RES practical

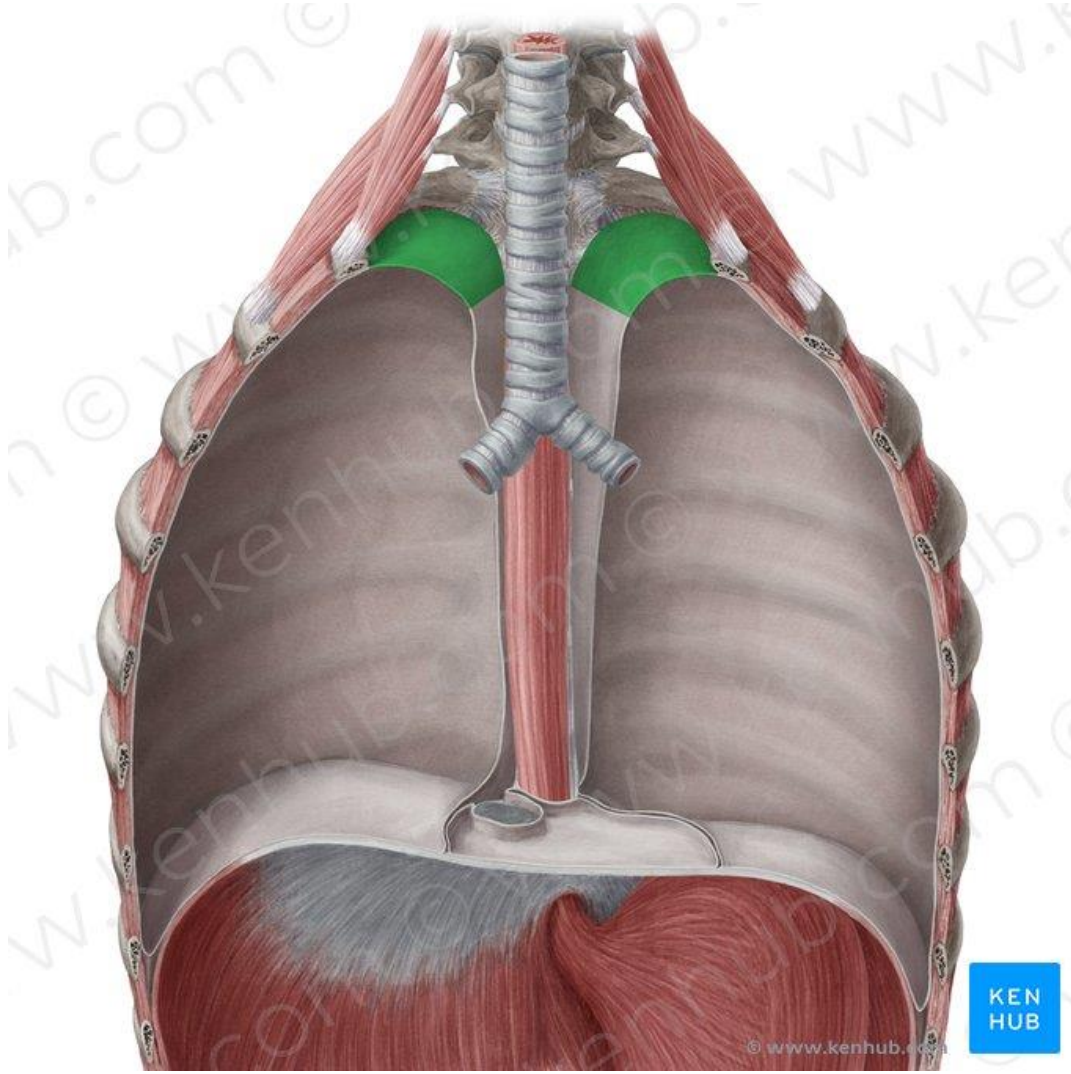
Anatomy

Trachea

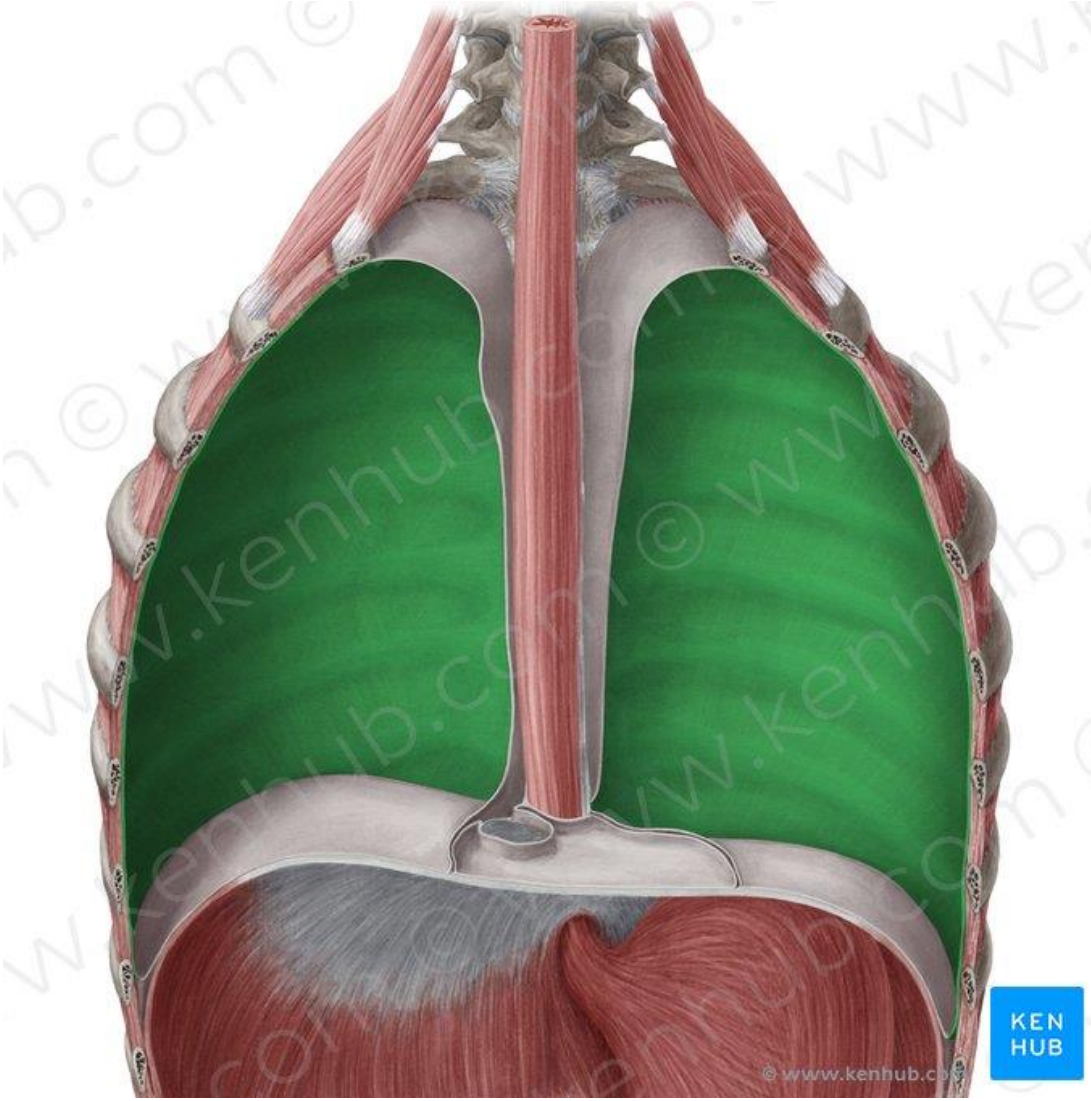
