Thorax & Thoracic Wall. Muscles of Respiration. Pleurae & Pleural Cavities. Respiratory Movements.

Structures of the Thorax that Produce Respiratory Movements

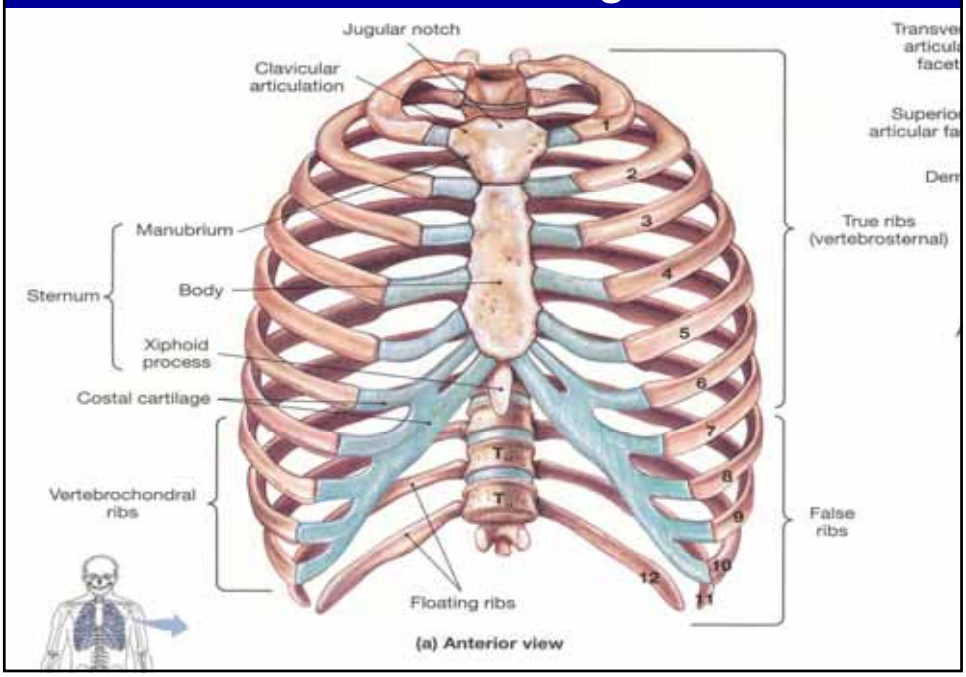
- Bones & Joints of the Thorax
- Muscles of Respiration
- Pleurae & Pleural cavities

- Respiratory Movements of the Chest
  - Inspiration
    - It requires expansion of the thorax and increase of the:
      - Anteroposterior diameter of the thoracic chest
      - Transverse (lateral) diameter of the thoracic chest
      - Vertical diameter of the thoracic chest
  - Expiration
    - It requires decrease of the above diameters and volume of thoracic cavity

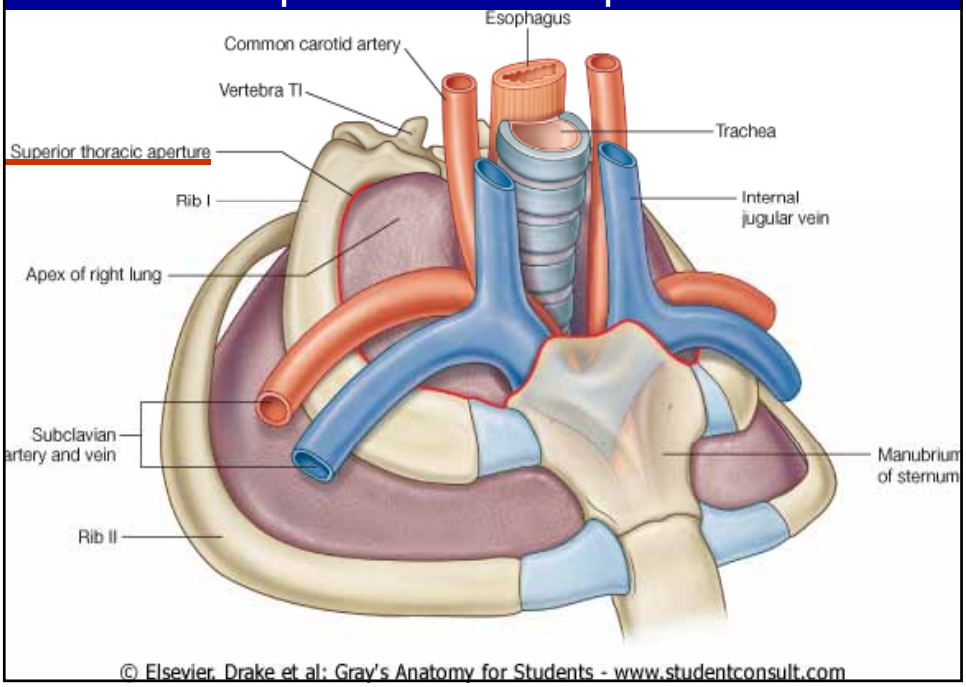
Bones of the Thoracic Cage

- 12 thoracic vertebrae
  - 12 pairs of ribs articulate with them
- 12 pairs of ribs (24 costal bones)
  - Rib 1–7 “true” ribs
    - They have direct attachment to sternum
  - Rib 8-12 "false" ribs
    - Rib 8-10 have attachment to sternum via the costal arch and cartilage of 7th rib
  - Costal arch is formed by cartilages of 7 to 10 ribs
  - Rib 11-12 "floating" ribs
    - They do not form costotransverse joints and have no attachment to the sternum or costal arch
- One sternum. (It gives attachment to 2 clavicles.)
  - 7 upper pairs of ribs articulate with it directly & ribs from 8 to 10 indirectly via the costal arch

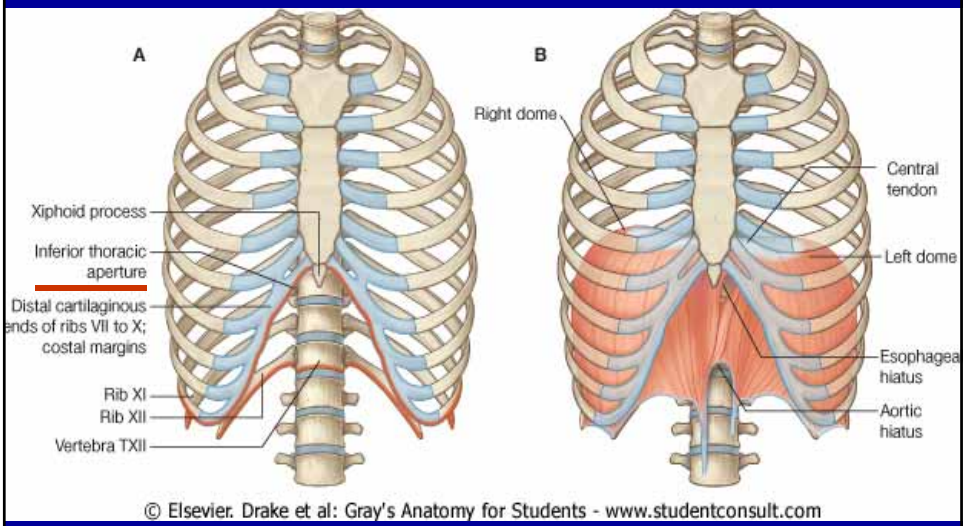
Thoracic Cage



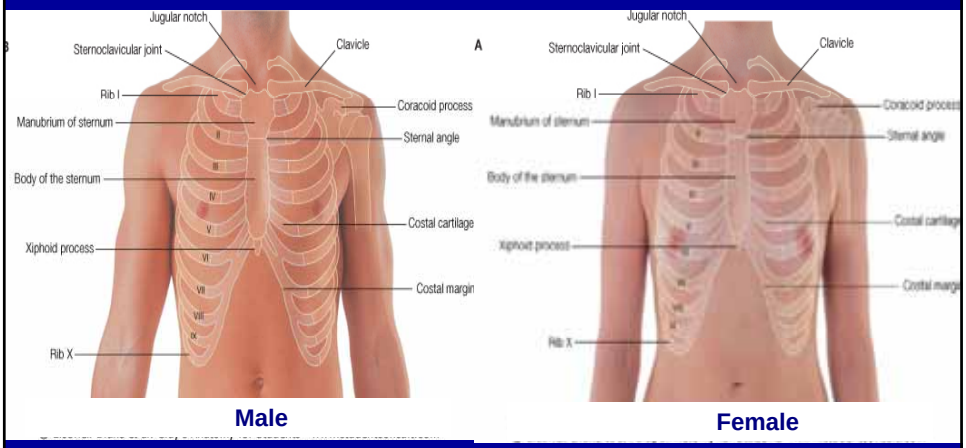
Superior Thoracic Aperture



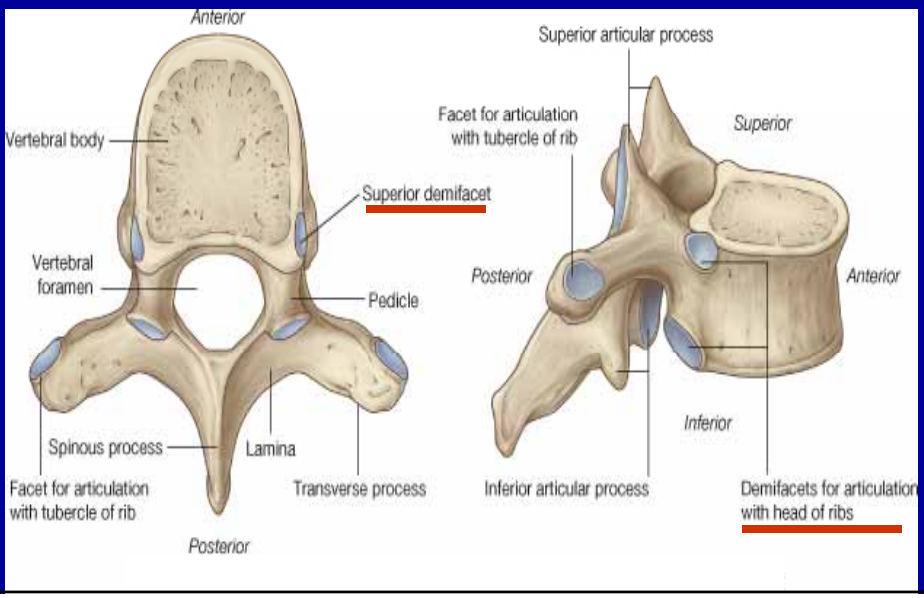
Inferior Thoracic Aperture



Surface Markings of Ribs & Sternum



Typical Thoracic Vertebra (6)
(Presence of Costal Demifacets)

