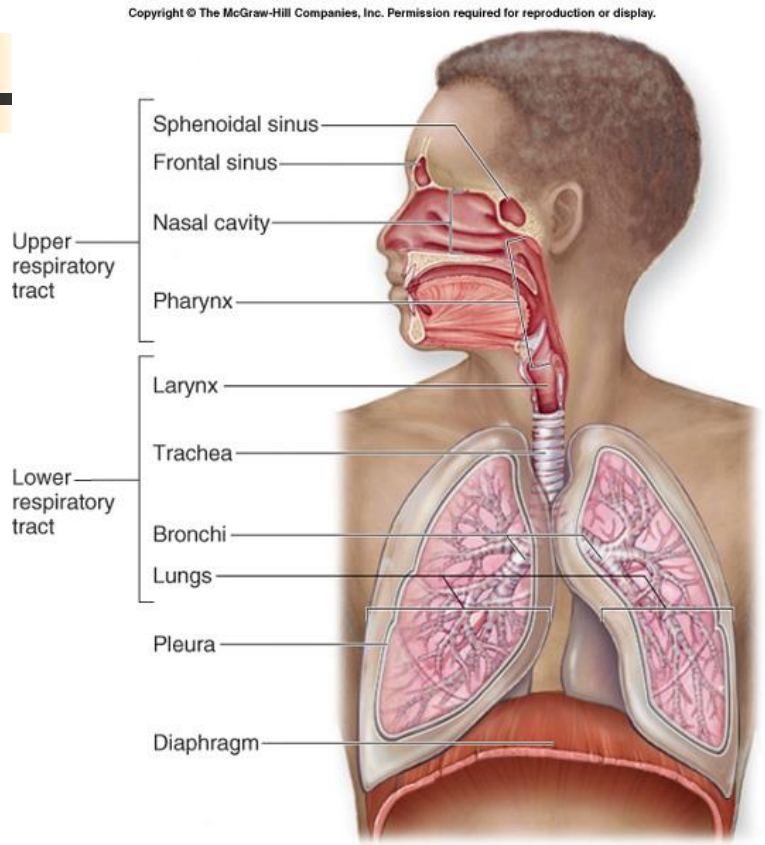
RESPIRATORY SYSTEM ANATOMY



Organization and Functions of the Respiratory System

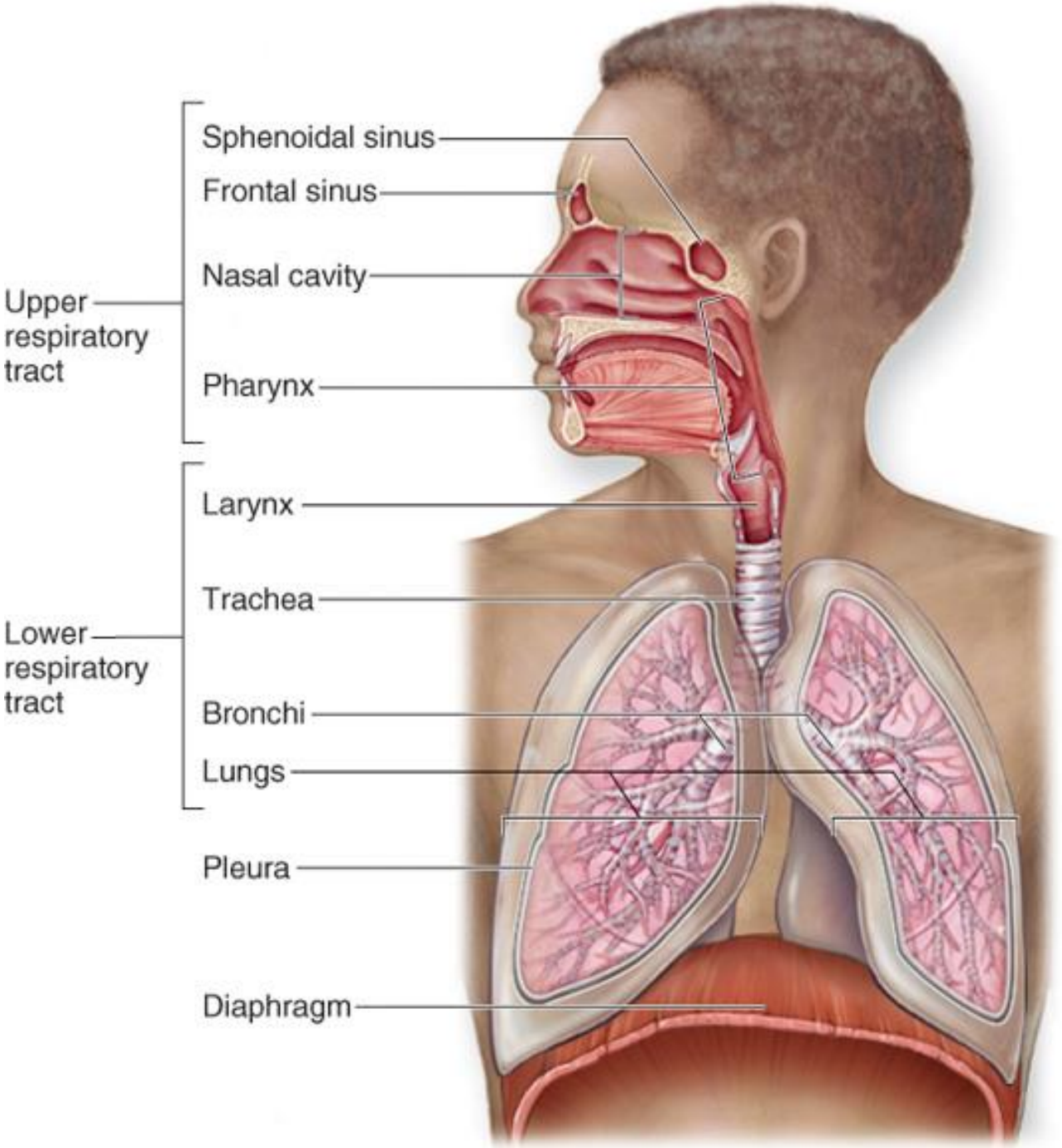
Structural classifications:

- upper respiratory tract
- lower respiratory tract.

- Functional classifications:
  - Conducting portion: transports air.
    - Nose
    - nasal cavity
    - Pharynx
    - Larynx
    - Trachea
    - progressively smaller airways, from the primary bronchi to the bronchioles

Organization and Functions of the Respiratory System

- Functional classifications: continued
  - Conducting portion: transports air.
  - Respiratory portion: carries out gas exchange.
    - respiratory bronchioles
    - alveolar ducts
    - air sacs called alveoli
- Upper respiratory tract is all conducting
- Lower respiratory tract has both conducting and respiratory portions



Respiratory System Functions

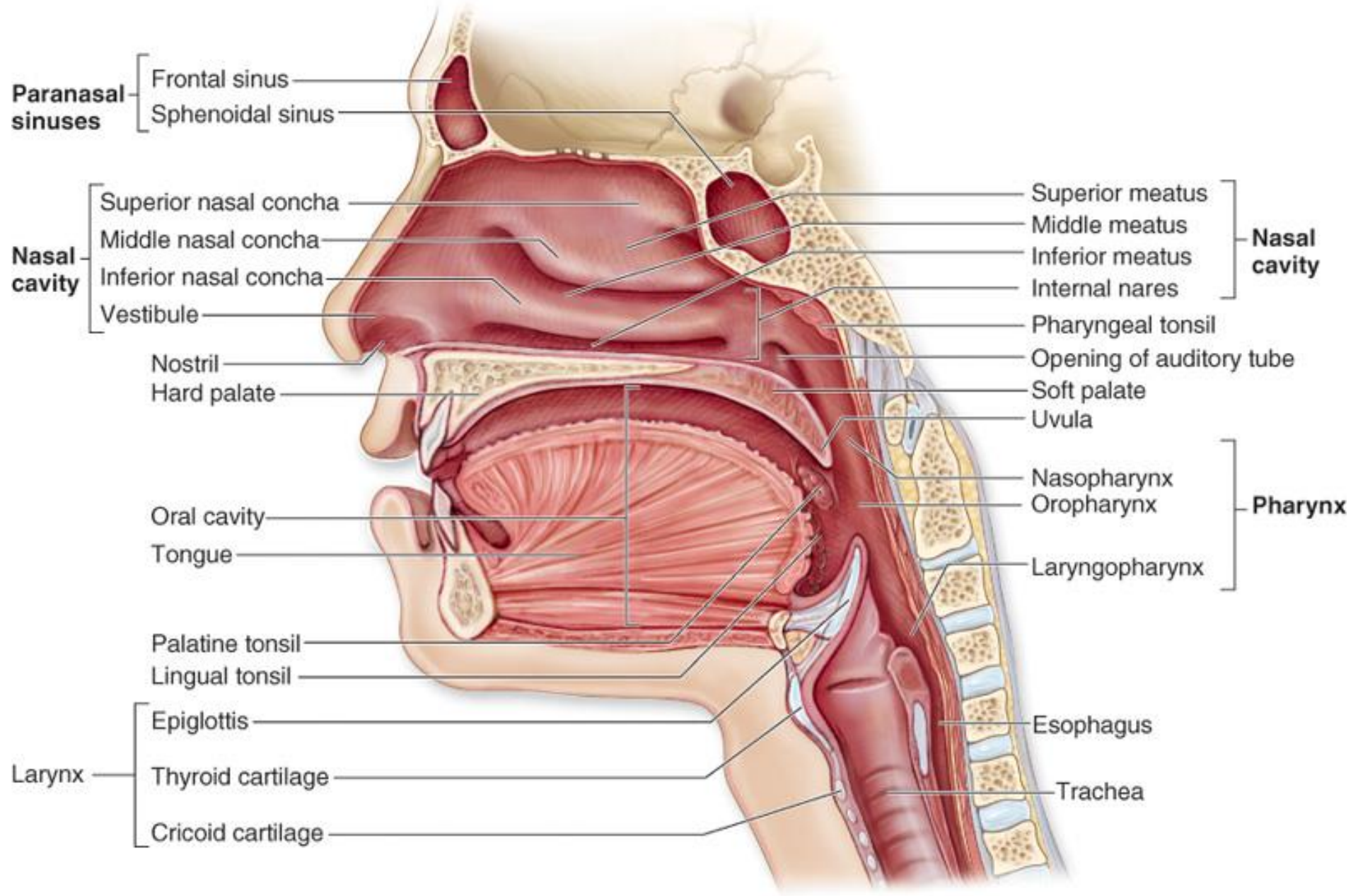
- Breathing (pulmonary ventilation):
  - consists of two cyclic phases:
    - inhalation, also called inspiration
    - exhalation, also called expiration
  - Inhalation draws gases into the lungs.
  - Exhalation forces gases out of the lungs.
- Gas exchange: O_2 and CO_2
  - External respiration
    - External environment and blood
  - Internal respiration
    - Blood and cells

Respiratory System Functions

- Gas conditioning:
  - Warmed
  - Humidified
  - Cleaned of particulates
- Sound production:
  - Movement of air over true vocal cords
  - Also involves nose, paranasal sinuses, teeth, lips and tongue
- Olfaction:
  - Olfactory epithelium over superior nasal conchae
- Defense:
  - Course hairs, mucus, lymphoid tissue

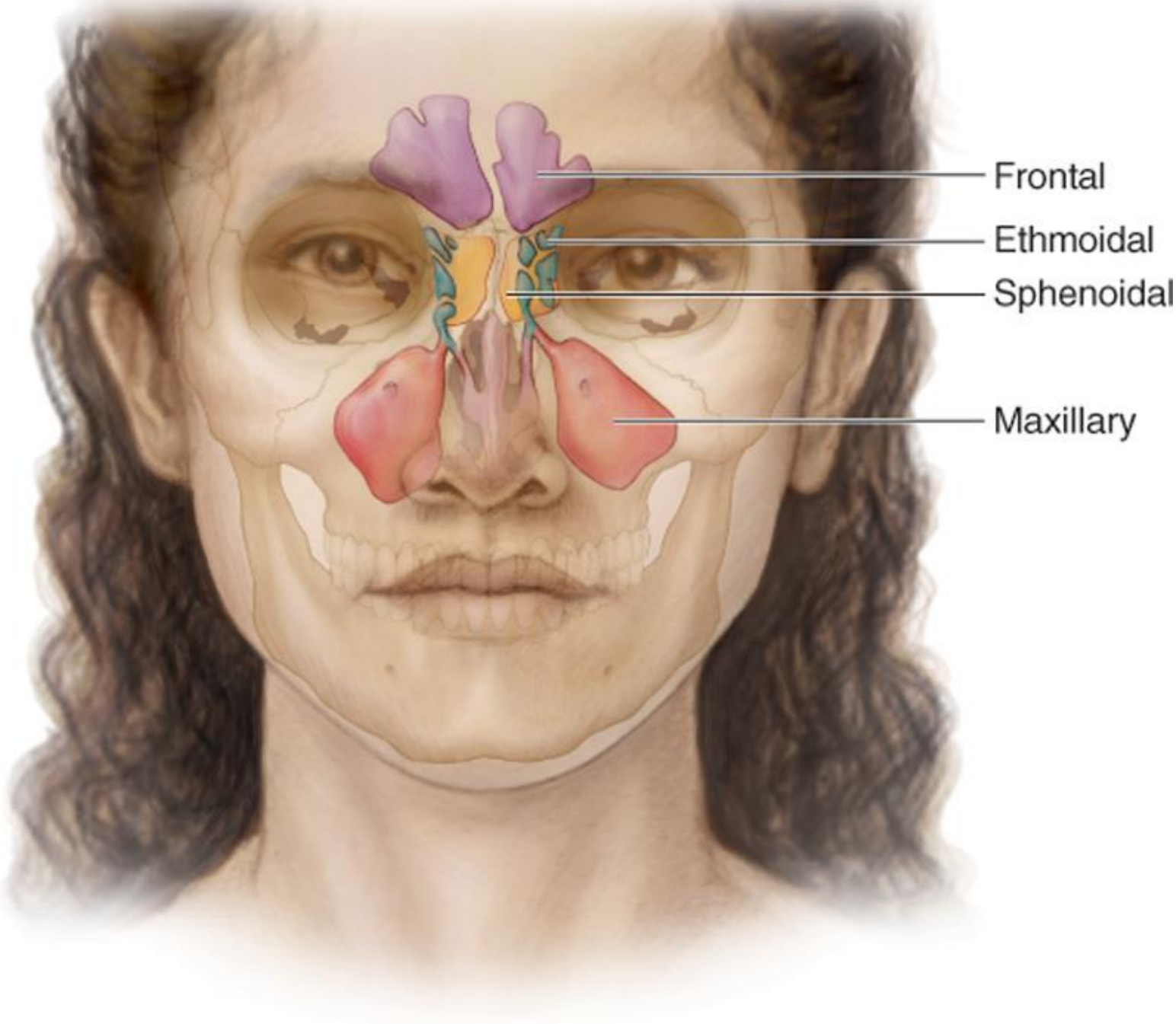
Upper Respiratory Tract

- Composed of
  - the nose
  - the nasal cavity
  - the paranasal sinuses
  - the pharynx (throat)
  - and associated structures.
- All part of the conducting portion of the respiratory system.



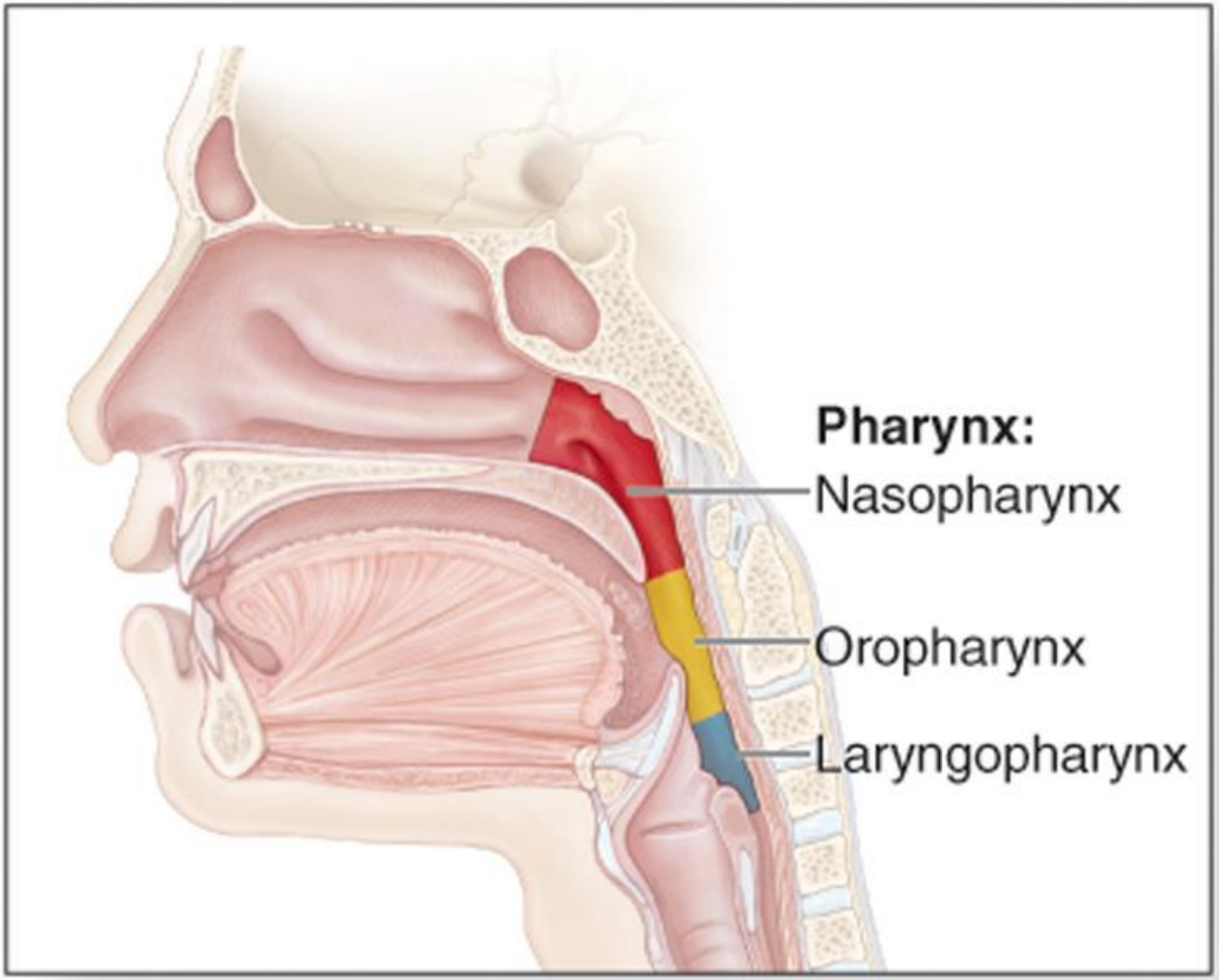
Paranasal Sinuses

- Paranasal sinuses:
  - In four skull bones
  - paired air spaces
  - decrease skull bone weight
- Named for the bones in which they are housed.
  - frontal
  - ethmoidal
  - sphenoidal
  - maxillary
- Communicate with the nasal cavity by ducts.
- Covered with the same pseudostratified ciliated columnar epithelium as the nasal cavity.



Pharynx

- Common to both the respiratory and digestive systems.
- Commonly called the throat.
- Funnel-shaped
  - slightly wider superiorly and narrower inferiorly.
- Originates posterior to the nasal and oral cavities
- Extends inferiorly near the level of the bifurcation of the larynx and esophagus.
- Common pathway for both air and food.



(b) Regions of pharynx

Pharynx

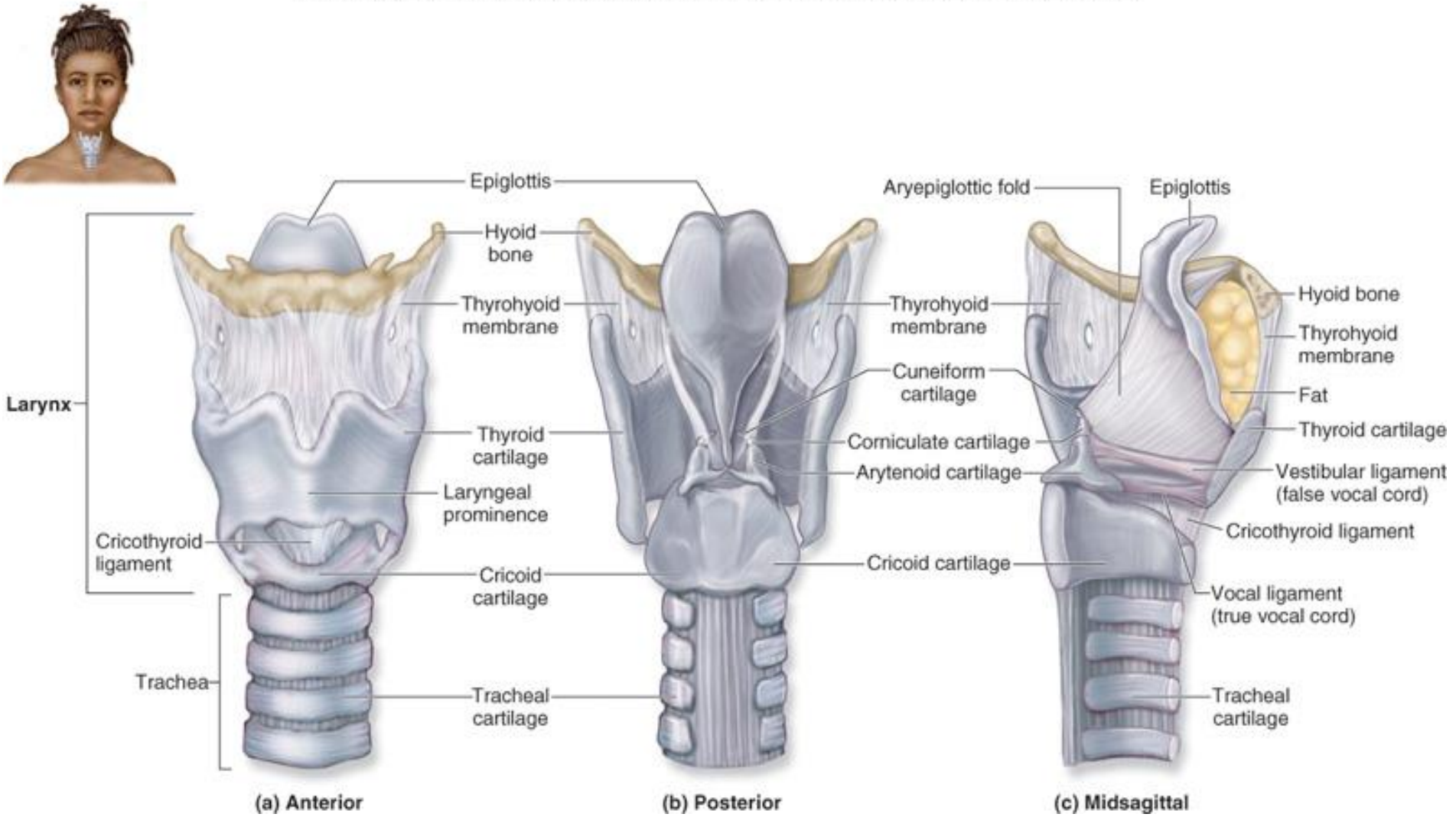
- Walls:
  - lined by a mucosa
  - contain skeletal muscles primarily used for swallowing.
- Flexible lateral walls
  - distensible
  - to force swallowed food into the esophagus.
- Partitioned into three adjoining regions:
  - nasopharynx
  - oropharynx
  - laryngopharynx

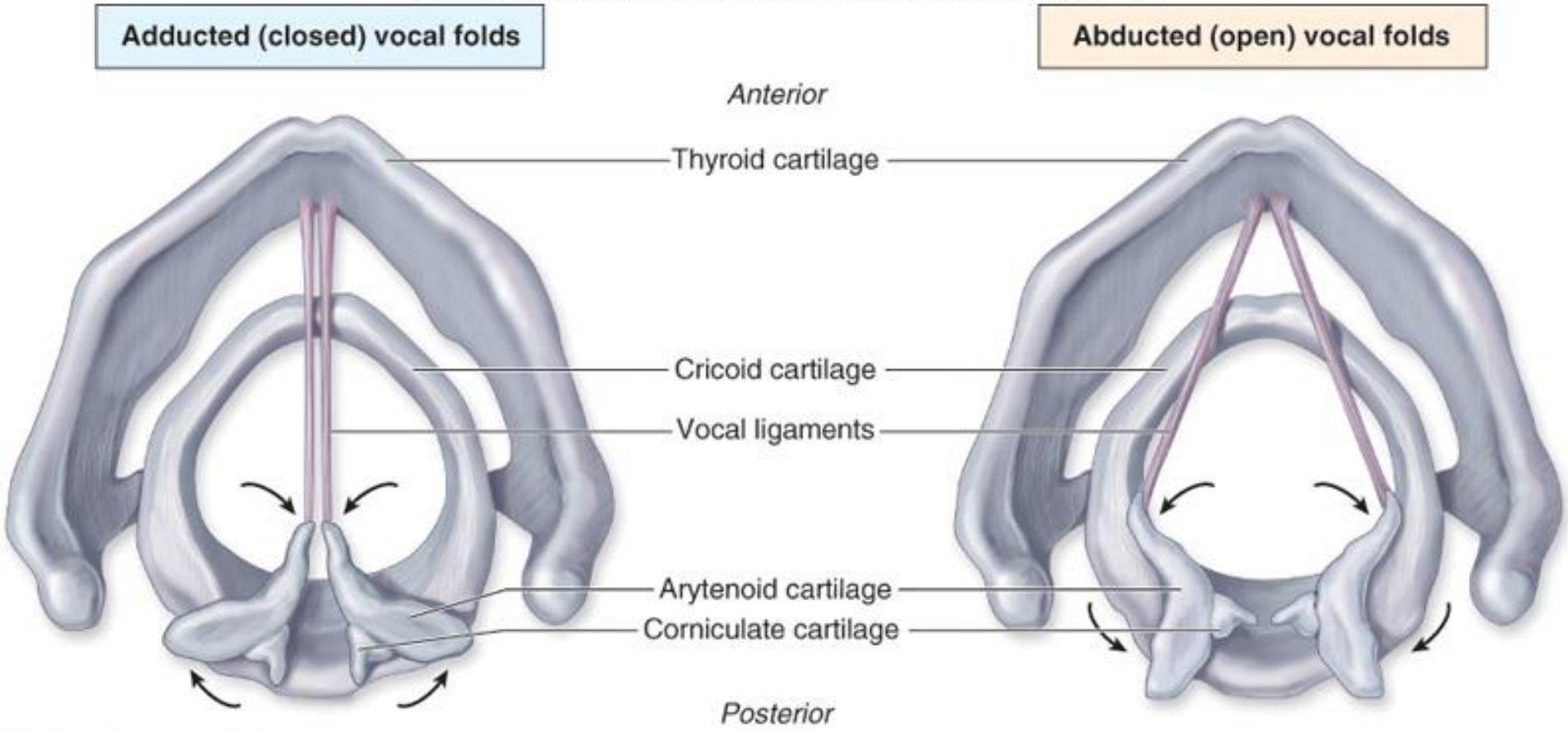
Lower Respiratory Tract

- Conducting portion
  - Larynx
  - Trachea
  - Bronchi
  - bronchioles and their associated structures
- Respiratory portion of the respiratory system
  - respiratory bronchioles
  - alveolar ducts
  - alveoli

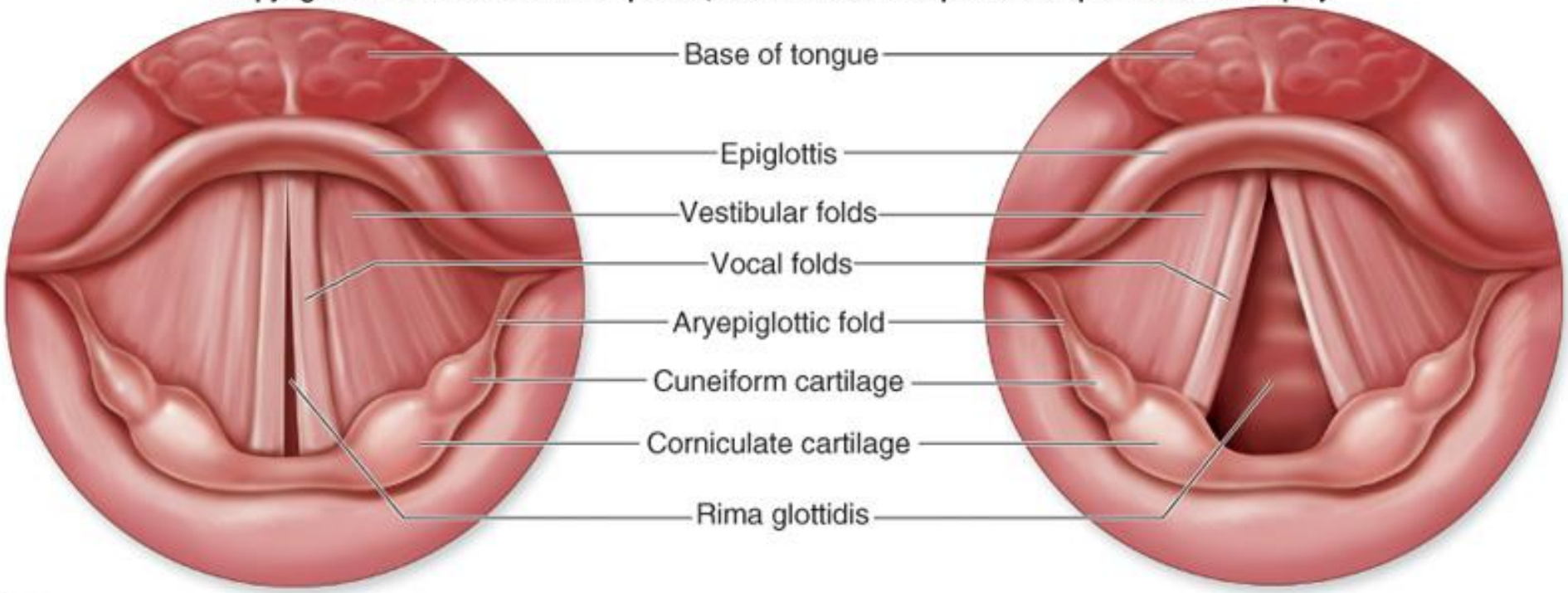
Larynx

- Short, somewhat cylindrical airway
- Location:
  - bounded posteriorly by the laryngopharynx,
  - inferiorly by the trachea.
- Prevents swallowed materials from entering the lower respiratory tract.
- Conducts air into the lower respiratory tract.
- Produces sounds.

