage and its nerve supply.
- Describe the origin, insertion, nerve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

- Text in BLUE was found only in the boys' slides
- Text in PINK was found only in the girls' slides
- Text in RED is considered important
- Text in GREY is considered extra notes

Thoracic Cage

Conical (مخروطي) in shape.
it has 2 apertures (openings):
1- superior: (thoracic outlet): narrow, open, continuous with neck.
2- inferior: wide, closed by diaphragm.

formed of :
A- Anteriorly: Sternum and costal cartilages.
B- Laterally: Twelve pairs of ribs.
C- Posteriorly: Twelve thoracic vertebrae.



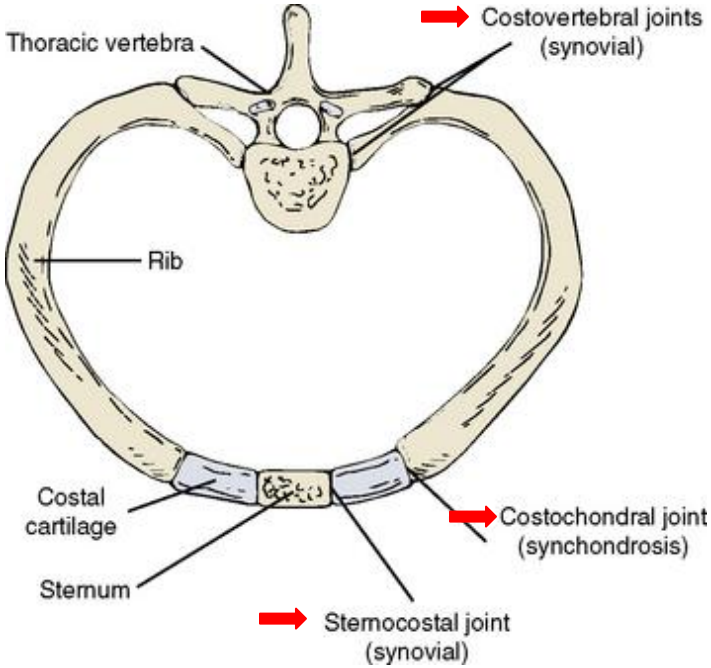
The articulations related to the thoracic cage

1- Costochondral (Primary cartilaginous joint):is an articulation between the ribs and the costal cartilages.

2- Sternocostal (1st cartilage with manubrium by primary cartilaginous joint it ossifies later // 2nd to 7th cartilages with sternum by plane synovial joint) is an articulation between the cartilage of true ribs and the sternum.

3- costovertebral (plane synovial joint): is an articulation between the thoracic vertebrae and the heads of the ribs.

4- Interchondral (Primary cartilaginous): between the 8,9, and 10 costal cartilages, and they all formed what is called costal margin



Thoracic cage

Ribs movement video

Respiratory movements

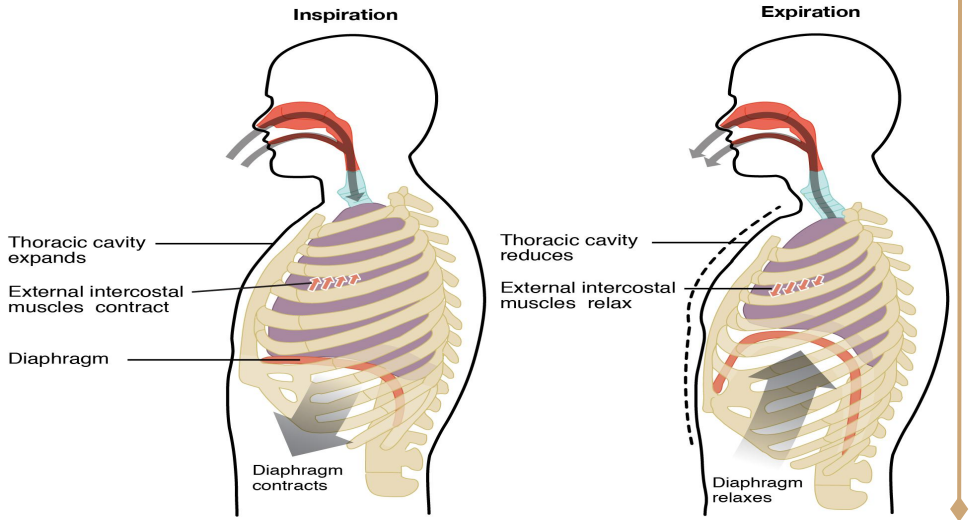
A-MOVEMENTS OF DIAPHRAGM

Inspiration:

Contractions (descend) of diaphragm → Increase of vertical diameter of thoracic cavity

Expiration:

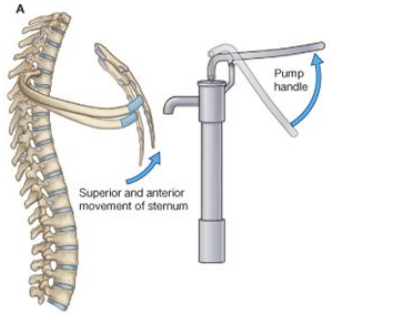
Relaxation (ascend) of diaphragm



B- MOVEMENTS OF RIBS (In Normal inspiration)