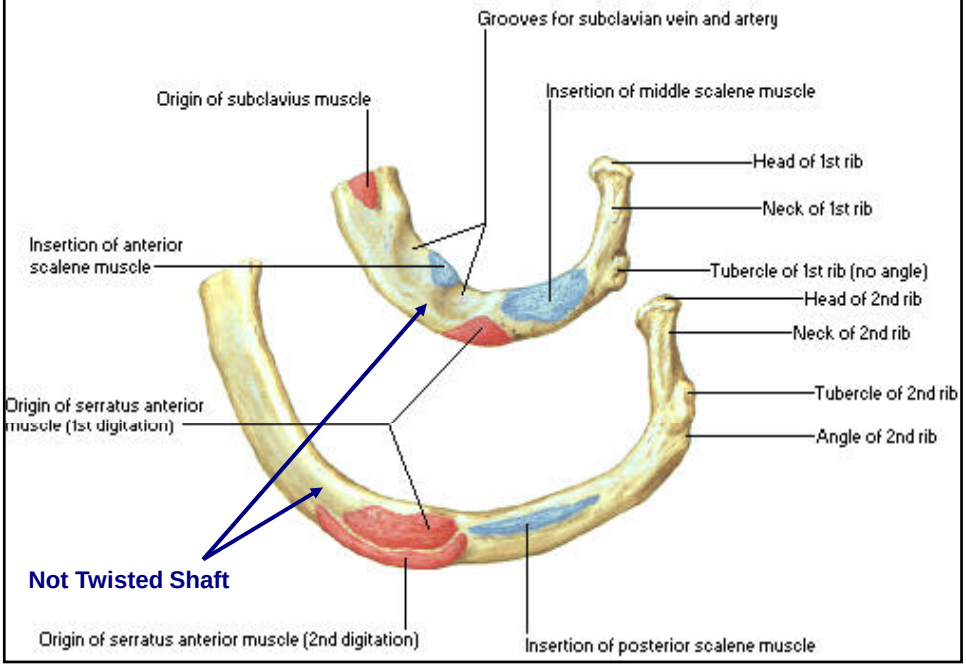


Atypical Thoracic Vertebrae

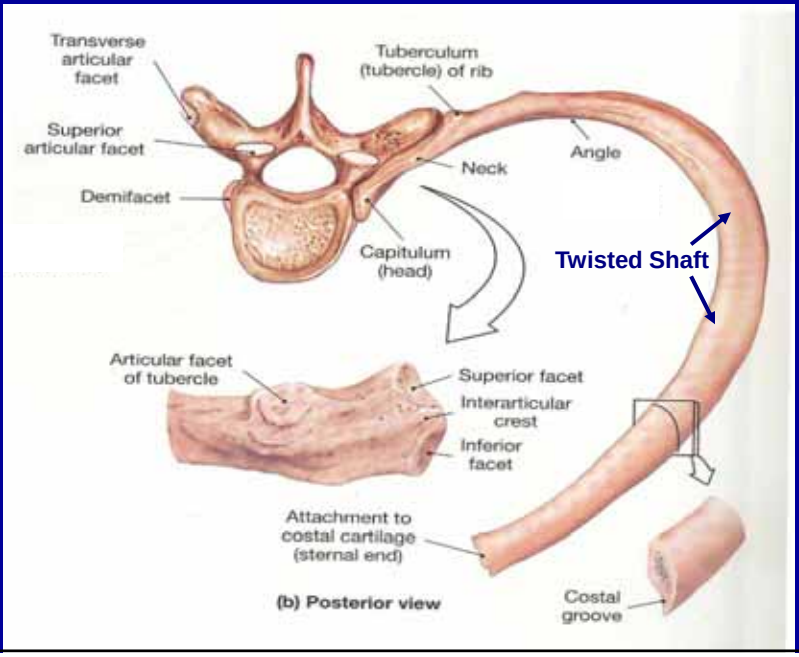
Superior vertebral notch

Inferior vertebral notch

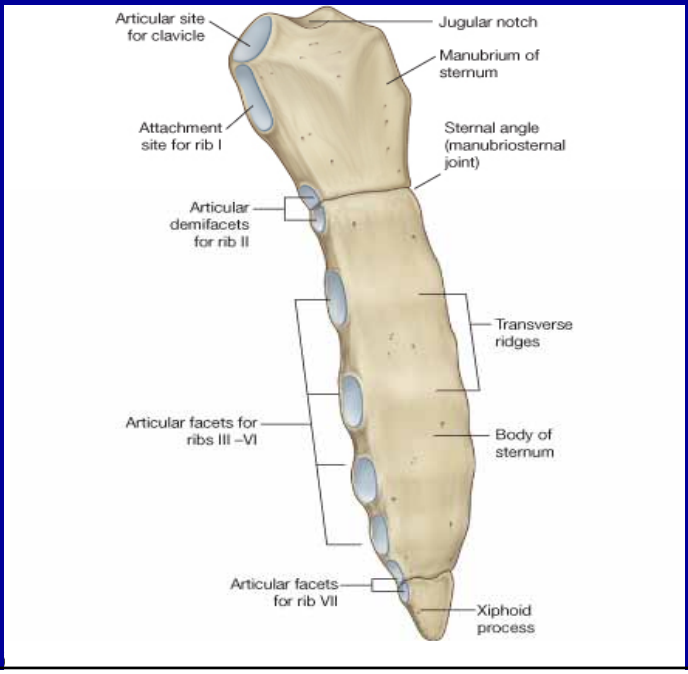
The 1st & 2nd Ribs



A Typical Rib



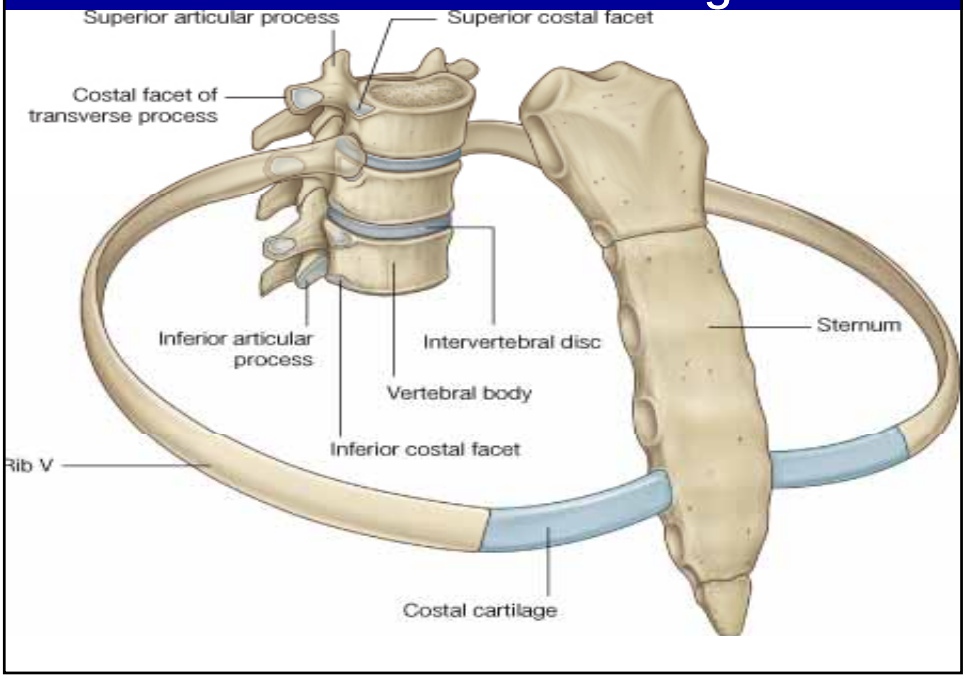
Sternum (Front view)



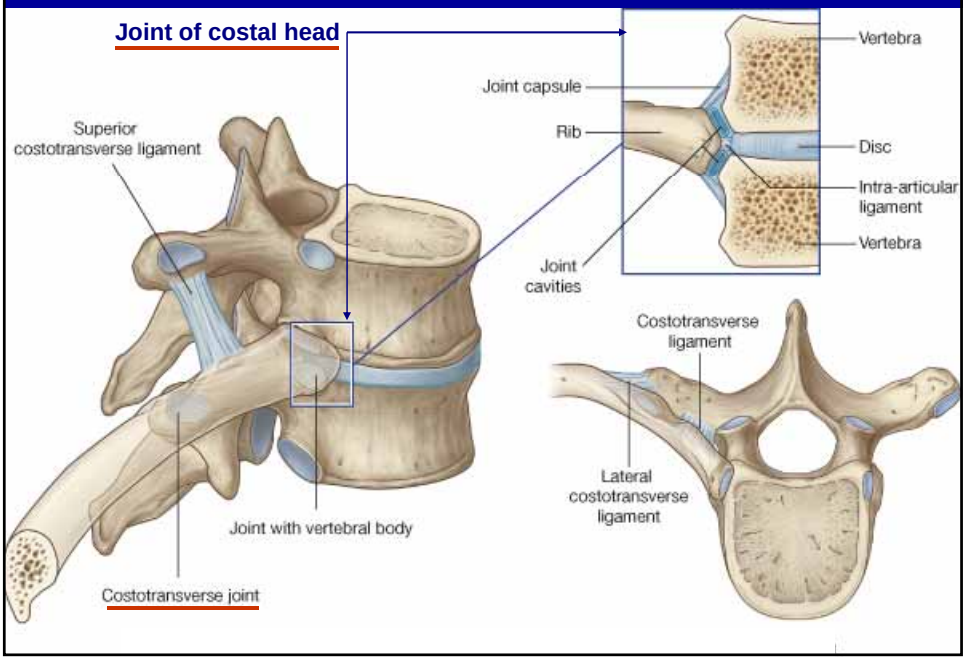
Joints of Thoracic Cage

- Costovertebral Joints
  - Sinovial
    - Joints of costal heads with vertebral bodies
      - They are reinforced by following ligaments: Radiate, Intraarticular
    - Costotransverse joints
      - They are reinforced by following ligaments
        - Superior & Lateral Costotransverse ligaments
- Sternocostal joints
  - Chondrosternal synovial joints (from 2nd to 7th ribs)
    - They are reinforces by Ligaments: Radiate sternocostal & Intraarticular
  - Interchondral synovial joints (from 6th to 9th cartilages
    - They are reinforces by Lateral & Medial Interchondral Ligaments
  - Synchondrosis of 1st costal cartilage with Manubrium Sterni
- Costochondral Junctions – between ribs and their cartilages
- Sternal Joints – Symphyses
  - Manubriosternal
  - Xiphisternal