Right main bronchus

Left main bronchus

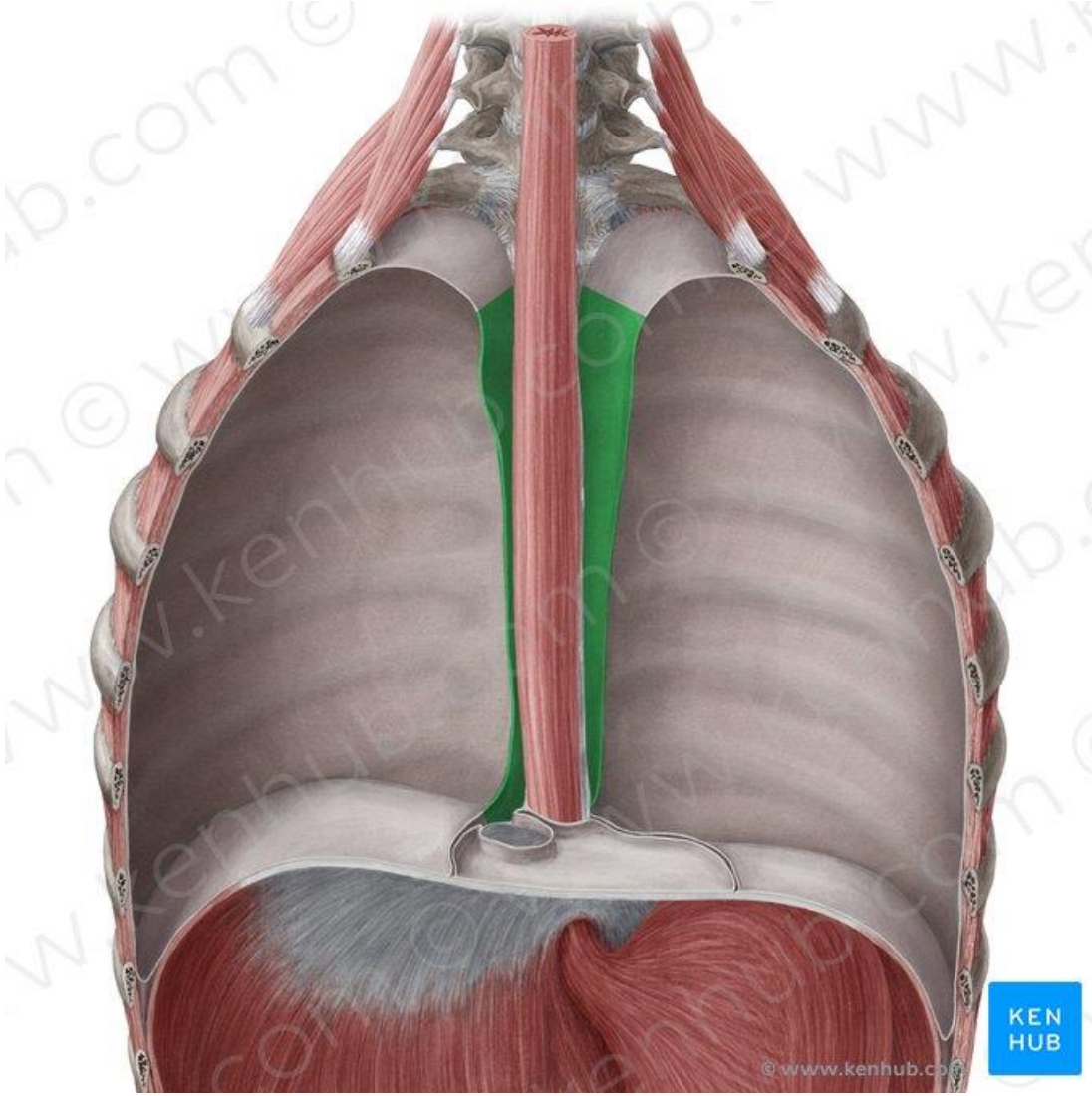
Cervical part of parietal pleura