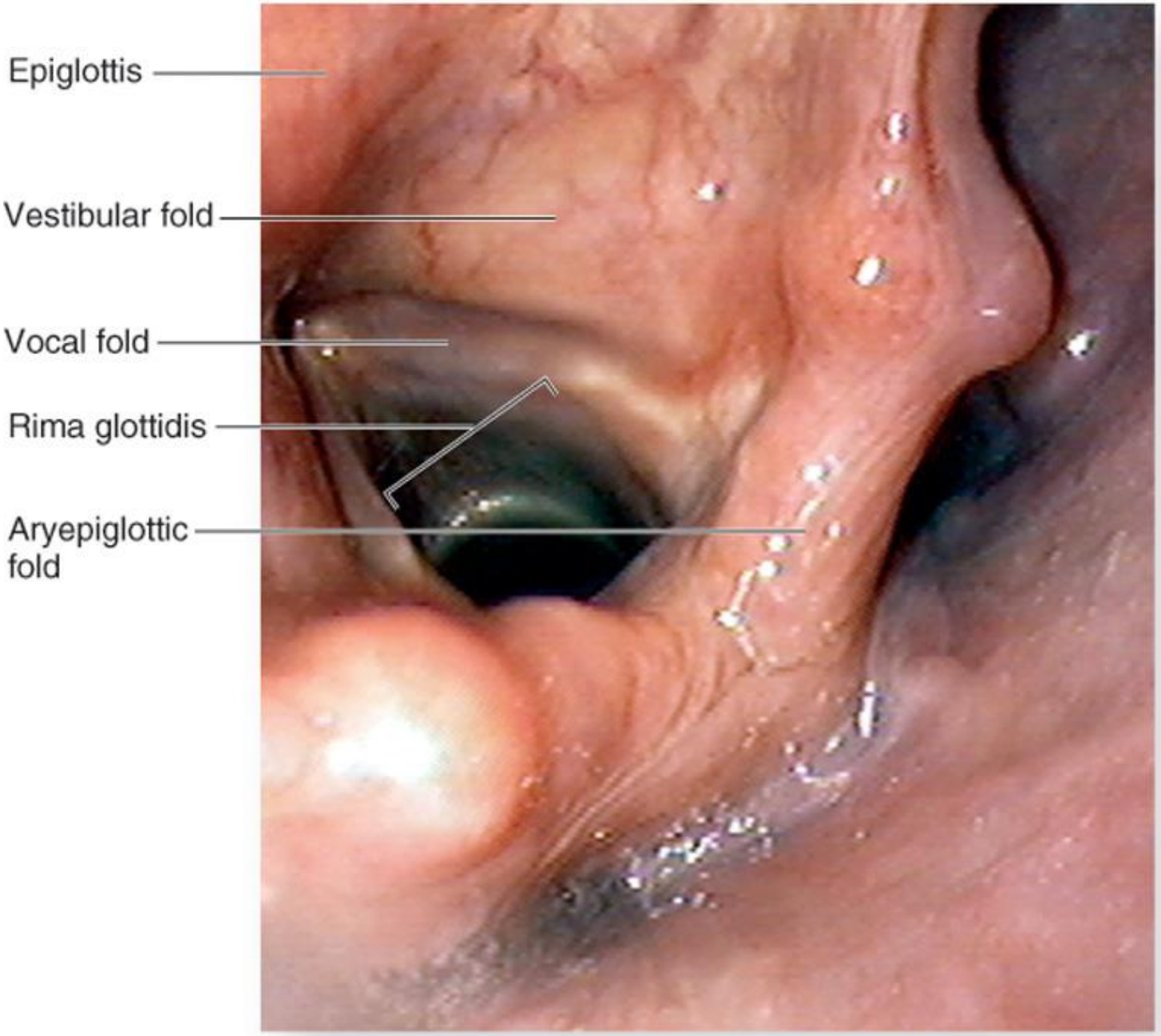




(a) Cartilages and ligaments

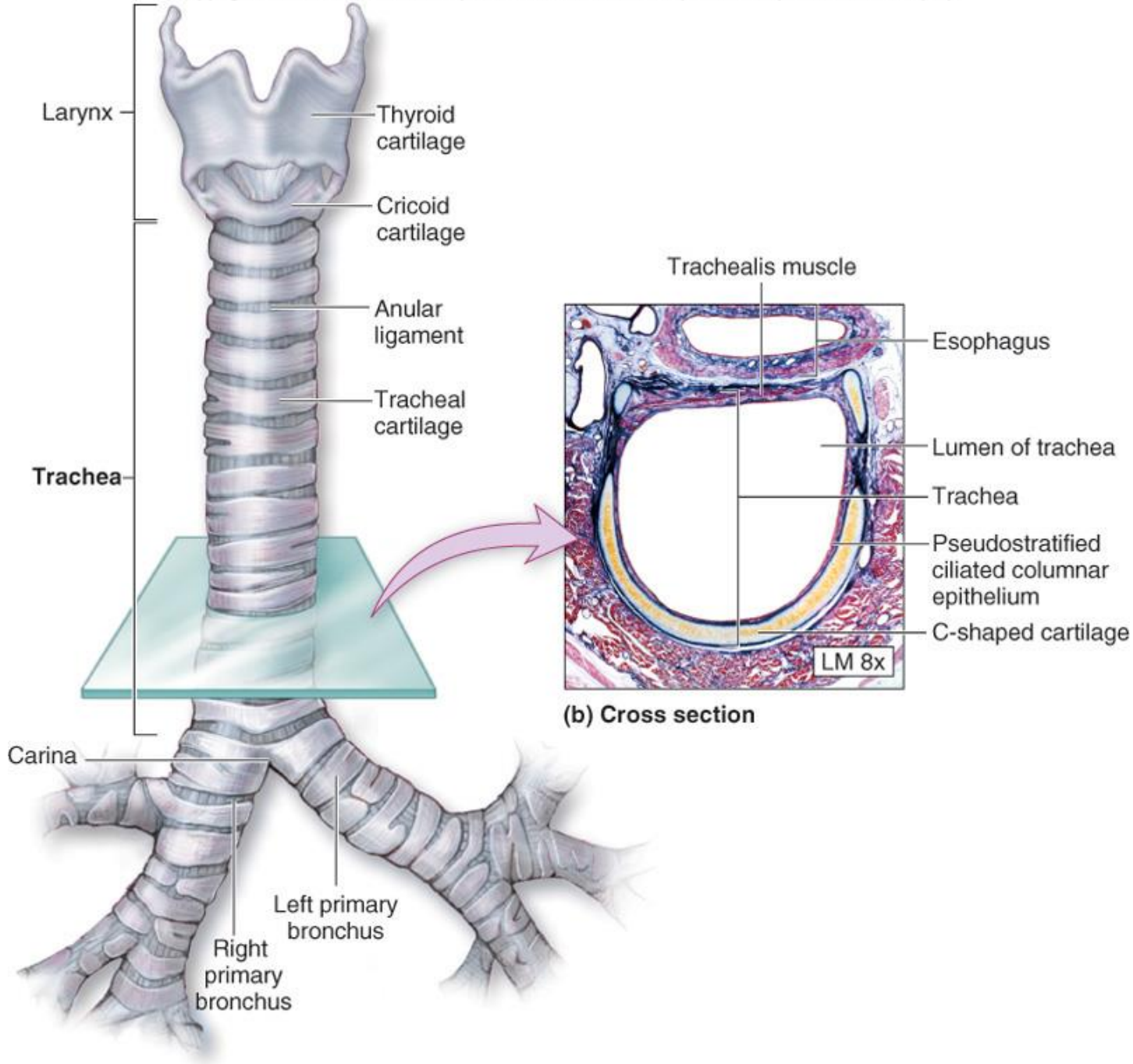


(b) Laryngoscope view



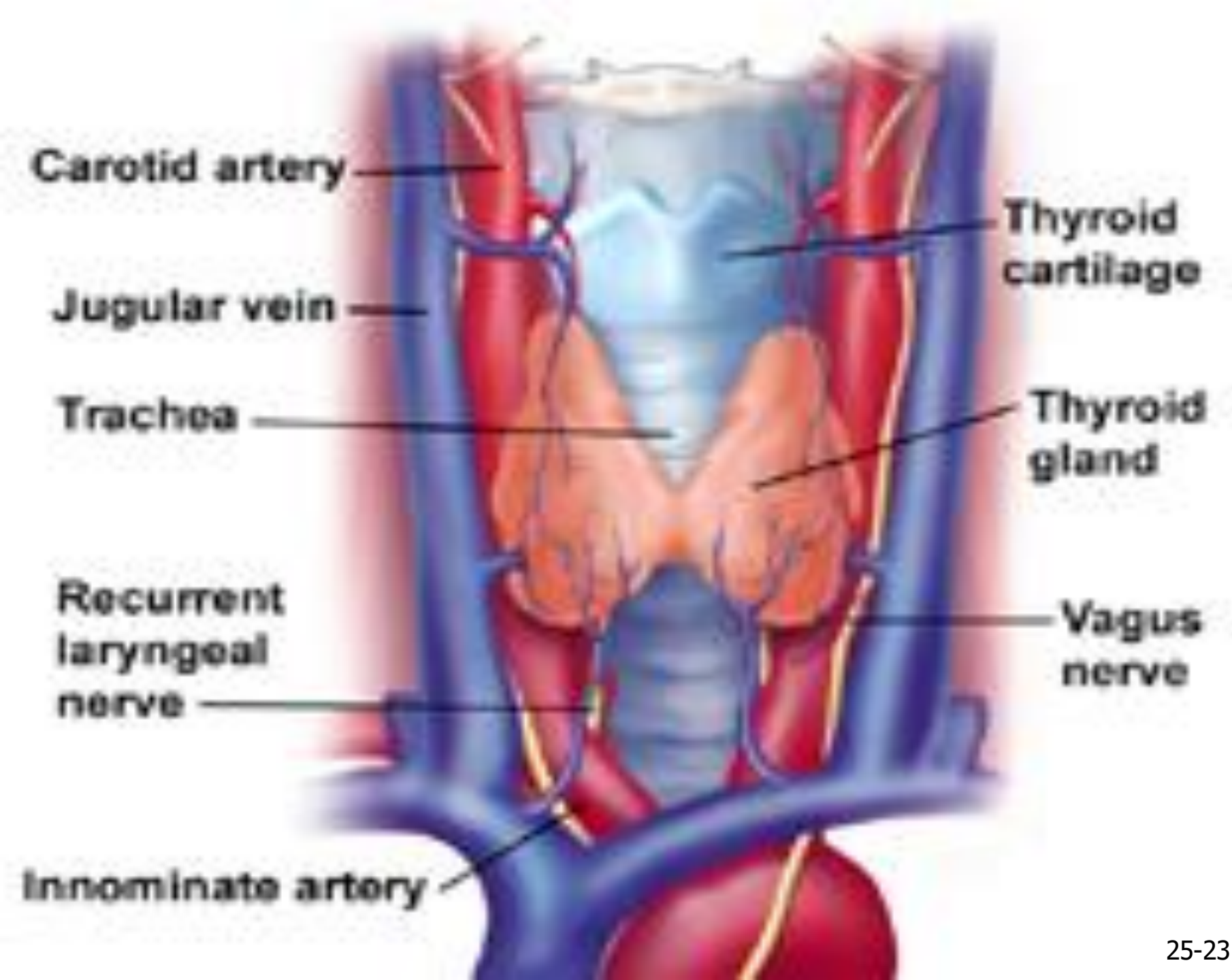
Trachea

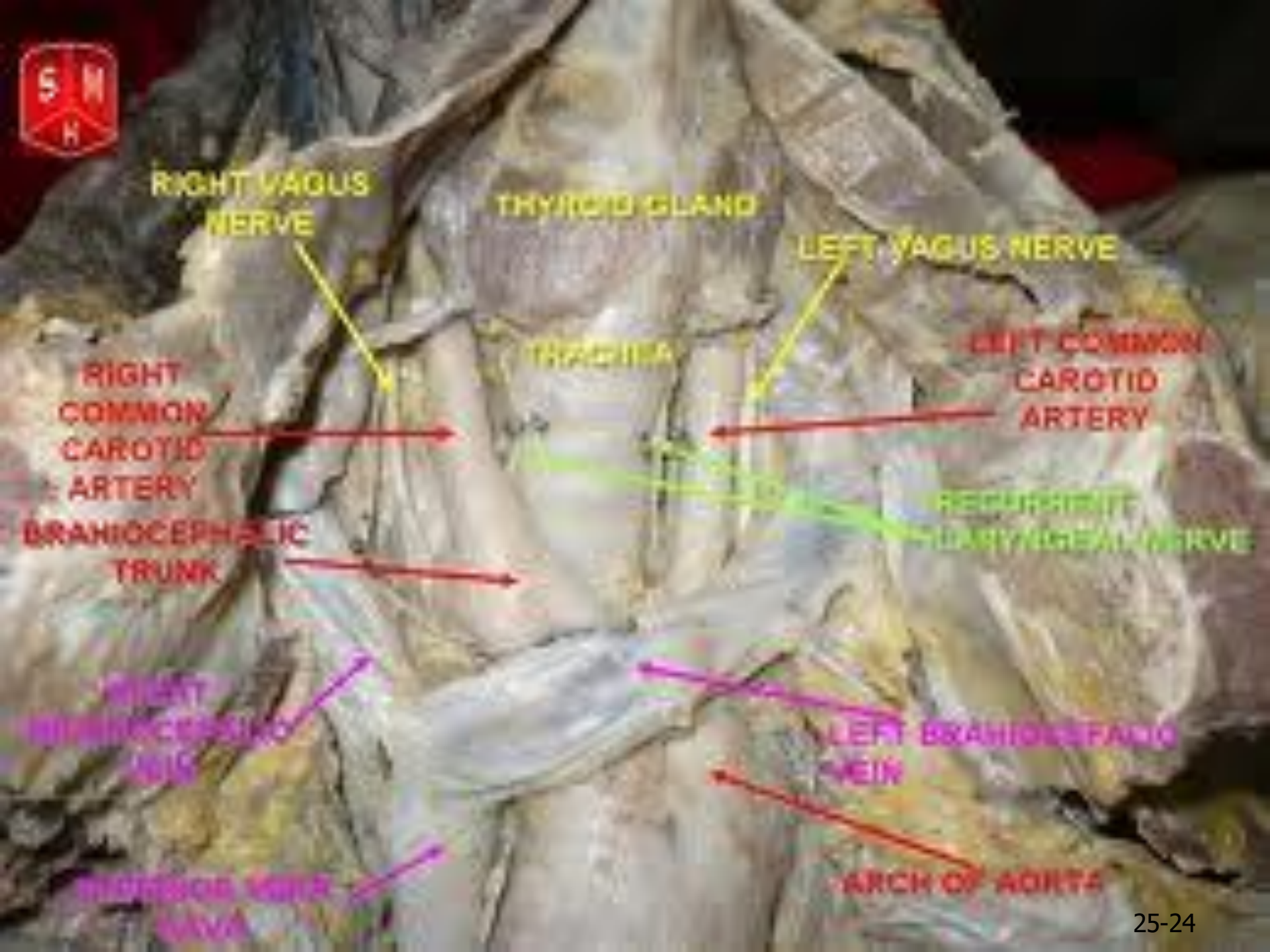
- A flexible, slightly rigid tubular organ
  - often referred to as the "windpipe."
- Extends through the mediastinum
  - immediately anterior to the esophagus
  - inferior to the larynx
  - superior to the primary bronchi of the lungs.
- Anterior and lateral walls of the trachea are supported by 18 to 22 C-shaped tracheal cartilages.
  - cartilage rings reinforce and provide some rigidity to the tracheal wall to ensure that the trachea remains open (patent) at all times
  - cartilage rings are connected by elastic sheets called anular ligaments



Trachea

- At the level of the sternal angle, the trachea bifurcates into two smaller tubes, called the right and left primary bronchi.
- Each primary bronchus projects laterally toward each lung.
- The most inferior tracheal cartilage separates the primary bronchi at their origin and forms an internal ridge called the carina.

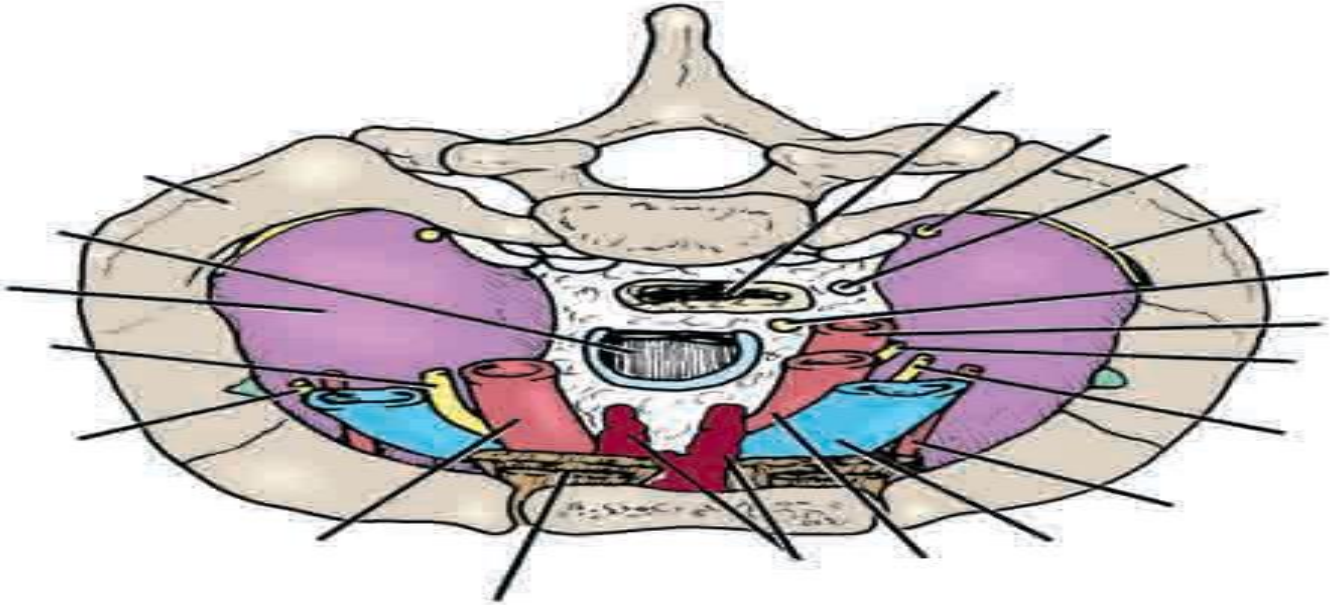

Carotid artery
Jugular vein
Trachea
Recurrent laryngeal nerve
Innominate artery
Thyroid cartilage
Thyroid gland
Vagus nerve

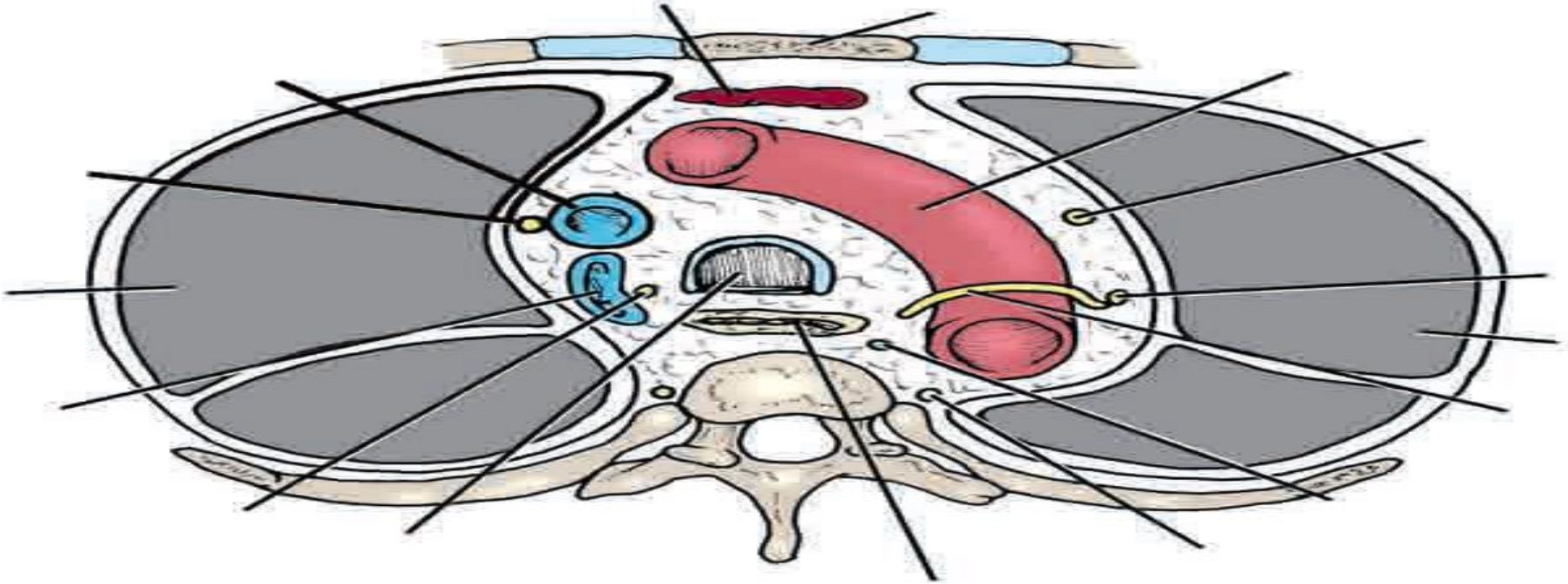

RIGHT VAGUS NERVE
THYROID GLAND
LEFT VAGUS NERVE
TRACHEA
RIGHT COMMON CAROTID ARTERY
BRAHIOCEPHALIC TRUNK
ARCH OF AORTA

- **■■ Anteriorly: The sternum, the thymus, the left brachiocephalic**
- vein, the origins of the brachiocephalic and
- left common carotid arteries, and the arch of the aorta

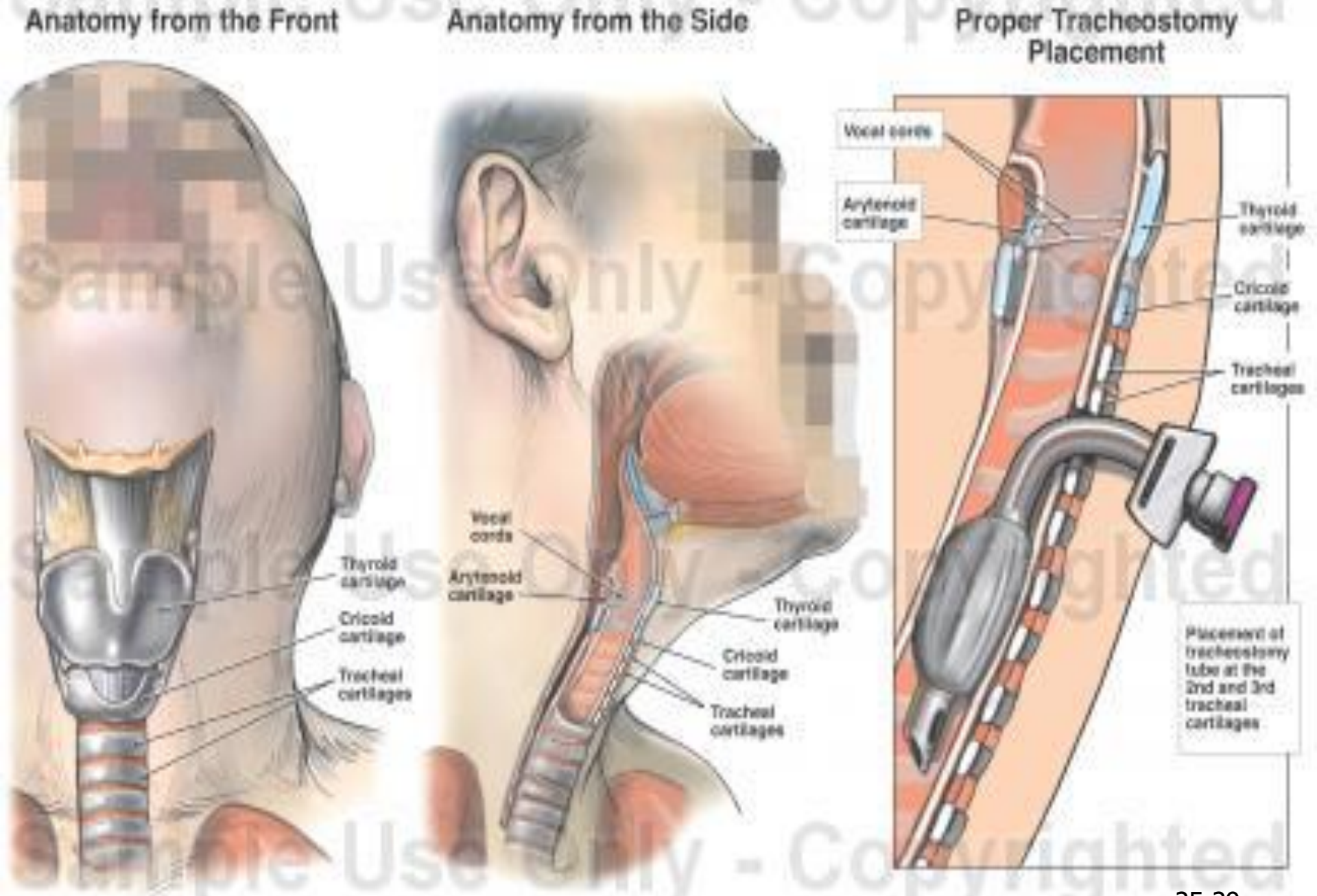
- **■■ Posteriorly: The esophagus and the left recurrent laryngeal**
- nerve (Fig. 3.6A

- **■■ Right side: The azygos vein, the right vagus nerve, and**
- the pleura
- **■■ Left side: The arch of the aorta, the left common**
- carotid and left subclavian arteries, the left vagus and
- left phrenic nerves, and the pleura





Anatomy of the Trachea with Proper Tracheostomy Placement

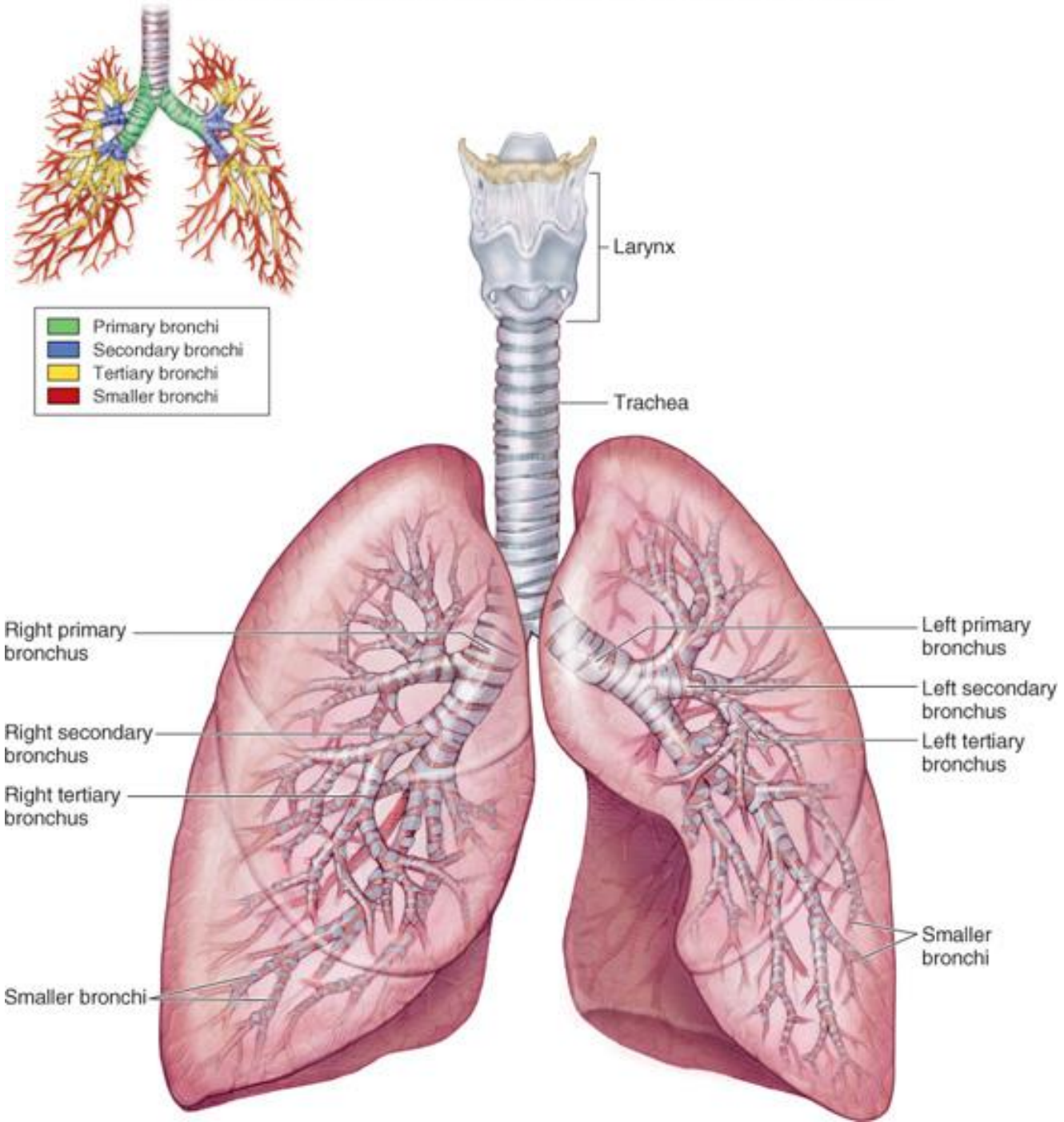


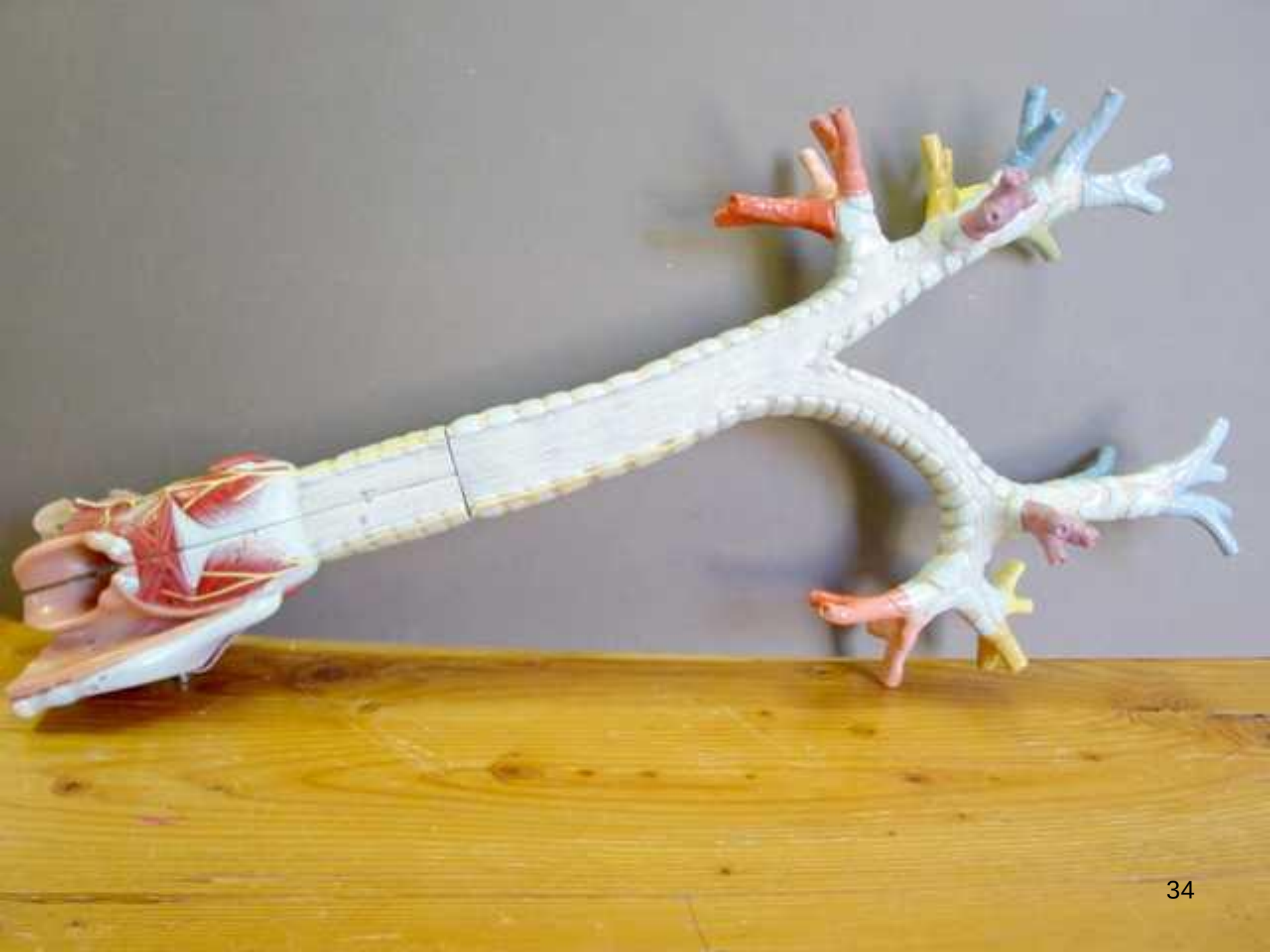
Bronchial Tree

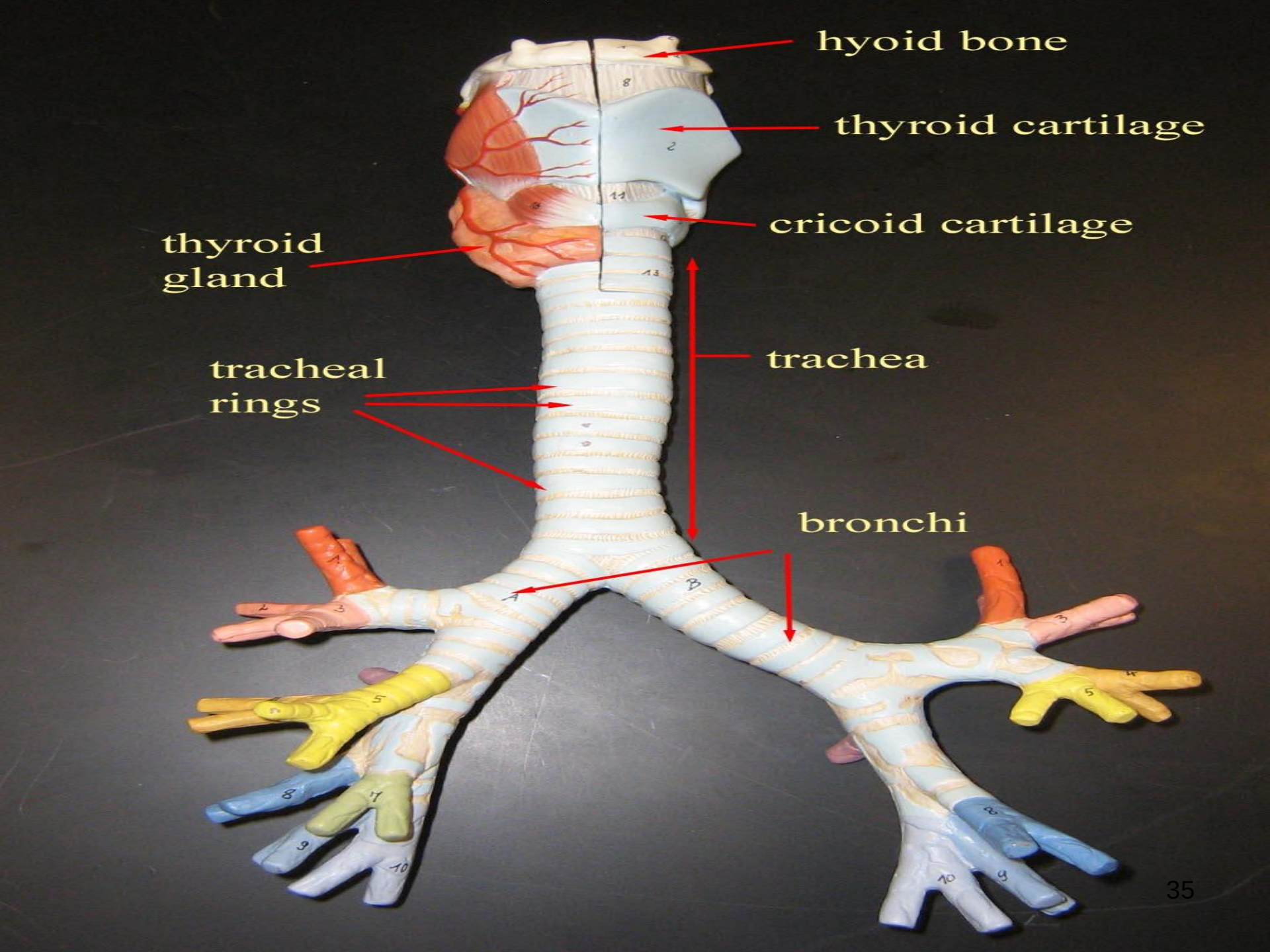
- A highly branched system
  - air-conducting passages
  - originate from the left and right primary bronchi.
- Progressively branch into narrower tubes as they diverge throughout the lungs before terminating in terminal bronchioles.
- Primary bronchi
  - Incomplete rings of hyaline cartilage ensure that they remain open.
  - Right primary bronchus
    - shorter, wider, and more vertically oriented than the left primary bronchus.
  - Foreign particles are more likely to lodge in the right primary bronchus.