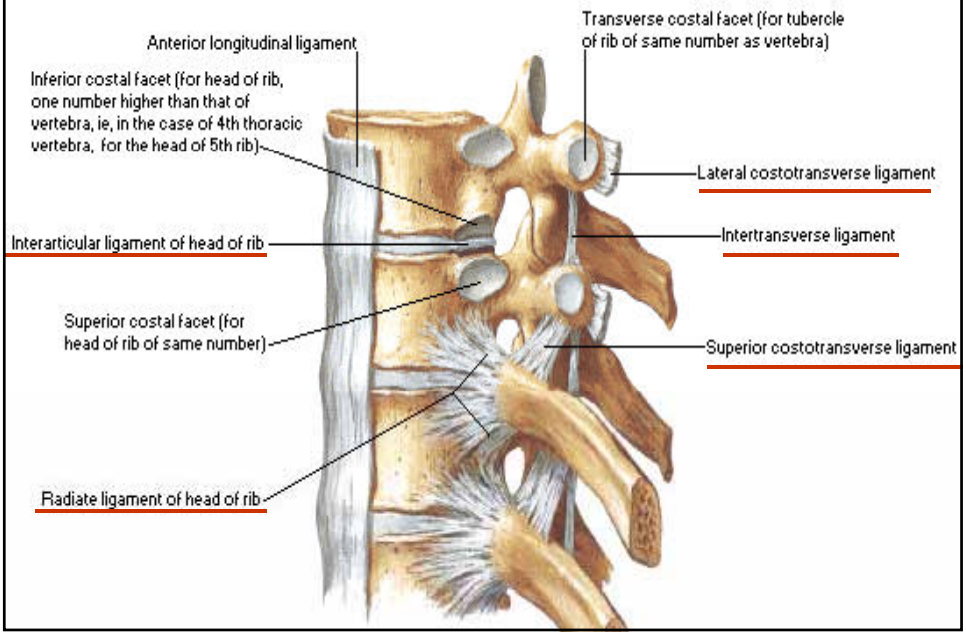
Joints of Thoracic Cage



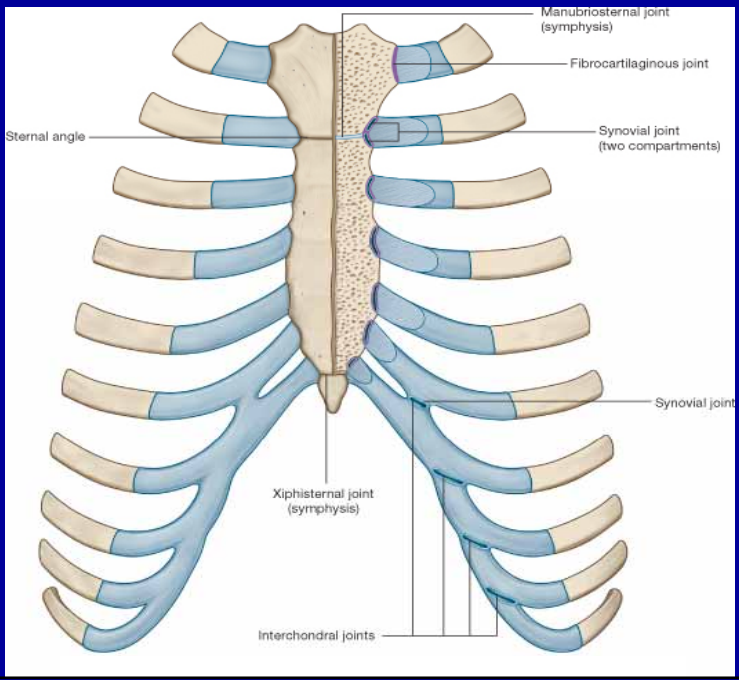
Costovertebral Joints



Costovertebral Joints



Chondrosternal & Interchondral Joints

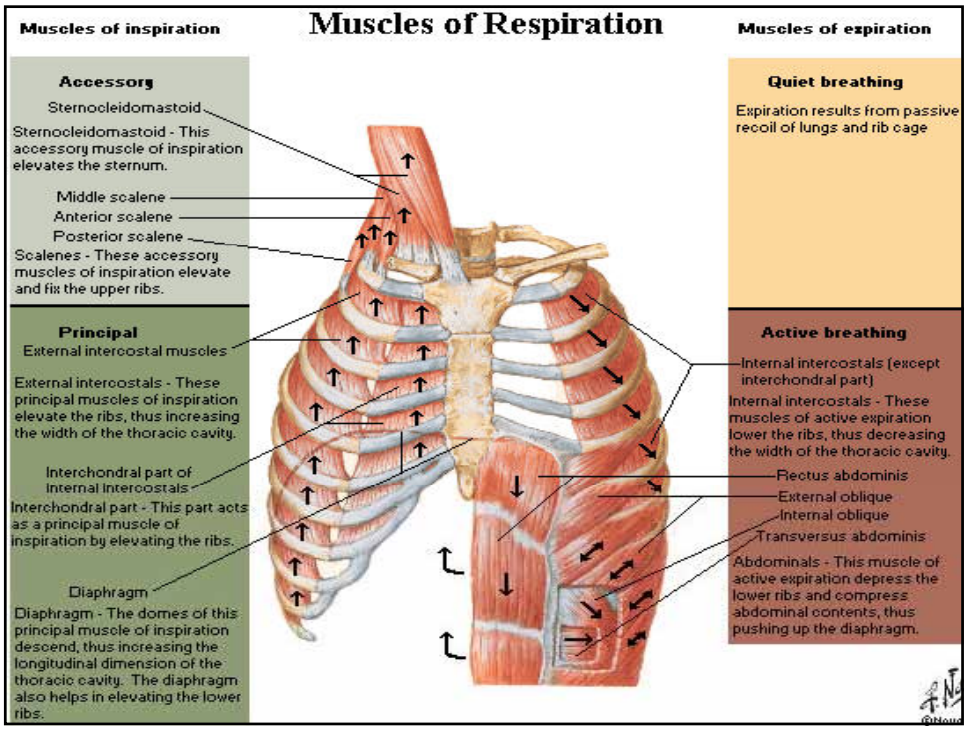


Muscles of Inspiration

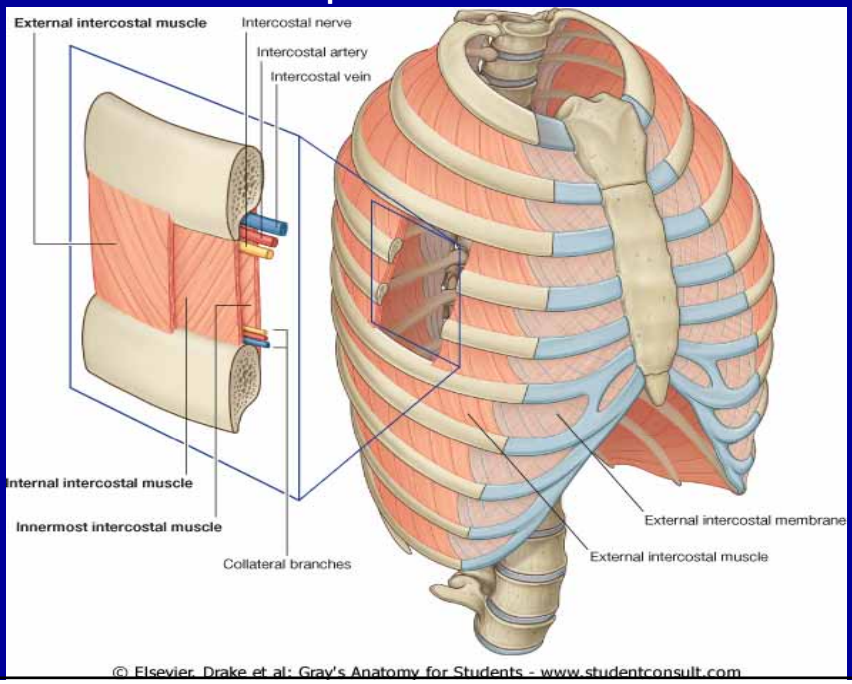
- **Quiet and Forceful Inspiration**
- External intercostals
- Diaphragm
- **Forceful Inspiration**
- Scaleni (anterior, medius, posterior)
- Sternocleidomastoid
- Serratus anterior
- Serratus posterior superior
- Pectoralis major
- Pectoralis minor
- Levatores Costarum
- Quadratus Lumborum

Muscles of Expiration

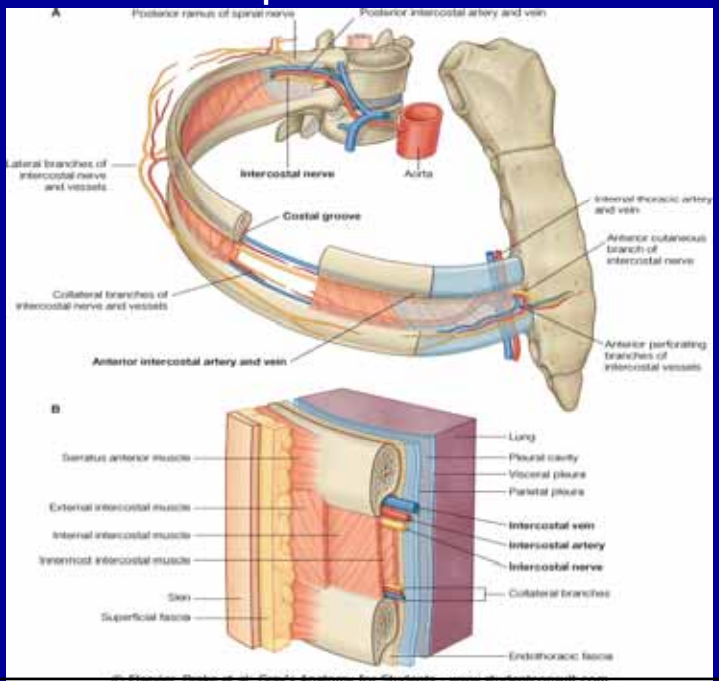
- **Quiet and Forceful Expiration**
- Internal & innermost intercostals
- Subcostals
- **Forceful Expiration**
- Transversus thoracis
- Rectus abdominis
- Obliquus externus abdominis
- Obliquus internus abdominis
- Transversus abdominis
- Latissimus dorsi
- Serratus posterior inferior