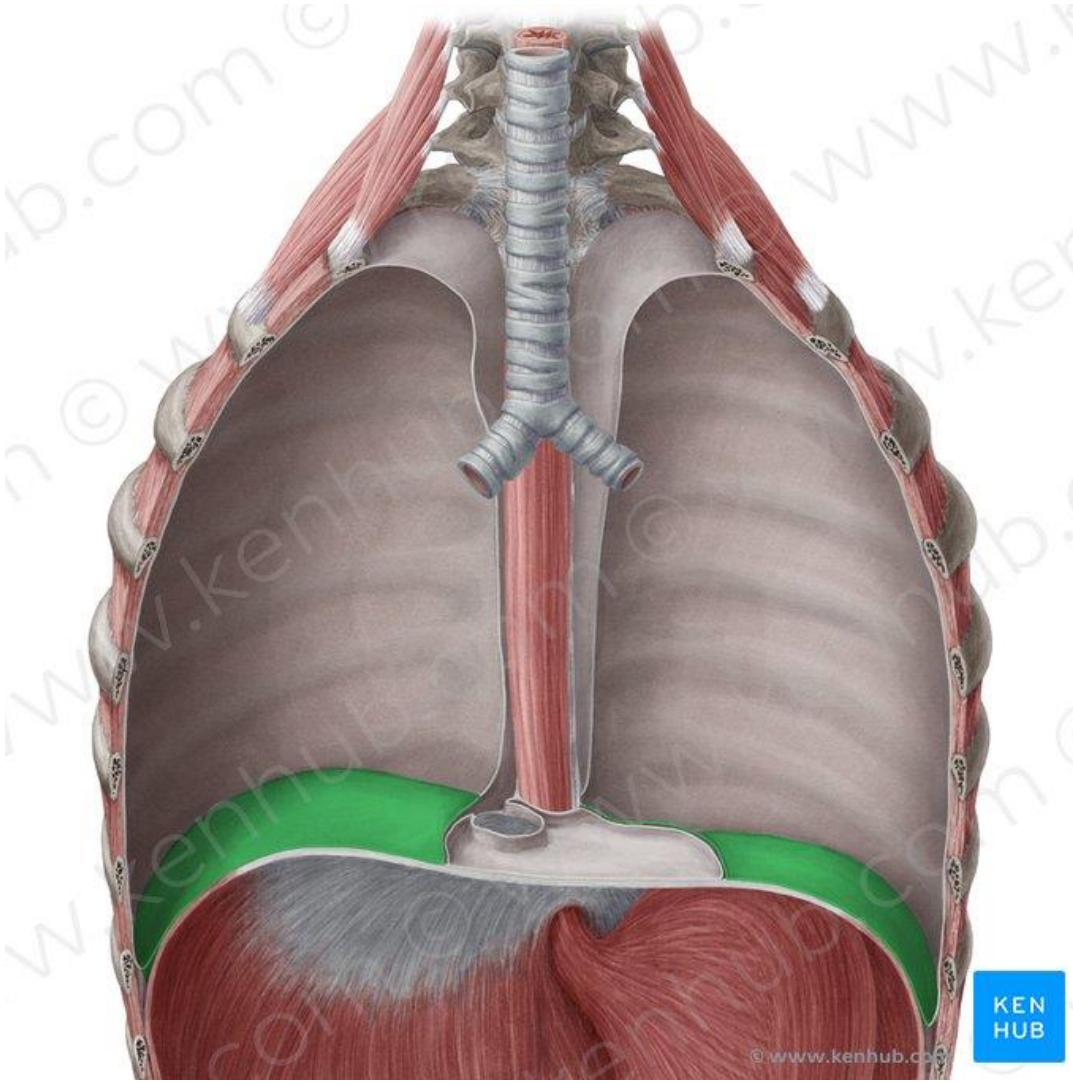
Costal part of parietal pleura



Mediastinal part of parietal pleura