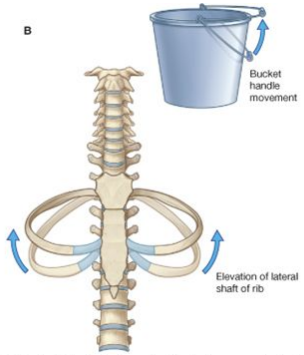
1- PUMP HANDLE MOVEMENT:

Elevation of ribs → Increase in antero-posterior diameter of thoracic cavity



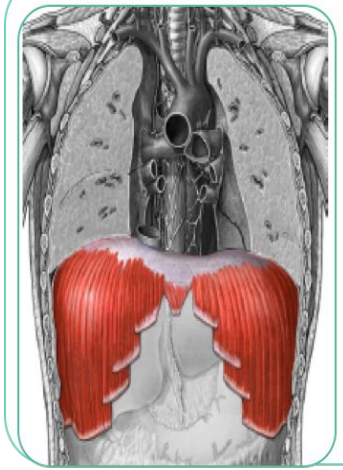
2- BUCKET HANDLE MOVEMENT:

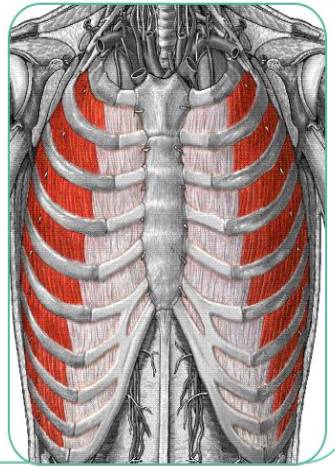
Elevation of ribs → Increase in lateral (transverse) diameter of thoracic cavity



Inspiratory Muscle

Muscle used in rest and forced inspiration



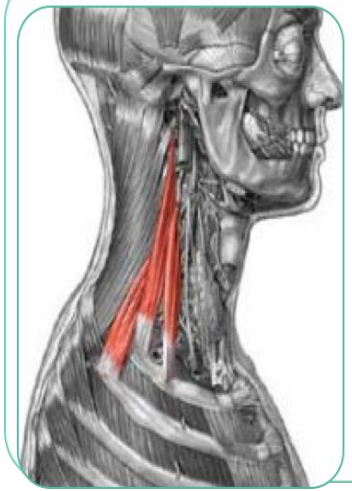


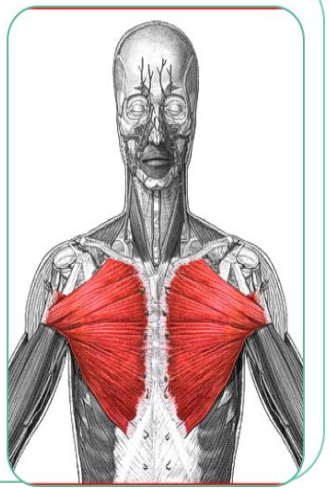
Diaphragm : most important muscle in inspiration

Rib elevators: **external intercostal muscles**

Accessory muscle (only during forced inspiration)

Note: their main function isn't inspiration





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

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

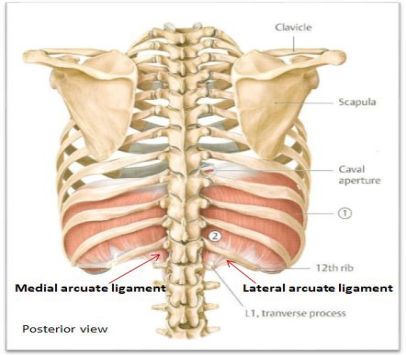
Note:
Why are the accessory muscles listed in anatomy different from the ones in physiology? Because they are BOTH correct.
Grey's Anatomy: *"Any muscles attaching to the ribs can potentially move one rib relative to another and therefore act as accessory respiratory muscles."*

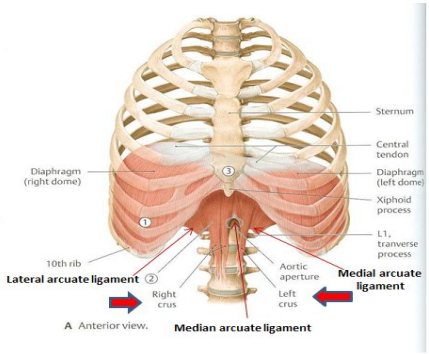
Diaphragm

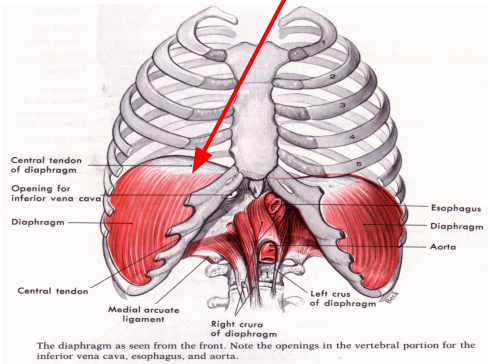
- A musculotendinous partition between thoracic & abdominal cavity
- Convex toward thoracic & concave toward abdominal cavity
- Fibers converge to join the central tendon