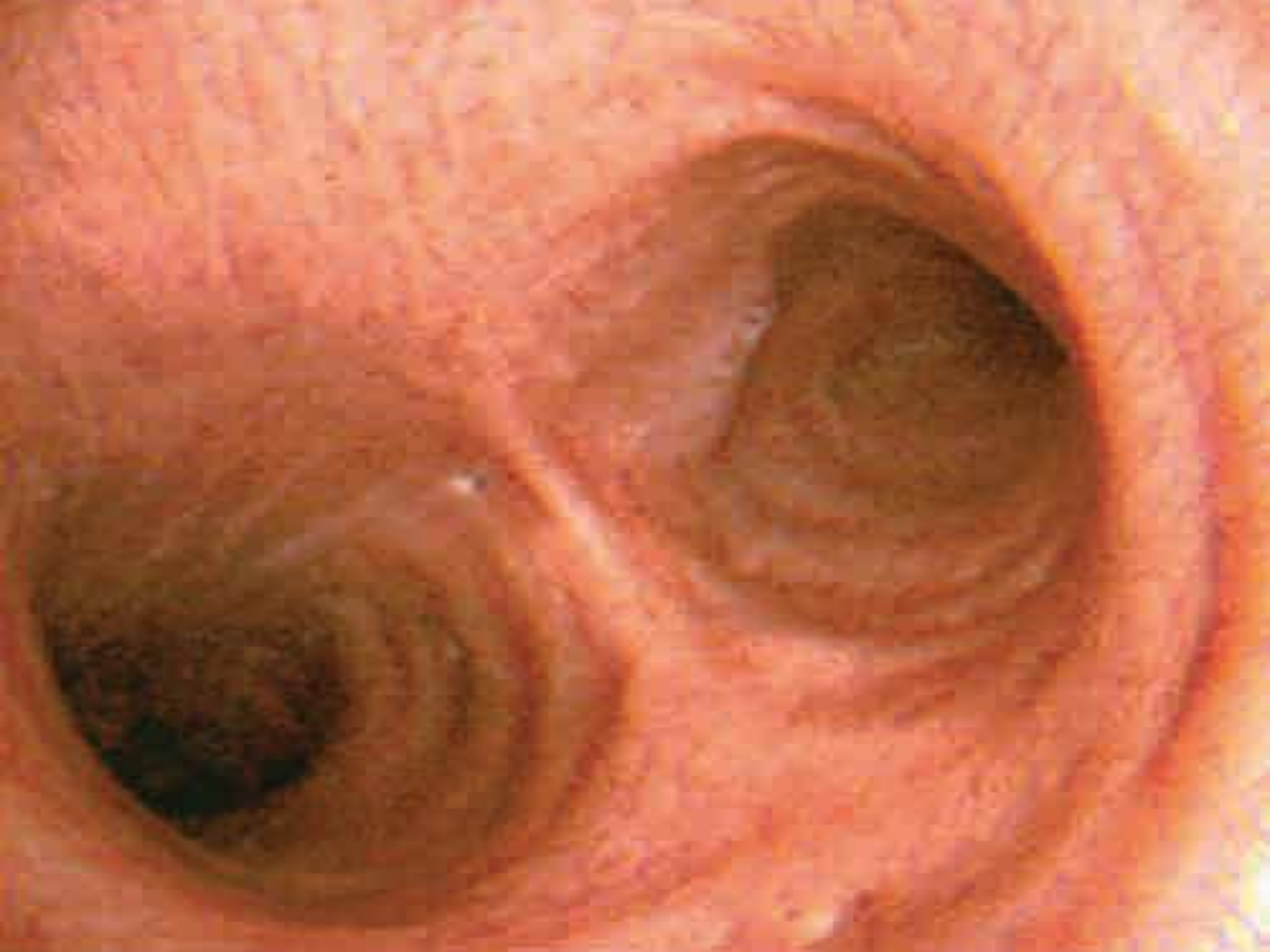
Bronchial Tree

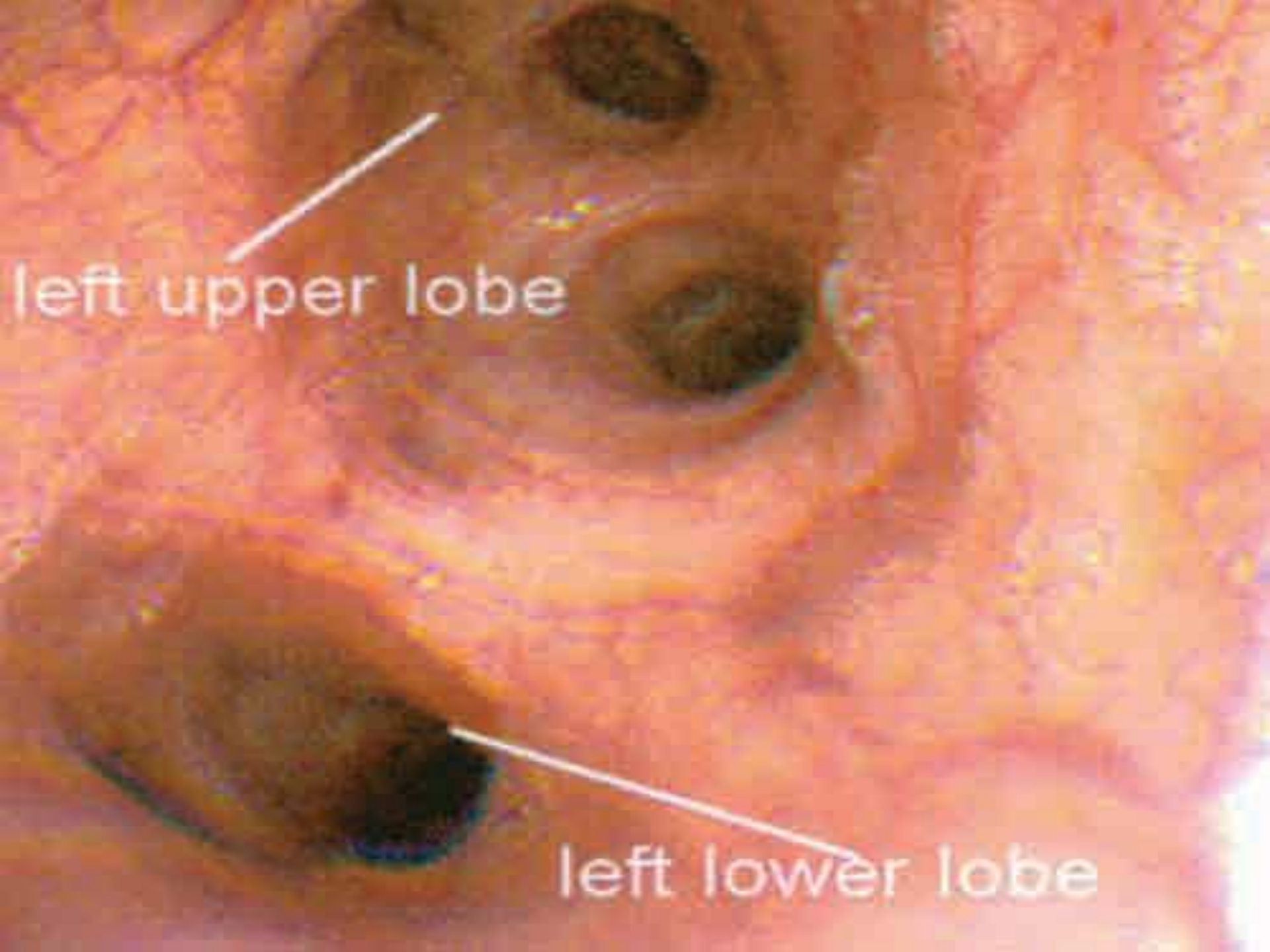
- Primary bronchi
  - enter the hilum of each lung
  - Also entering hilum:
    - pulmonary vessels
    - lymphatic vessels
    - nerves.
- Secondary bronchi (or lobar bronchi)
  - Branch of primary bronchus
  - left lung:
    - two lobes
    - two secondary bronchi
  - right lung
    - three lobes
    - three secondary bronchi.
- Tertiary bronchi (or segmental bronchi)
  - Branch of secondary bronchi
  - left lung is supplied by 8 to 10 tertiary bronchi.
  - right lung is supplied by 10 tertiary bronchi
  - supply a part of the lung called a bronchopulmonary segment.





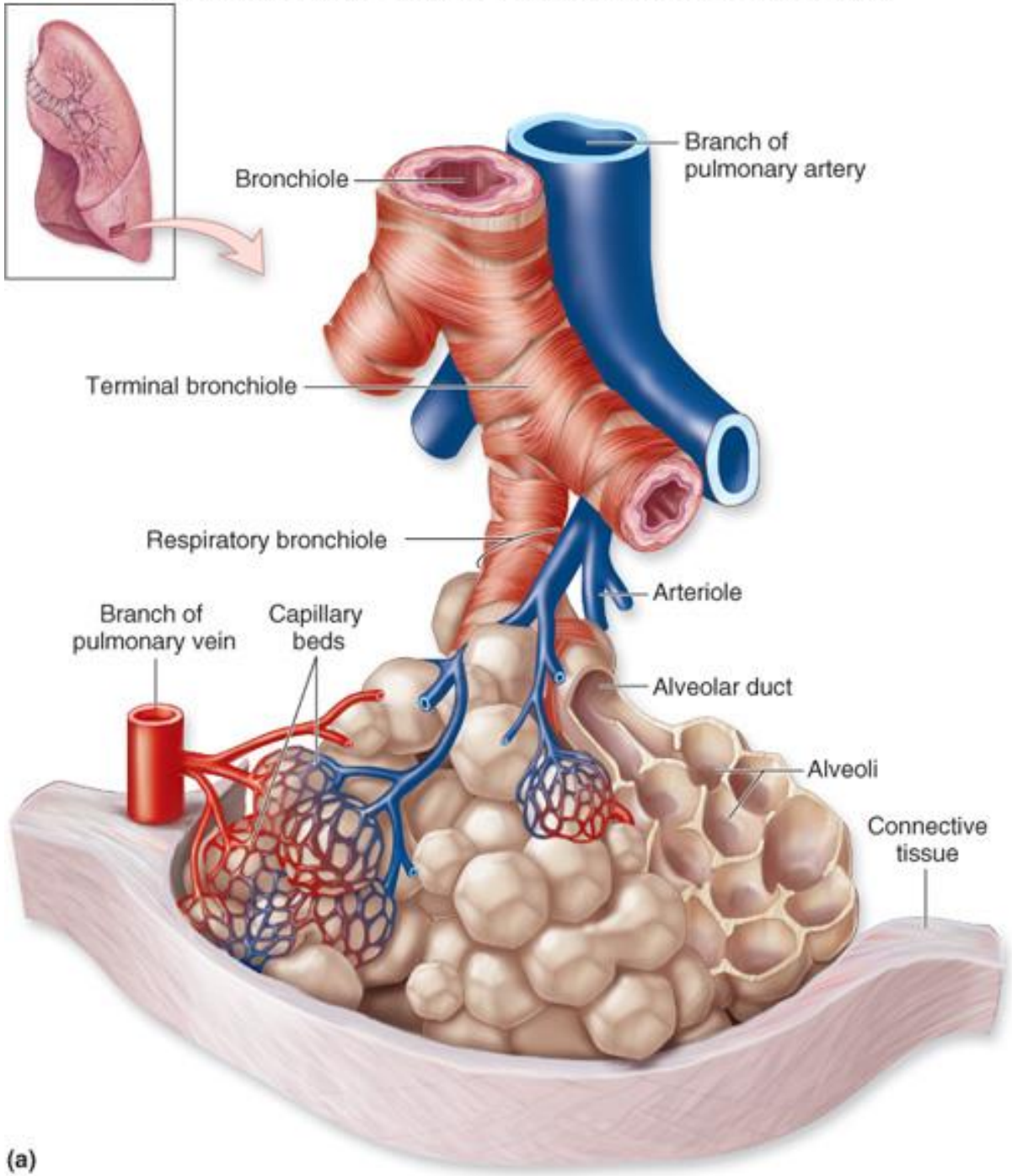

hyoid bone
thyroid cartilage
cricoid cartilage
thyroid gland
trachea
tracheal rings
bronchi




left upper lobe
left lower lobe

Respiratory Bronchioles, Alveolar Ducts, and Alveoli

- Contain small saccular outpocketings called alveoli.
- An alveolus is about 0.25 to 0.5 millimeter in diameter.
- Its thin wall is specialized to promote diffusion of gases between the alveolus and the blood in the pulmonary capillaries.
- Gas exchange can take place in the respiratory bronchioles and alveolar ducts as well as in the lungs, which contain approximately 300–400 million alveoli.
- The spongy nature of the lung is due to the packing of millions of alveoli together.

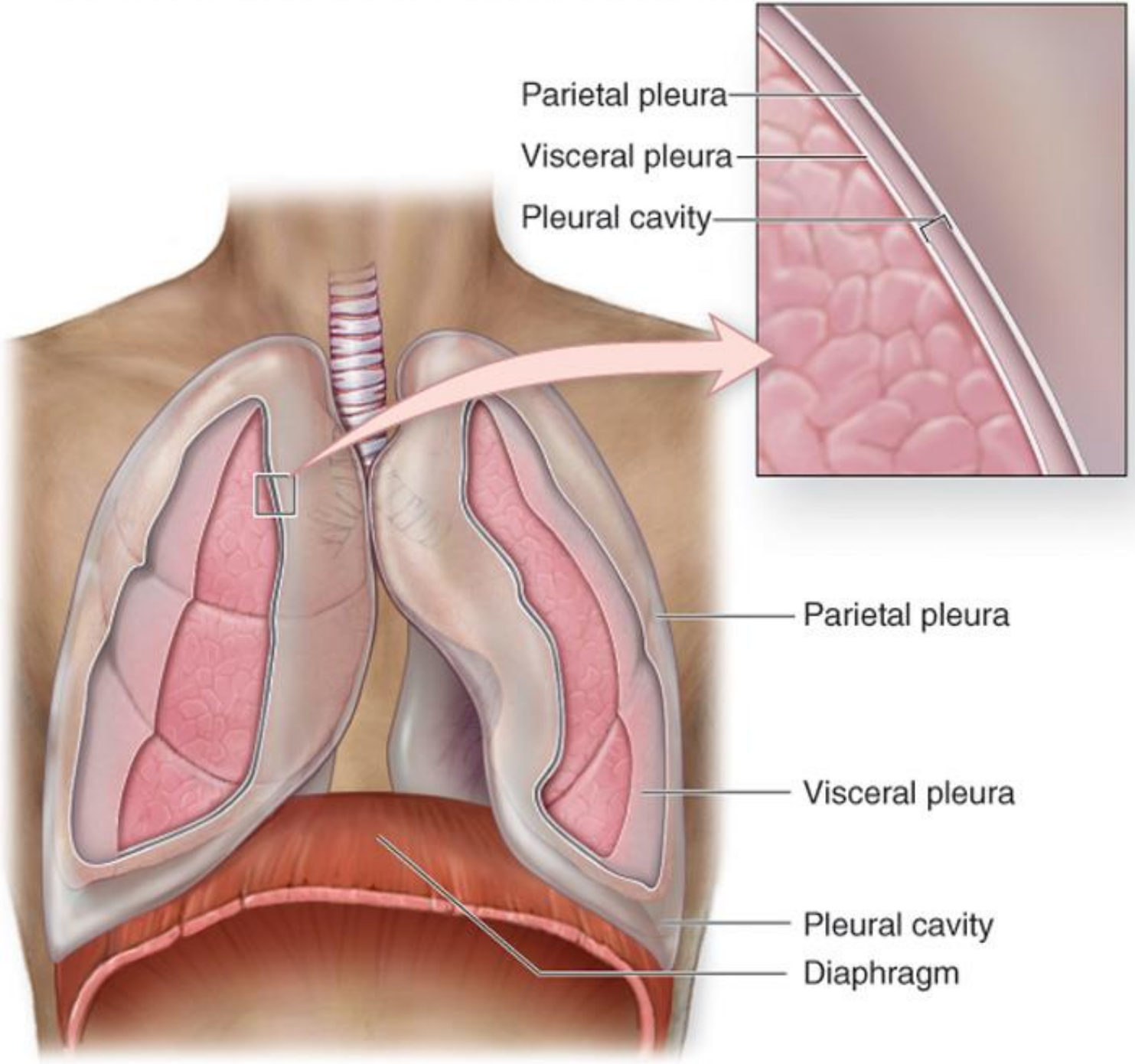


Pleura and Pleural Cavities

- The outer surface of each lung and the adjacent internal thoracic wall are lined by a serous membrane called pleura, which is formed from simple squamous epithelium.
- The outer surface of each lung is tightly covered by the visceral pleura, while the internal thoracic walls, the lateral surfaces of the mediastinum, and the superior surface of the diaphragm are lined by the parietal pleura.
- The parietal and visceral pleural layers are continuous at the hilum of each lung.

Pleura and Pleural Cavities

- The outer surface of each lung is tightly covered by the visceral pleura, while the internal thoracic walls, the lateral surfaces of the mediastinum, and the superior surface of the diaphragm are lined by the parietal pleura.
- The potential space between these serous membrane layers is a pleural cavity.
- The pleural membranes produce a thin, serous fluid that circulates in the pleural cavity and acts as a lubricant, ensuring minimal friction during breathing.



Parietal Pleura Divisions

- Costal pleura lines the ribs.
- Diaphragmatic pleura covers the diaphragm.
- Mediastinal pleura lies against the mediastinum.
- Cervical pleura extends above the level of the first rib.

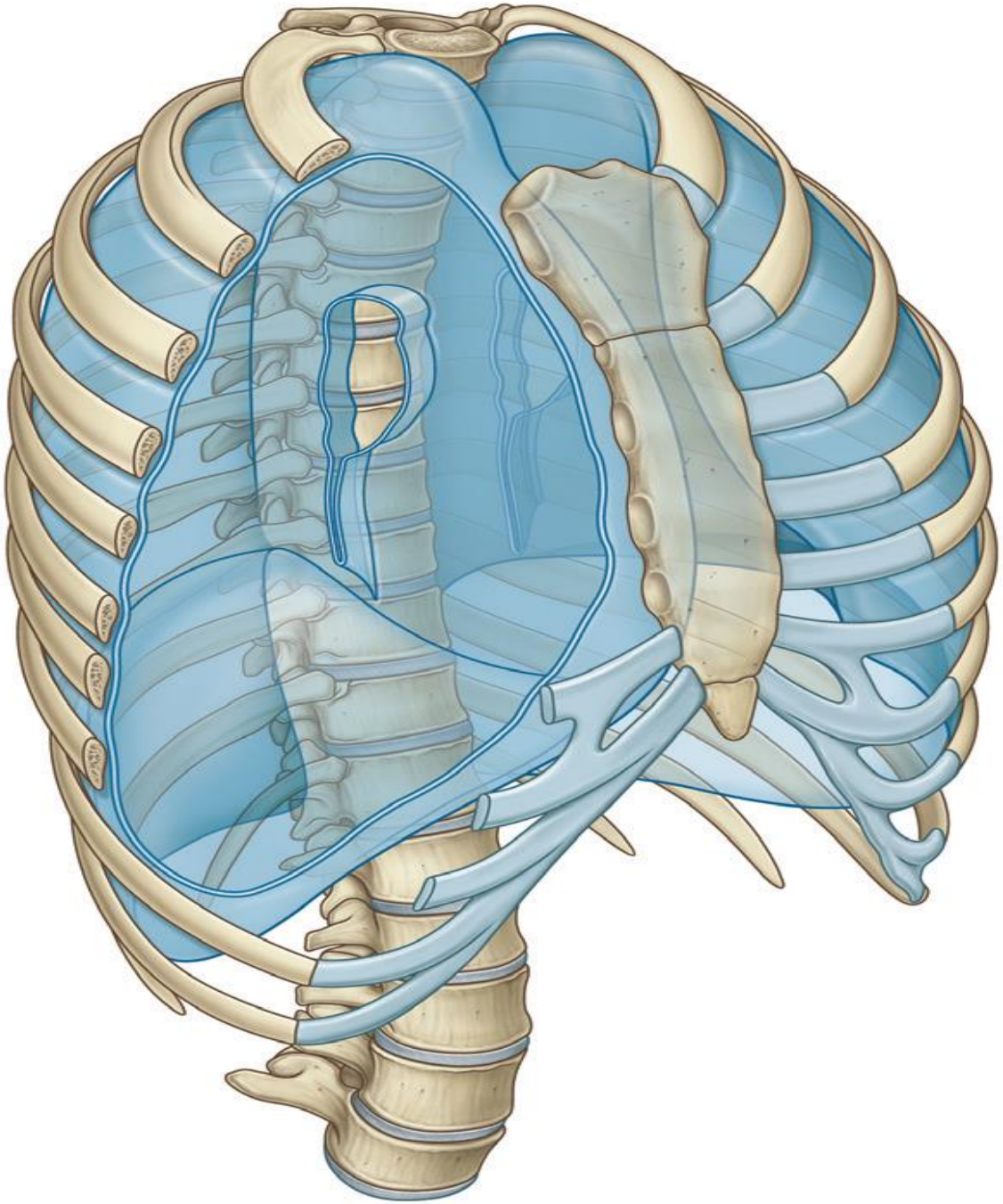
Pleural Reflections

- Costodiaphragmatic recess (space):

  Space where costal and diaphragmatic pleura meet.
- Costomediastinal recess (space):

  Space where mediastinal and costal pleura meet.
- Pulmonary ligament:

  Transition between visceral and parietal pleura at root of the lung.



Pleural Lines of Reflection

- Cervical dome of pleura:

  Level with neck of the first rib.

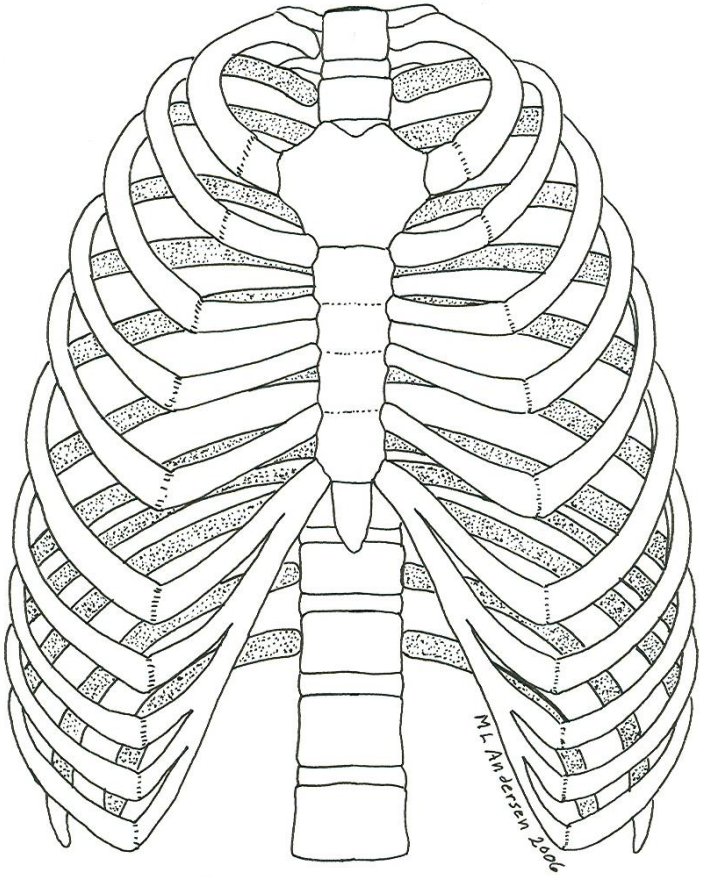
  Anteriorly, 1.5-2.5 cm above the sternal end of the clavicle.

  Anterior margin extends obliquely behind the sternoclavicular joint.

  At sternal angle, the pleura is at the median line and two sides stay in contact until the fourth costal cartilage.

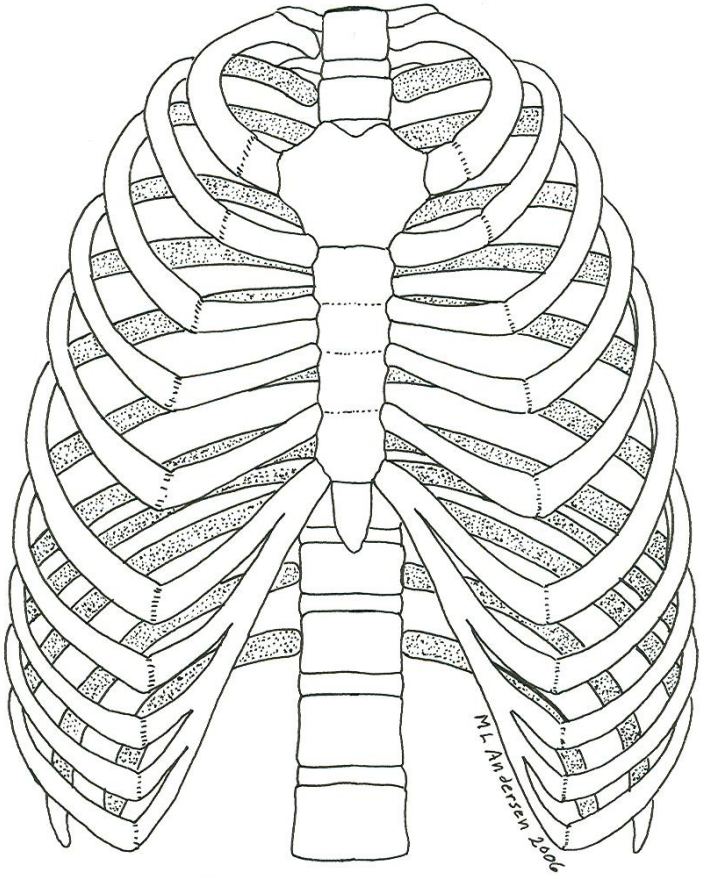
Pleural Lines of Reflection

- Right side:
  - Leaves sternum at 6th costal cartilage.
  - At 8th costal cartilage at midclavicular line.
  - At 10th rib at axillary line.
  - At 11th rib at scapular line.
  - Extends to level of body of T12 and then ascends.



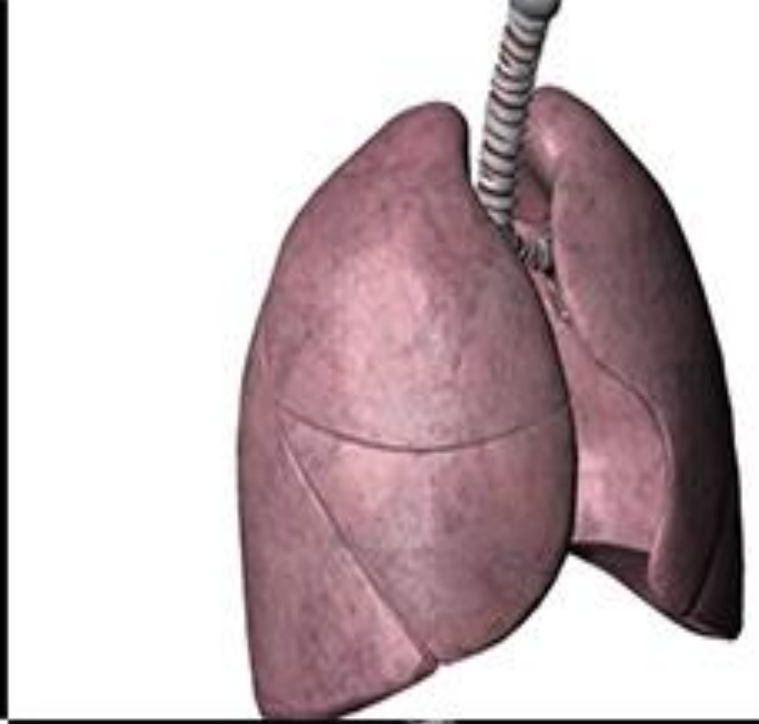
Pleural Lines of Reflection

- Left side:
  - Leaves sternum at IC space 5.
  - 1.5 cm from sternal margin at 6th costal cartilage.
  - Follows same landmarks as right side from this point.