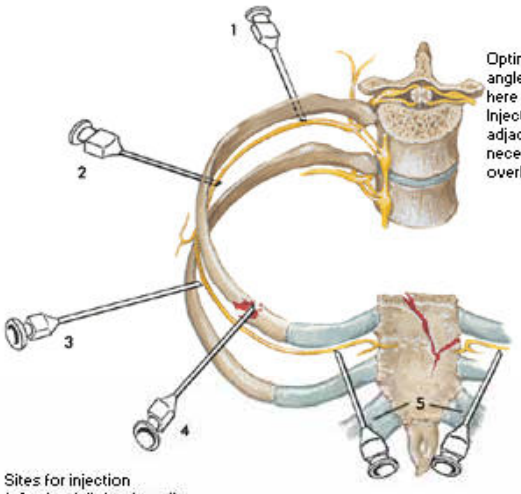
Intercostal Spaces & their Contents



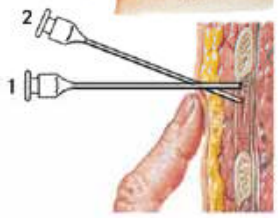
Intercostal Spaces & their Contents



Intercostal Nerve Block



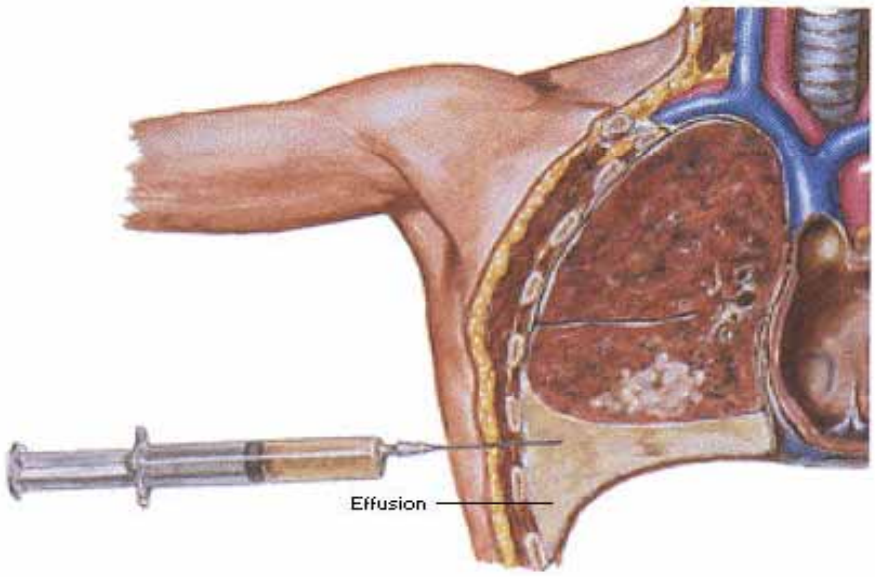
Optimal point to inject is angle of rib because rib is here most easily palpable. Injection of several adjacent nerves may be necessary because of overlapping innervation



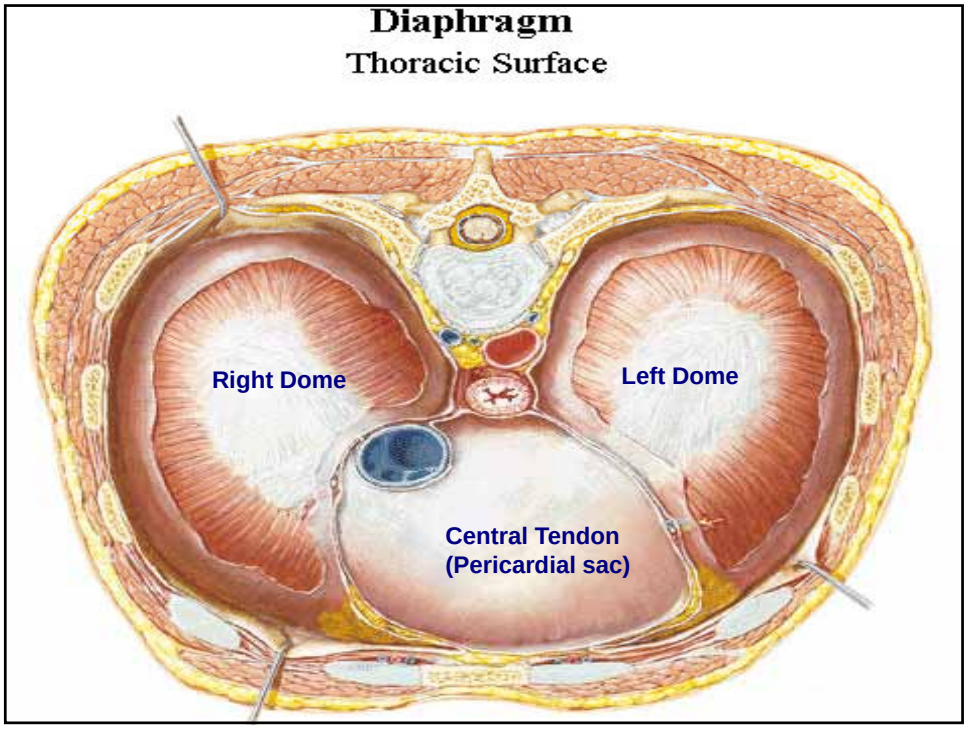
Sites for injection
1. Angle of rib (preferred)
2. Posterior axillary line
3. Anterior axillary line
4. Infiltration at fracture site
5. Parasternal

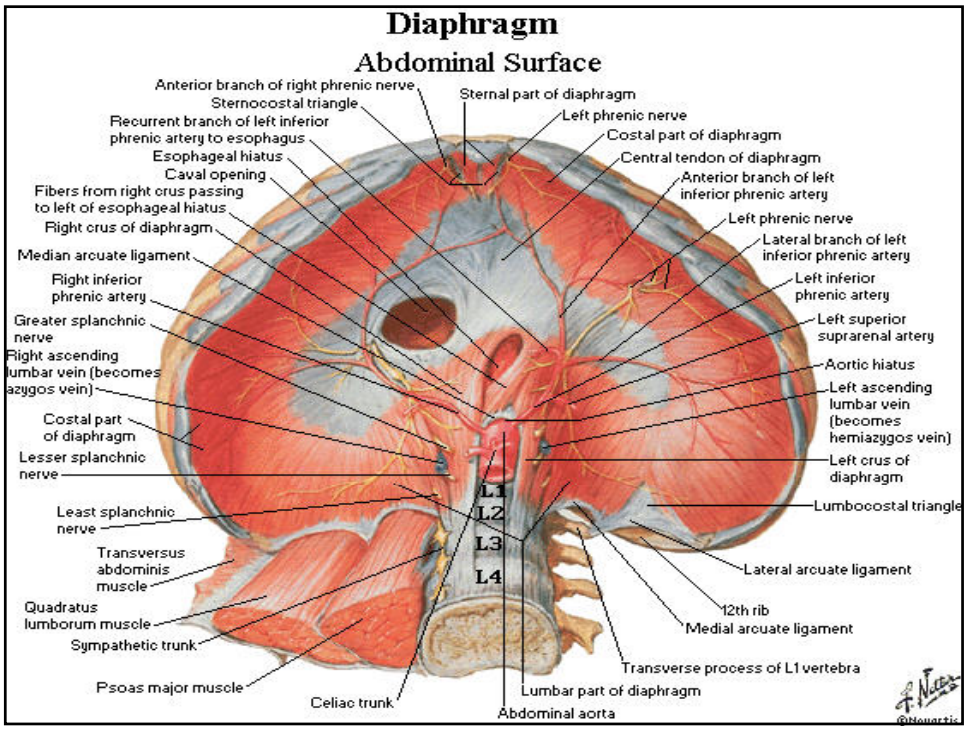
Needle introduced to contact lower border of rib (1), withdrawn slightly, directed caudad, advanced 1/8 inch to slip under rib and enter intercostal space (2). To avoid pneumothorax, aspirate before injecting 5 ml anesthetic

Thoracentesis

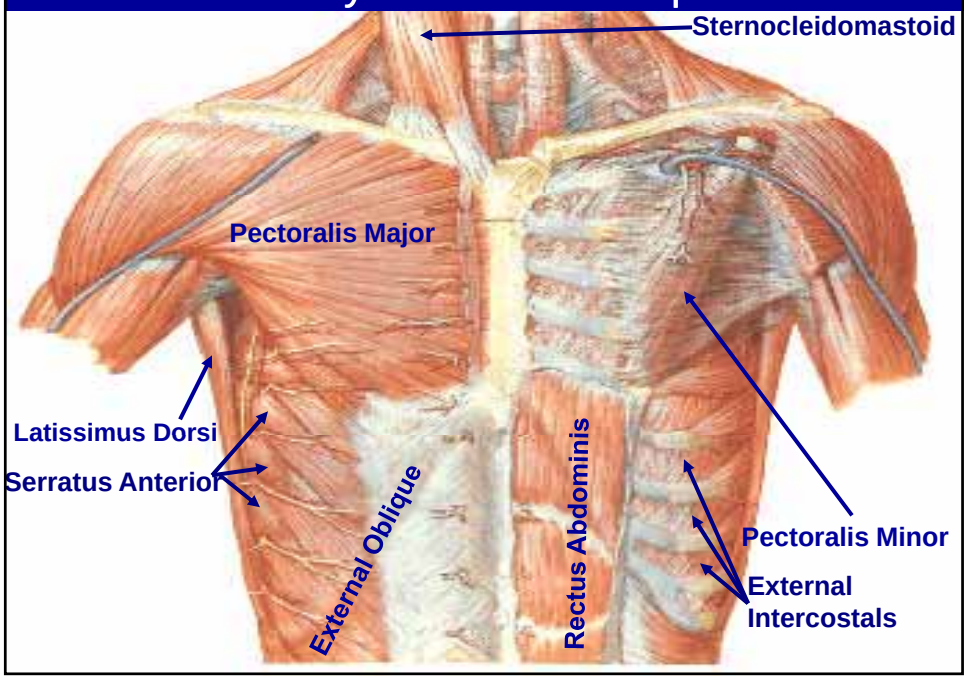


Thoracentesis performed to obtain sample for testing

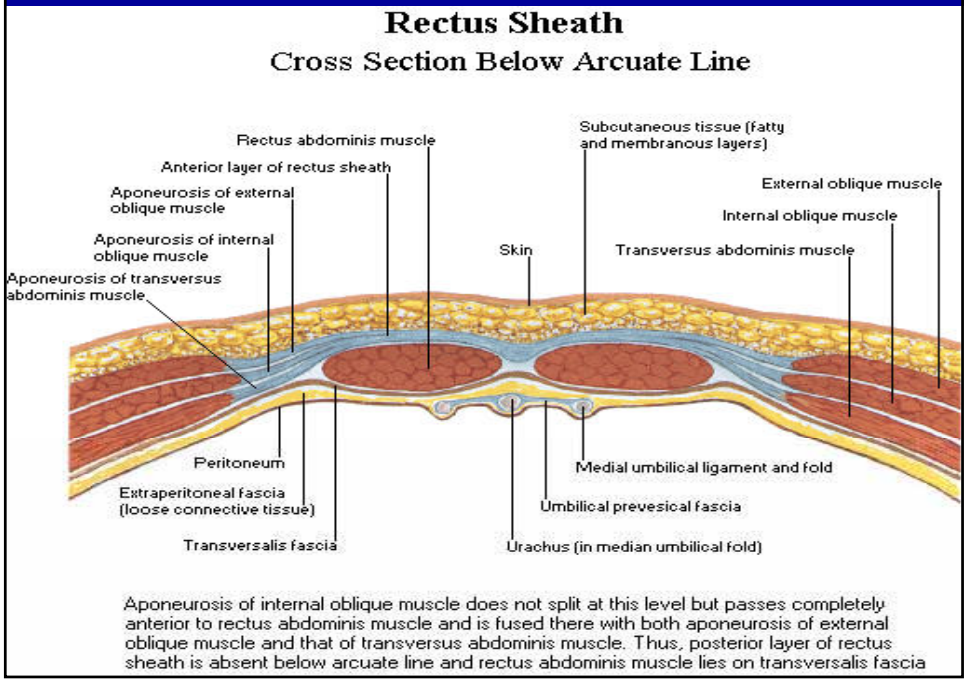

Diaphragm
Thoracic Surface
Right Dome
Left Dome
Central Tendon
(Pericardial sac)