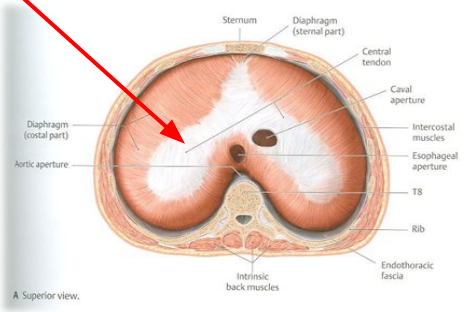
Nerve supply: phrenic nerve (C3,4,5), penetrates diaphragm & innervates it from abdominal surface

	origin	attachment	insertion	action
Diaphragm	• **costal**: lower 6 costal cartilages • **vertebral**: upper 3 lumbar vertebrae (right and left crus + arcuate ligament) • **sternal**: xiphoid process of sternum	• sternum • costal cartilages • 12th rib • lumbar vertebrae	central tendon (Lies at the level of xiphisternal joint , at 9th thoracic vertebra)	contraction (descent) of diaphragm increase the vertical diameter of thoracic cavity (essential for normal breathing)









Vertebral origin of diaphragm

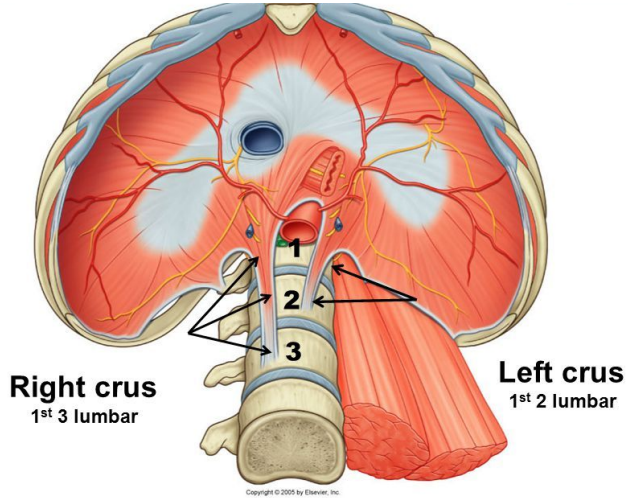
Extra slide but was explained by the doctors!

formed of 2 crura:

- **Right crus**: larger than the left crus, and attached to the upper 3 lumbar vertebrae.
  - it form the physiological sphincter of the stomach.
- **Left crus:** smaller than the right crus, and attached to the upper 2 lumbar vertebrae.

they (right and left crura) are supplemented by 5 arcuate ligaments

- **Arcuate ligaments:**
  - **median arcuate ligament:** connecting both crura, and forming the anterior boundary of the aortic opening.
  - **2 medial arcuate ligaments:** from each crus to the transverse process of L1
  - **2 lateral arcuate ligaments:** from the transverse process of L1 to the last 3 transverse process on each side (L3-L4-L5).

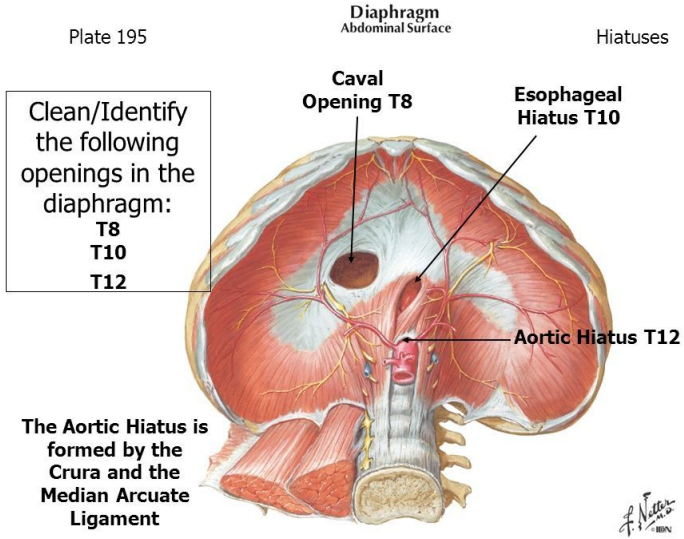


Openings of diaphragm (extra)

3 openings:

1) **Vena caval opening:** left side of the diaphragm, 0.5 inches from the median line, at T8.
2) **Oesophageal opening** (esophagus): right side of diaphragm, 0,5 inches from the median line, at T10.
3) **Aortic opening**: at the middle of diaphragm, at T12.

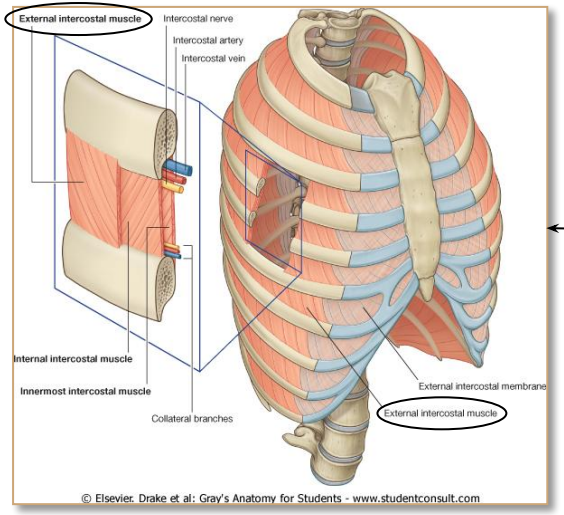
mnemonic to remember them:
Voice of Arab (from left to right)