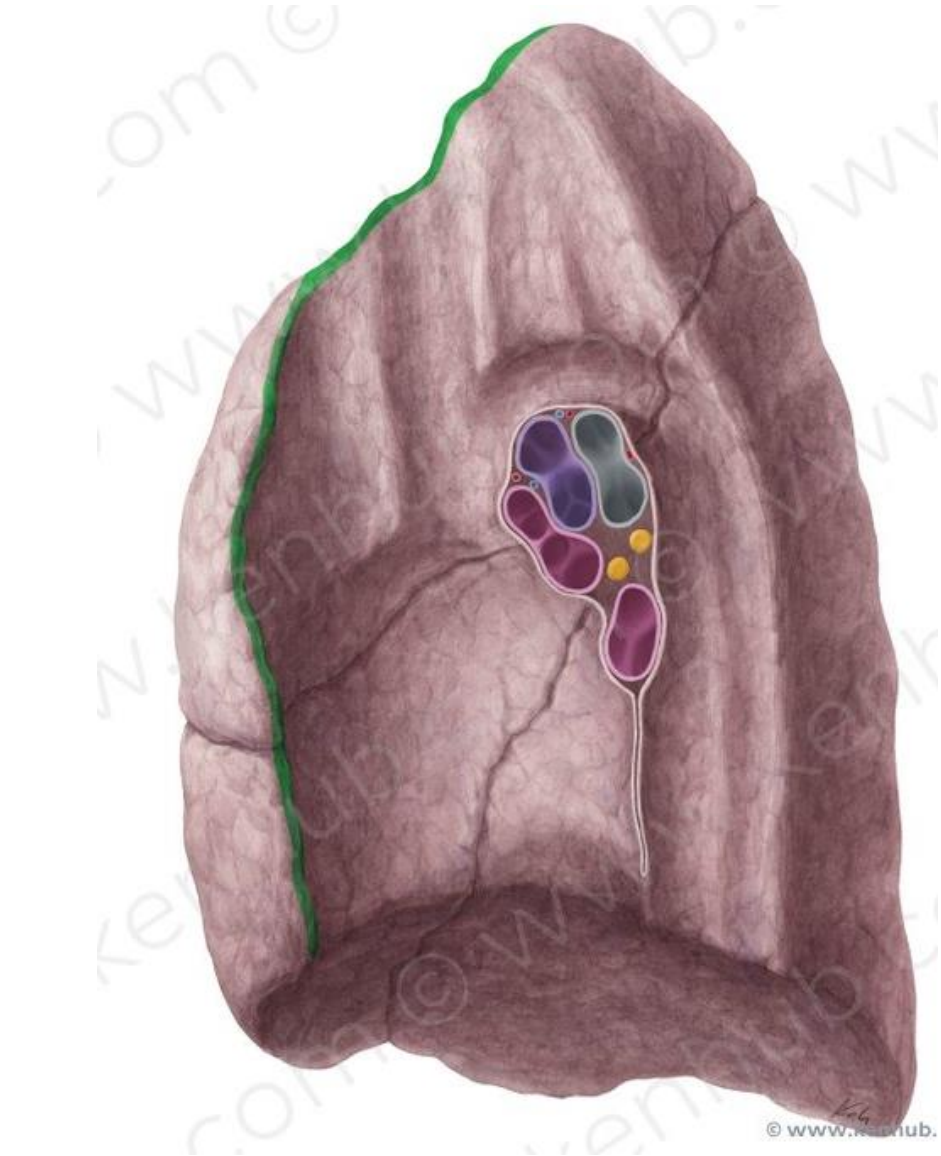


Diaphragmatic part of parietal pleura

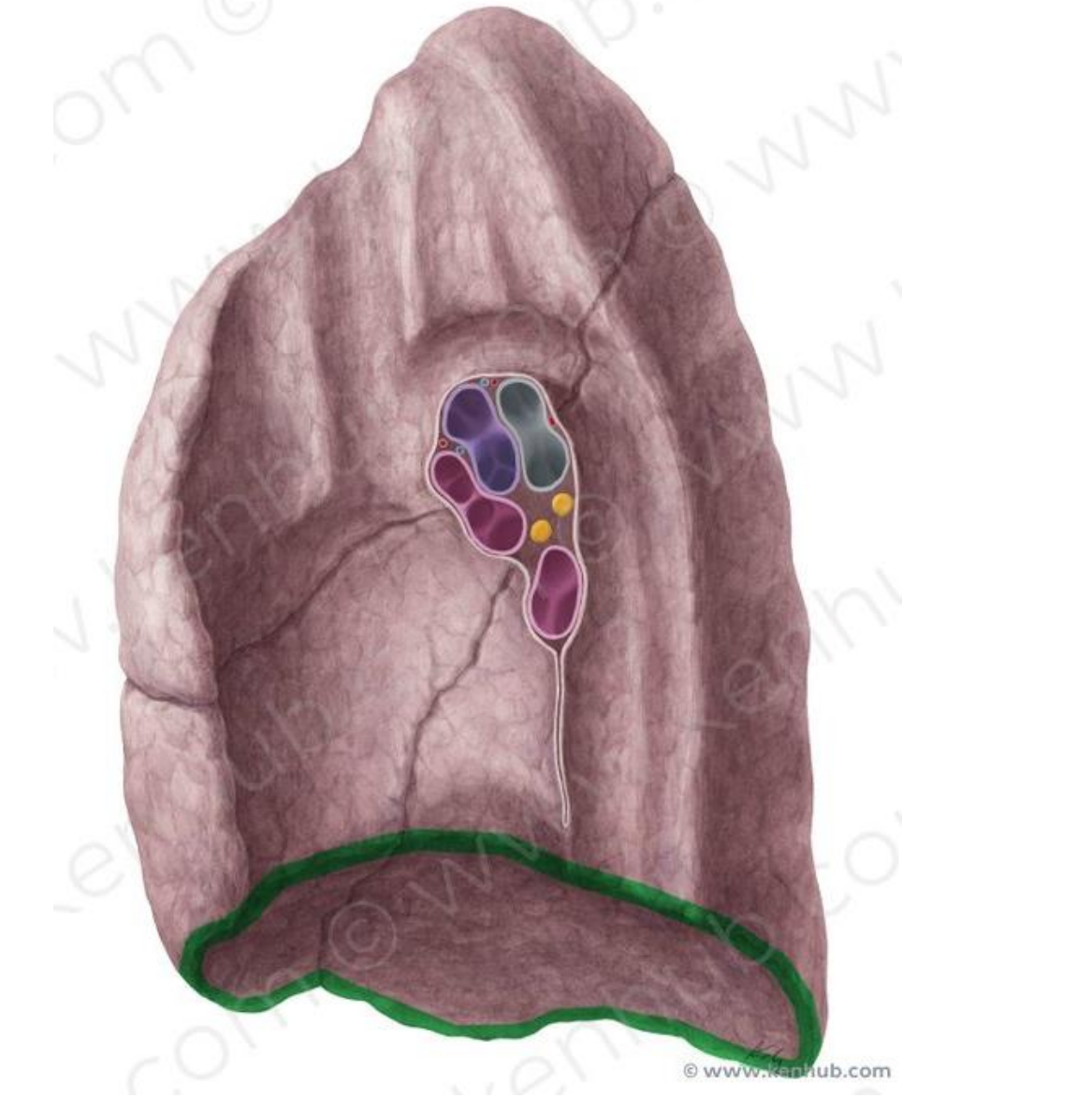