Diaphragm
Abdominal Surface
Anterior branch of right phrenic nerve
Sternocostal triangle
Recurrent branch of left inferior phrenic artery to esophagus
Esophageal hiatus
Caval opening
Fibers from right crus passing to left of esophageal hiatus
Right crus of diaphragm
Median arcuate ligament
Right inferior phrenic artery
Greater splanchnic nerve
Right ascending lumbar vein (becomes azygos vein)
Costal part of diaphragm
Lesser splanchnic nerve
Least splanchnic nerve
Transversus abdominis muscle
Quadratus lumborum muscle
Sympathetic trunk
Psoas major muscle
Celiac trunk
Sternal part of diaphragm
Left phrenic nerve
Costal part of diaphragm
Central tendon of diaphragm
Anterior branch of left inferior phrenic artery
Left phrenic nerve
Lateral branch of left inferior phrenic artery
Left inferior phrenic artery
Left superior suprarenal artery
Aortic hiatus
Left ascending lumbar vein (becomes hemiazygos vein)
Left crus of diaphragm
L1
L2
L3
L4
Lumbocostal triangle
Lateral arcuate ligament
12th rib
Medial arcuate ligament
Transverse process of L1 vertebra
Lumbar part of diaphragm
Abdominal aorta

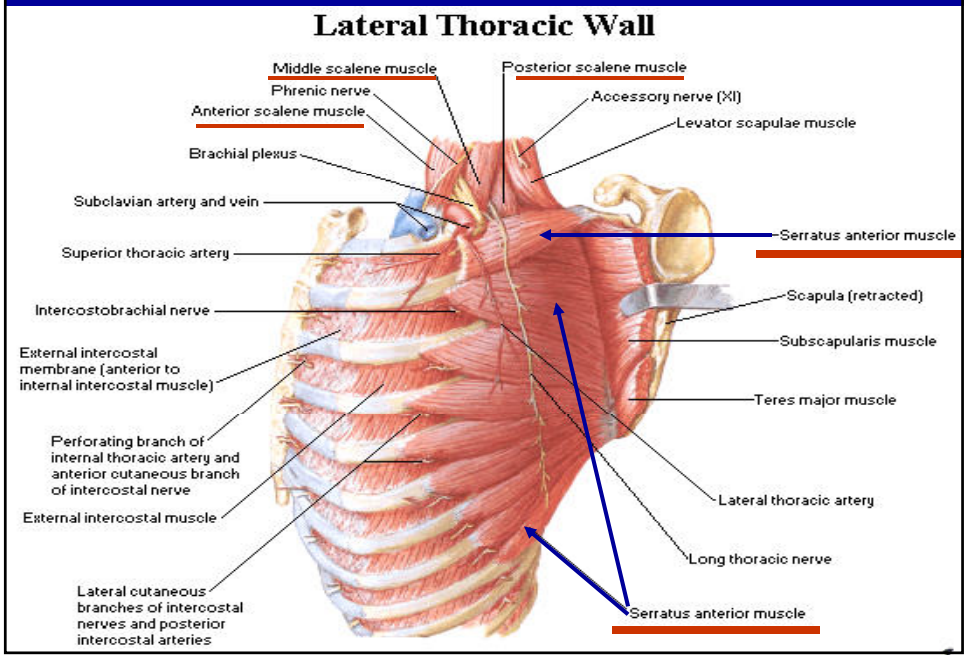
Accessory Muscles of Respiration



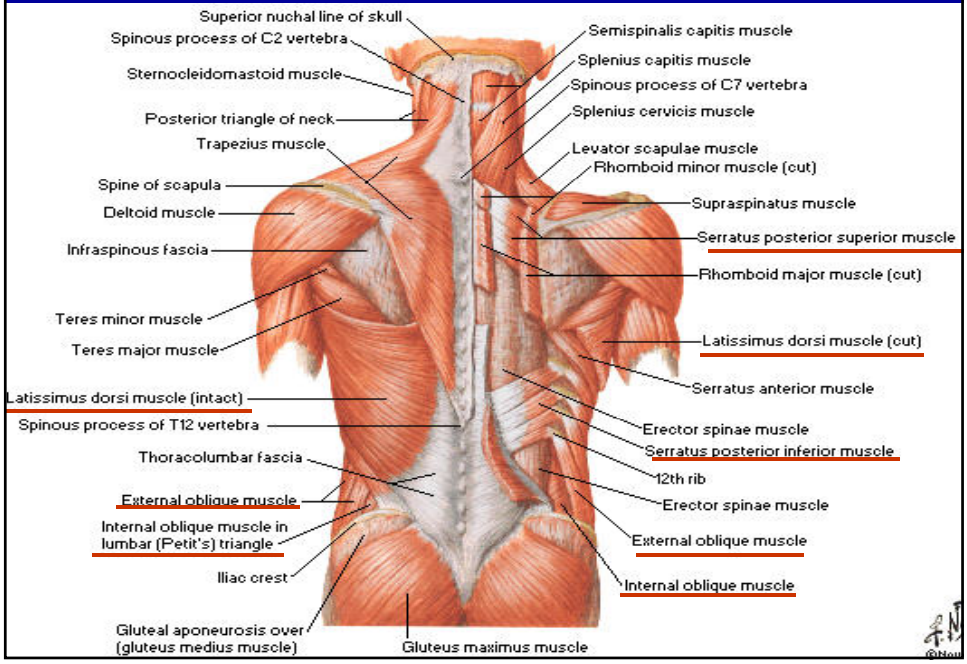
Anterolateral Abdominal Muscles



Accessory Muscles of Respiration



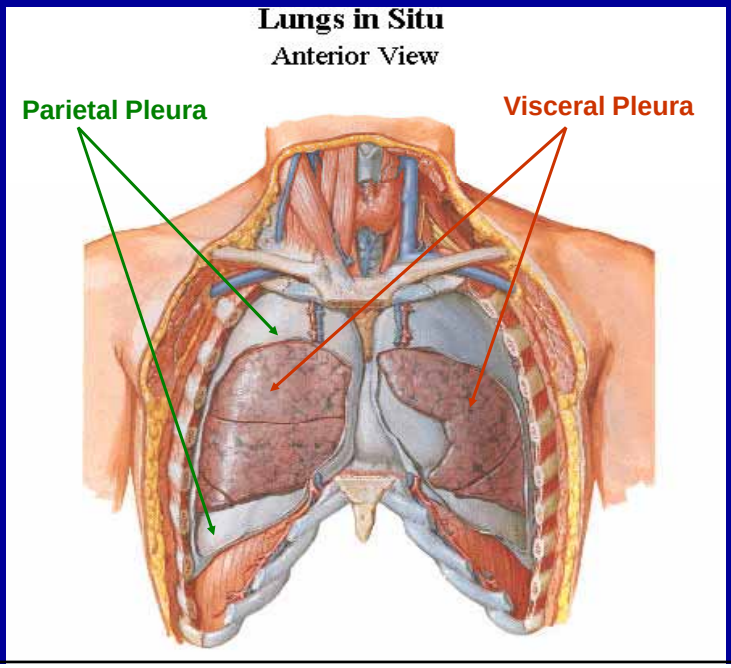
Accessory Muscles of Respiration



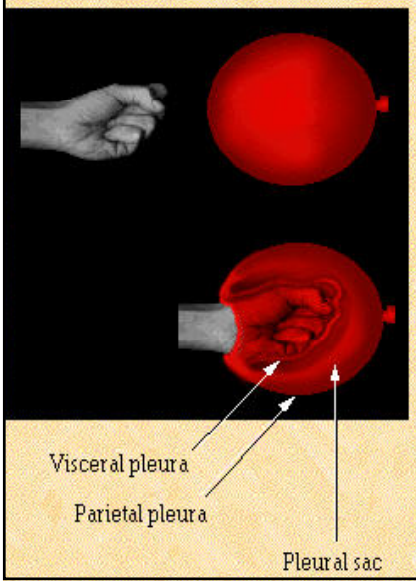
PLEURA

- **Pleura :** is a serous membrane, investing the lungs and lining the walls of the pleural cavities.
  - **Visceral Pleura:** The inner membrane of the pleural cavity, or the membrane immediately surrounding the lung. It covers each lobe invaginating into the fissure(s) of the lung (where there are extension(s) of the pleural cavity between lobes) and it is reflected over the root of the lung to the mediastinum, where it is continuous with the Parietal Pleura.
  - **Parietal Pleura:** The outer membrane, lining the walls of the pleural cavity. It is subdivided into four parts:
    - The **Costal Pleura**: That portion of the parietal pleura bordering the rib-cage.
    - The **Mediastinal Pleura:** That portion of the parietal pleura bordering the mediastinum.
    - The **Diaphragmatic Pleura:** That portion of the parietal pleura bordering the diaphragm.
    - The **Cervical Pleura :** That portion of the parietal pleura above the level of the superior thoracic aperture, projecting to the root of the neck.

Pleurae



Arrangement of Pleura



The arrangement of pleura and lungs is similar to that of a partly expanded balloon against which one puts one's fist. The rubber adjacent to the fist is like the visceral pleura, while the outer rubber is like the parietal pleura.

The space between the visceral and parietal pleural membranes is the pleural sac, or cavity. It contains a very small amount of pleural fluid, for lubrication of adjacent surfaces during lung movements.