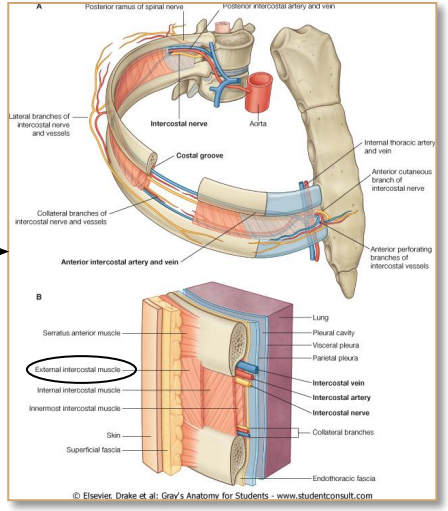


Inspiratory muscles

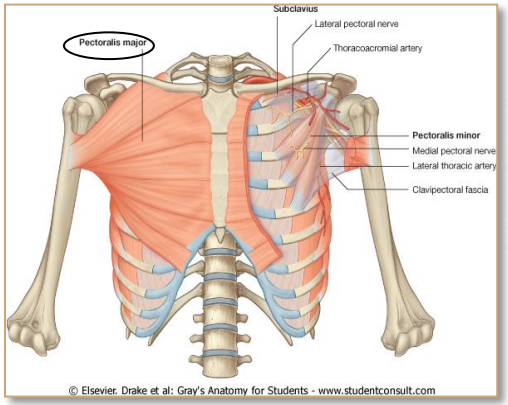
EXTERNAL INTERCOSTAL MUSCLES

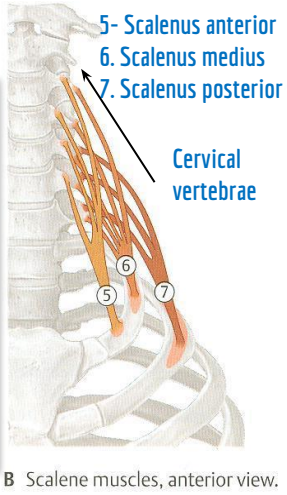
- 11 muscles.
- Attachments: from lower border of rib above to upper border of rib below.
- Direction of fibers: downward & medially (and forward).
- Nerve supply: intercostal nerves (T1-T11), subcostal nerve (T12).
- Action: rib elevators (inspiratory).





Accessory muscles in forced Inspiration:	Origin	Insertion	Action
PECTORALIS MAJOR	Sternum + costal cartilages.	Bicipital groove of Humerus.	Increases anteroposterior diameter of thoracic cavity, when arm is fixed (inspiratory).
SCALENE MUSCLES	Cervical vertebrae.	1st (anterior and medius) & 2nd (posterior) ribs	Elevates 1st & 2nd ribs (inspiratory), main action is lateral flexion of the neck.





B Scalene muscles, anterior view.

Expiratory Muscles

in quiet/normal expiration there is no need for muscles (passive) , However ONLY in forced expiration (exercising,running,etc..) these muscles is needed and will be Active.

Expiratory Muscles is divided into:-

A-Rib Depressors:

Function: (depress/bring down the ribs)
Nerve supply: Intercostal nerves (ventral rami of **T1-T11**)
1-internal intercostal
2-innermost intercostal
3-subcostals
4-transversus thoracis (or sterno costalis)

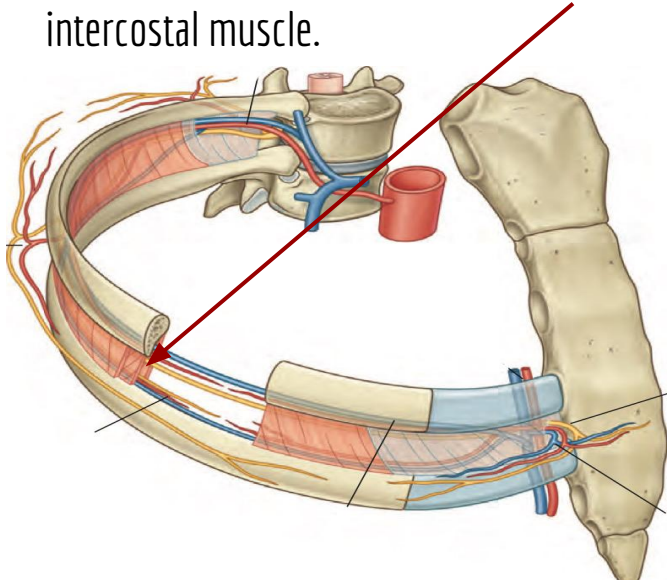
B- Anterior abdominal wall muscles:

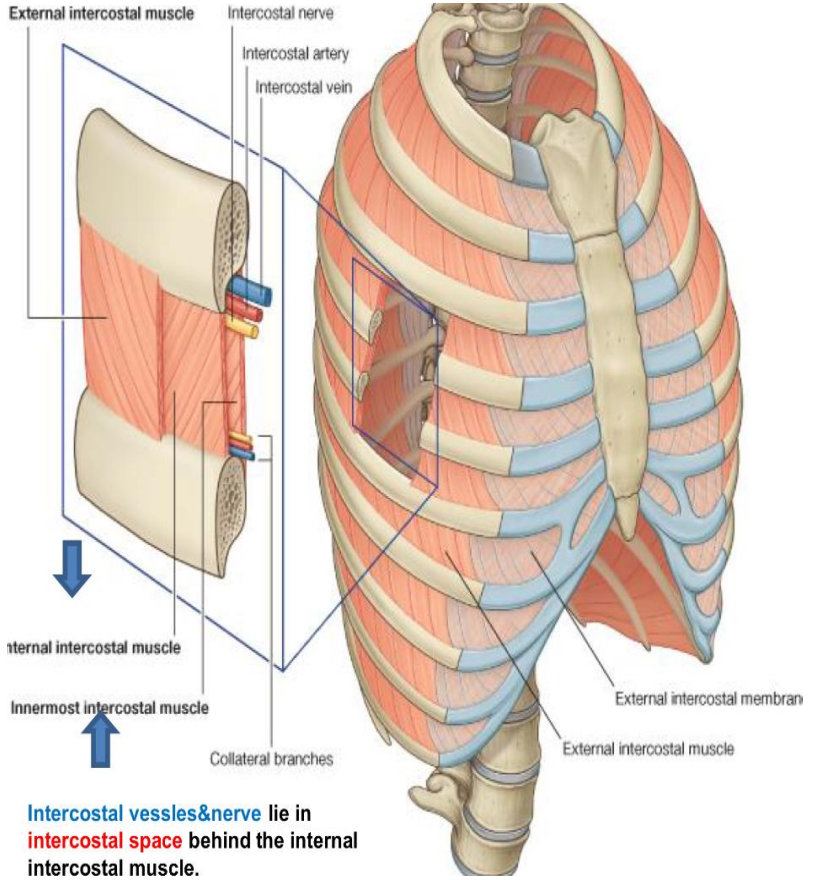
Function:(Compression of abdominal viscera to help in ascent diaphragm)
1-external oblique
2-internal oblique
3-transversus abdominis
4-rectus abdominis

Rib Depressors (the rest of intercostal muscles):

1-internal intercostal
2-innermost intercostal
(Direction:Upward and Medially)

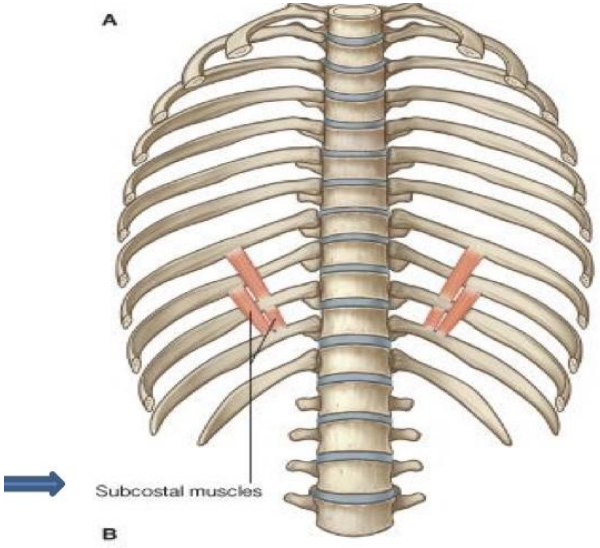
- Lies between these two muscles the intercostal vessels and nerves in a space called the intercostal space behind internal intercostal muscle.



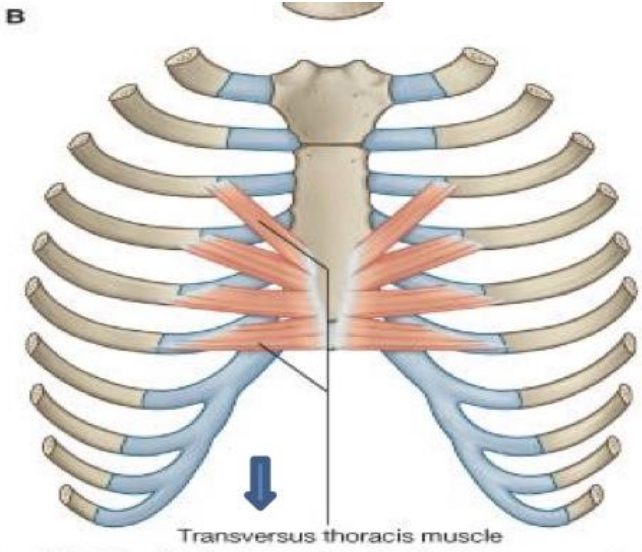


Rib Depressors (the rest of intercostal muscles):

3- Subcostal muscle



4-transversus thoracis



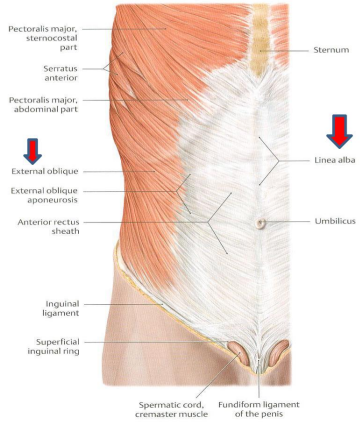
‘’note,the intercostal muscles are 5:- (with same nerve supply, intercostal nerves)

1-External intercostal (Rib elevator-inspiratory)

2-internal intercostal , 3-innermost intercostal ,4-subcostalis ,5-transversus thoracis (rib depressors-expiratory)