Costal surface of right lung

Anterior border of right lung

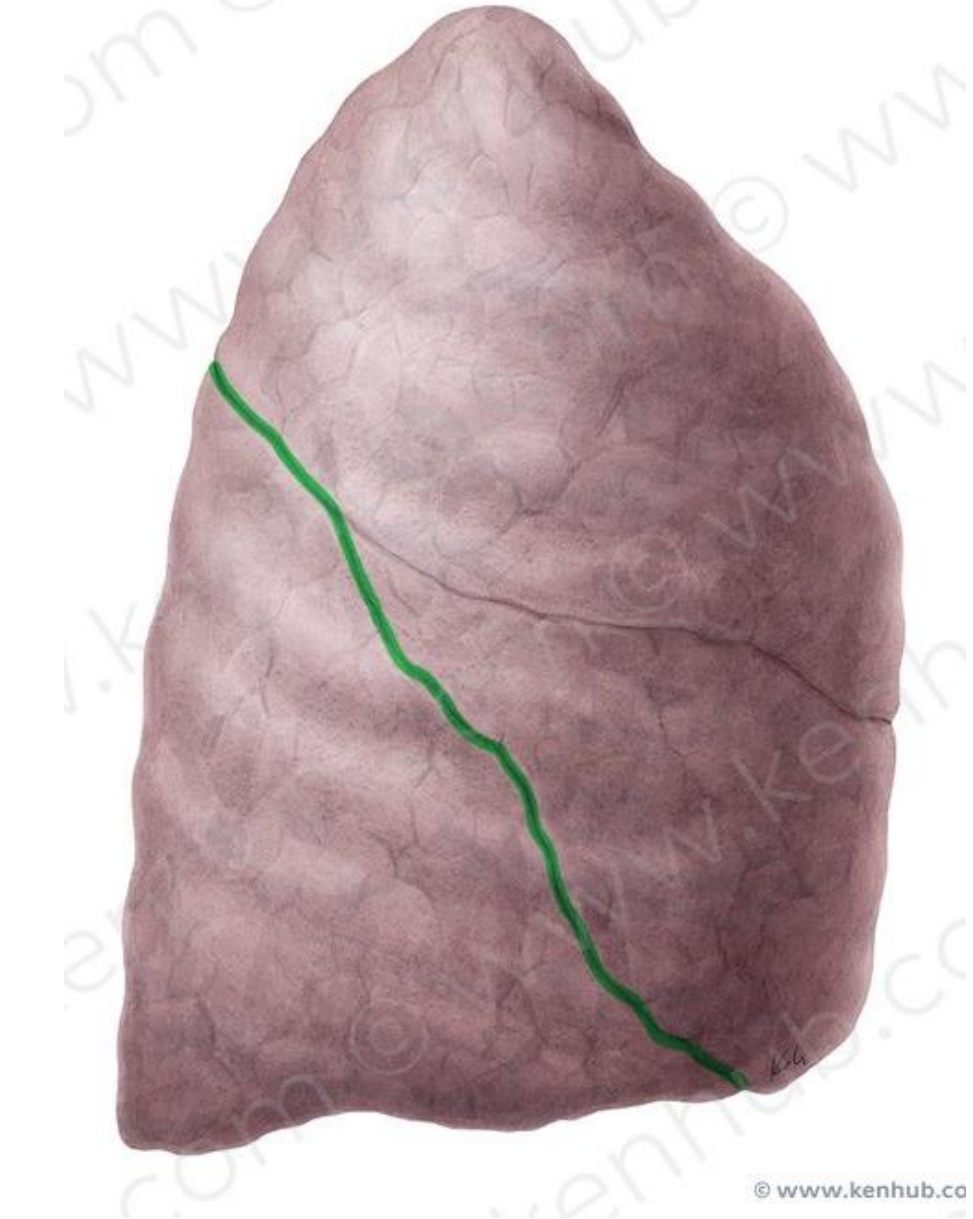