Gross Anatomy of the Lungs

- Each lung has a conical shape.
- Its wide, concave base rests upon the muscular diaphragm.
- Its relatively blunt superior region, called the apex or (cupola), projects superiorly to a point that is slightly superior and posterior to the clavicle.
- Both lungs are bordered by the thoracic wall anteriorly, laterally, and posteriorly, and supported by the rib cage.
- Toward the midline, the lungs are separated from each other by the mediastinum.
- The relatively broad, rounded surface in contact with the thoracic wall is called the costal surface of the lung.



Right Lung Projections

- Follows rib 1 to sternoclavicular joint.
- Located at median plane at sternal angle.
- Extends along median plane from 2nd costal cartilage to 4th costal cartilage.
- Leaves sternum at 6th costal cartilage.
- At 6th rib at midclavicular line.

Right Lung Projections

- At 8th rib at axillary line.
- At 10th rib at scapular line.
- Ends opposite T10.

Left Lung Projections

- Same as right lung except:

  Cardiac notch begins at 4th costal cartilage.

  Horizontal at parasternal line.

  Medial to costochondral junction at 6th cartilage.

Right Lung Morphology

- Oblique fissure :

  Separates superior and inferior lobes.

  Begins at base of scapular spine.

  At 5-6th rib at midaxillary line.

  Ends at 6th costochondral junction.

Right Lung Morphology

- Horizontal fissure :

  Separates superior and middle lobes.

  Begins at axillary line.

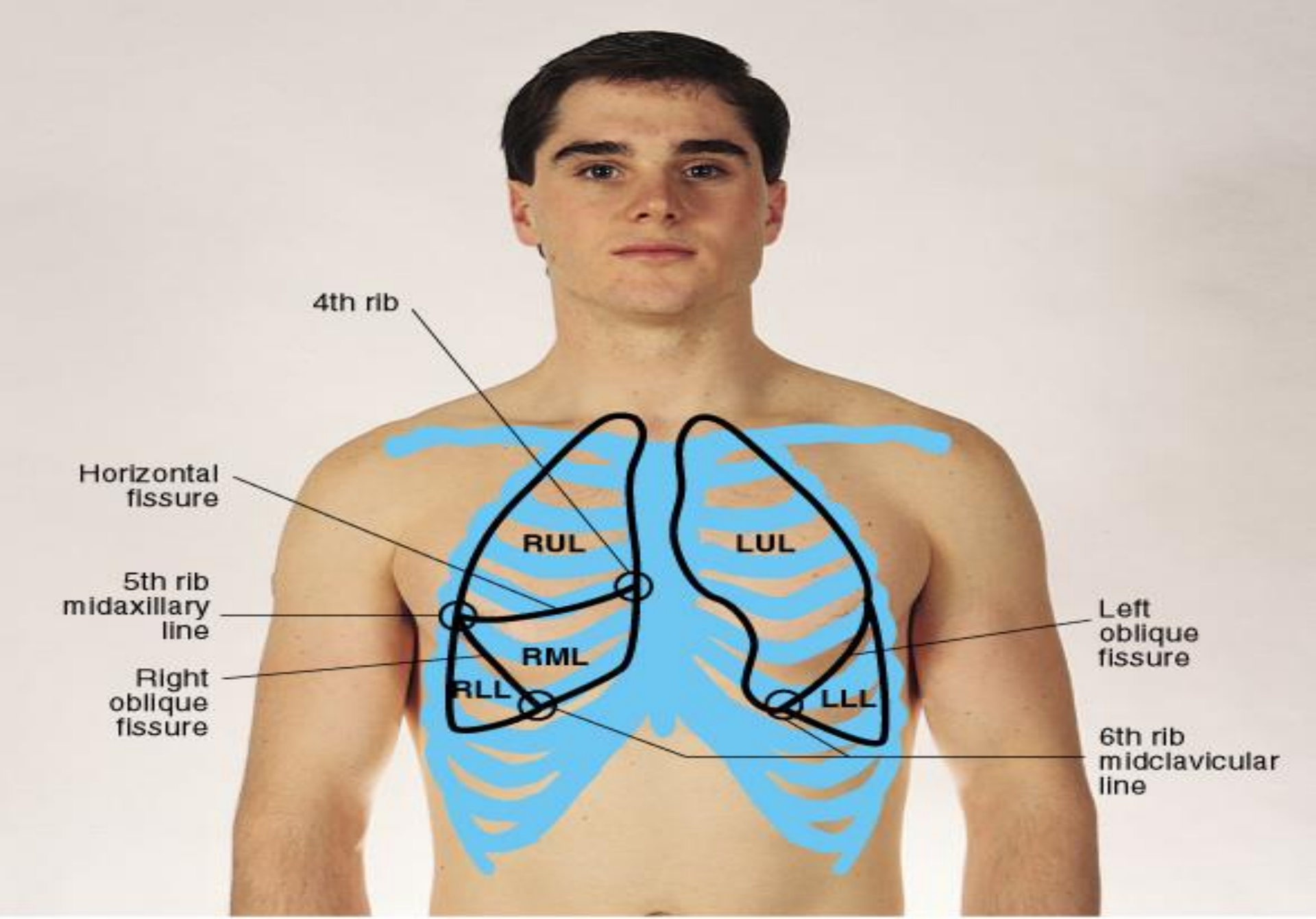
  Follows rib 4.

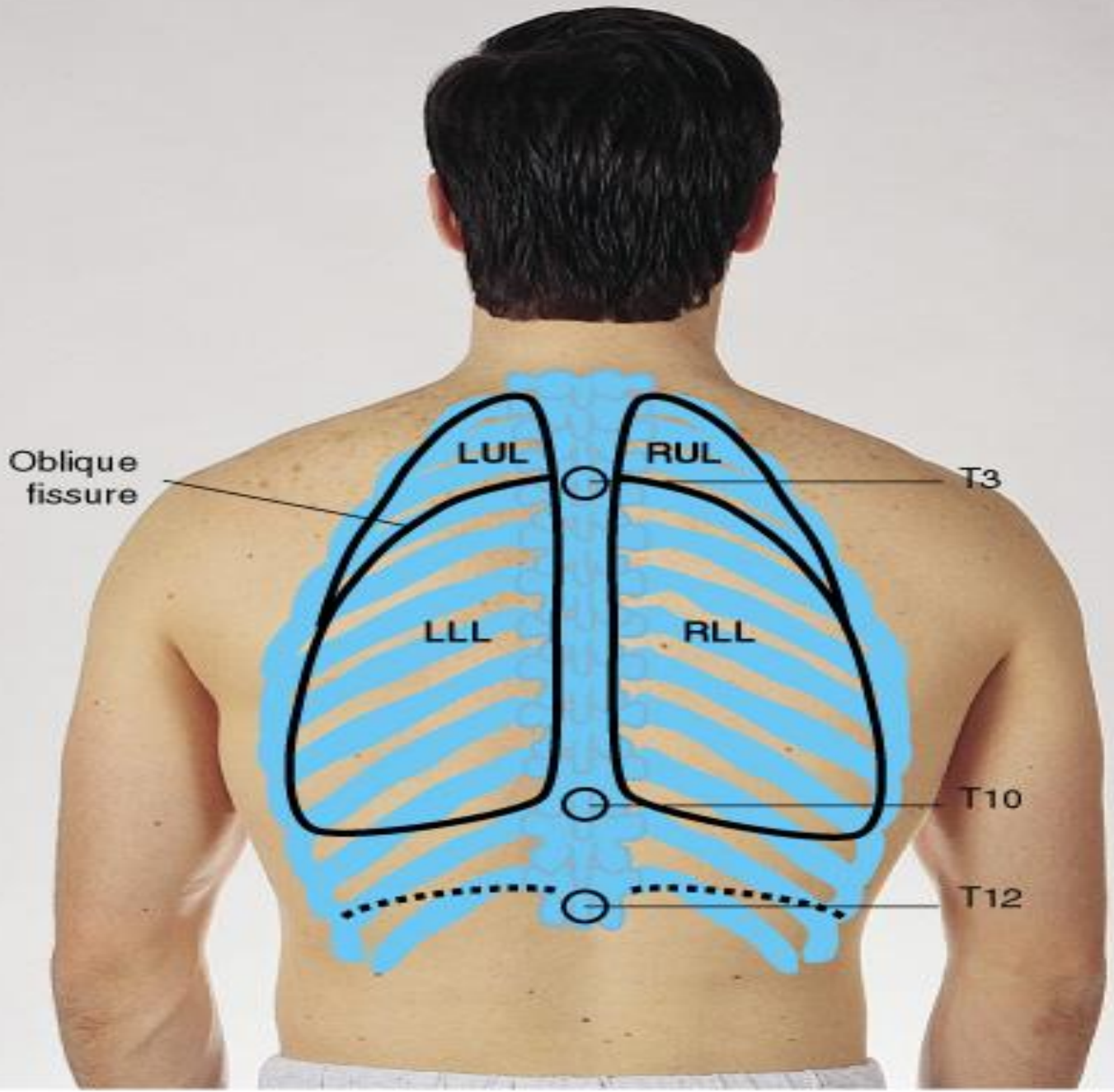
Left Lung Morphology

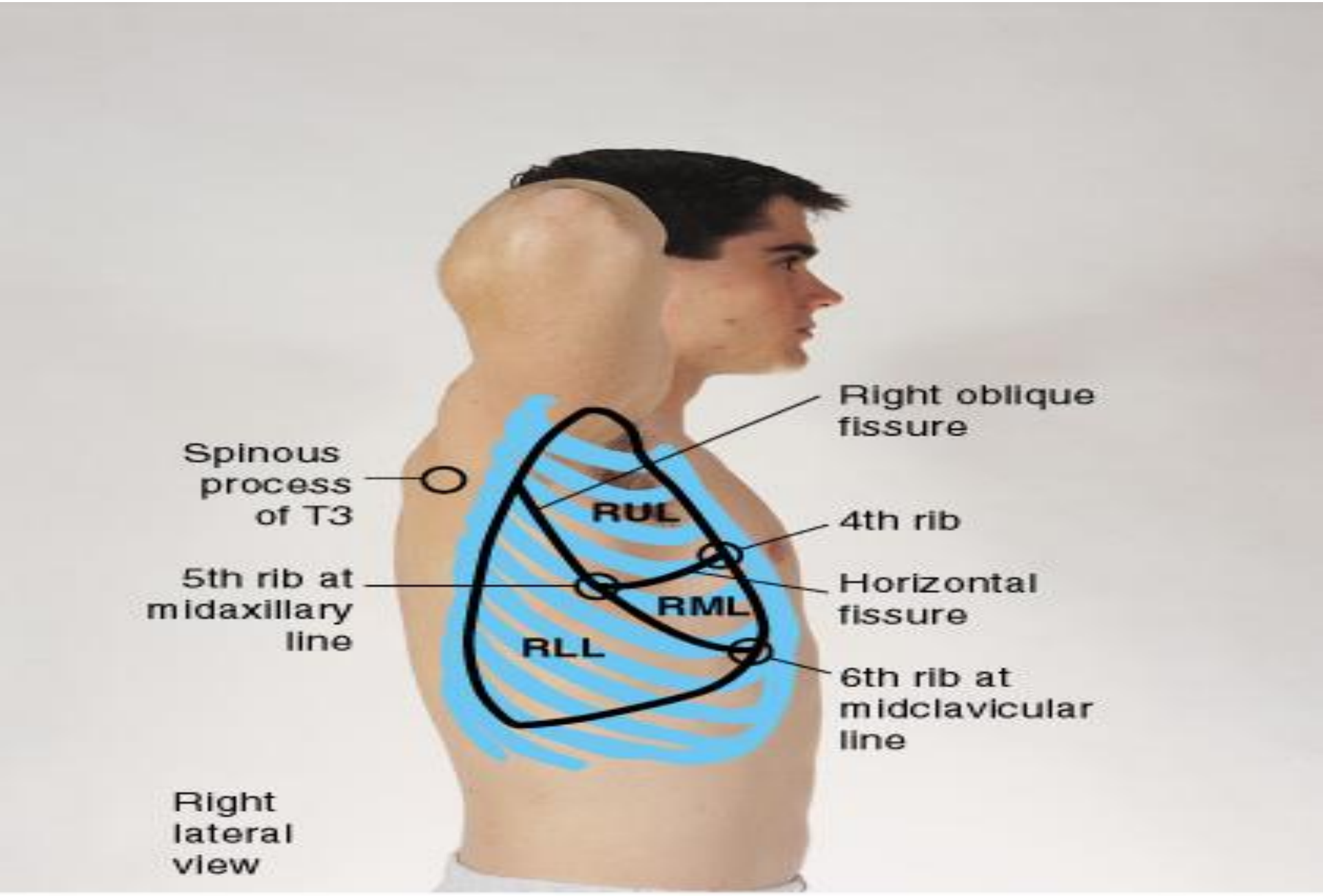
- Oblique fissure:

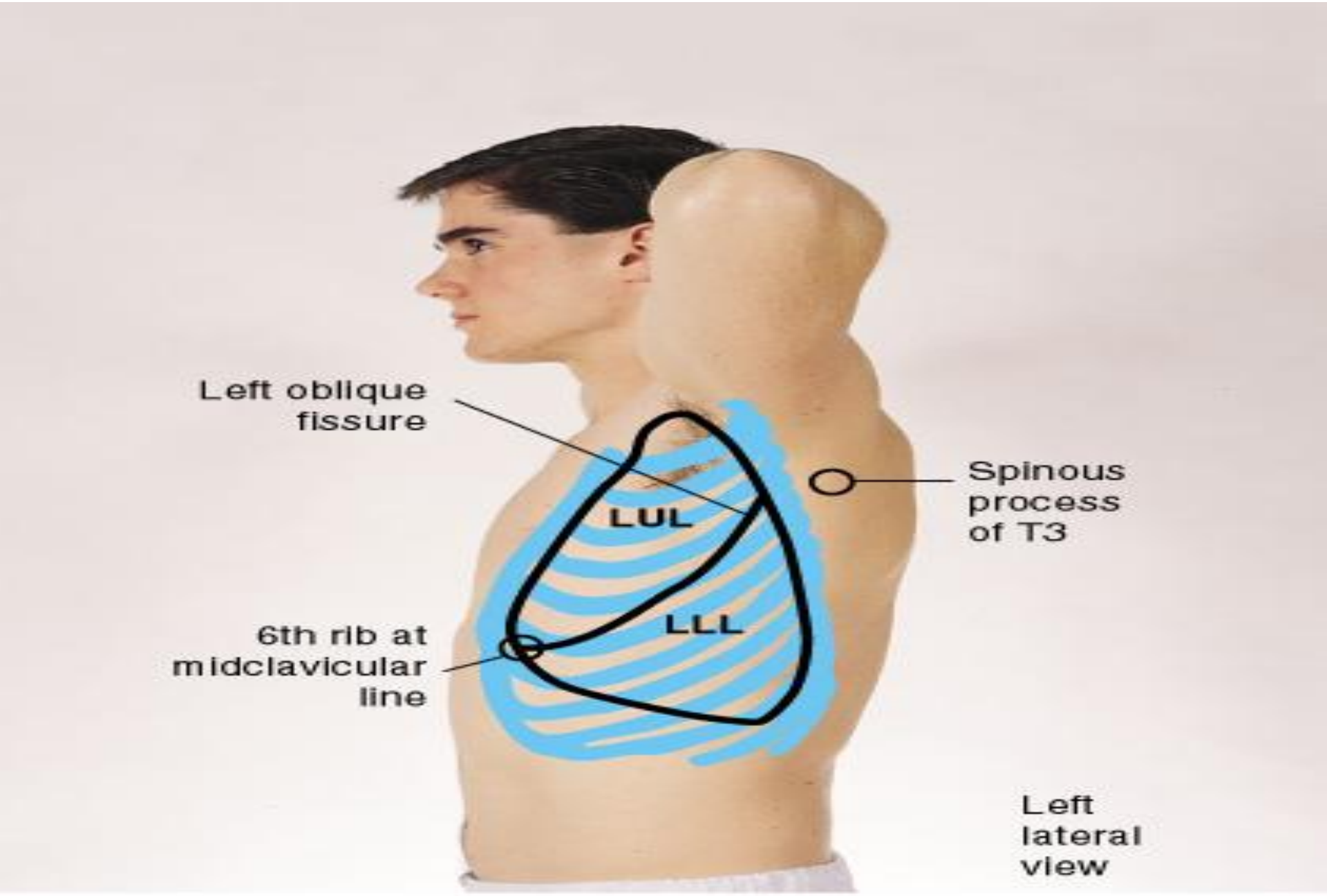
  Same as for right lung.

- No horizontal fissure.







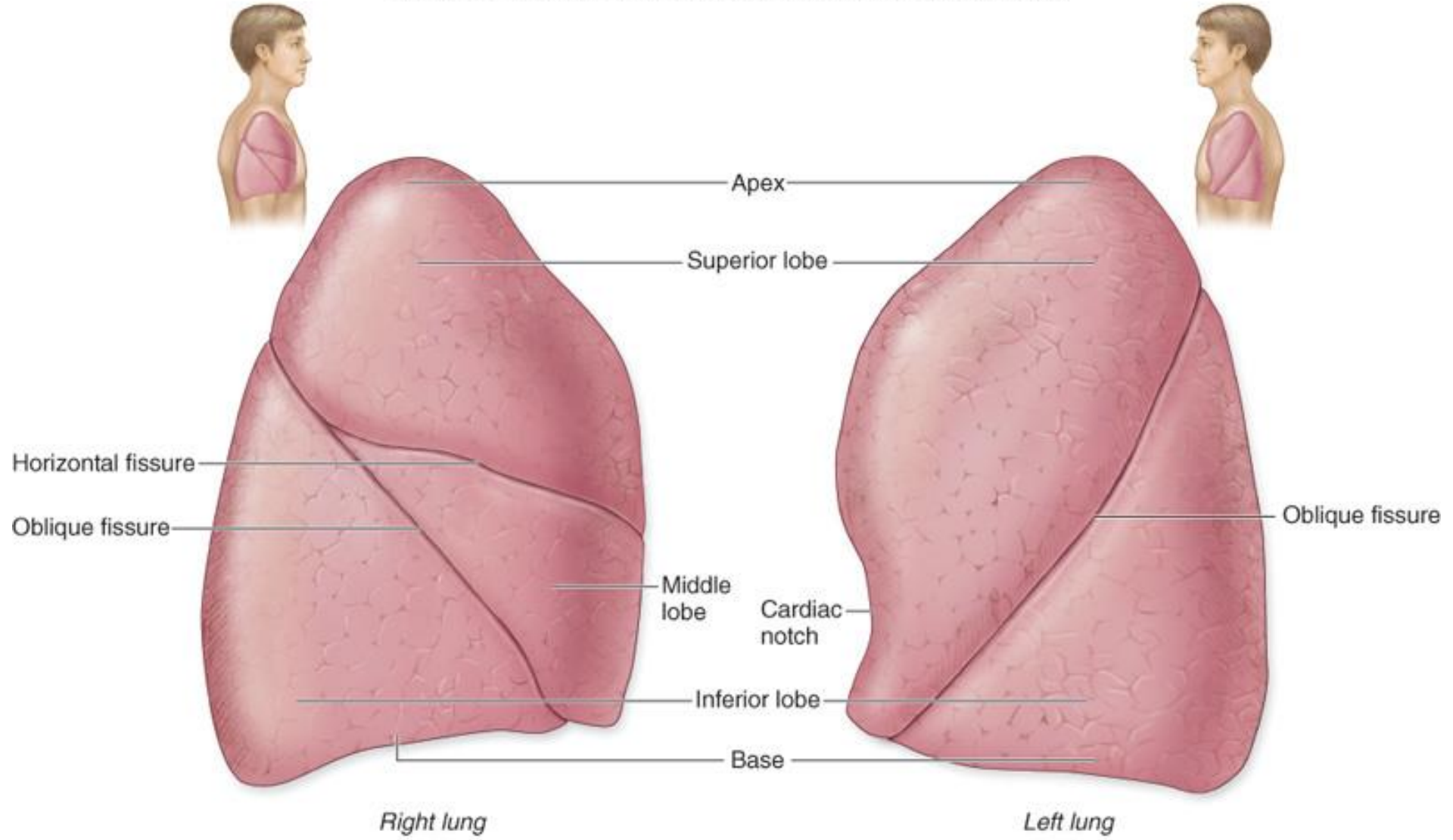


3 Important Points

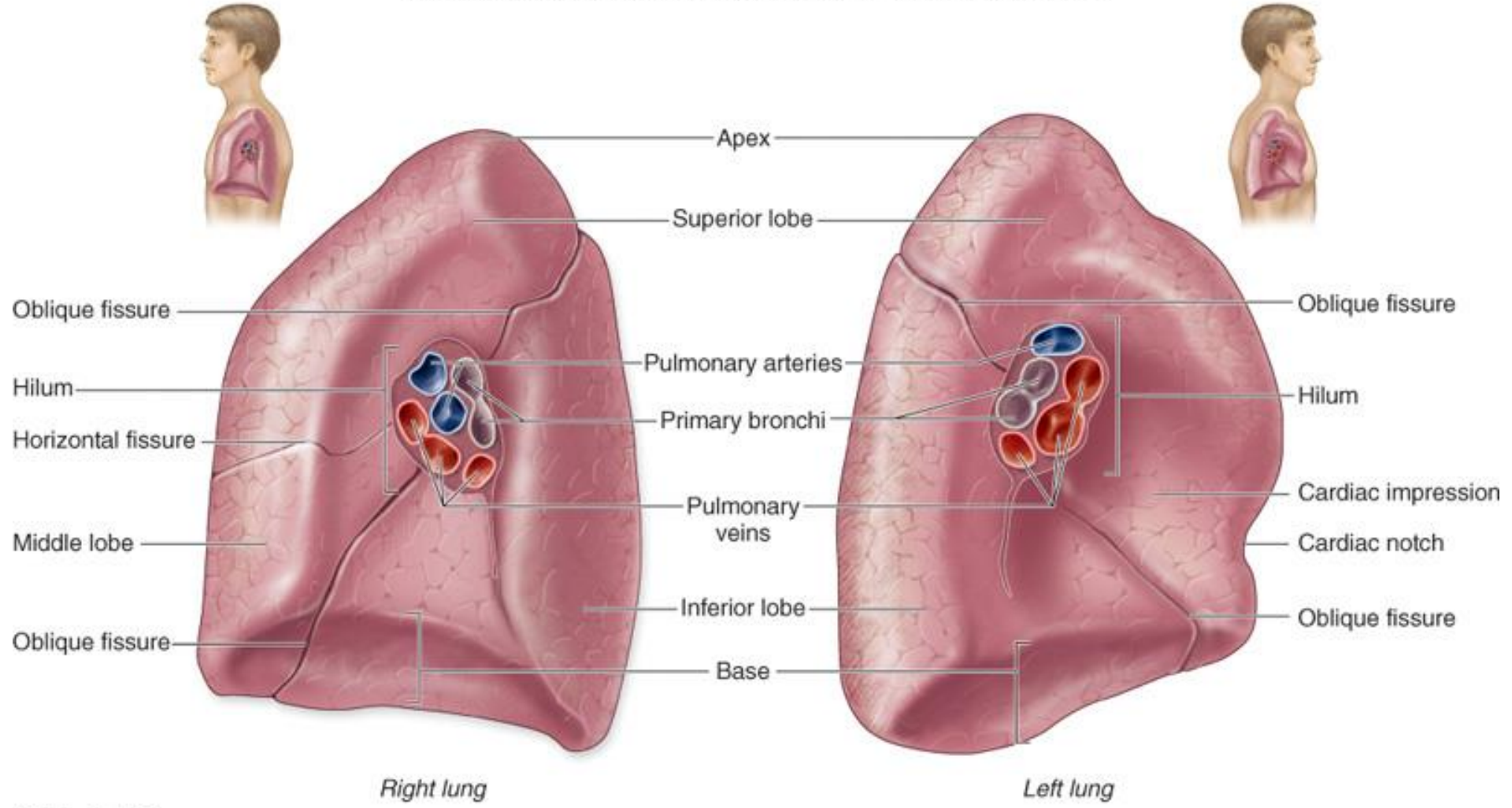
1. Left Lung – no middle lobe

2. Anterior chest contains upper & middle lobes with very little lower lobe

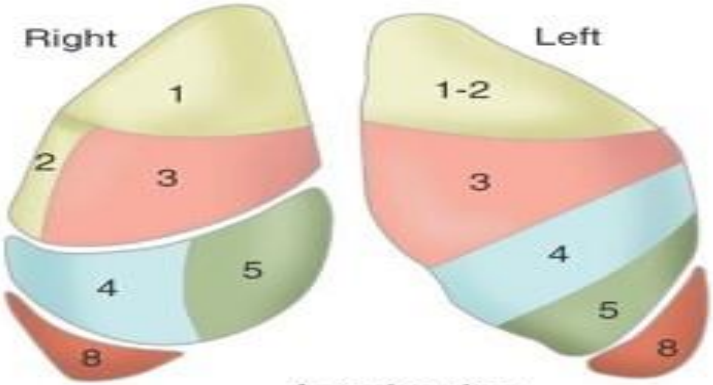
3. Posterior chest has almost all lower lobe. Rt middle lobe does not project into the posterior chest



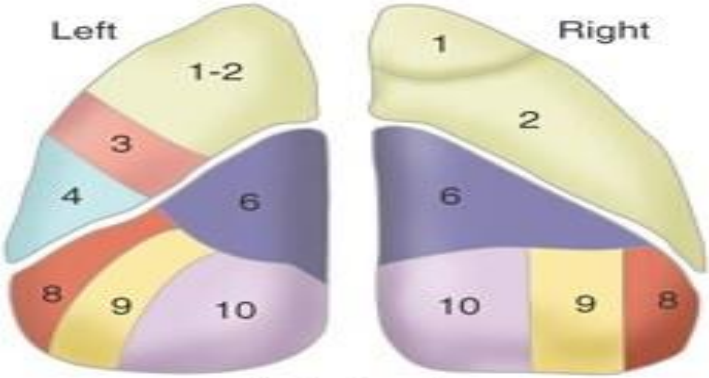
(a) Lateral views



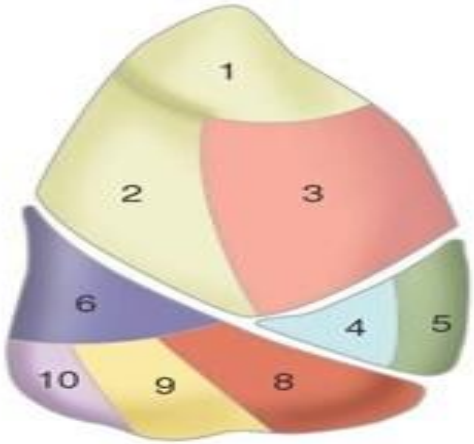
(b) Medial views



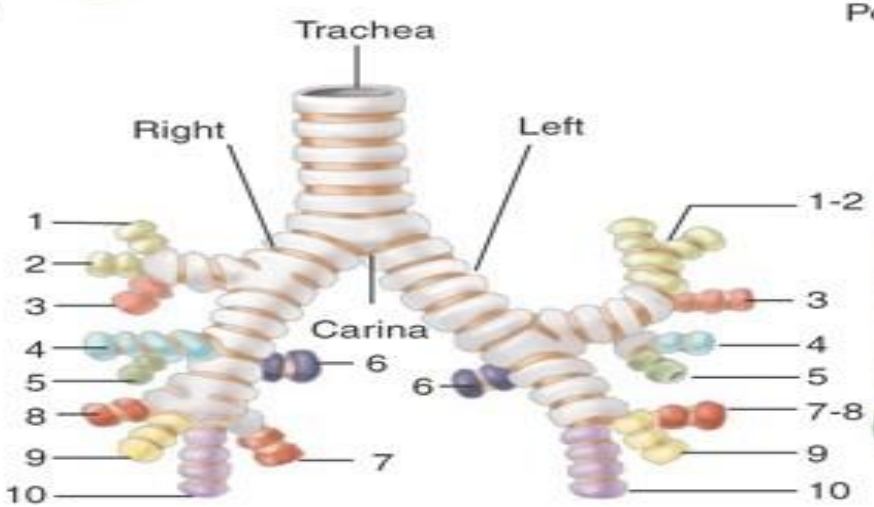
Anterior view

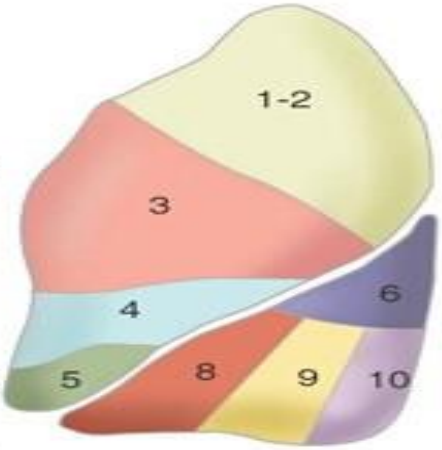


Posterior view

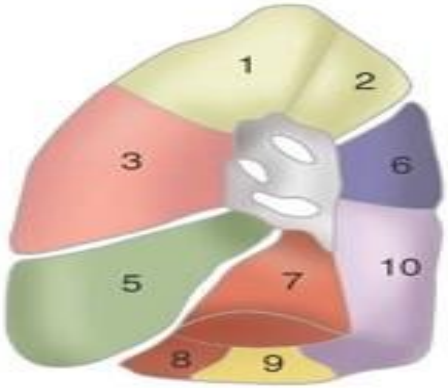


Right lateral view





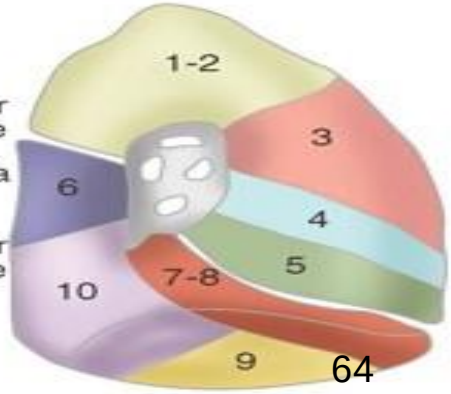
Left lateral view



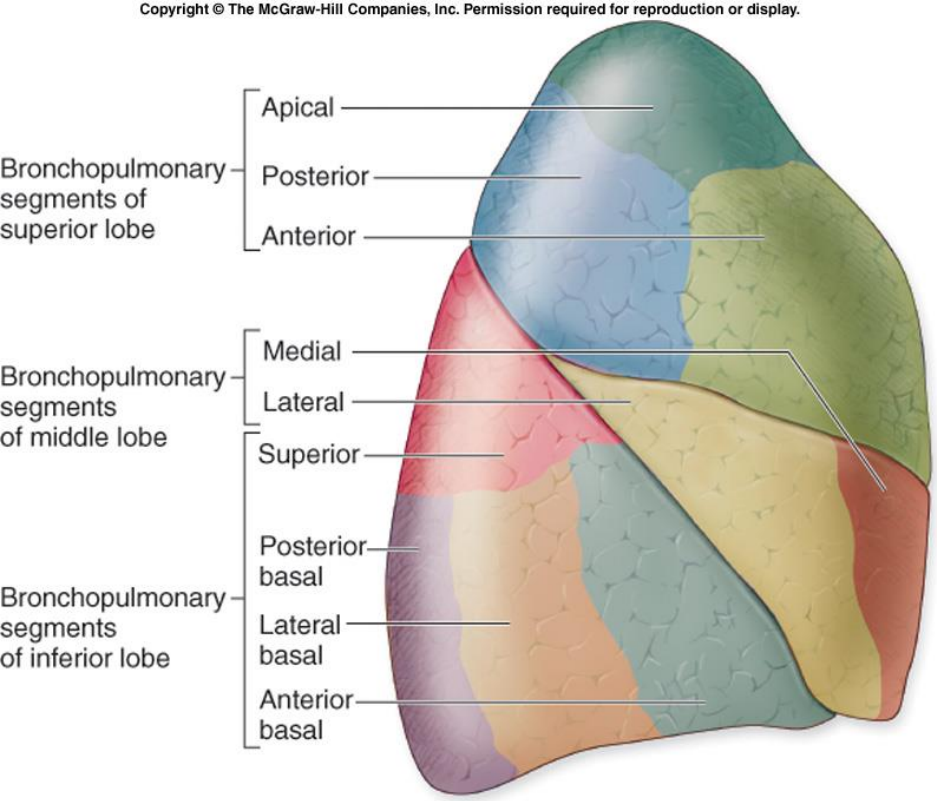
Right medial view

Upper lobe	1.	Apical
	2.	Posterior
	3.	Anterior
Middle lobe	4.	Lateral
	5.	Medial
Lower lobe	6.	Superior
	7.	Med. basal
	8.	Lat. basal
	9.	Lat. basal
	10.	Post. basal