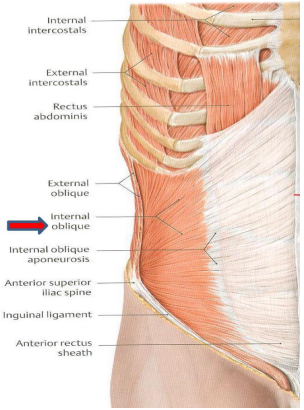
Anterior Abdominal wall

is made of 4 muscles 3 are Layers and 1 is normal muscle (not layer)



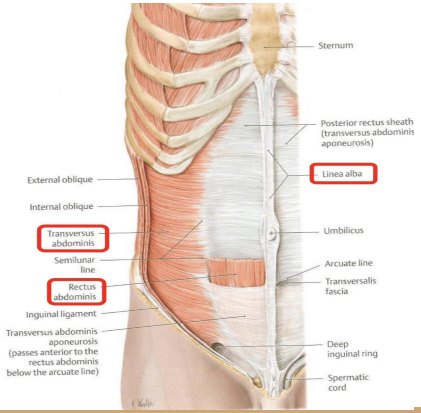
1-External Oblique (outer layer)

Direction: Downward & Medialy



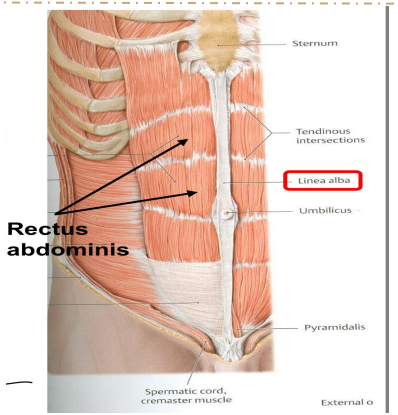
2-Internal Oblique (middle layer)

Direction: Upward and Medially



3-Transversus abdominis (inner layer)

Direction: Transverse

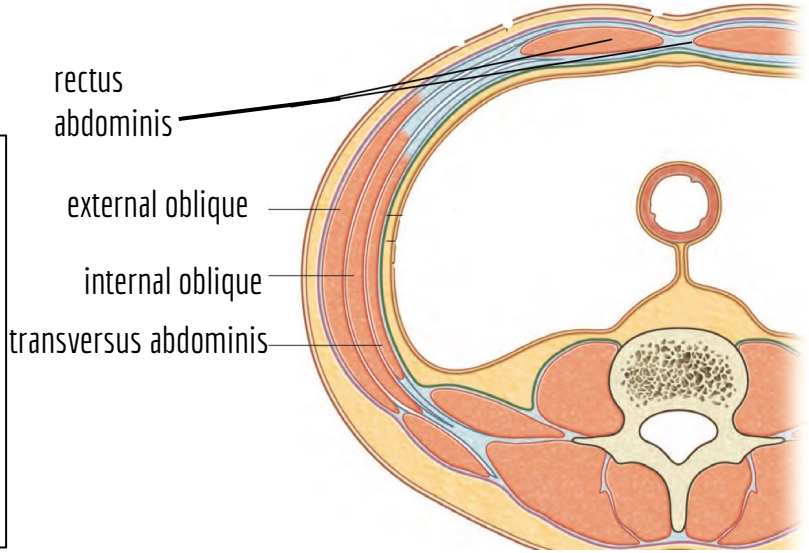


4-Rectus abdominis: (forms the six-packs)

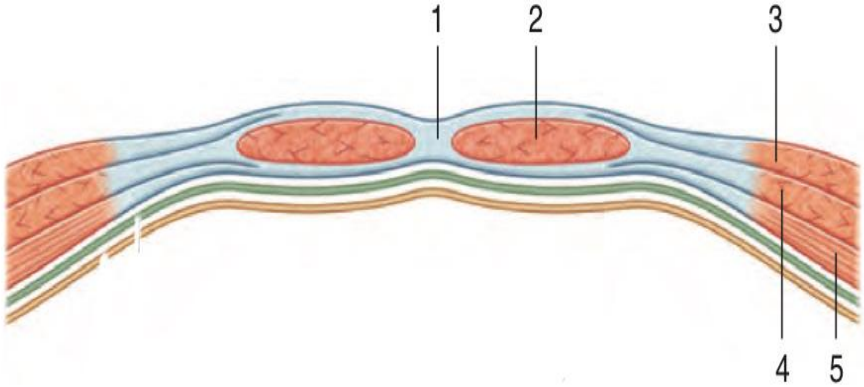
Direction: vertical

Extra

* a way to remember directions of muscles :
-oblique means inclined (مائل) so any
muscle have oblique in it means its direction is NOT straight (direction of external oblique+internal oblique is not straight)
-Rectus means straight so if rectus in the muscle name that mean IT IS straight (direction of rectus abdominis=vertical)
-direction of transversus abdominis = transverse



1-linea alba*(white line in latin): fused aponeurosis (NOT tendinous) of 6 muscles from xiphoid process to pubic symphysis
2-Rectus abdominis:(LOCATED BETWEEN- 4 internal and 5 transversus)
3-External Oblique
4-Internal Oblique
5-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 (L1).