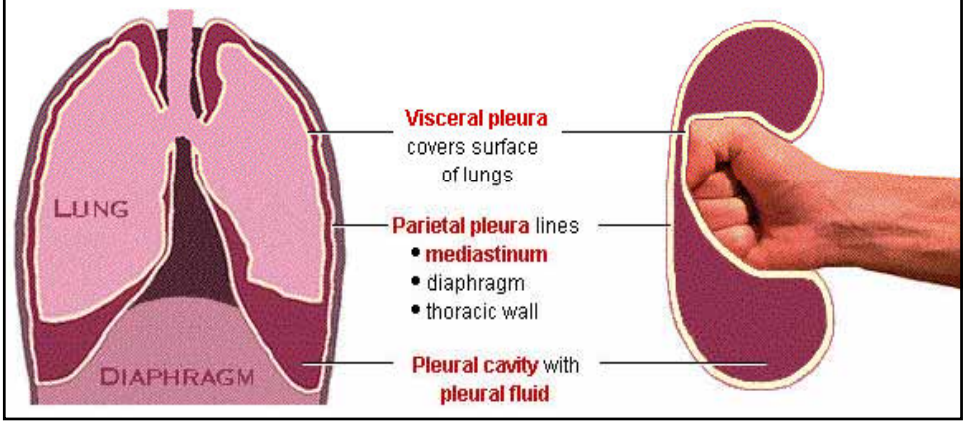
Arrangement of Pleura

Demonstration of Pleurae and the Lungs

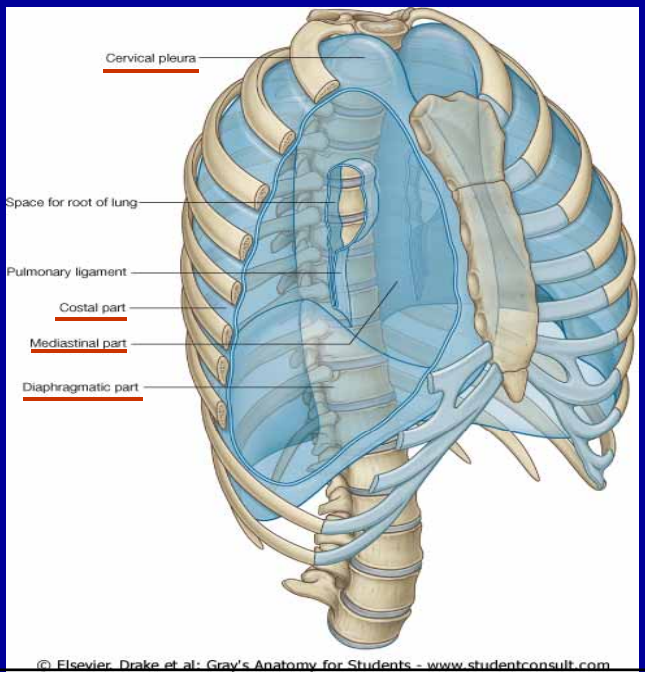
Each lung is surrounded by two layers of **serous membrane** known as the **pleurae**.

The visceral and parietal pleurae are actually a continuation of the same membrane.

The relationship between the pleurae and the lungs can be demonstrated by pushing a fist into a water-filled balloon.



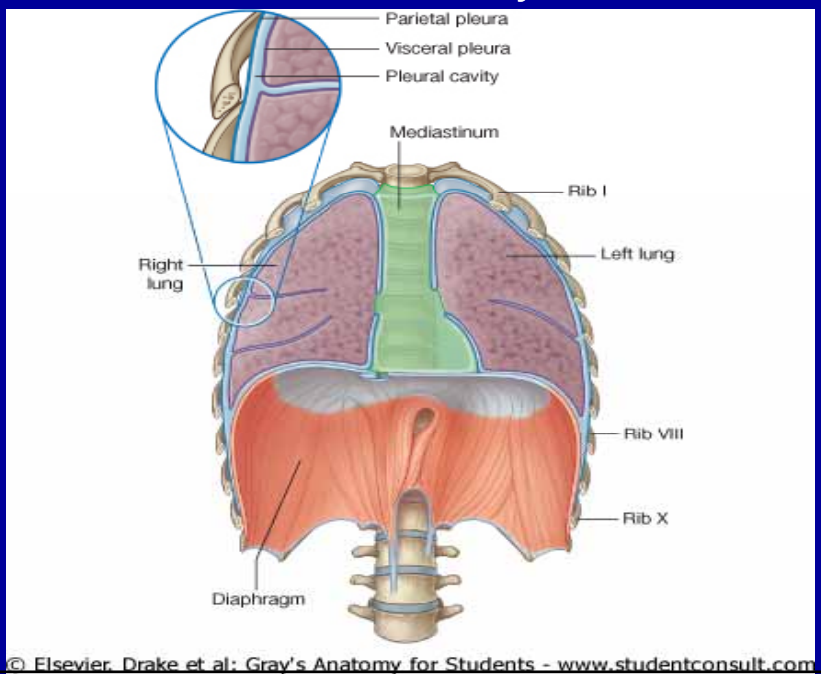
Subdivisions of Parietal Pleura



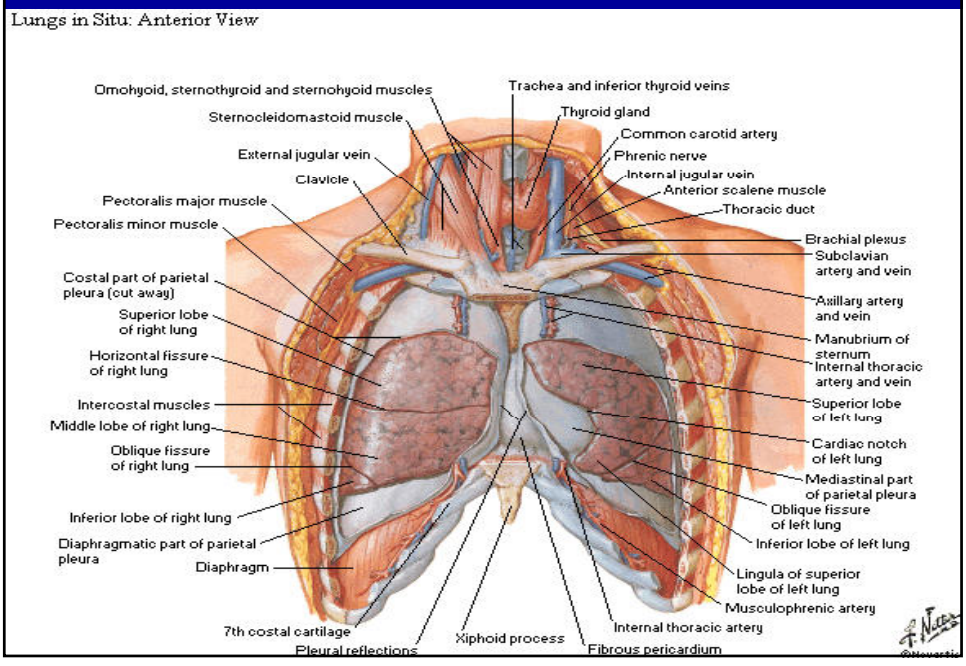
PLEURAL CAVITY

- Pleural Cavity is a slit-like cavity (containing a capillary film of serous fluid) between the visceral and parietal pleurae (with a negative sub atmospheric pressure).
- There are two (right and left) pleural cavities separated by the mediastinum in which the lungs are contained. All surfaces of the lung, covered by the visceral pleura, are surrounded by the pleural cavity.
- The **Pleural Recess** is an extension of pleural cavity limited by two adjacent parts of the parietal pleura, which a lung can enter only during a deep inspiration. There are three main paired pleural recesses on each side of the thorax:
- **Costodiaphragmatic Recess:** reflection between the costal pleura and diaphragmatic pleura.
- **Costomediastinal Recess:** reflection between the mediastinal pleura and costal pleura.
  - The **left** costomediastinal recess is larger than the right, due to the **cardiac notch** -- the impression left on the left lung from the heart.
- **Mediastinodiaphragmatic Recess:** reflection between the mediastinal pleura and diaphragmatic pleura.

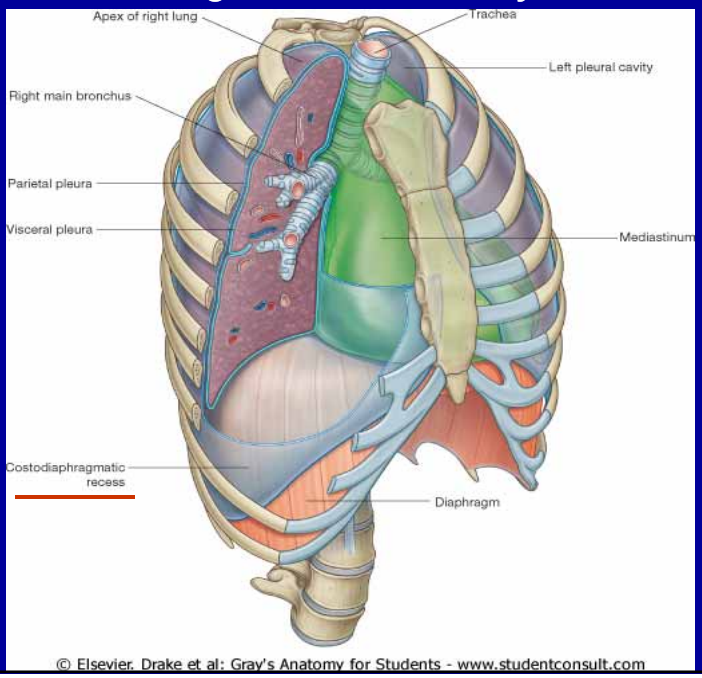
Pleural Cavity



Pleural Cavities



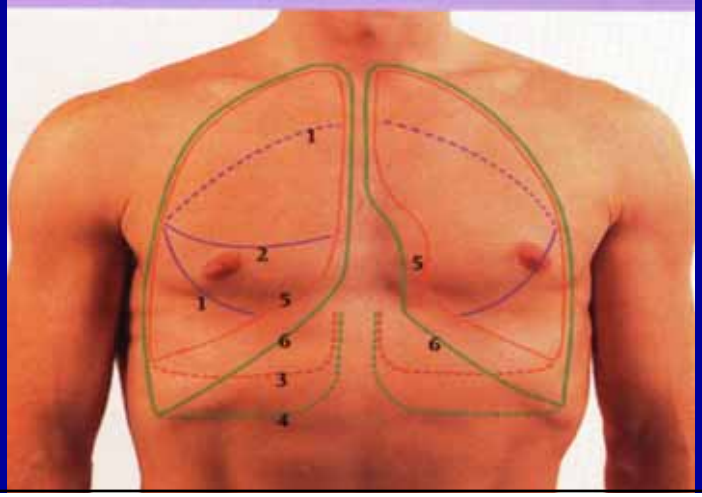
Right Pleural Cavity



Surface Markings of Pleurae

1 Oblique fissure
2 Transverse fissure
3 Back border of lung
4 Back border of pleura
5 Anterior border of lung
6 Anterior border of pleura