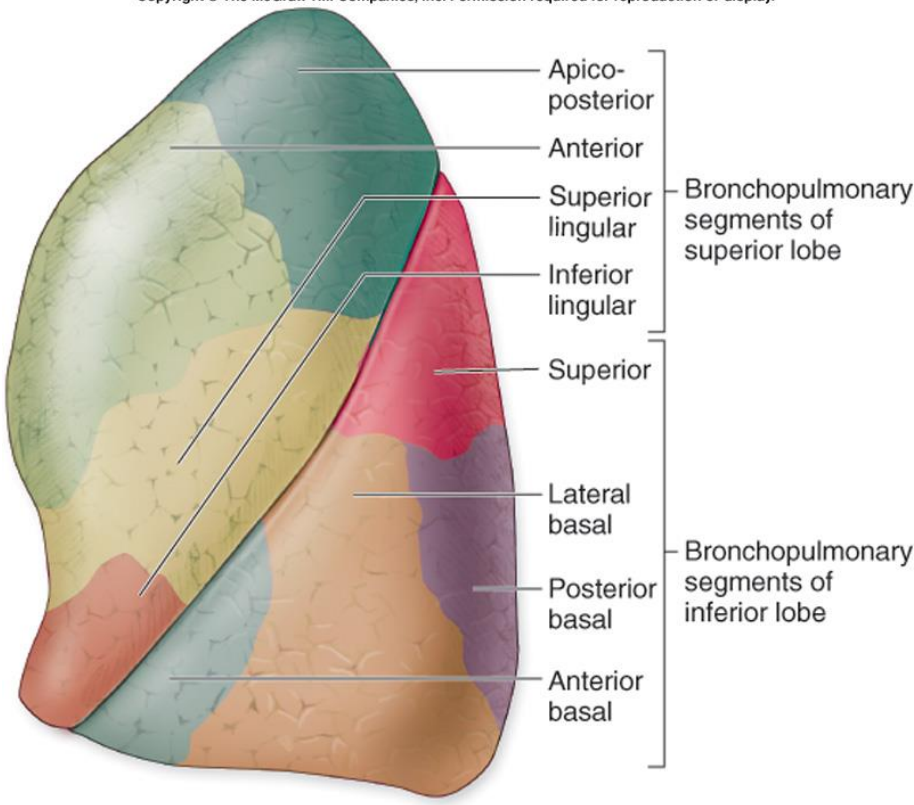
1-2.	Apical-posterior	Upper lobe
3.	Anterior	
4.	Superior	Lingula
5.	Inferior	
6.	Superior	Lower lobe
7-8.	Ant. basal	
9.	Lat. basal	
10.	Post. basal	



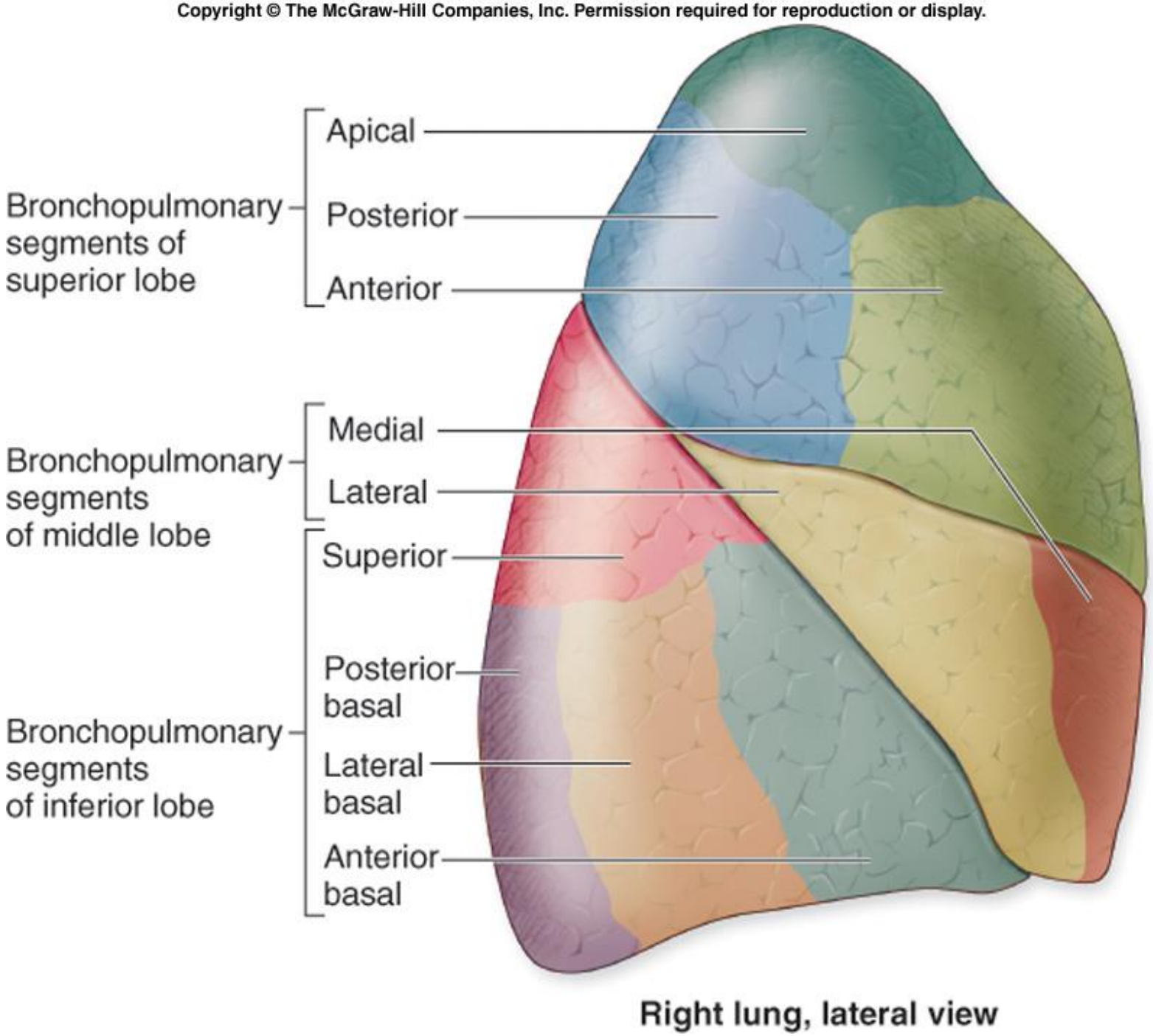
Left medial view



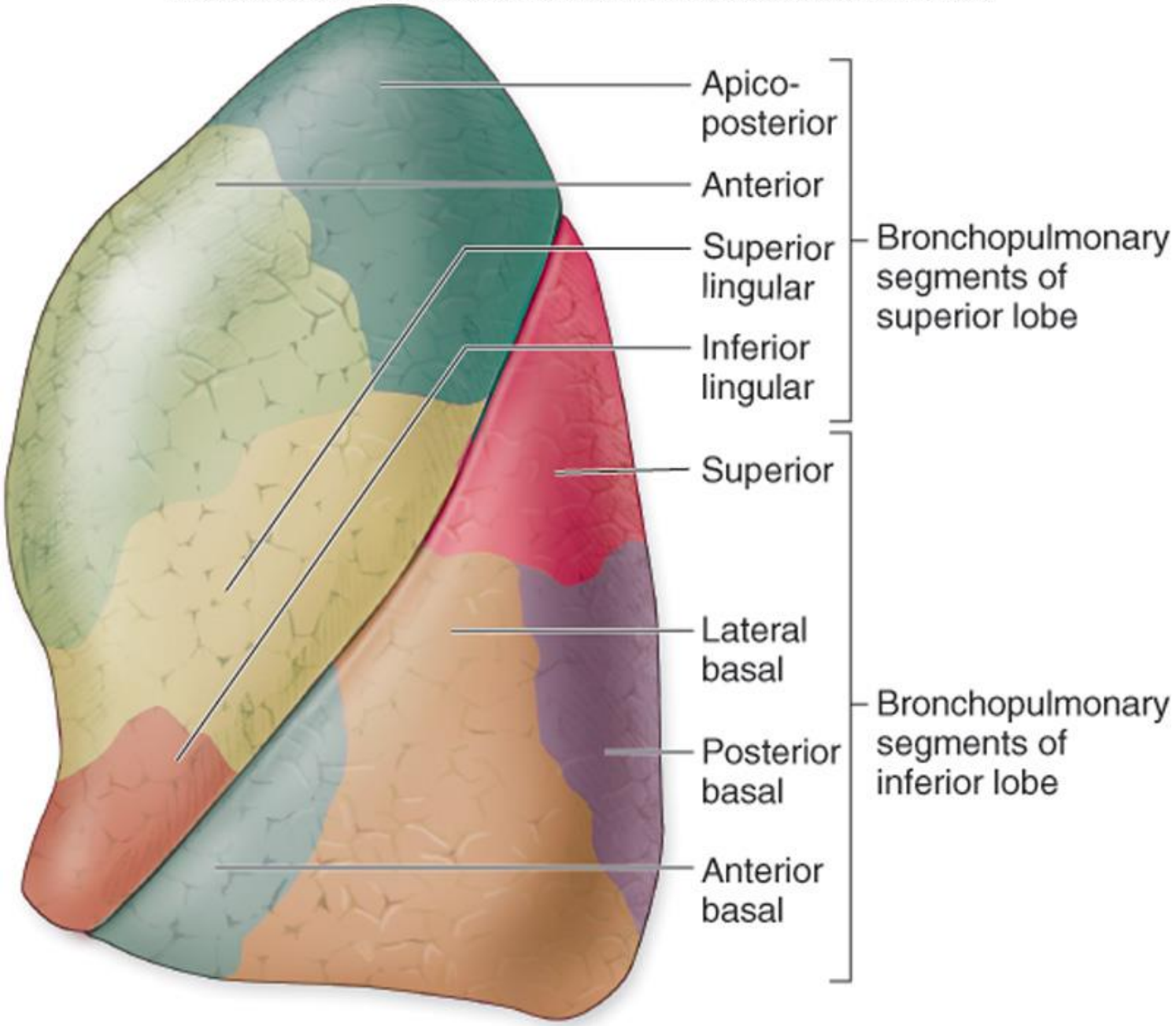
Right lung, lateral view



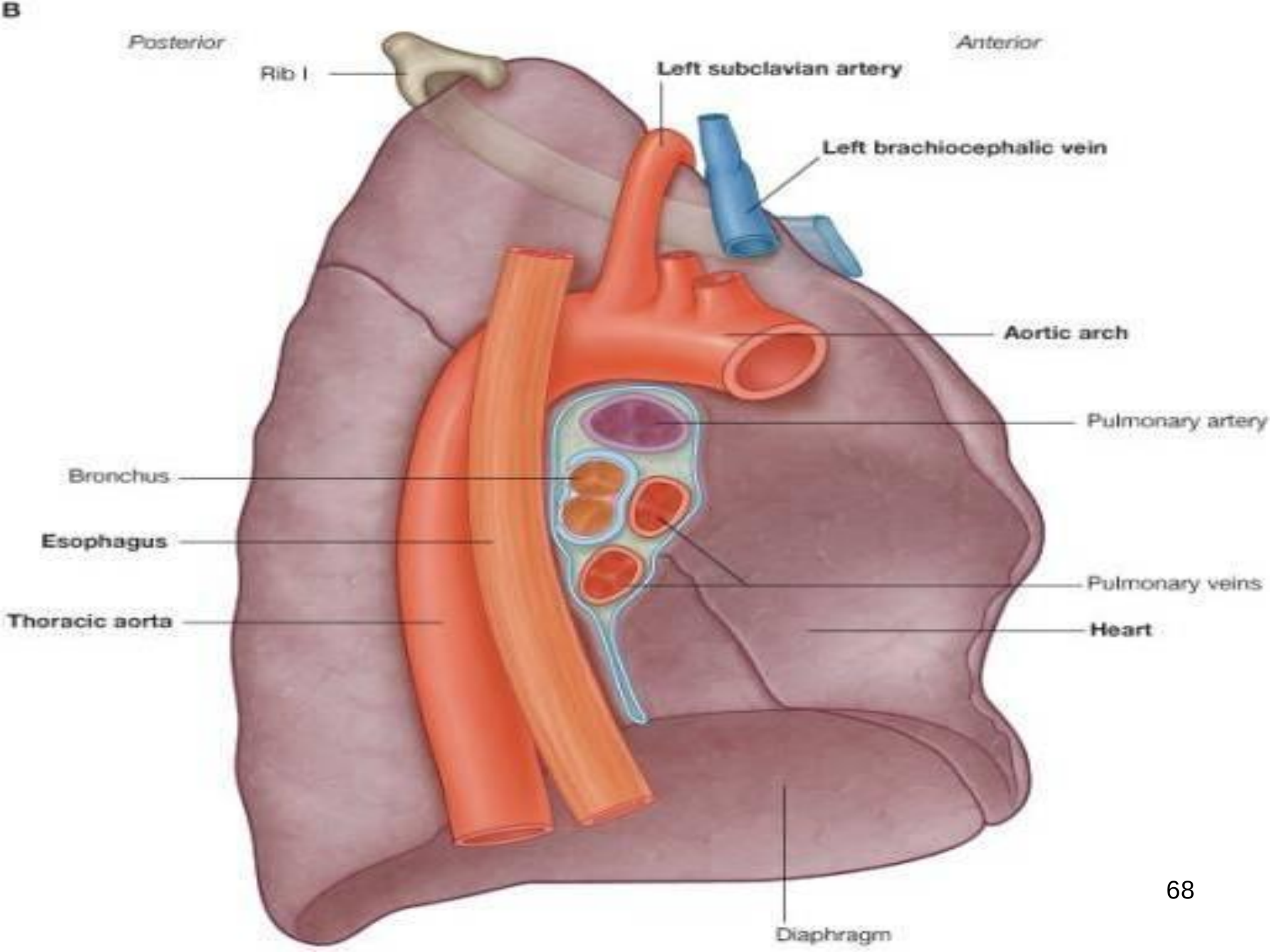
Left lung, lateral view

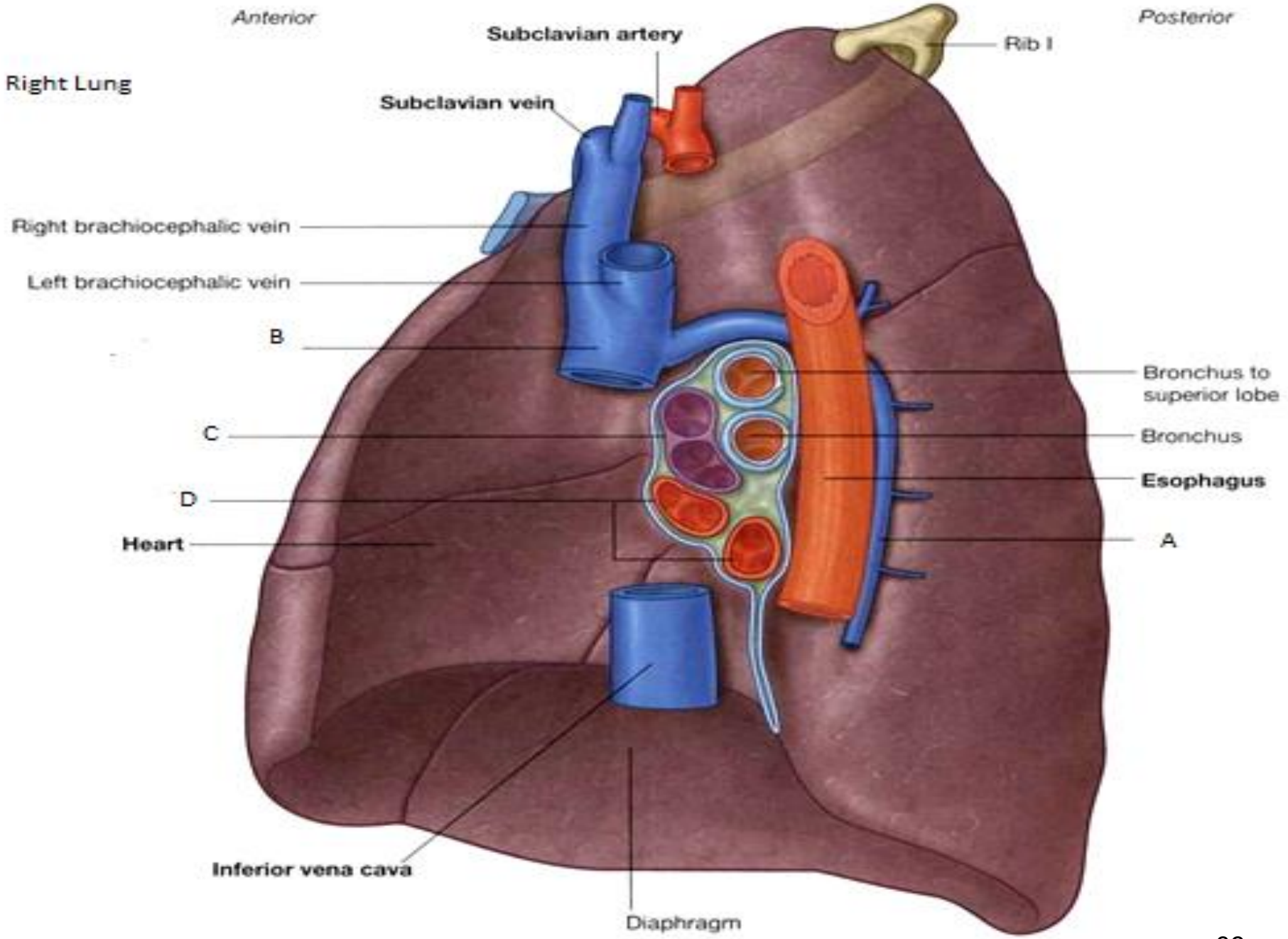


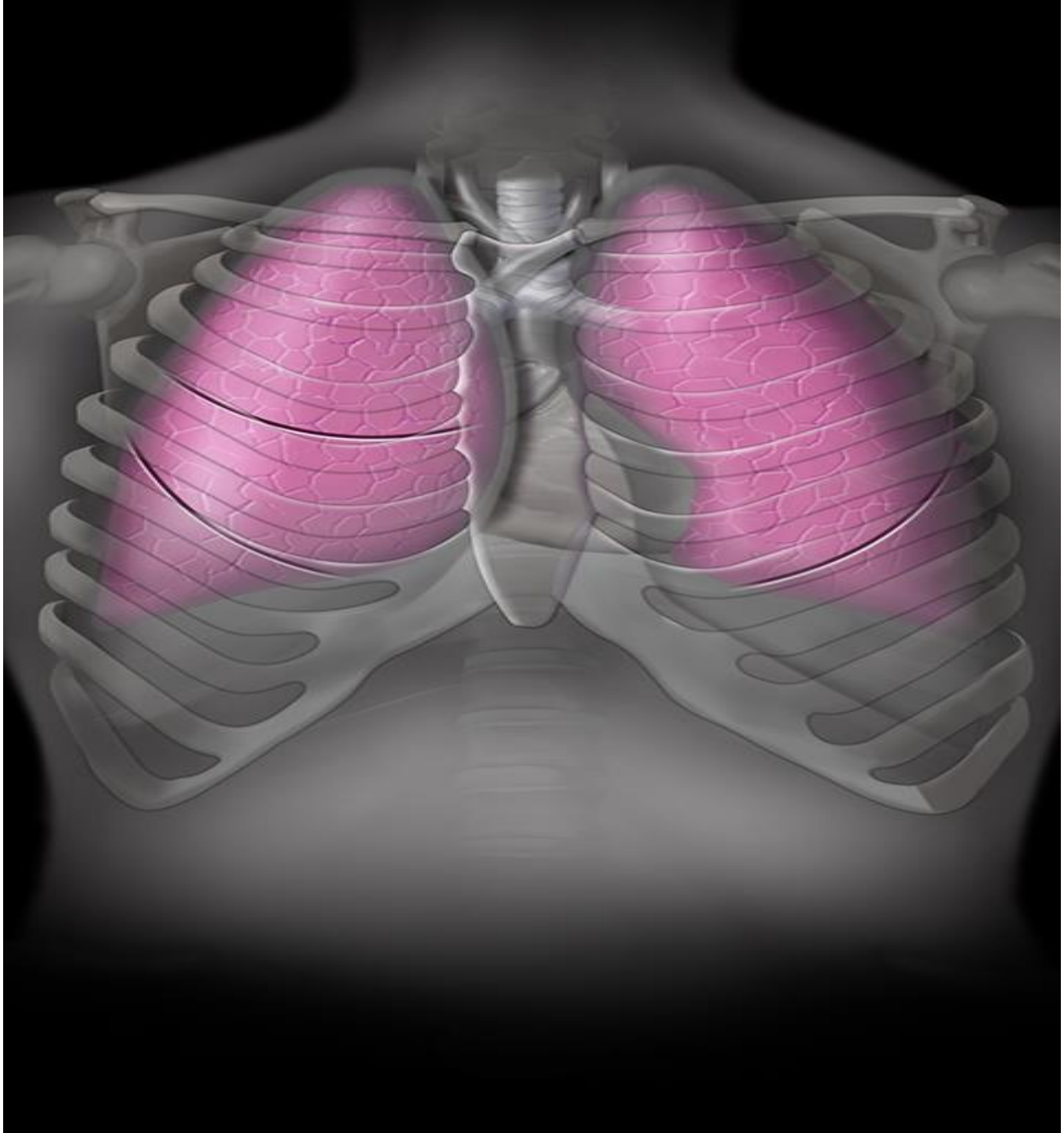
Right lung, lateral view

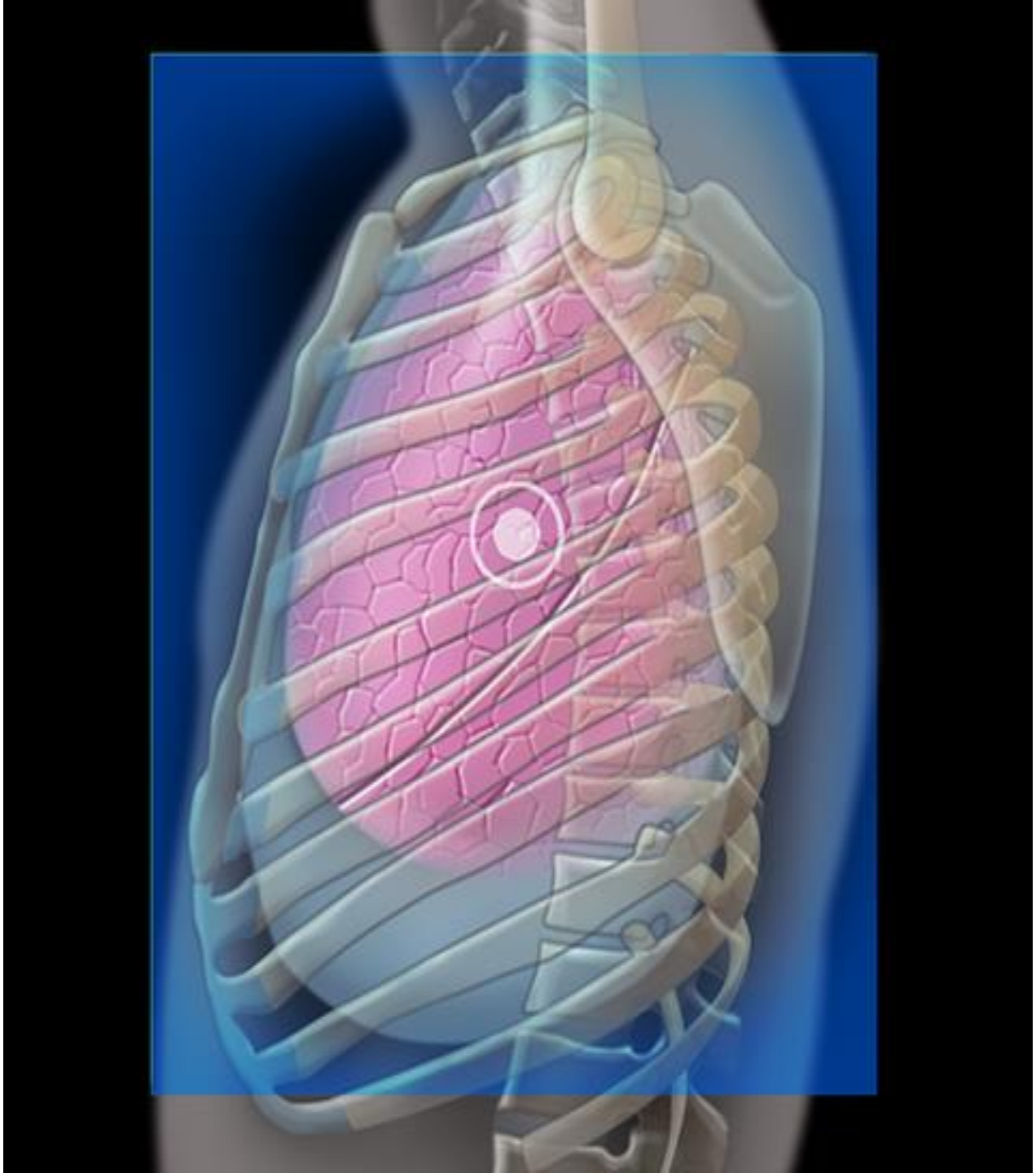


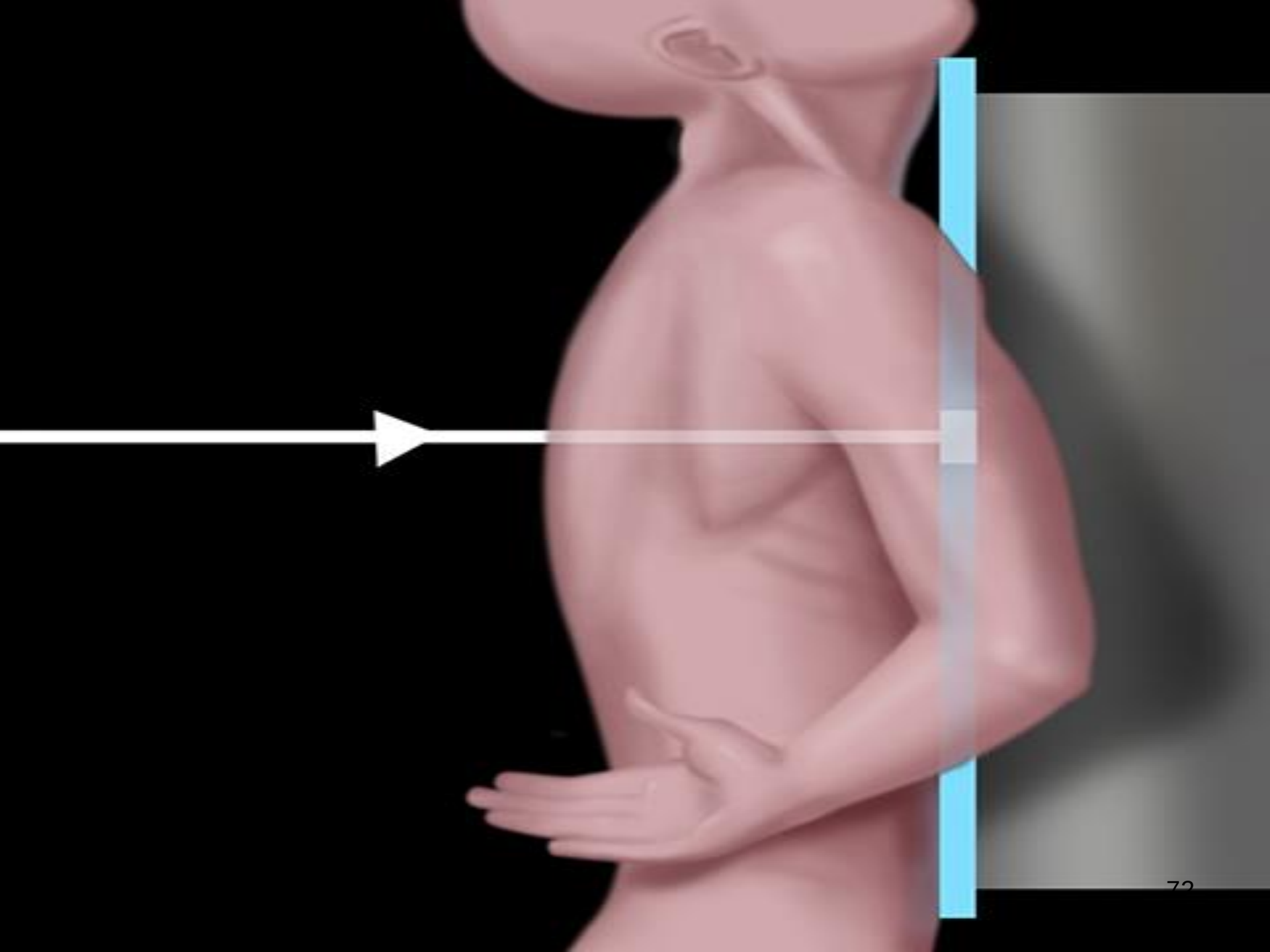
Left lung, lateral view

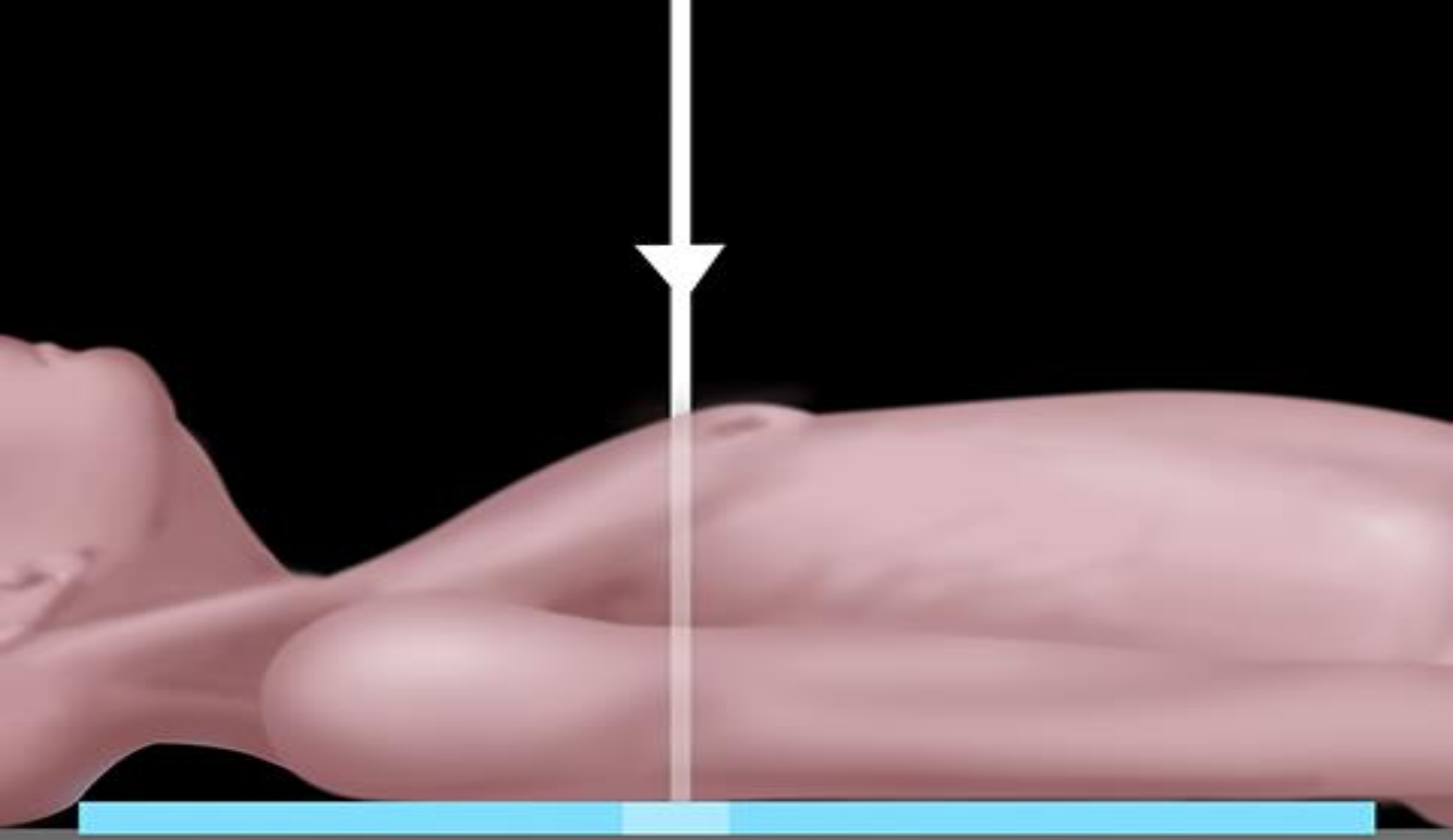

B
Posterior
Anterior
Rib I
Left subclavian artery
Left brachiocephalic vein
Aortic arch
Pulmonary artery
Bronchus
Esophagus
Pulmonary veins
Thoracic aorta
Heart
Diaphragm