Summary of Respiratory Movement

Inspiration

Quite

Contraction(Descent) of diaphragm

↑ In vertical diameter

Elevation of ribs (External intercostal)

↑ In :
-Anteroposterior diameter.
-Lateral diameter

Forced

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

Expiration

Quite

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

Forced

Contraction of anterior Abdominal wall muscle

Compression of abdominal viscera

Ascent of diaphragm

Depression of ribs (Rest of intercostal muscles)

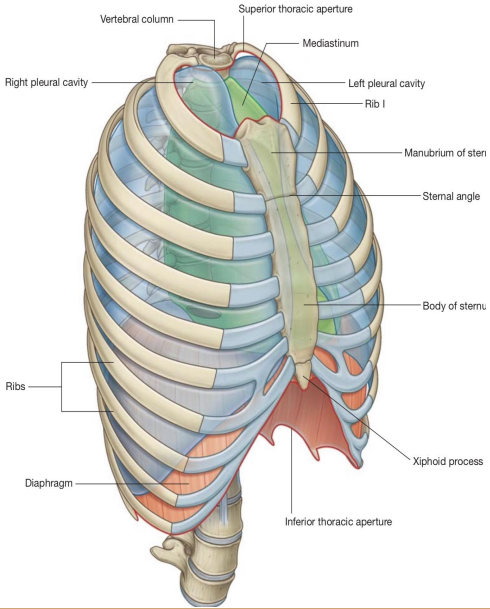
Summary

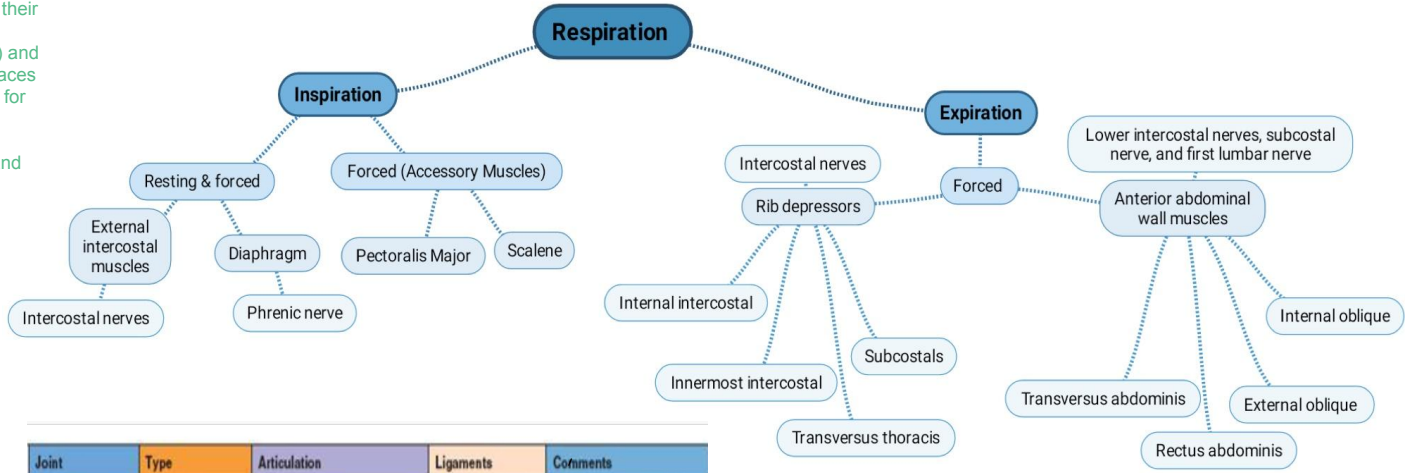
Thoracic wall :

posteriorly, it is made up of twelve thoracic vertebrae and their intervening intervertebral discs;

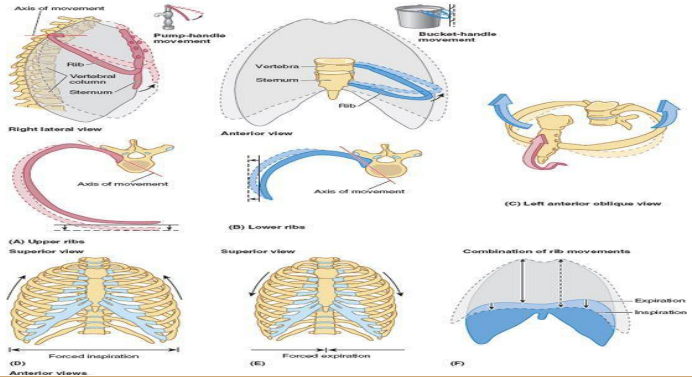
■ laterally, the wall is formed by ribs (twelve on each side) and three layers of flat muscles, which span the intercostal spaces between adjacent ribs, move the ribs and provide support for the intercostal spaces;

■ anteriorly, the wall is made up of the sternum, which consists of the manubrium of sternum, body of sternum, and xiphoid process.





Joint	Type	Articulation	Ligaments	Comments
Costovertebral Joints of head of rib Costotransverse	Synovial plane joint	Head of each rib with superior demi or costal facet of vertebral body of same number and inferior demi- or costal facet of vertebral body superior to it and IV disc between them Tubercle of rib with transverse process of vertebra of same number	Radiate and intra-articular ligaments of head of rib Costotransverse; lateral and superior costotransverse	Heads of 1st, 11th, and 12th ribs (sometimes 10th) articulate only with vertebral body of same number 11th and 12th ribs do not articulate with transverse process of vertebrae of same number
Costochondral	Primary (hyaline) cartilaginous joint	Lateral end of costal cartilage with sternal end of rib	Cartilage and bone bound together by periosteum	No movement normally occurs at this joint; costal cartilage provides flexibility
Sternocostal	1st: primary cartilaginous joint (synchondrosis) 2nd–7th: synovial plane joint	Articulation of 1st costal cartilages with manubrium of sternum Articulation of the 2nd–7th pairs of costal cartilages with sternum	Anterior and posterior radiate sternocostal; intra-articular	Articular cavities often absent; fibrocartilage covers articular surfaces