Parietal Pleura
Visceral Pleura



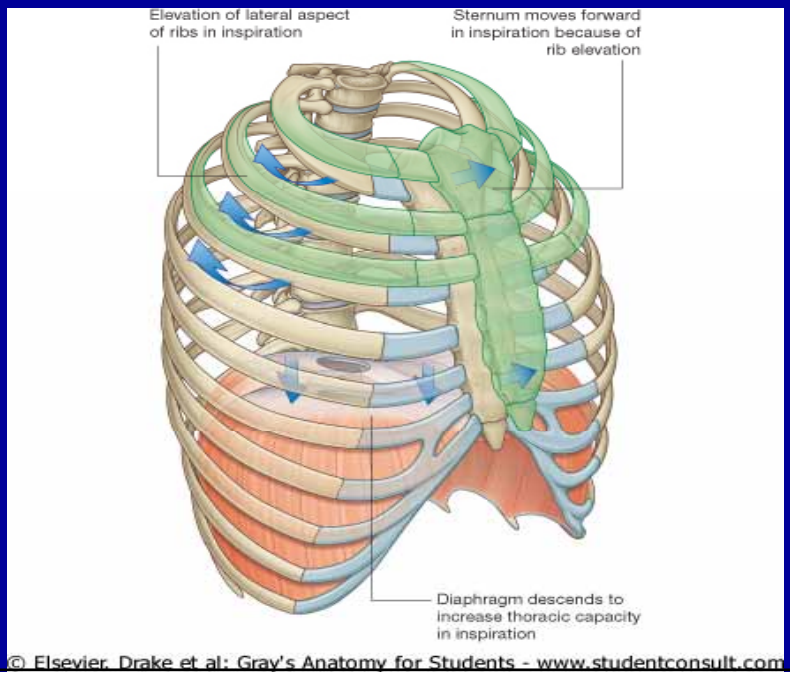
Respiratory Movements & Structures Producing Them

- Inspiration
  - Elevation of sternal ends of ribs
    - Pump handle (forward & upward) movement of sternum
      - Increase of anteroposterior diameter of the chest
  - Elevation of lateral shafts of ribs
    - Bucket handle movement of ribs (upward & laterally)
      - Increase of lateral (transverse) diameter of the chest
  - Depression (lowering) of Diaphragm
    - Increase of vertical size of the chest
  - It results in expansion of the chest and drop of pressure in pleural cavities. It causes expansion of lungs and drop of pressure in alveoli. Atmospheric air will enter lungs through the airway and inflate & expand them.
- Expiration
  - Pump handle (backward & downward) movement of sternum
    - Depression of sternal ends of ribs
    - Decrease of anteroposterior diameter of chest
  - Bucket handle movement of ribs (downward & medially)
    - Depression of lateral shafts of ribs
    - Decrease of lateral diameter of chest
  - Elevation of Diaphragm
    - Decrease of vertical size of chest
  - It results in reduction of chest volume and squeeze of lungs. Because of this and elastic recoil of lungs alveolar air will be pushed through airway into atmosphere

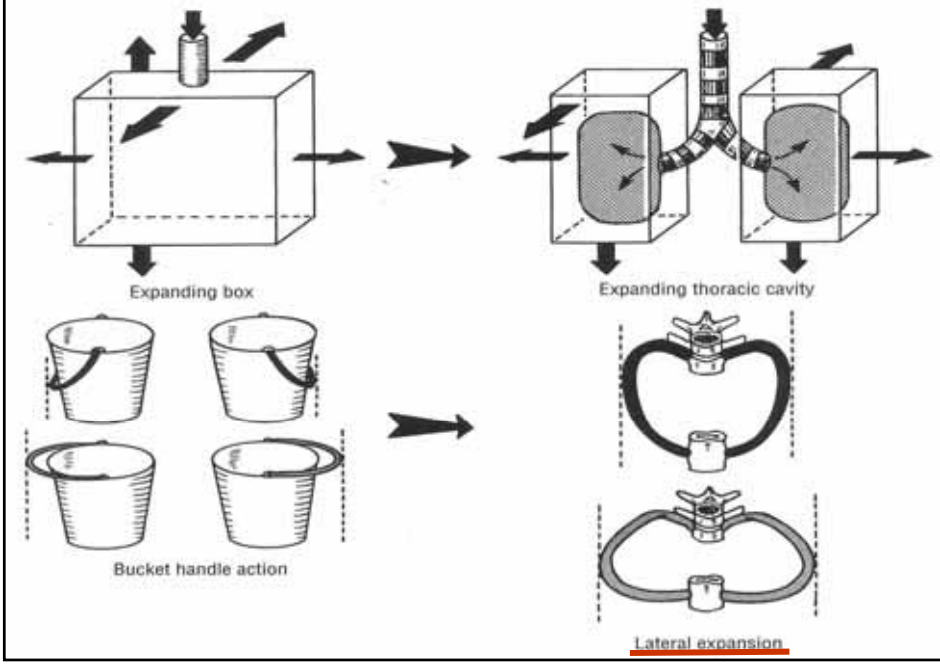
Events occurring during inhalation and exhalation:

- Movements of ribs at costovertebral joints:
- Up and down gliding movements of costal head and tubercle, which permit rotation of costal neck around its long axis
  - **Upward rotation** brings about elevation of shaft and sternal end of a rib during inspiration (**tubercle glides Down**)
  - **Downward rotation** brings about depression of shaft and sternal end of a rib during expiration (**tubercle glides Up**)
- **Bucket-handle** inspiratory movement, when pail handle is raising, its convexity moves laterally, increasing transverse diameter of thorax. It occurs during elevation of shafts of ribs. Depression of shafts causes expiration.
- **Pump-handle** inspiratory movement, when sternal end is elevating it also moves anteriorly like a pump handle, increasing anteroposterior diameter of thorax. Depression of sternal end causes expiration.
- Movements of Diaphragm:
- Depression of Diaphragm during its Contraction increases vertical diameter of thorax & causes Inspiration
- During relaxation Diaphragm is pushed up by abdominal organs thus decreasing vertical diameter of thorax and this causes Expiration

Expansion of the Thorax in Inspiration



Expansion of Thorax in Inspiration (Bucket handle action)



Expansion of Thorax in Inspiration (Pump handle action)

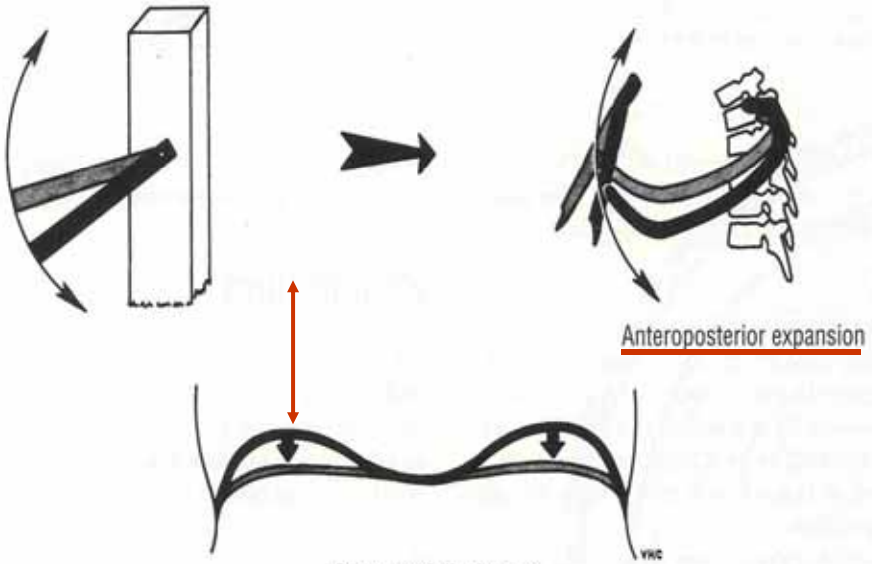
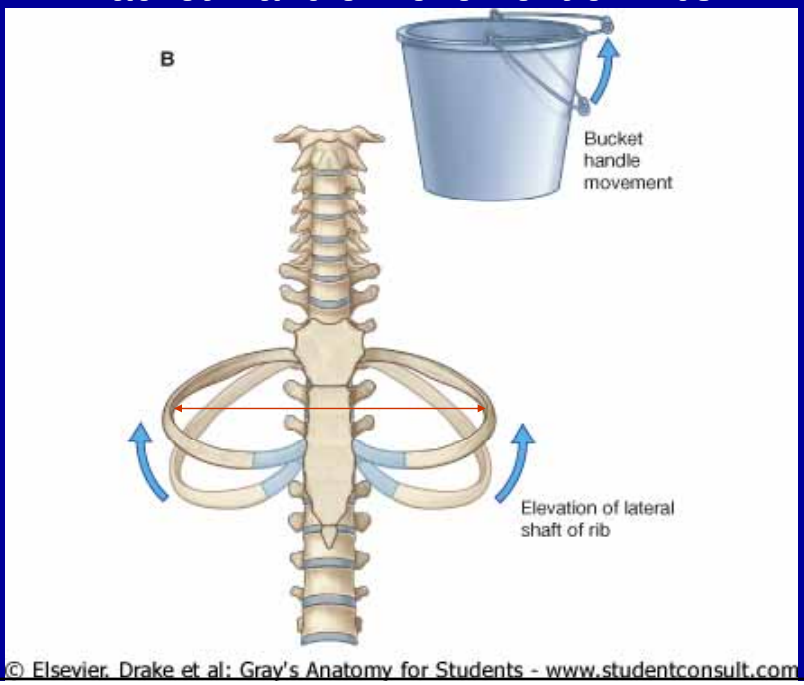


FIGURE 3-13 The different ways in which capacity of thoracic cavity is increased during inspiration.