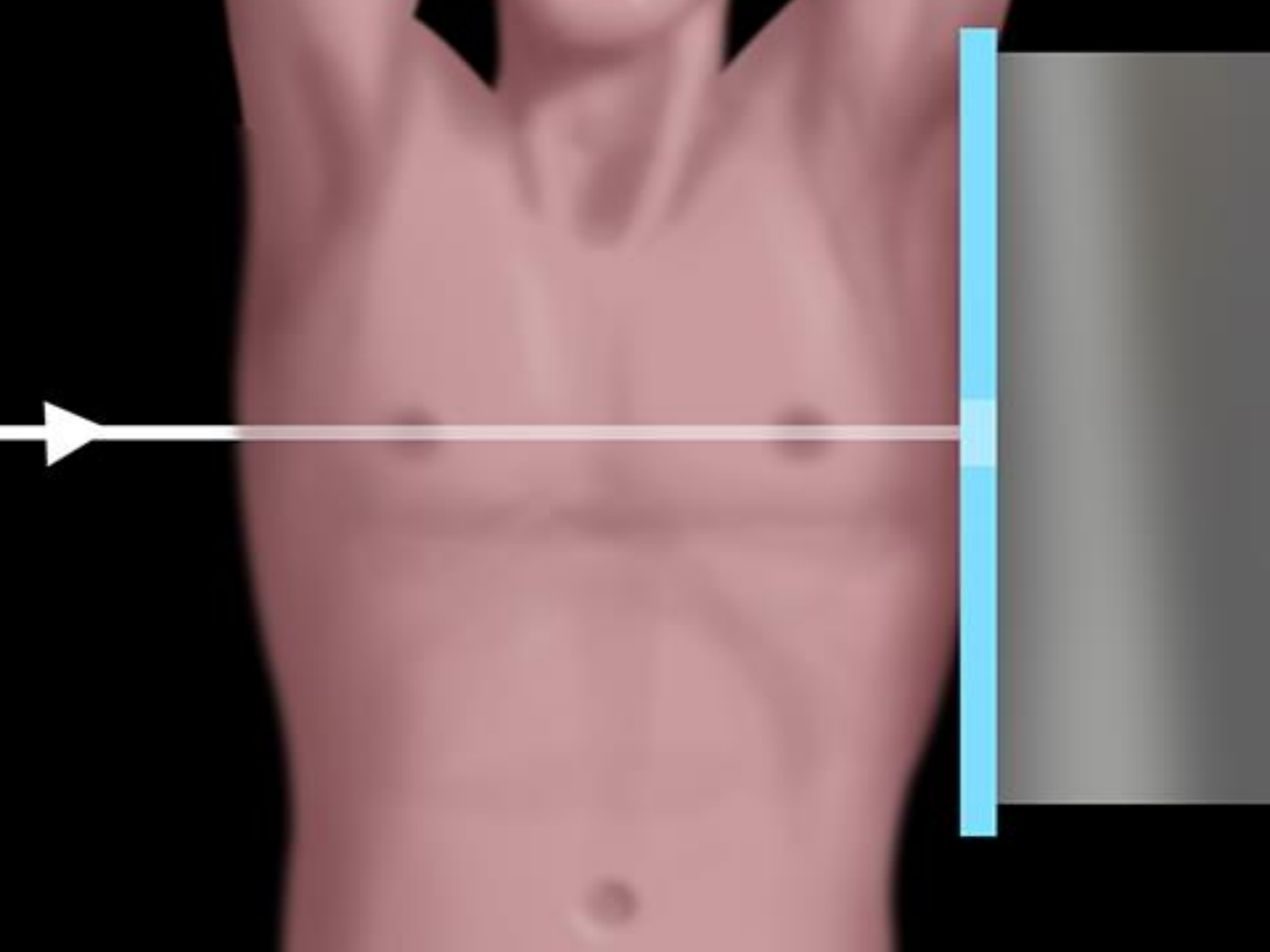

Anterior
Posterior
Right Lung
Subclavian artery
Rib I
Subclavian vein
Right brachiocephalic vein
Left brachiocephalic vein
B
Bronchus to superior lobe
C
Bronchus
Esophagus
D
Heart
A
Inferior vena cava
Diaphragm

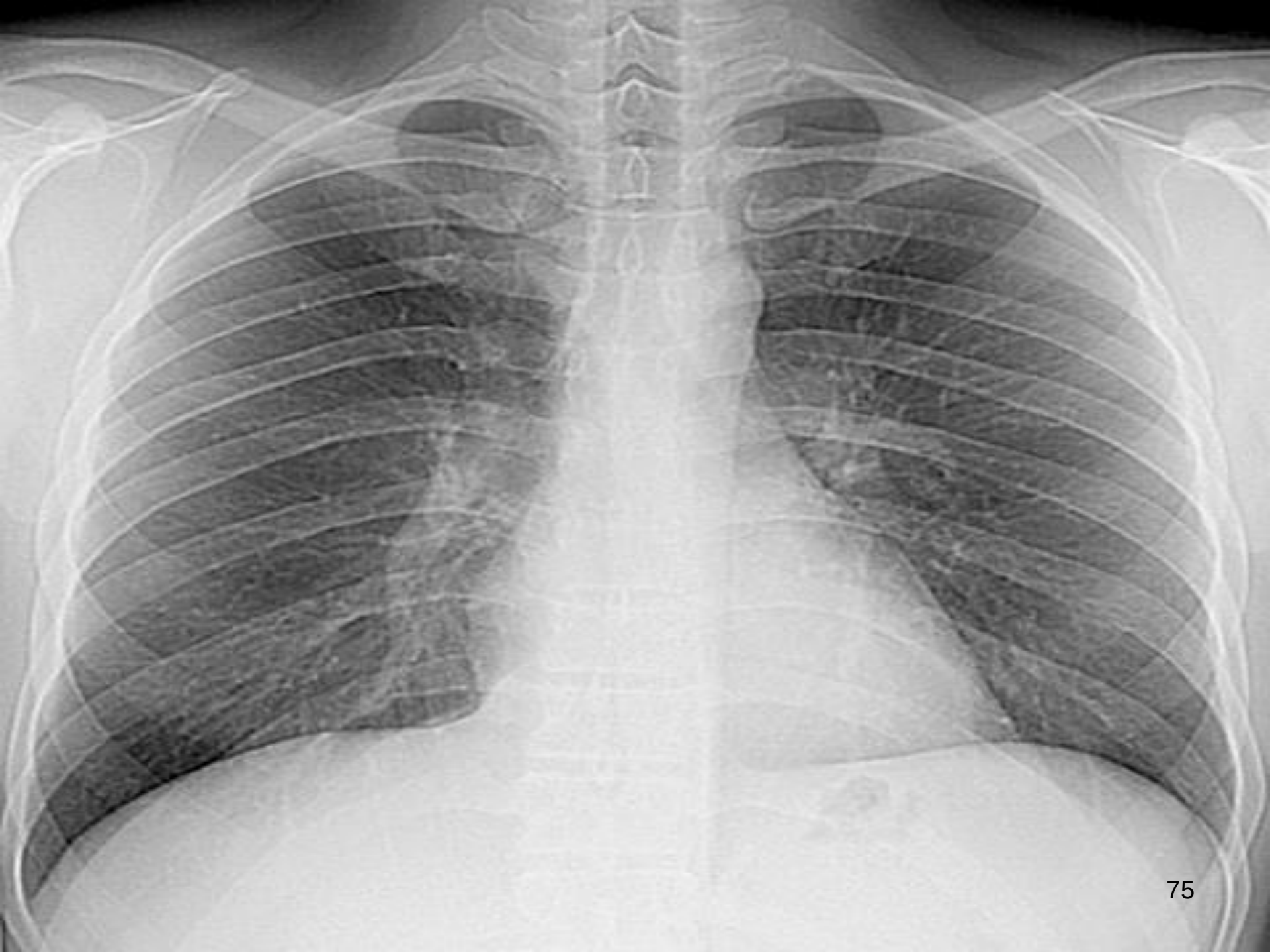










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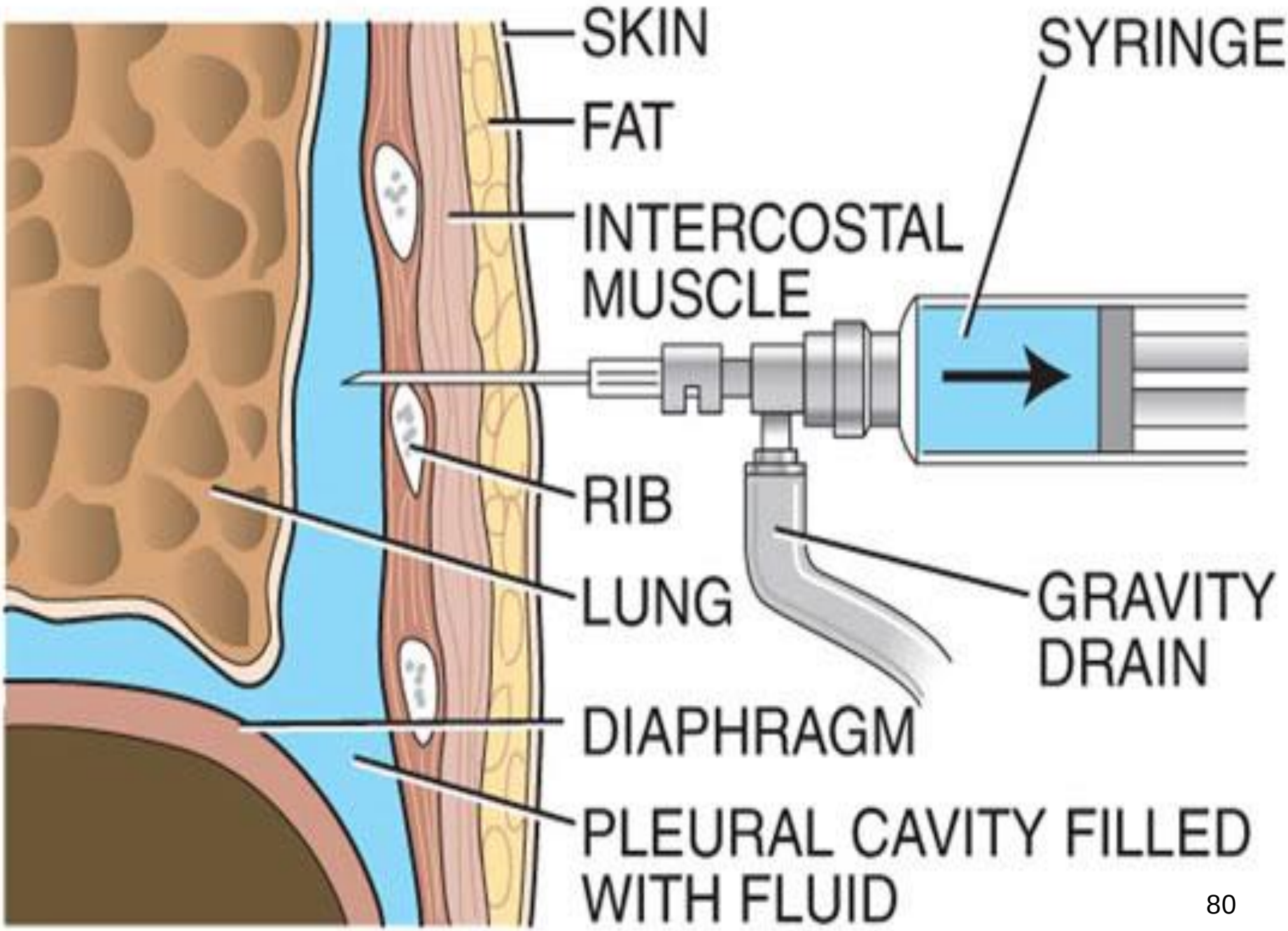
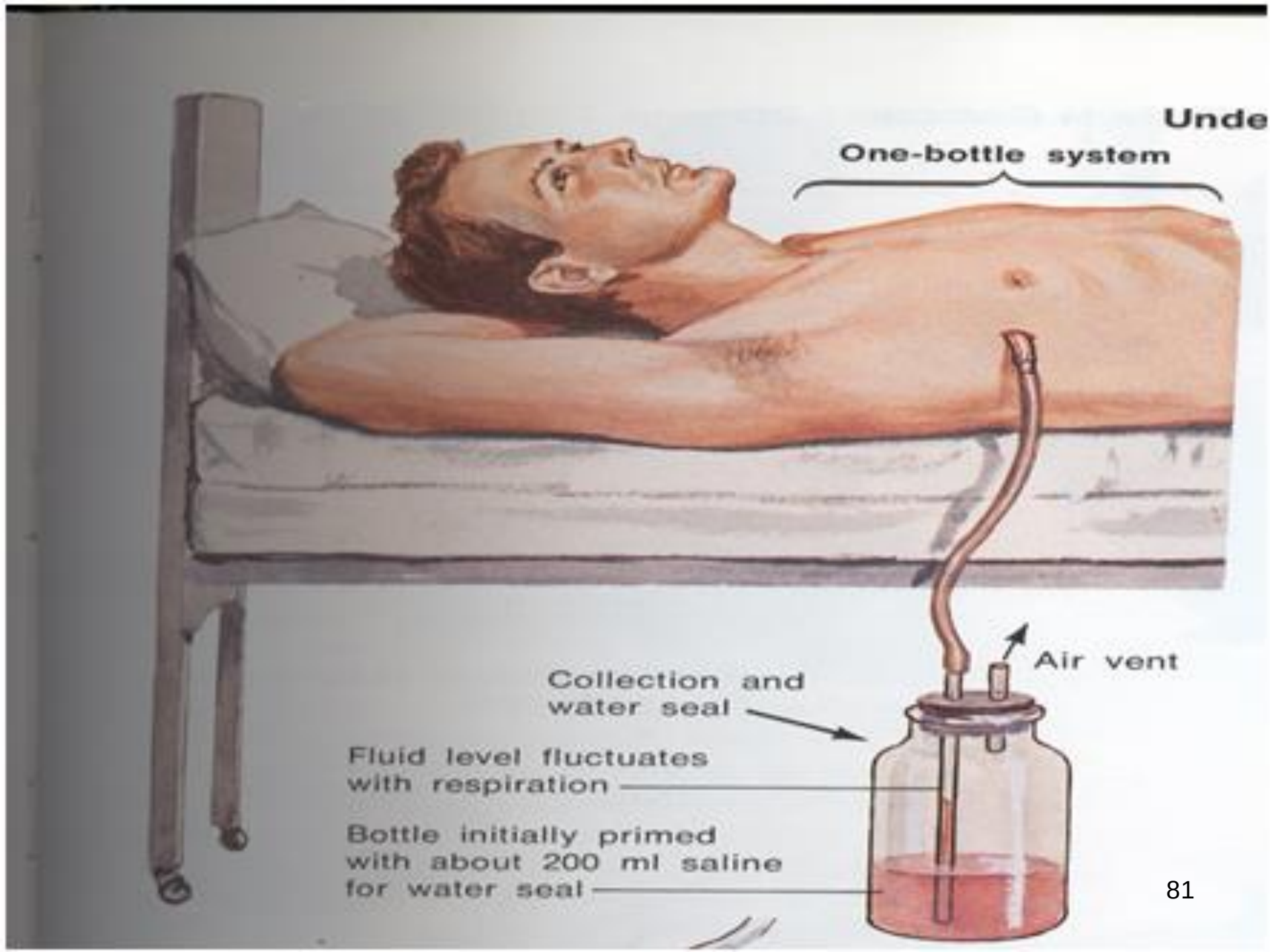
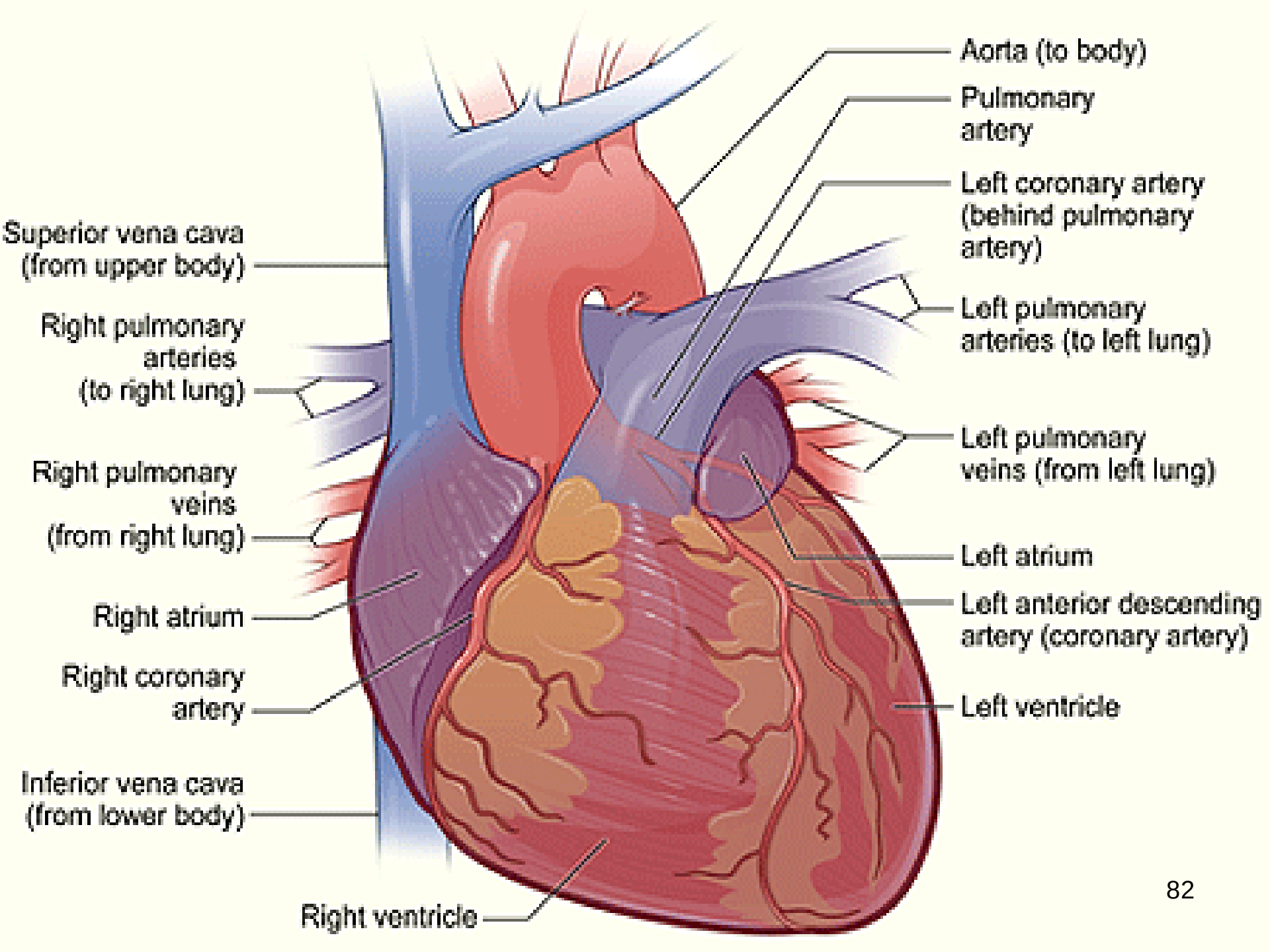
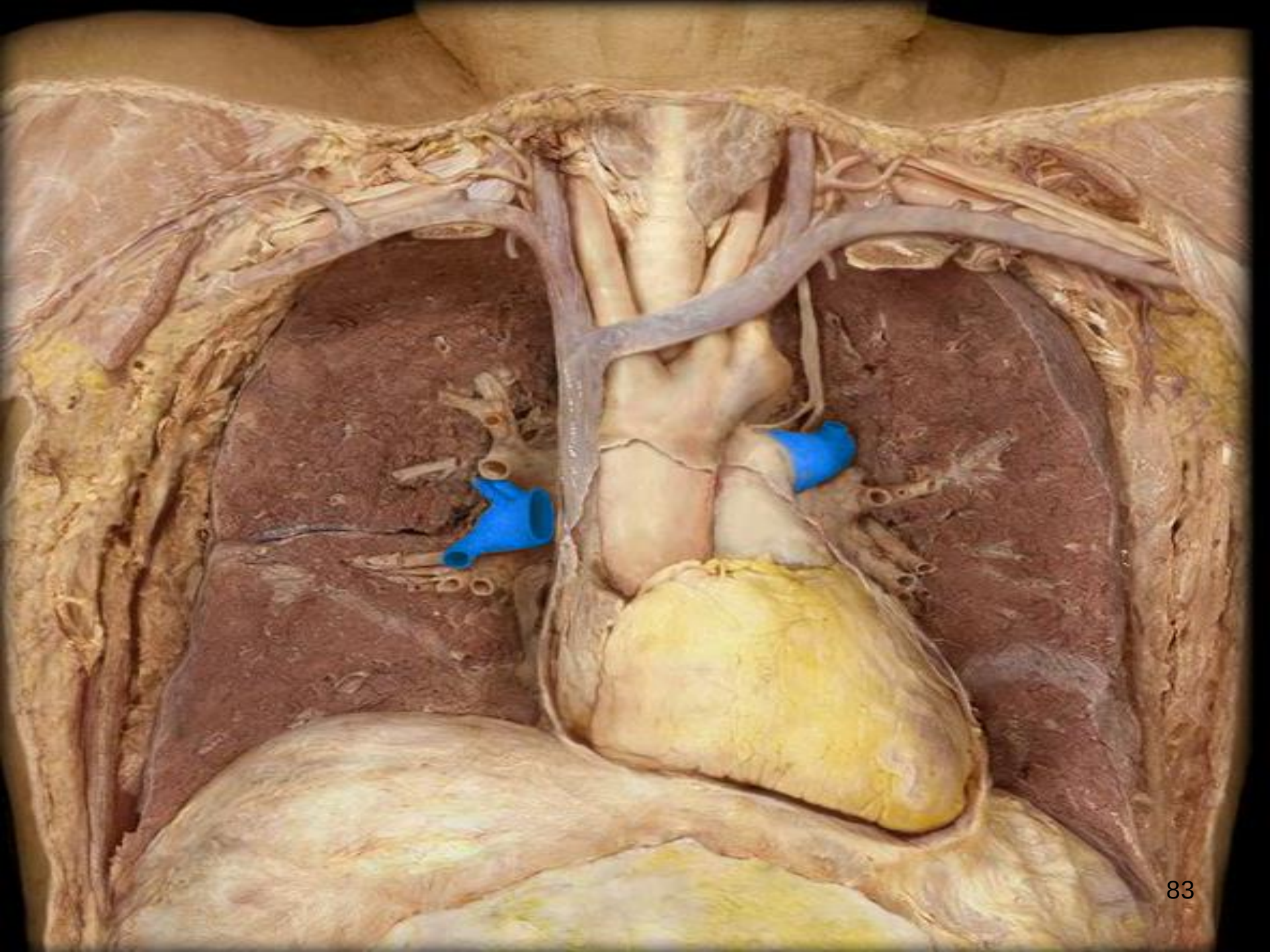
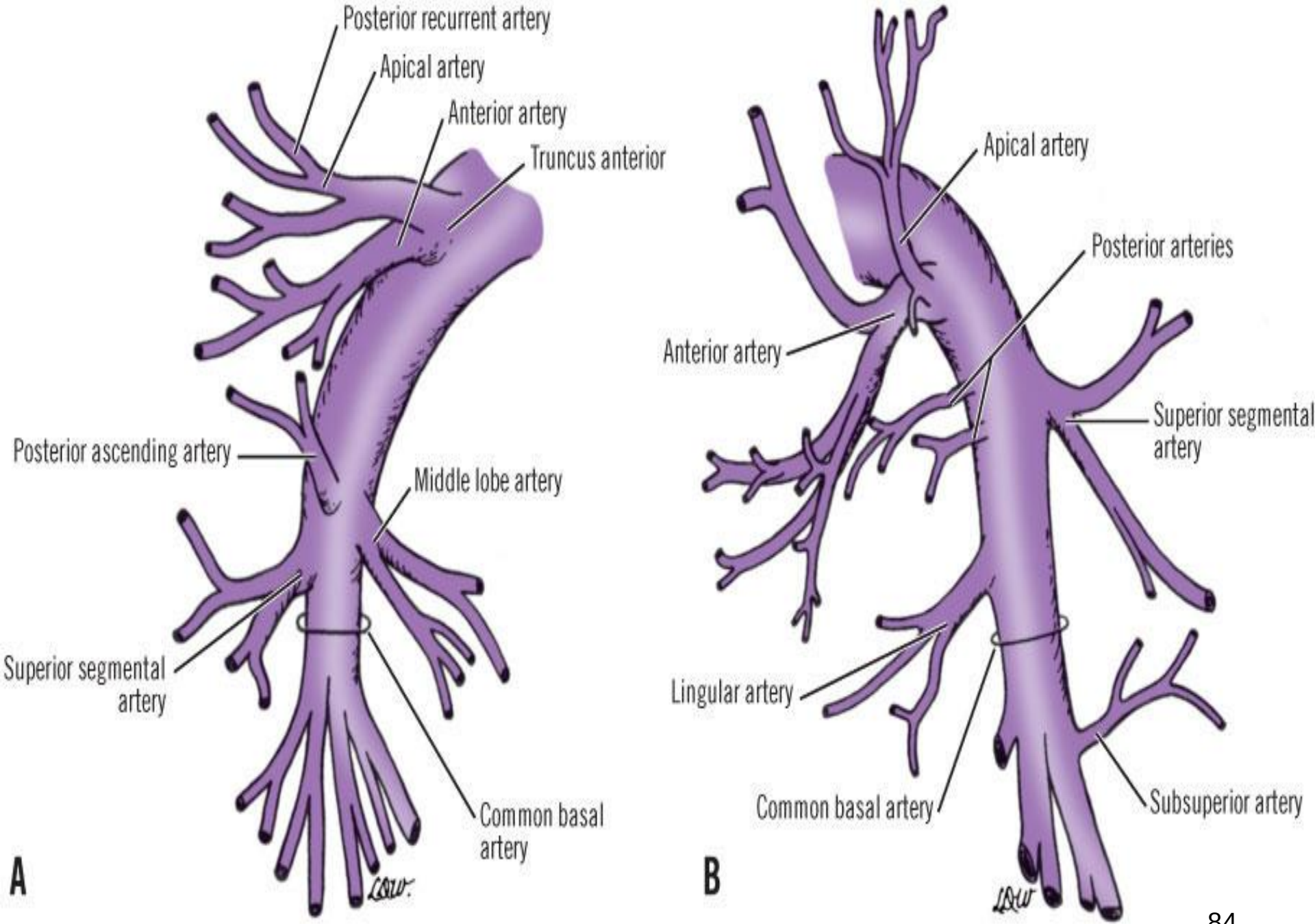
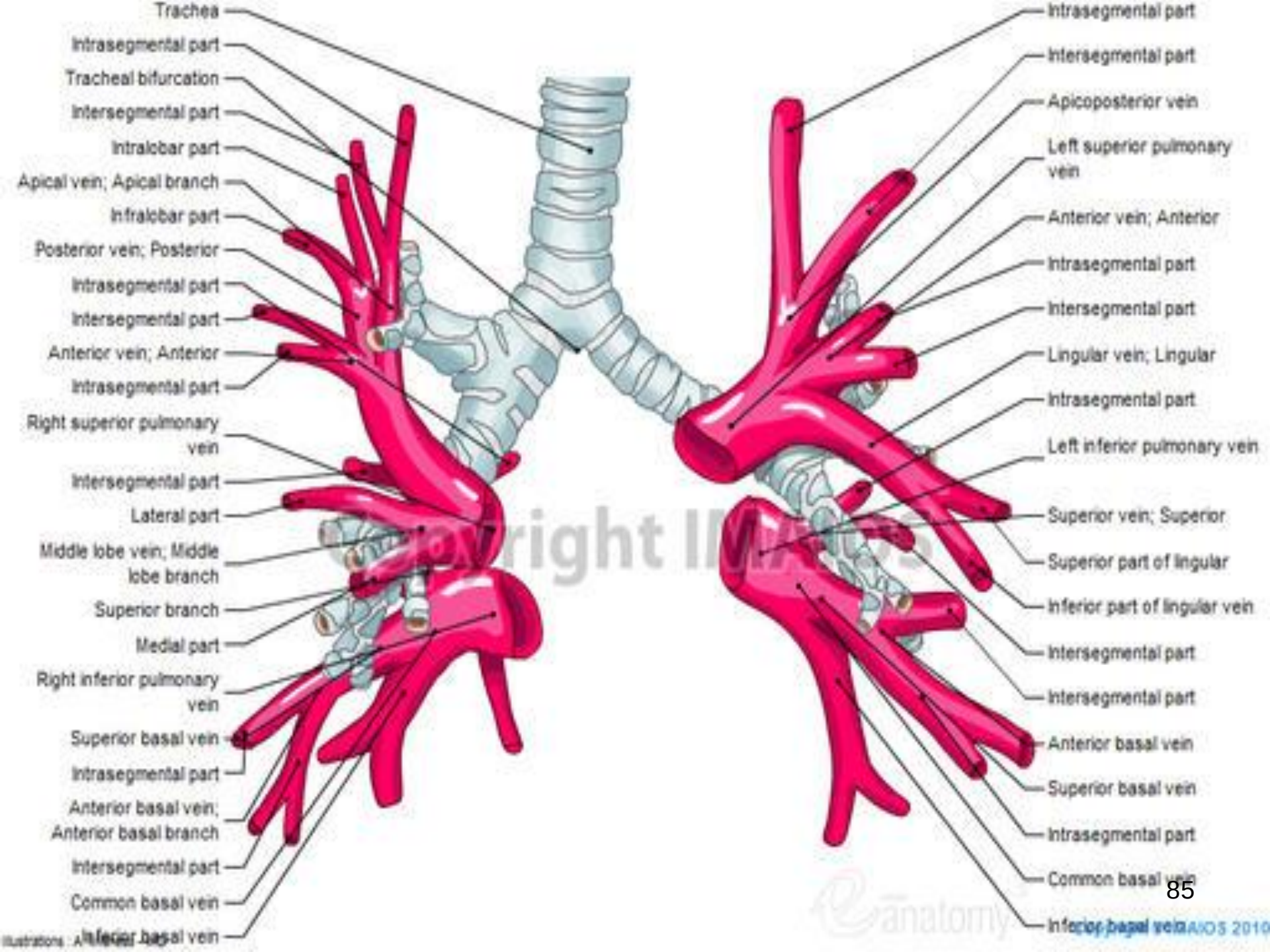