Inferior border of right lung



Horizontal fissure of right lung

Oblique fissure of right lung

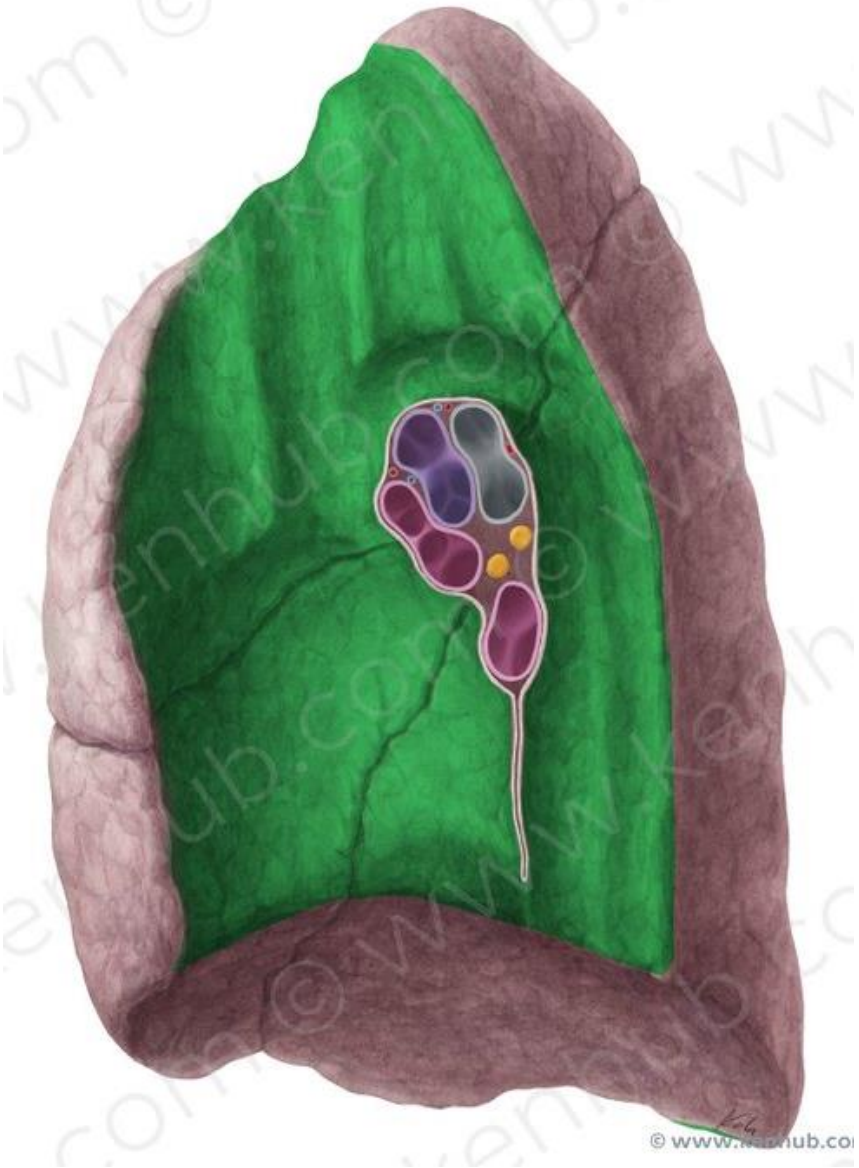


Superior lobe of right lung

Middle lobe of right lung

Inferior lobe of right lung