Summary

Table 4.1 Abdominal wall muscles

Muscle	Origin	Insertion	Innervation	Function
External oblique	Muscular slips from the outer surfaces of the lower eight ribs (ribs V to XII)	Lateral lip of iliac crest; aponeurosis ending in midline raphe (linea alba)	Anterior rami of lower six thoracic spinal nerves (T7 to T12)	Compress abdominal contents; both muscles flex trunk; each muscle bends trunk to same side, turning anterior part of abdomen to opposite side
Internal oblique	Thoracolumbar fascia; iliac crest between origins of external and transversus; lateral two-thirds of inguinal ligament	Inferior border of the lower three or four ribs; aponeurosis ending in linea alba; pubic crest and pectineal line	Anterior rami of lower six thoracic spinal nerves (T7 to T12) and L1	Compress abdominal contents; both muscles flex trunk; each muscle bends trunk and turns anterior part of abdomen to same side
Transversus abdominis	Thoracolumbar fascia; medial lip of iliac crest; lateral one-third of inguinal ligament; costal cartilages lower six ribs (ribs VII to XII)	Aponeurosis ending in linea alba; pubic crest and pectineal line	Anterior rami of lower six thoracic spinal nerves (T7 to T12) and L1	Compress abdominal contents
Rectus abdominis	Pubic crest, pubic tubercle, and pubic symphysis	Costal cartilages of ribs V to VII; xiphoid process	Anterior rami of lower seven thoracic spinal nerves (T7 to T12)	Compress abdominal contents; flex vertebral column; tense abdominal wall
Pyramidalis	Front of pubis and pubic symphysis	Into linea alba	Anterior ramus of T12	Tenses the linea alba

Summary

Table 3.2 Muscles of the thoracic wall

Muscle	Superior attachment	Inferior attachment	Innervation	Function
External intercostal	Inferior margin of rib above	Superior margin of rib below	Intercostal nerves; T1–T11	Most active during inspiration; supports intercostal space; moves ribs superiorly
Internal intercostal	Lateral edge of costal groove of rib above	Superior margin of rib below deep to the attachment of the related external intercostal	Intercostal nerves; T1–T11	Most active during expiration; supports intercostal space; moves ribs inferiorly
Innermost intercostal	Medial edge of costal groove of rib above	Internal aspect of superior margin of rib below	Intercostal nerves; T1–T11	Acts with internal intercostal muscles
Subcostales	Internal surface (near angle) of lower ribs	Internal surface of second or third rib below	Related intercostal nerves	May depress ribs
Transversus thoracis	Inferior margins and internal surfaces of costal cartilages of second to sixth ribs	Inferior aspect of deep surface of body of sternum, xiphoid process and costal cartilages ribs IV–VII	Related intercostal nerves	Depresses costal cartilages

Questions (MCQs):

1- the joint between the 1st cartilage and the manubrium is:
A- primary cartilaginous B- secondary cartilaginous C- plane synovial joint D- none of these.

2- which of these statements is true:
A- the superior aperture of the thoracic cage is narrow, closed and continuous with neck
B- the inferior aperture of the thoracic cage is wide and unclosed by the diaphragm
C- the thoracic cage is pyramidal in shape
D- the thoracic cage is formed of costal cartilages anteriorly.

3-What is the respiratory function of Anterior abdominal wall muscles ?
A-Rib elevator
B-Rib Depressor
C-Compression of abdominal viscera to help in ascent diaphragm
D-Compression of abdominal viscera to help in descent diaphragm

4-How many Intercostal Muscle does the regular human have?
A-2 B-3 C-4 D-5

Answers:
1)A
2)D
3)C
4)D

Team Members

Lamia Abdullah Alkuwaiz (Team Leader)

Rawan Mohammad Alharbi
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Afnan Abdulaziz Almustafa
Ahad Ahmed Algrain
Albandari Alshaye
AlFhadah abdullah alsaleem
Ghaida Alsanad
Layan Hassan Alwatban
Lojain Azizalrahman
Maha Barakah
Majd Khalid AlBarrak
Nouf Alotaibi
Rinad Musaed Alghoraiby
Wafa Alotaibi
Wejdan Fahad Albadrani

Faisal Fahad Alsaif (Team Leader)

Abdulaziz Al dukhayel
Abdulelah Aldossari
Abdulrahman Alduhayyim
Hamdan Aldossari
Mohammed Alomar
Saud Alghufaily
Hassan Aloraini
Abdullah Alomar
Fahad Alfaiz
Saad Aloqile
Abdulmajeed Alwardi
Rayyan Almousa
Sultan Alfuhaid
Ali Alammari
Fahad alshughaithry
Fayez Ghiyath Aldarsouni
Mohammed Alquwayfili
Saleh Almoaiqel
Abdullah Almeaither
Abduljabbar Al-yamane
Sultan Al-nasser
Majed Aljohani
Zeyad
Al-khenaizan
Mohammed Nouri
Abdulaziz Al-drgam
Fahad Aldhowaihy
Omar alyabis
Akram Alfandi
Abdulhaziz Alabdulkareem