SKIN
FAT
INTERCOSTAL MUSCLE
SYRINGE
RIB
LUNG
GRAVITY DRAIN
DIAPHRAGM
PLEURAL CAVITY FILLED WITH FLUID


Unde
One-bottle system
Air vent
Collection and water seal
Fluid level fluctuates with respiration
Bottle initially primed with about 200 ml saline for water seal


Aorta (to body)
Pulmonary artery
Left coronary artery (behind pulmonary artery)
Left pulmonary arteries (to left lung)
Left pulmonary veins (from left lung)
Left atrium
Left anterior descending artery (coronary artery)
Left ventricle
Superior vena cava (from upper body)
Right pulmonary arteries (to right lung)
Right pulmonary veins (from right lung)
Right atrium
Right coronary artery
Inferior vena cava (from lower body)
Right ventricle






Trachea
Intrasegmental part
Tracheal bifurcation
Intersegmental part
Intralobar part
Apical vein; Apical branch
Infralobar part
Posterior vein; Posterior
Intrasegmental part
Intersegmental part
Anterior vein; Anterior
Intrasegmental part
Right superior pulmonary vein
Intersegmental part
Lateral part
Middle lobe vein; Middle lobe branch
Superior branch
Medial part
Right inferior pulmonary vein
Superior basal vein
Intrasegmental part
Anterior basal vein; Anterior basal branch
Intersegmental part
Common basal vein
Inferior basal vein
Intrasegmental part
Intersegmental part
Apicoposterior vein
Left superior pulmonary vein
Anterior vein; Anterior
Intrasegmental part
Intersegmental part
Lingular vein; Lingular
Intrasegmental part
Left inferior pulmonary vein
Superior vein; Superior
Superior part of lingular
Inferior part of lingular vein
Intersegmental part
Intersegmental part
Anterior basal vein
Superior basal vein
Intrasegmental part
Common basal vein
Inferior basal vein

The diaphragm

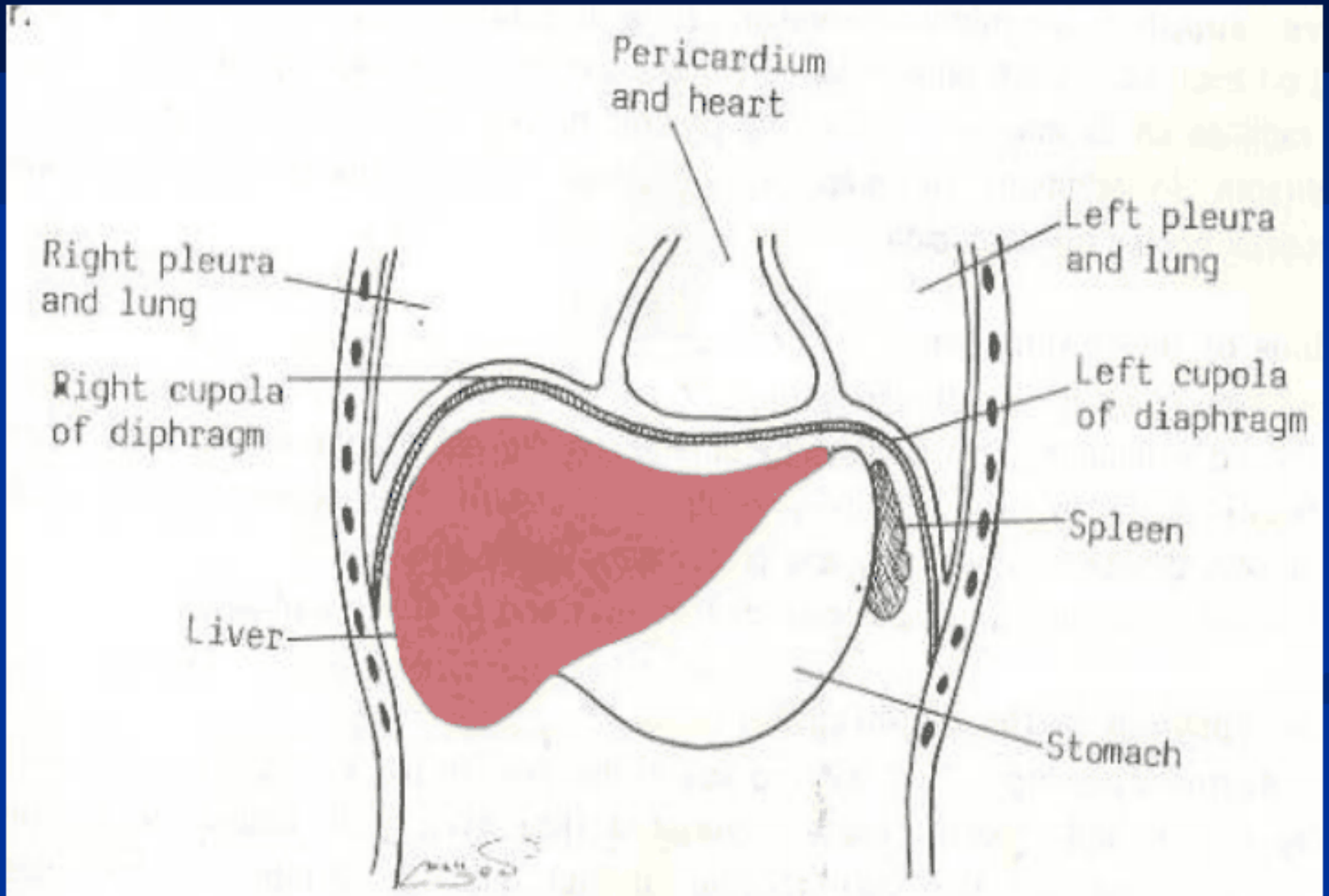
- It is a muscular and tendinous septum that separates the thoracic cavity from the abdominal cavity.
- It is the primary muscle of respiration.

❖ Shape of the diaphragm :it is dome shaped, consists of a peripheral muscular part ,and a centrally tendon part.

Shape of Diaphragm

- It curves up into right & left domes ,or cupolae .
- The right dome reaches as high as the upper border of 5th rib (due to upward bulge of right lobe of liver) and the left dome at lower border of 5th rib. The central tendon lies at level of xiphisternal joint.

Shape of Diaphragm :



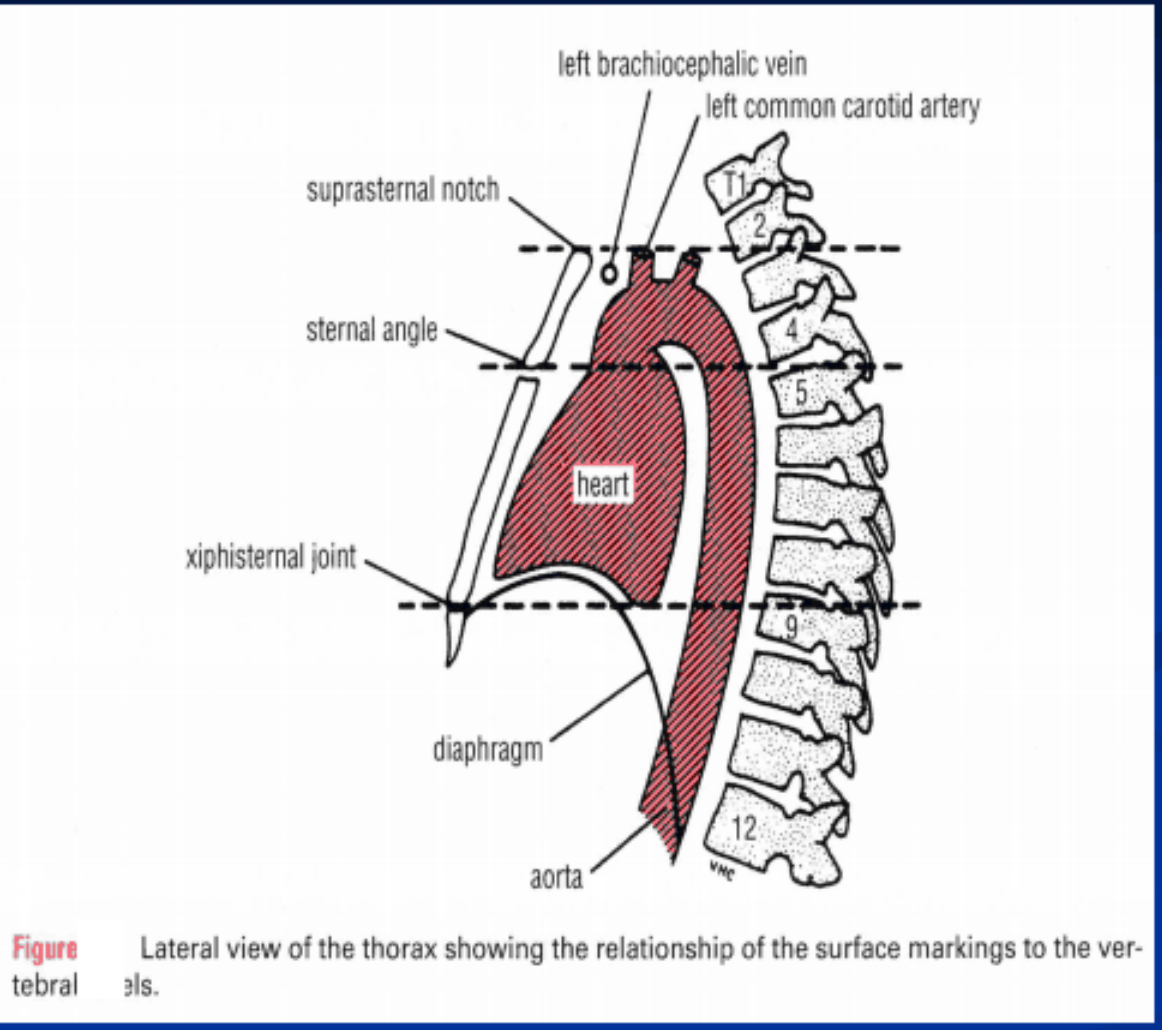


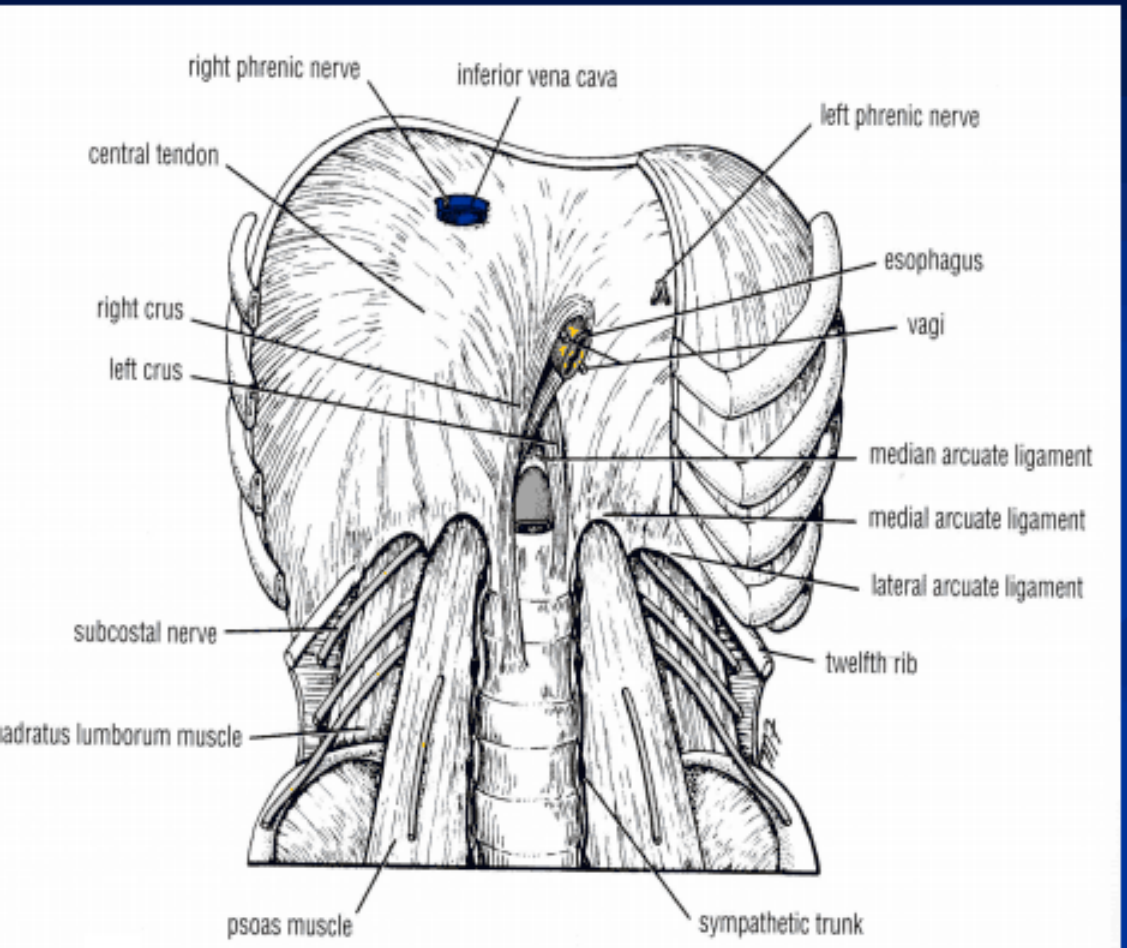
Figure Lateral view of the thorax showing the relationship of the surface markings to the vertebral els.

- It is bounded **anteriorly** by xiphisternal junction (9^{th} Th.V.).
- **Laterally** by ribs & costal cartilages.
- **Posteriorly** by 12^{th} thoracic vertebra.

- **Origin:**

1. **Sternal origin :** by 2-slips from back of xiphoid process.
2. **Costal origin :** by 6-slips from inner surfaces of lower 6 ribs & their costal cartilages.
3. **Vertebral origin : from the lumbar vertebrae** by 2-crura (right &left) , 3-arcuate ligaments (med.,/lat./,and median).

Vertebral origin (2-crura)



Figur 2 Diaphragm as seen from below. The anterior portion of the right side has been re-
move ite the sternal, costal, and vertebral origins of the muscle and the important structures
that p : nrough it.

- **Right crus** : from the sides of upper 3-lumbar vertebrae & intervertebral discs. Some fibres surround the esophageal orifice in **a sling like loop,** it acts as a **sphincter** to the lower end of esophagus.

- **Left crus** : from sides of the upper 2-lumbar vertebrae & intervertebral discs.

Vertebral origin (3-arcuate ligaments)

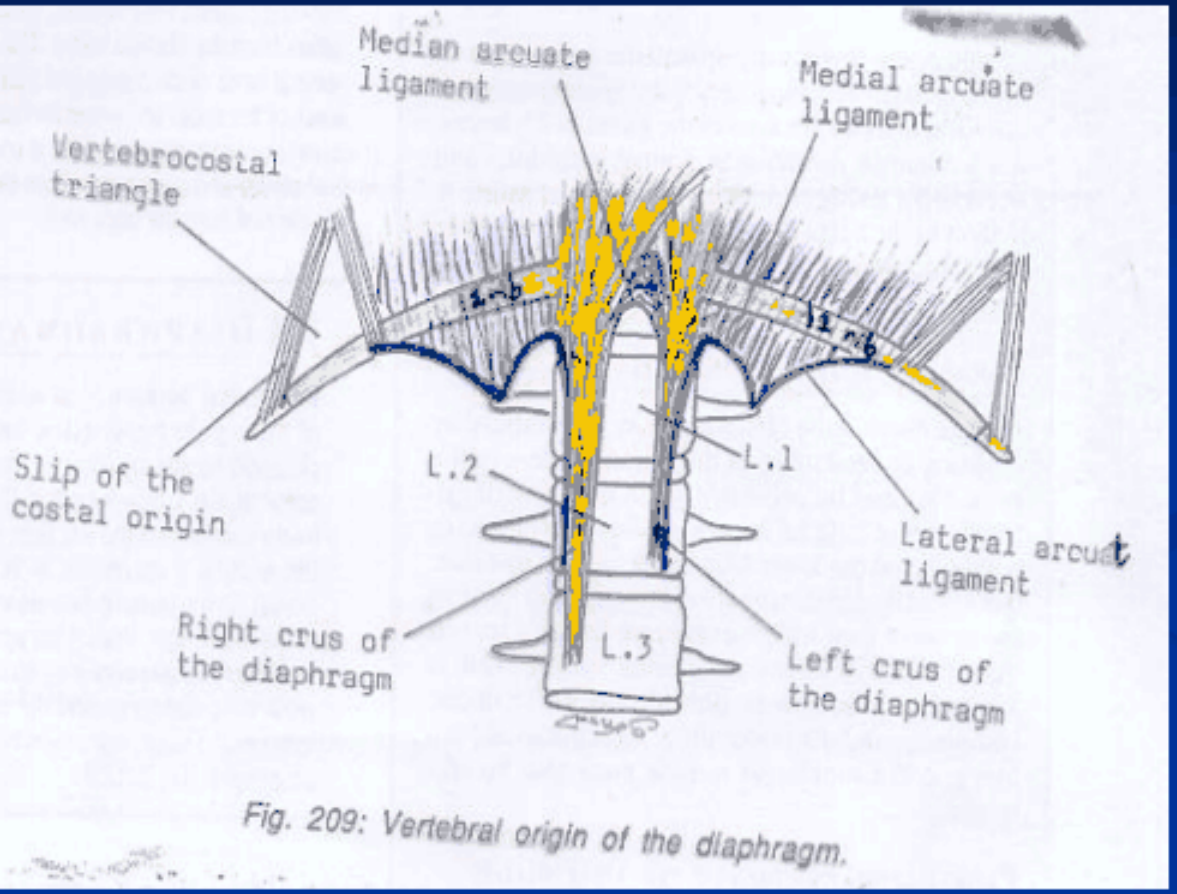


Fig. 209: Vertebral origin of the diaphragm.

- **Median arcuate lig.:** it connects the fibrous medial borders of the 2-crura ,and crosses over the aorta.

Vertebral origin (3-arcuate ligaments)

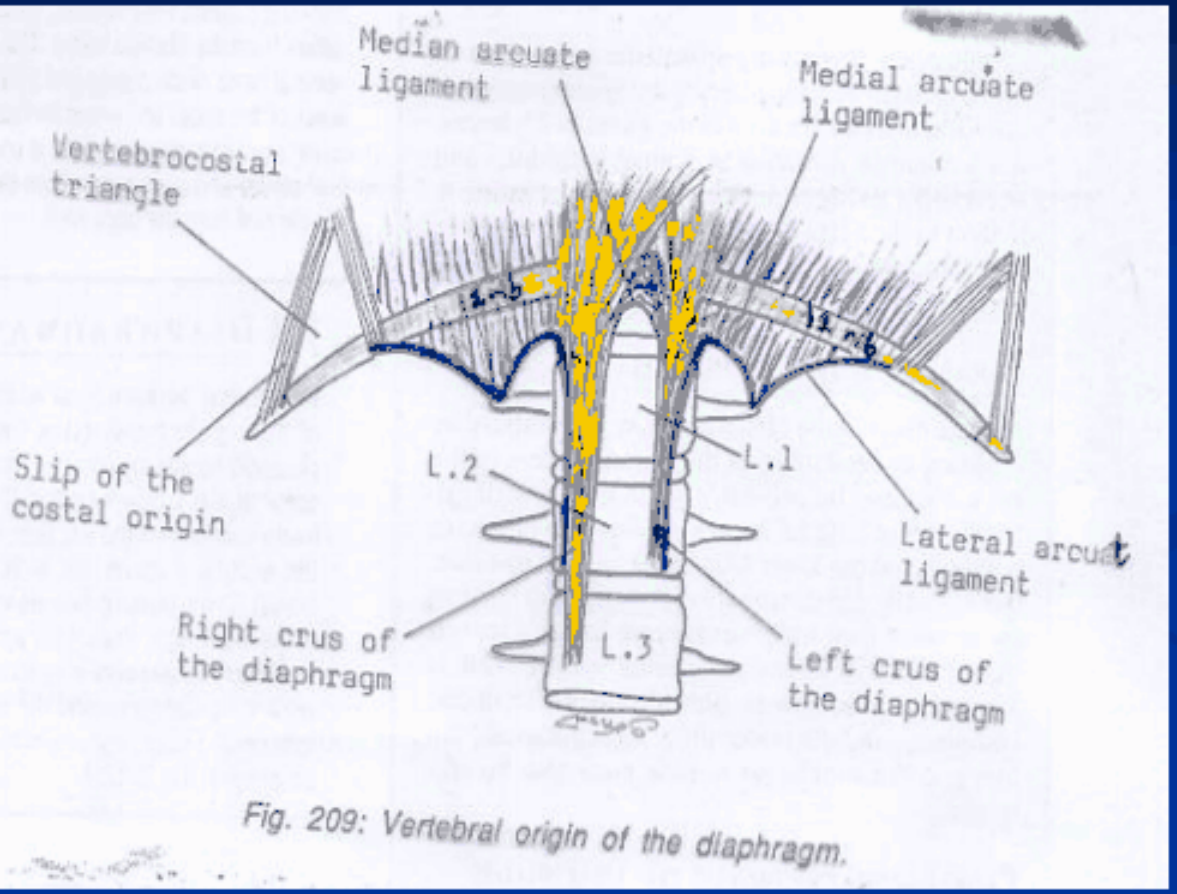
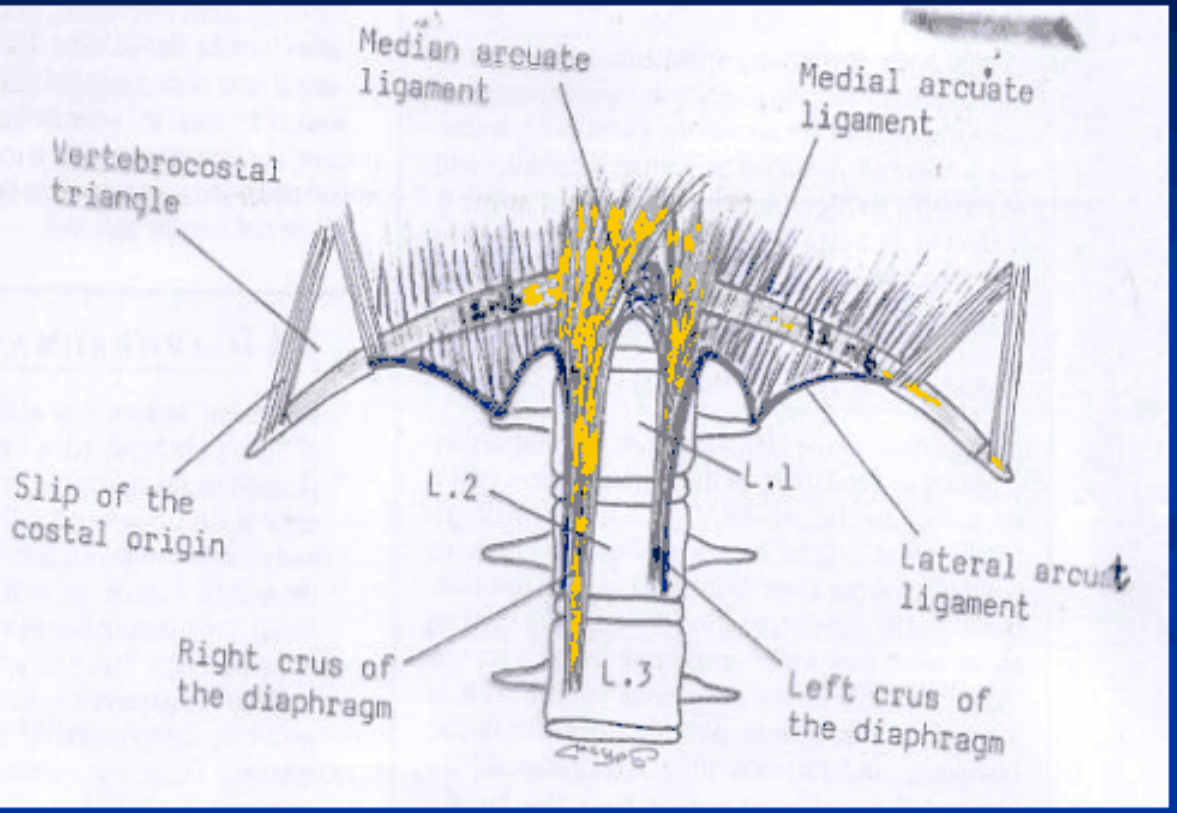


Fig. 209: Vertebral origin of the diaphragm.

➢**Lateral arcuate** lig. : it is the thickened upper margin of fascia covering the anterior surface of quadratus lumborum muscle, it extends from the tip of transverse process of 1st L.V. to the lower border of 12th rib.

Vertebral origin (3-arcuate ligaments)



➢**Medial arcuate lig.:** it is the thickened upper margin of fascia covering ant.surface of psoas muscle, it extends from side of body of L2.vertebra to the tip of transverse process of 1st L.V.

Insertion of diaphragm

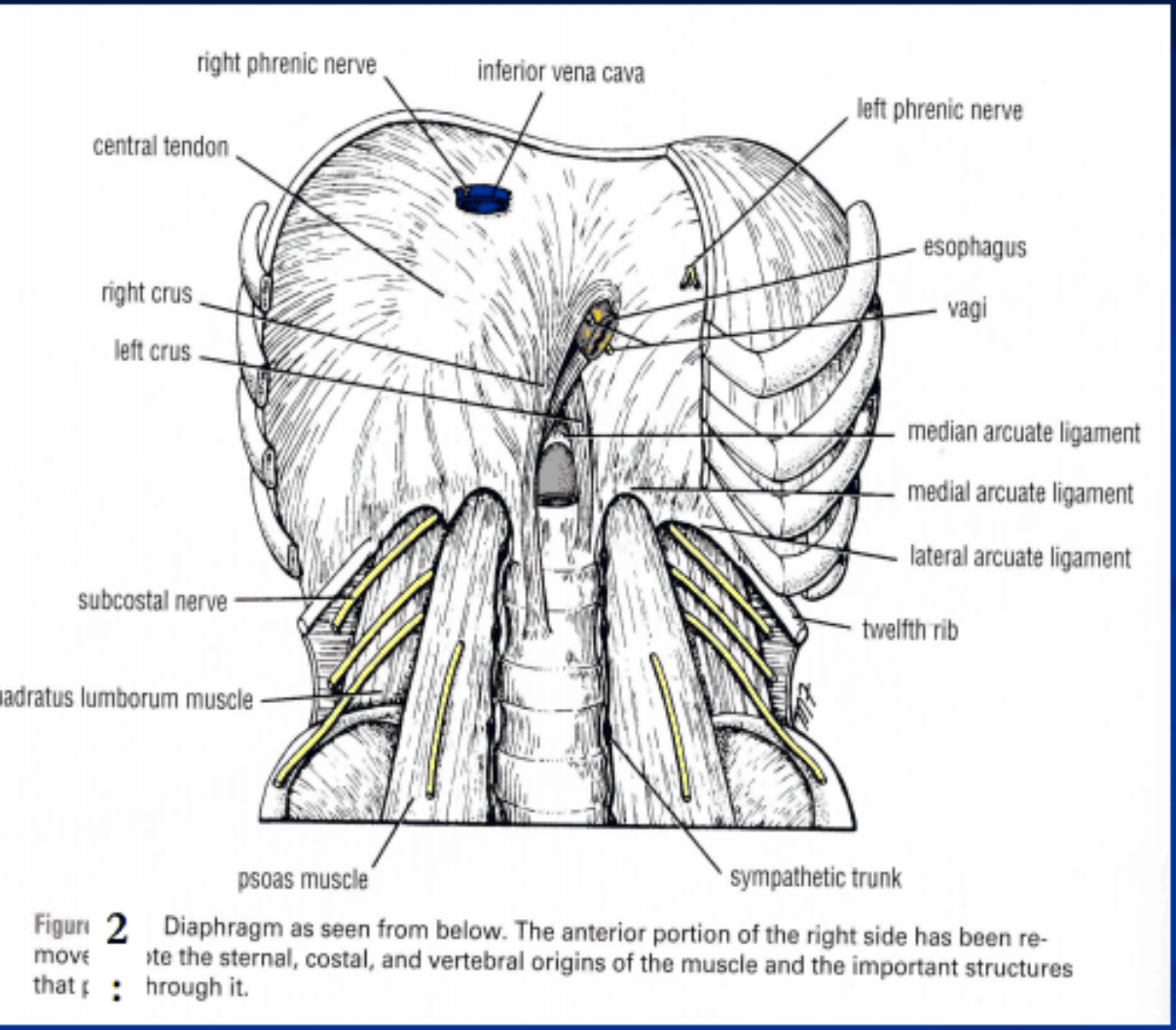


Figure 2 : Diaphragm as seen from below. The anterior portion of the right side has been removed to show the sternal, costal, and vertebral origins of the muscle and the important structures that pass through it.

- Into the **centeral tendon (lies at the level of xiphisternal joint)** ,which is partially fused with the inferior surface of the fibrous pericardium and supports the heart.