Backet-Handle Movement of Ribs



Backet-Handle Movement of Ribs

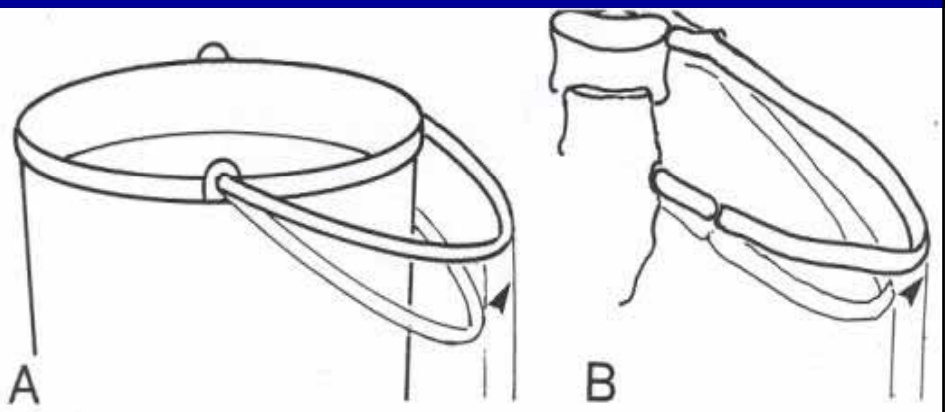
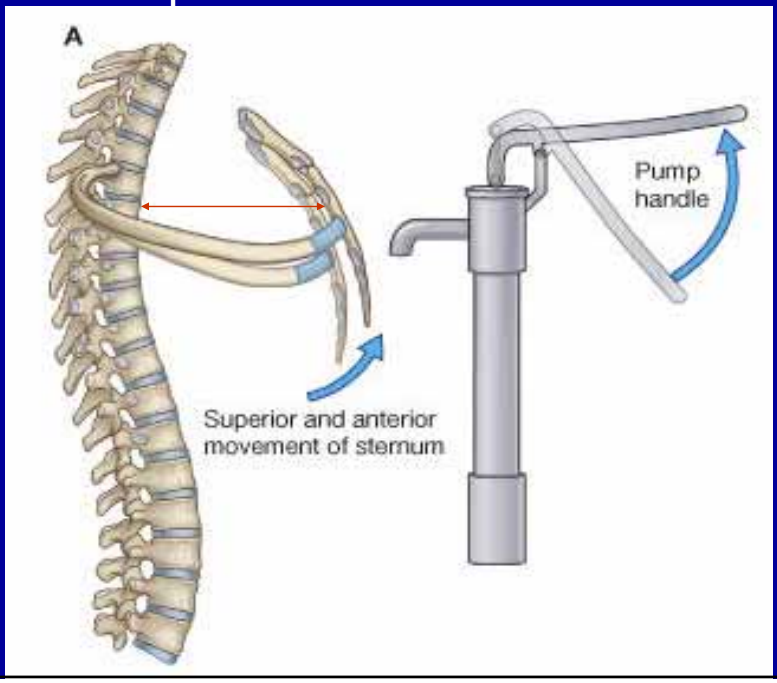


Figure 1-15. The ''bucket-handle'' inspiratory movement. *A*, when the pail handle is raised, its convexity moves laterally, away from its attachments. *B*, similarly, when the intercostal muscles contract the ribs move superolaterally, increasing the transverse diameter of the thorax.

Pump-Handle Movement of Ribs



Pump-Handle Movement of Ribs

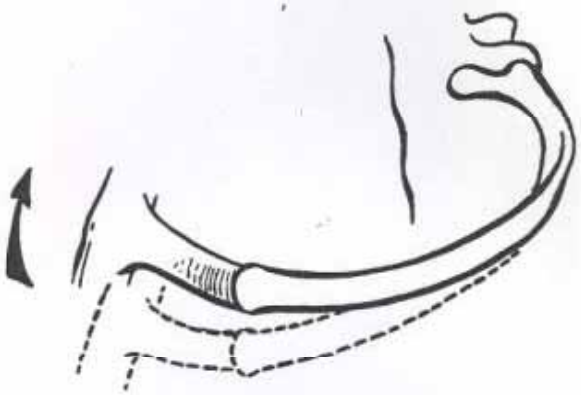
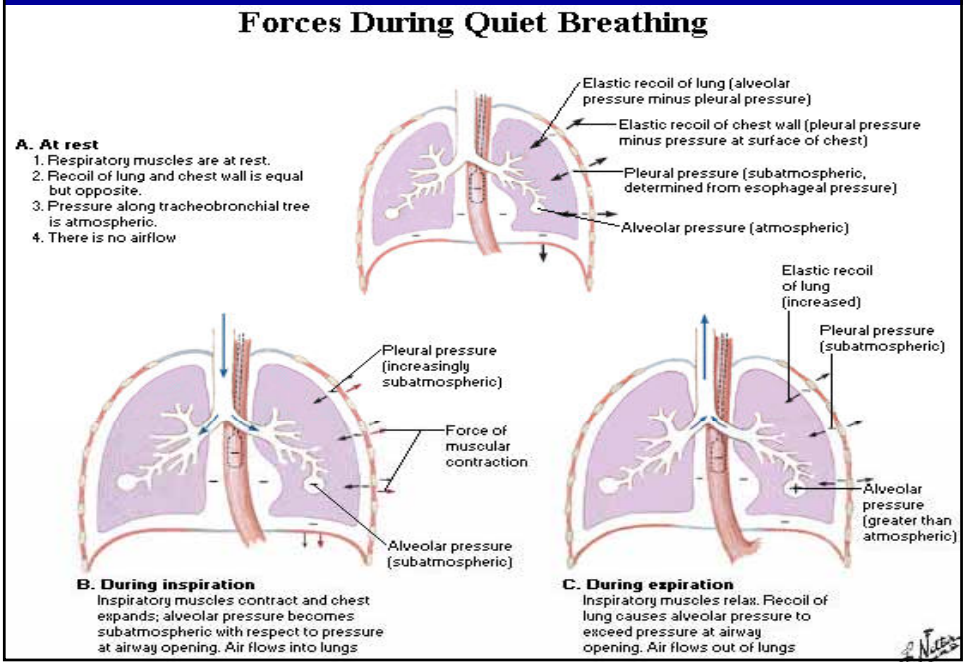
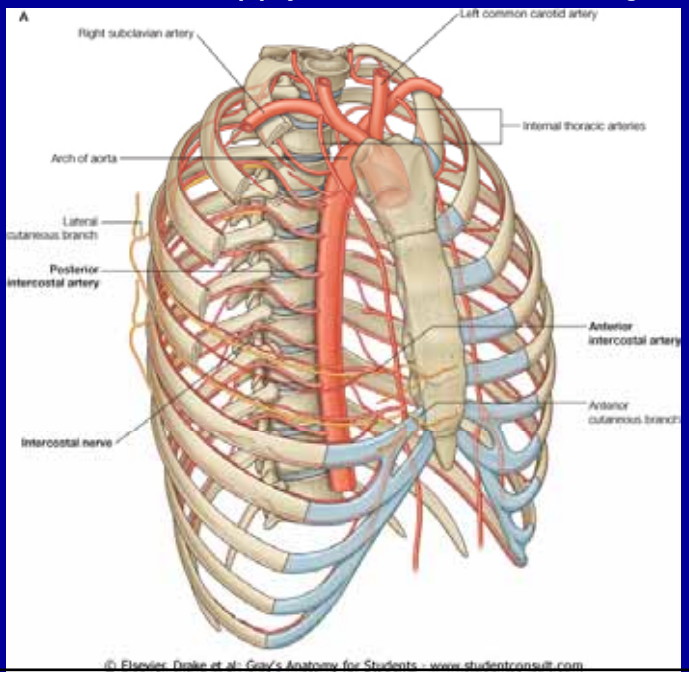


Figure 1-16. The "pump-handle" inspiratory movement. Anterior parts of the ribs move anteriorly like a pump handle. This action moves the sternum up and down, increasing and decreasing the anteroposterior diameter of the thorax.

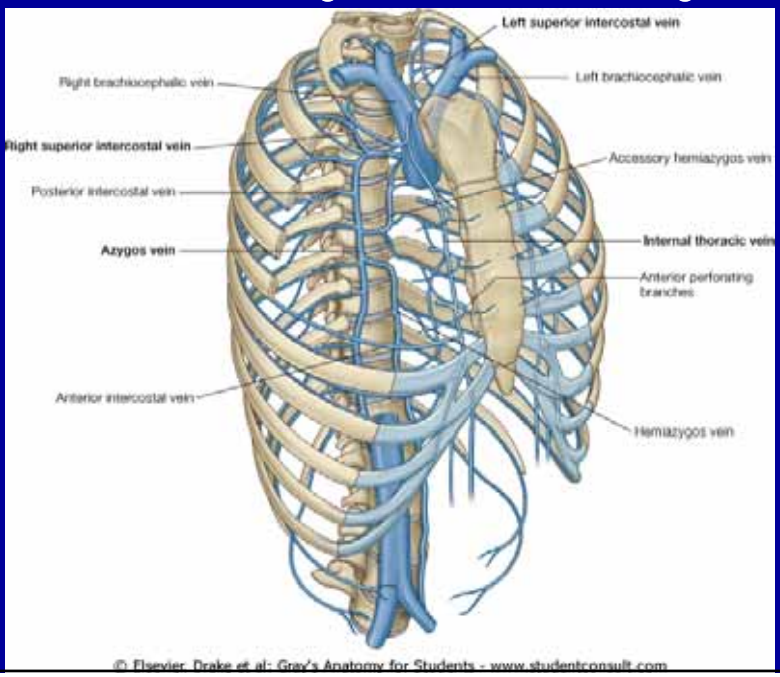
Forces During Quiet Breathing



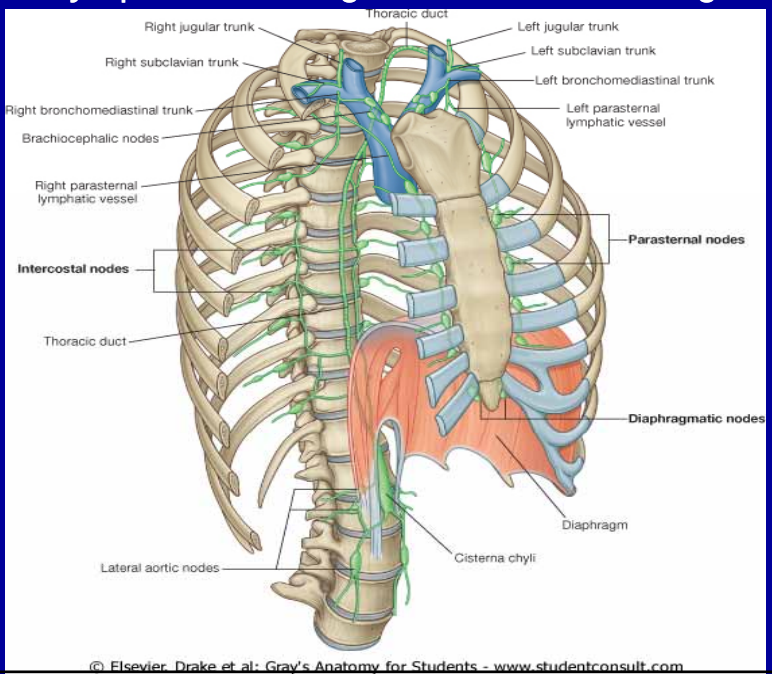
Arterial Supply of the Thoracic Cage



Venous Drainage of the Thoracic Cage



Lymphatic Drainage of the Thoracic Cage



Segmental Innervation of the Thorax & Abdomen