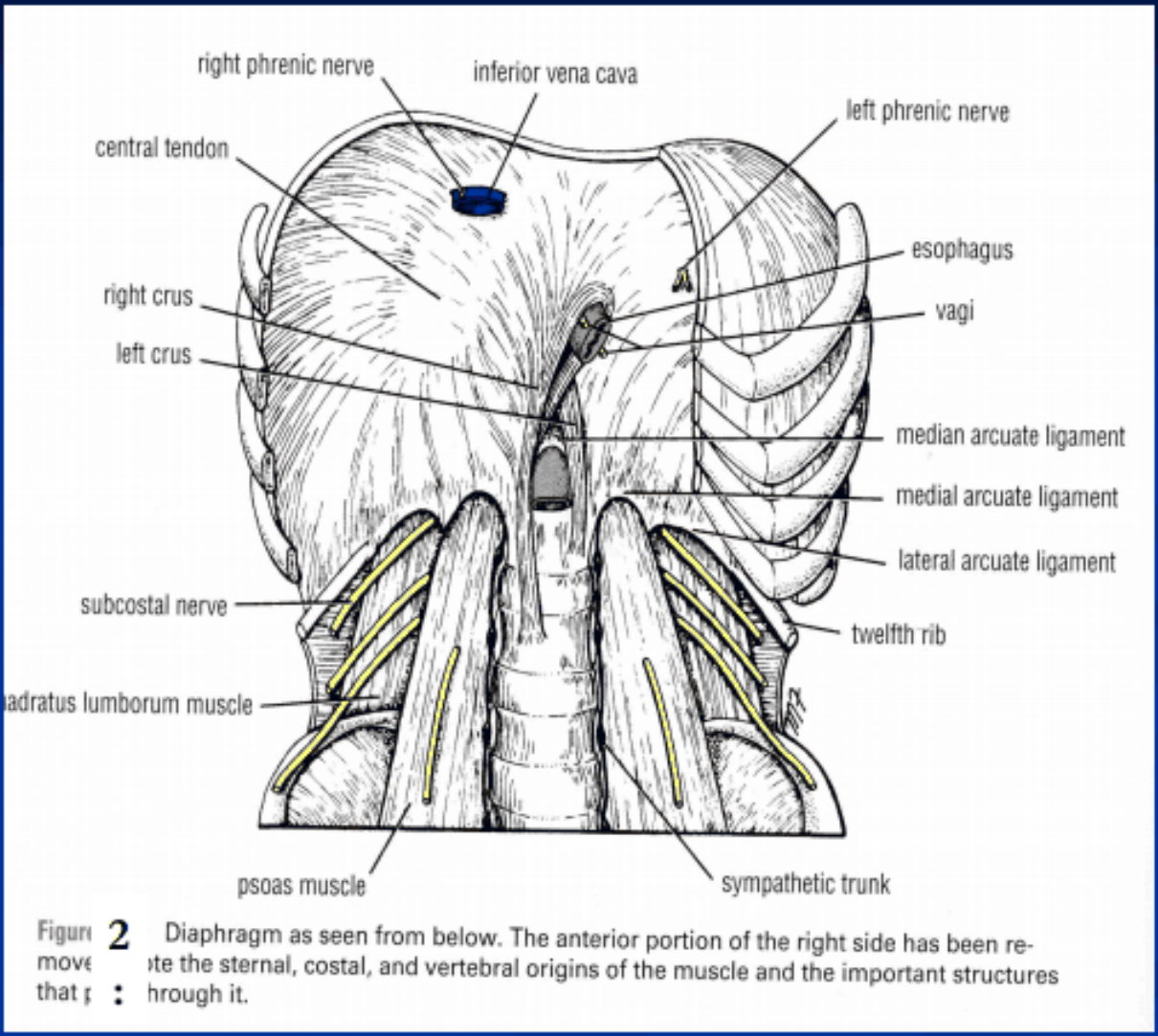
Main Openings in the diaphragm :

There are 3 main openings

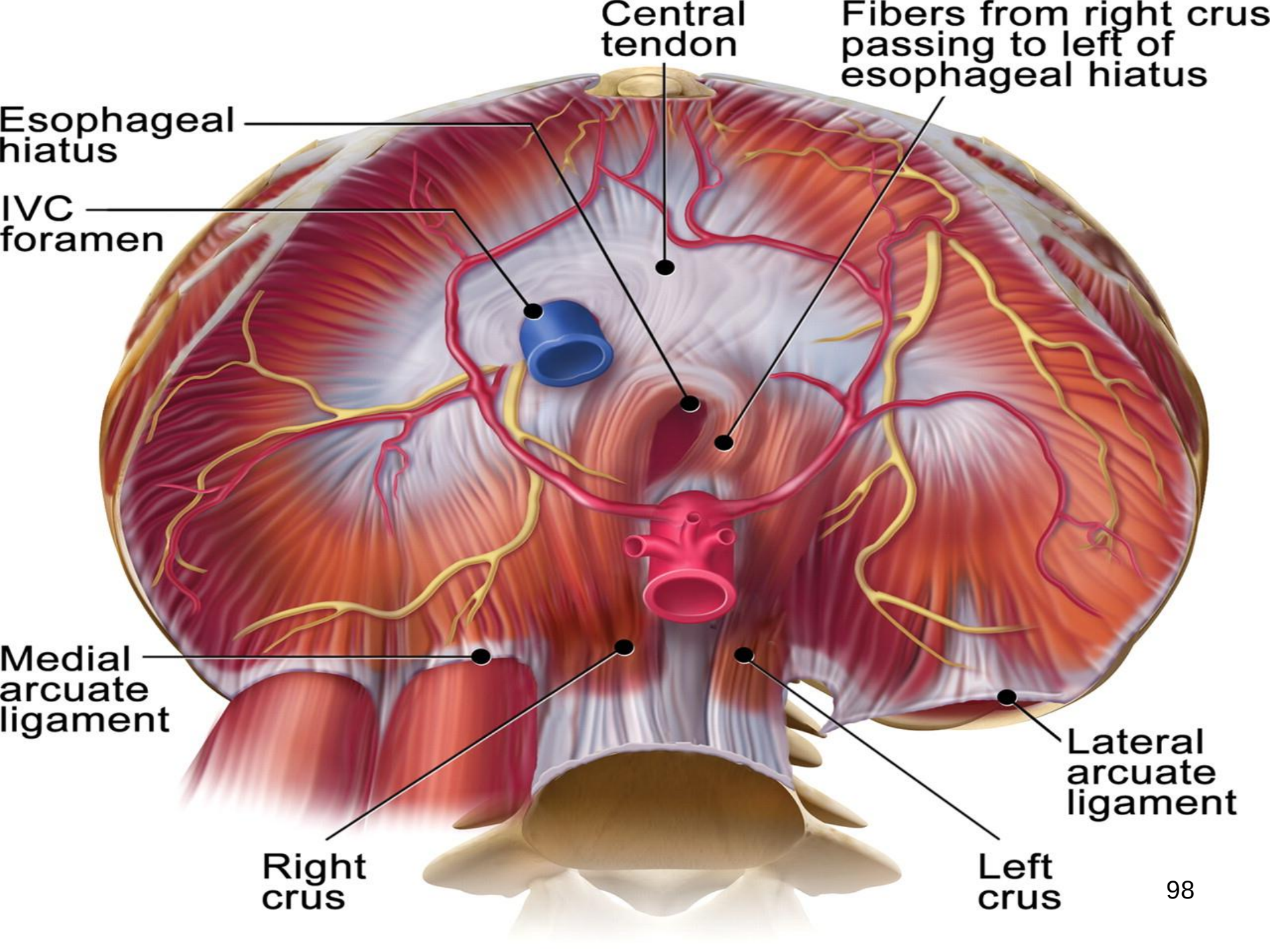
1. Aortic: at T12,- ---aorta, thoracic duct, azygos V.
2. Esophageal : at T10 , -- esophagus, 2 vagi, esophageal branches of left gastric vessels.
3. Caval : at T8 in the central tendon , --- I.V.C. , right phrenic.

Action . It is the primary Ms.of respiration , on contraction, the diaphragm pulls down its centeral tendon & increases the vertical diameter of the thorax during inspiration.

Openings of Diaphragm



Figur 2 Diaphragm as seen from below. The anterior portion of the right side has been re-
move te the sternal, costal, and vertebral origins of the muscle and the important structures
that p : hrough it.


Central tendon
Fibers from right crus passing to left of esophageal hiatus
Esophageal hiatus
IVC foramen
Medial arcuate ligament
Lateral arcuate ligament
Right crus
Left crus

Nerve supply :

1. **Motor supply :**

   Phrenic nerve (C3 ,4 ,5)only. it pierces the diaphragm & ramifies on its inferior surface.

2. **Sensory supply :**

- **Lower 6 intercostal nerves…to periphery of diaphragm**
- **Also, Phrenic Nerve… to parietal pleura & pericardium covering the central part.**

Clinical Notes : Aquired Hernia :

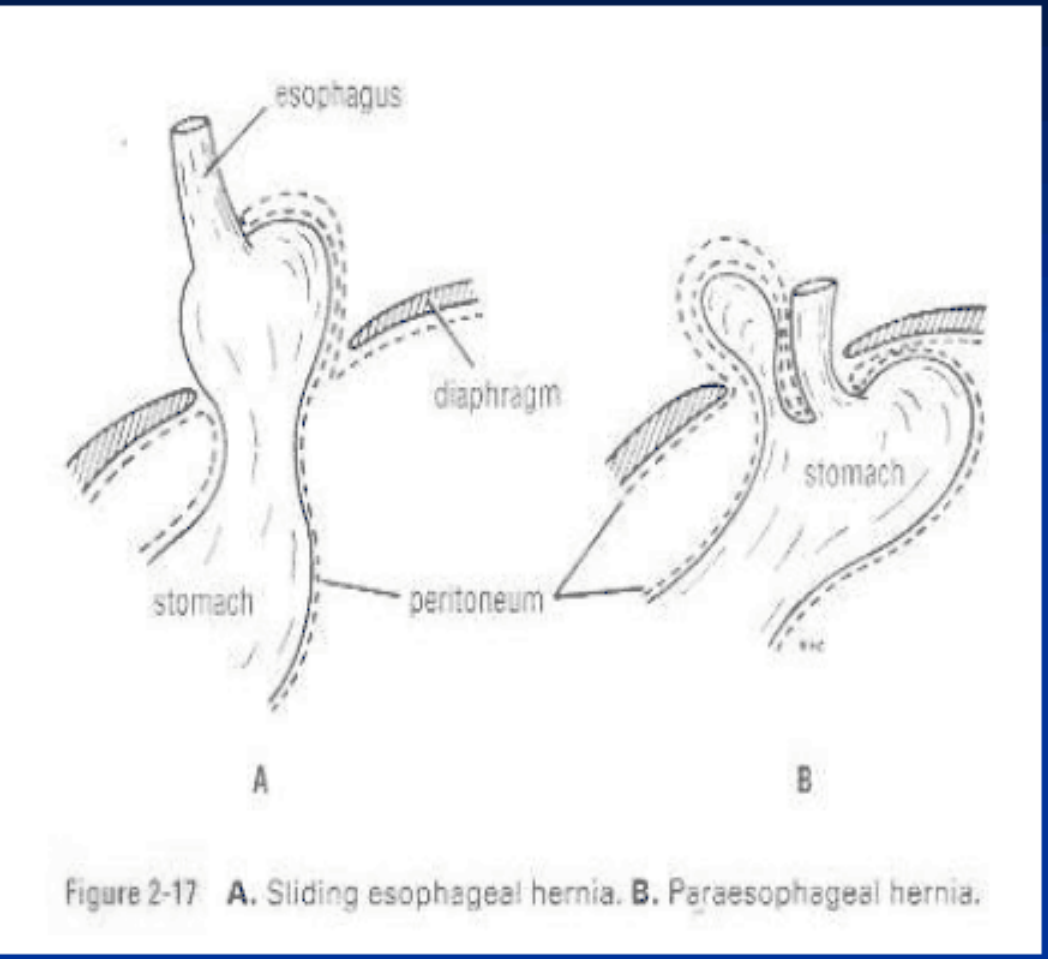


Figure 2-17 **A.** Sliding esophageal hernia. **B.** Paraesophageal hernia.

- **Esophageal hiatus hernia** :may occur in middle age,due to weak musculature around the esophageal opening in the diaphragm.
- It may be either **sliding,** or **paraesophageal** hernia (alongside the esophagus).

Other Clinical Notes : Hiccup

- It is involuntary spasmodic contraction of diaphragm, accompanied by approximation of vocal folds & closure of glottis of larynx.
- it is common in normal individuals after eating or drinking as a result of gastric irritation of vagus nerve endings.
- It may be due to pleurisy ,peritonitis ,or pericarditis.

Referred Pain to the Sholder :

- The sensory innervation of the central part of diaphragm is the phrenic N(C3,4,5) .
- The sensory nerve supply to skin over the shoulder is the supraclavicular nerve(C3,4).
- So, pain due to irritation of pleura or pericardium covering the central part of diaphragm may be referred to the shoulder.

Paralysis of Diaphragm :

- As a result of injury of the phrenic nerve in the neck .
- As a result of stab wound to the chest ,It leads to inspiratory defects.

Quiet Inspiration :

- 1st rib is fixed by scaleni muscles ,the intercostal Ms.elevate the other ribs upward towards 1st rib (A).
- The diaphragm descends, and the liver provides the platform that enables the diaphragm to assist the intercostal Ms.in raising the lower ribs (fig.C).
- So,increase the capacity & volum of thoracic cavity leads to decrease the pressure in thorax & lungs than in the atmospheric pressure, which sucks air into the lungs till becomes equal each other.
- It is an active process.

Quiet Expiration :

- It is a **passive process** due to elastic recoil of lungs and relaxation of intercostal Ms.& diaphragm. So, the **ribs depressed** and the **diaphragm elevated** to its normal position.
- So, the lungs become recoil & reduced in size ,so the pressure is increased inside the lungs enough to flow out of air outside till the pressure equal to the atmospheric pressure.

Thoracic Wall Dimensional Changes During Respiration

- Lateral dimensional changes occur with rib movements.
- Elevation of the ribs increases the lateral dimensions of the thoracic cavity, while depression of the ribs decreases the lateral dimensions of the thoracic cavity.

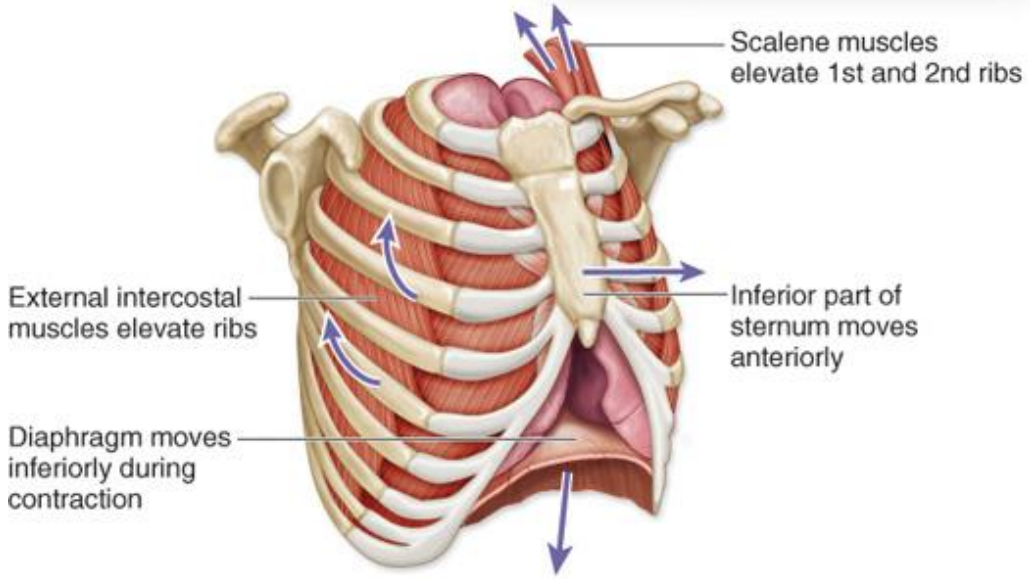
Muscles that Move the Ribs

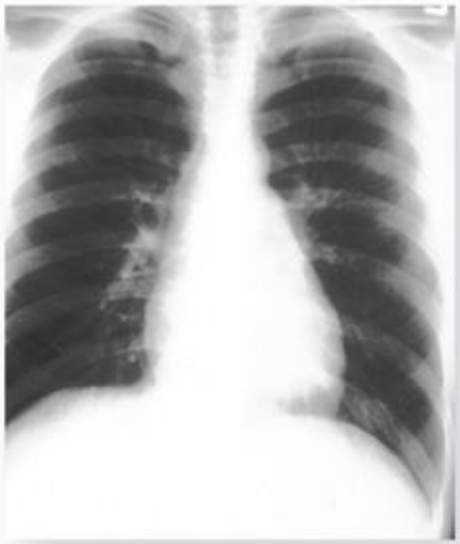
- The scalenes help increase thoracic cavity dimensions by elevating the first and second ribs during forced inhalation.
- The ribs elevate upon contraction of the external intercostals, thereby increasing the transverse dimensions of the thoracic cavity during inhalation.
- Contraction of the internal intercostals depresses the ribs, but this only occurs during forced exhalation.
- Normal exhalation requires no active muscular effort.
- A small transversus thoracis extends across the inner surface of the thoracic cage and attaches to ribs 2–6. It helps depress the ribs.

Muscles that Move the Ribs

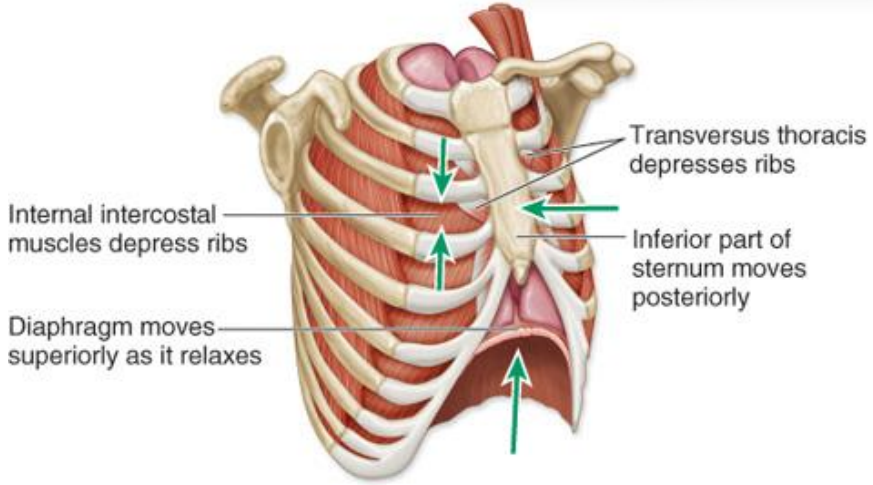
- Two posterior thorax muscles also assist with respiration. These muscles are located deep to the trapezius and latissimus dorsi, but superficial to the erector spinae muscles.
- The serratus posterior superior elevates ribs 2–5 during inhalation, and the serratus posterior inferior depresses ribs 8–12 during exhalation.
- In addition, some accessory muscles assist with respiratory activities.
- The pectoralis minor, serratus anterior, and sternocleidomastoid help with forced inhalation, while the abdominal muscles (external and internal obliques, transversus abdominis, and rectus abdominis) assist in active exhalation.

Inhalation

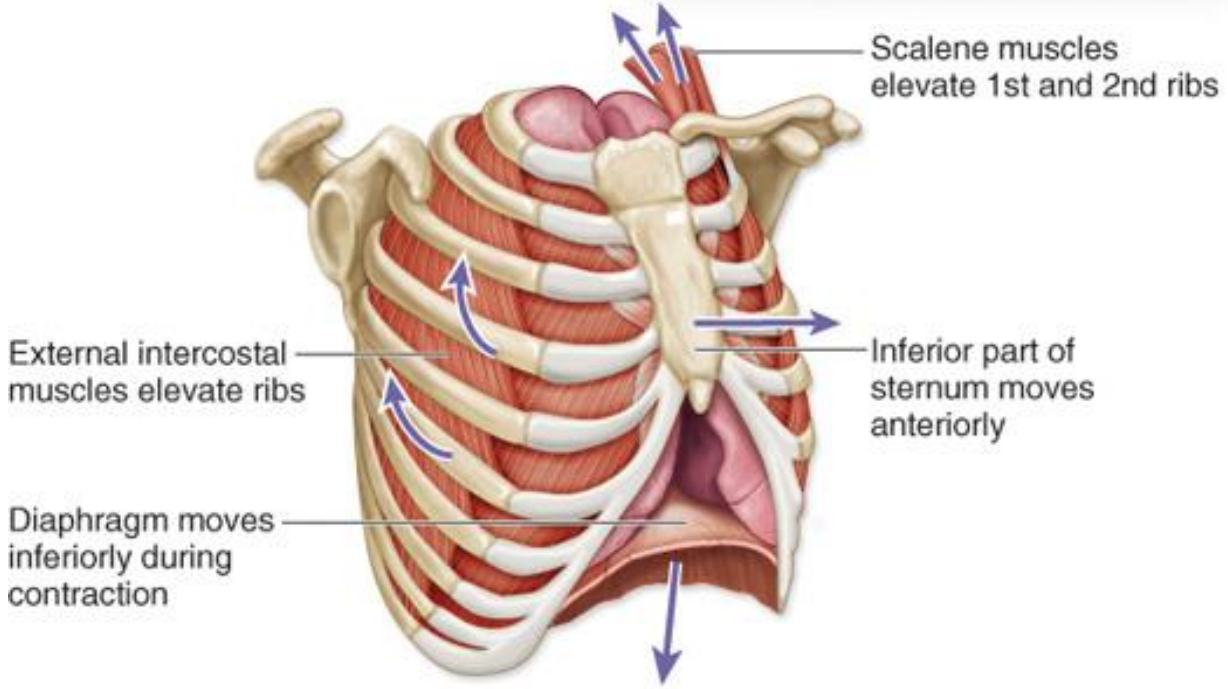


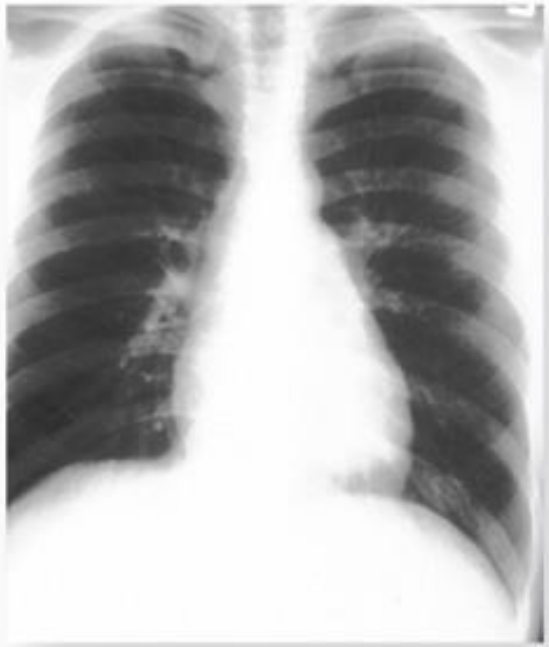


Exhalation

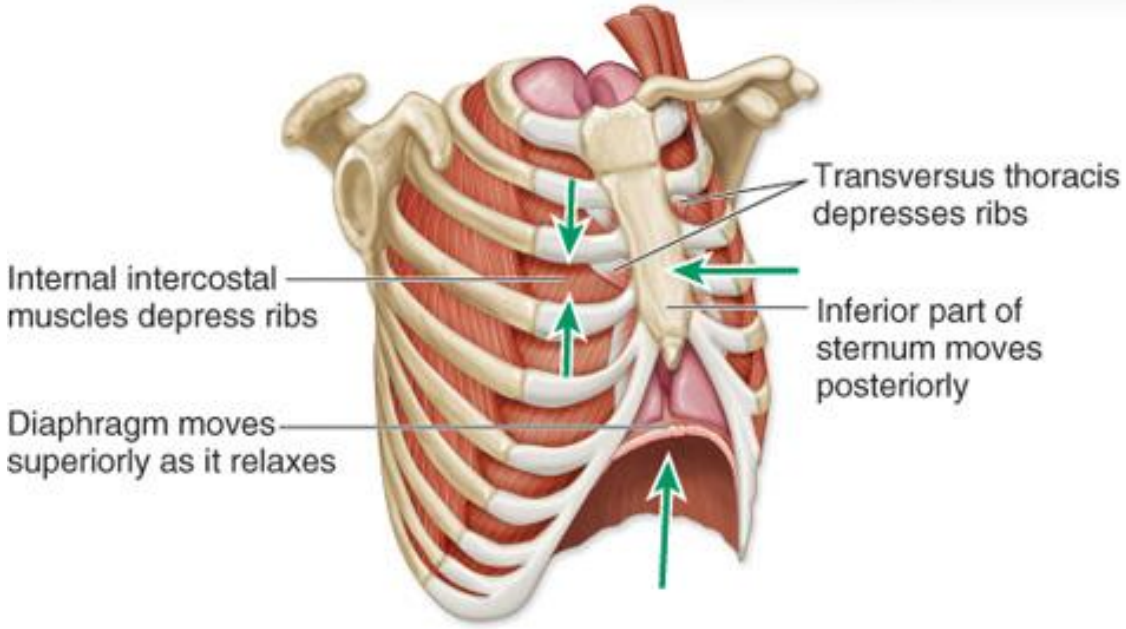


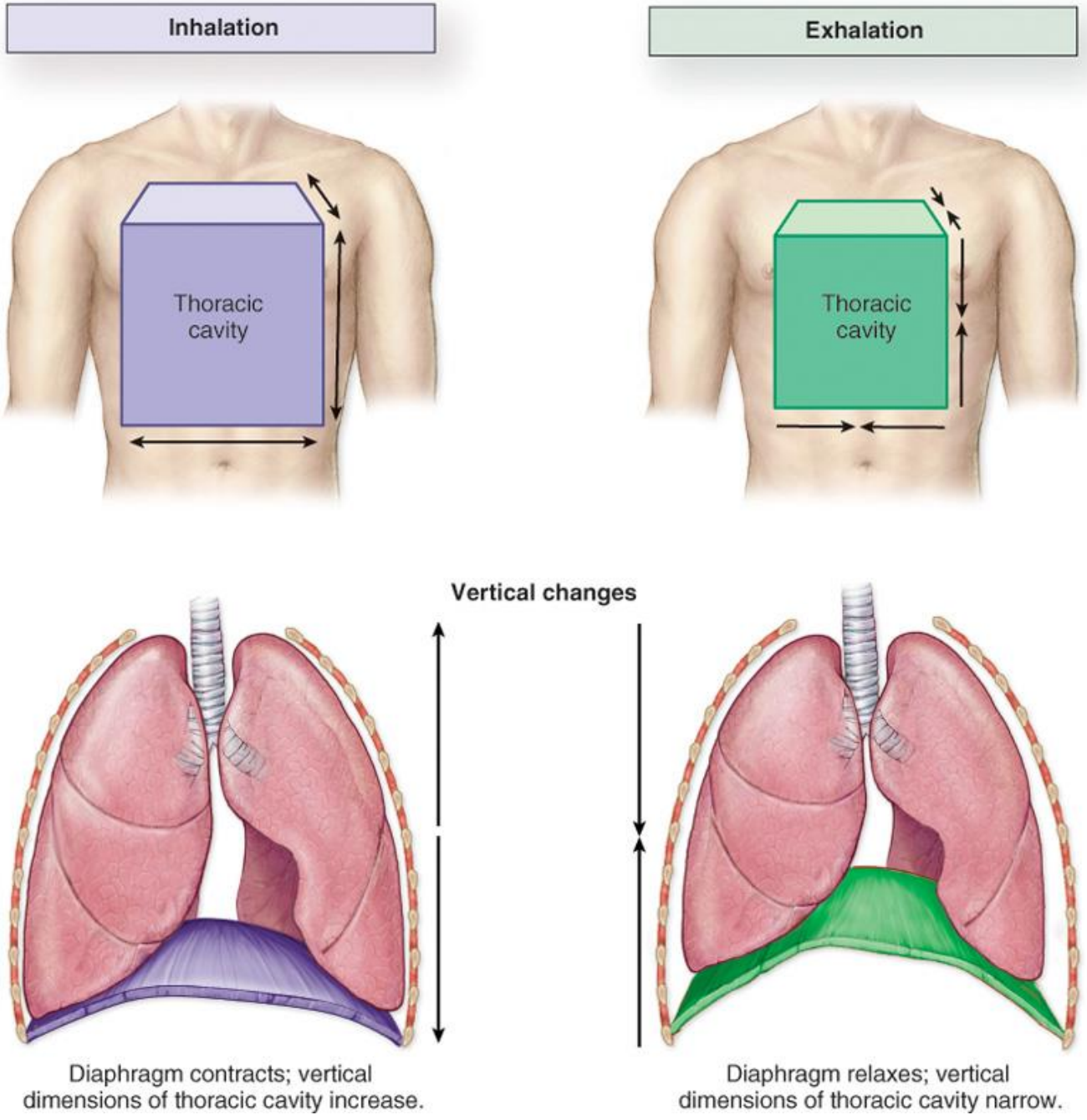
Inhalation



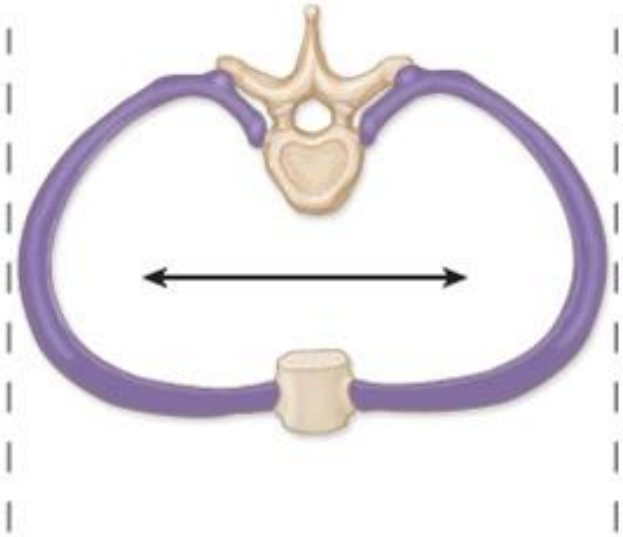


Exhalation

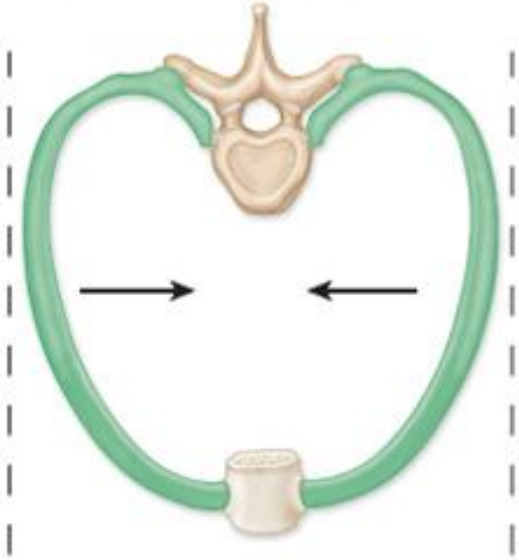




Lateral changes

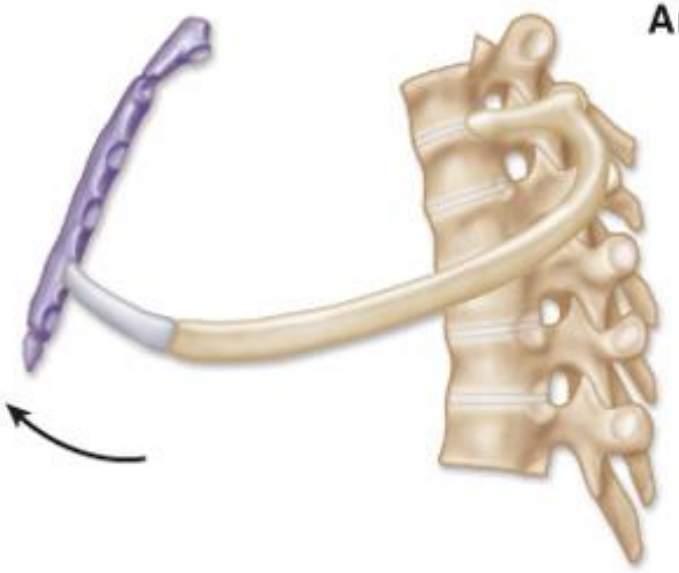


Ribs elevated and thoracic cavity widens.

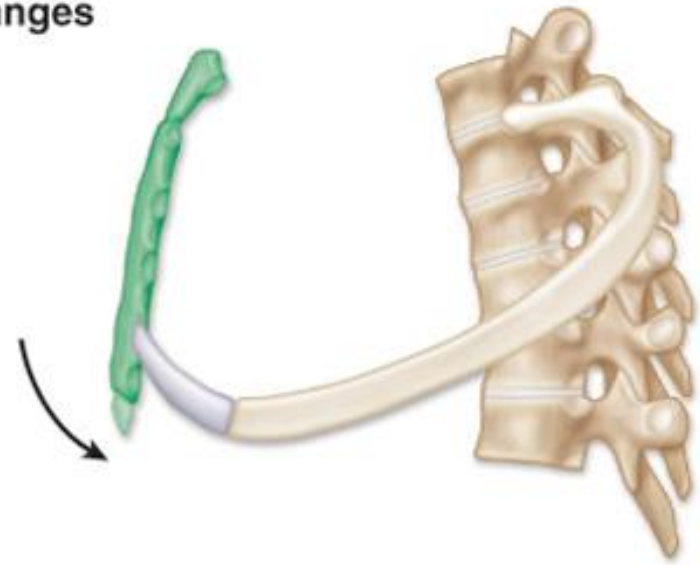


Ribs depressed and thoracic cavity narrows.

Anterior-posterior changes



Inferior portion of sternum moves anteriorly.



Inferior portion of sternum moves posteriorly.