Mediastinal surface of right lung

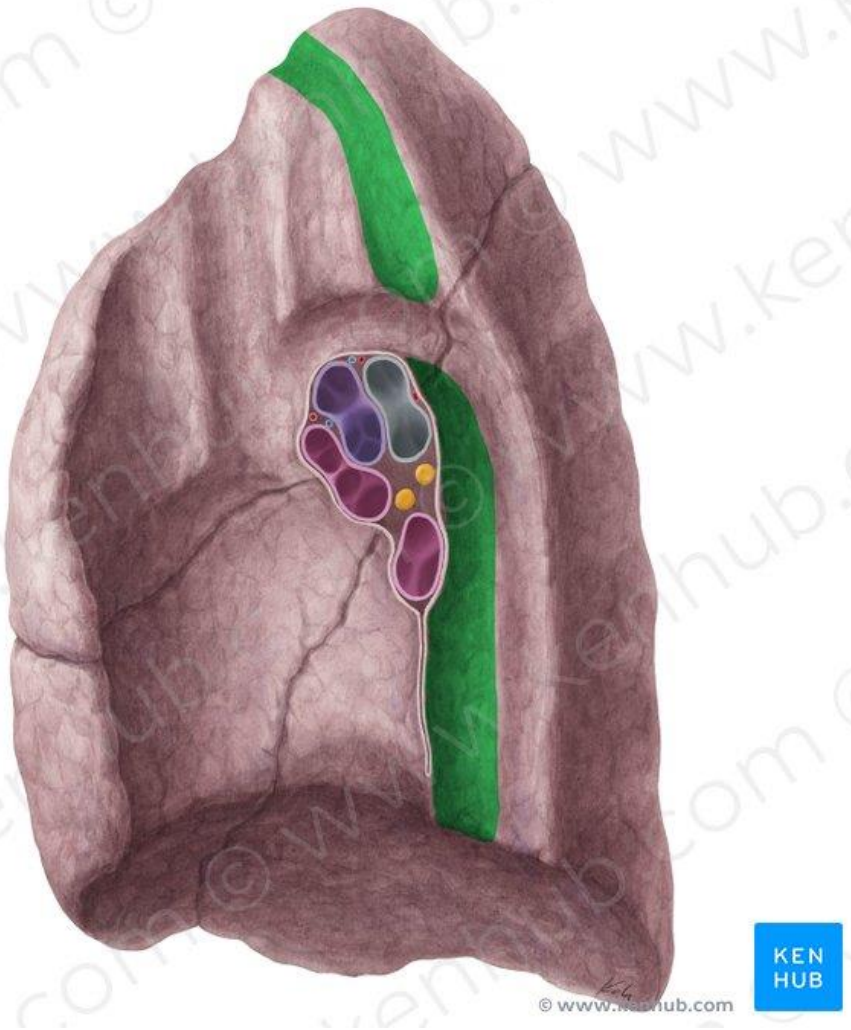


Vertebral surface of right lung

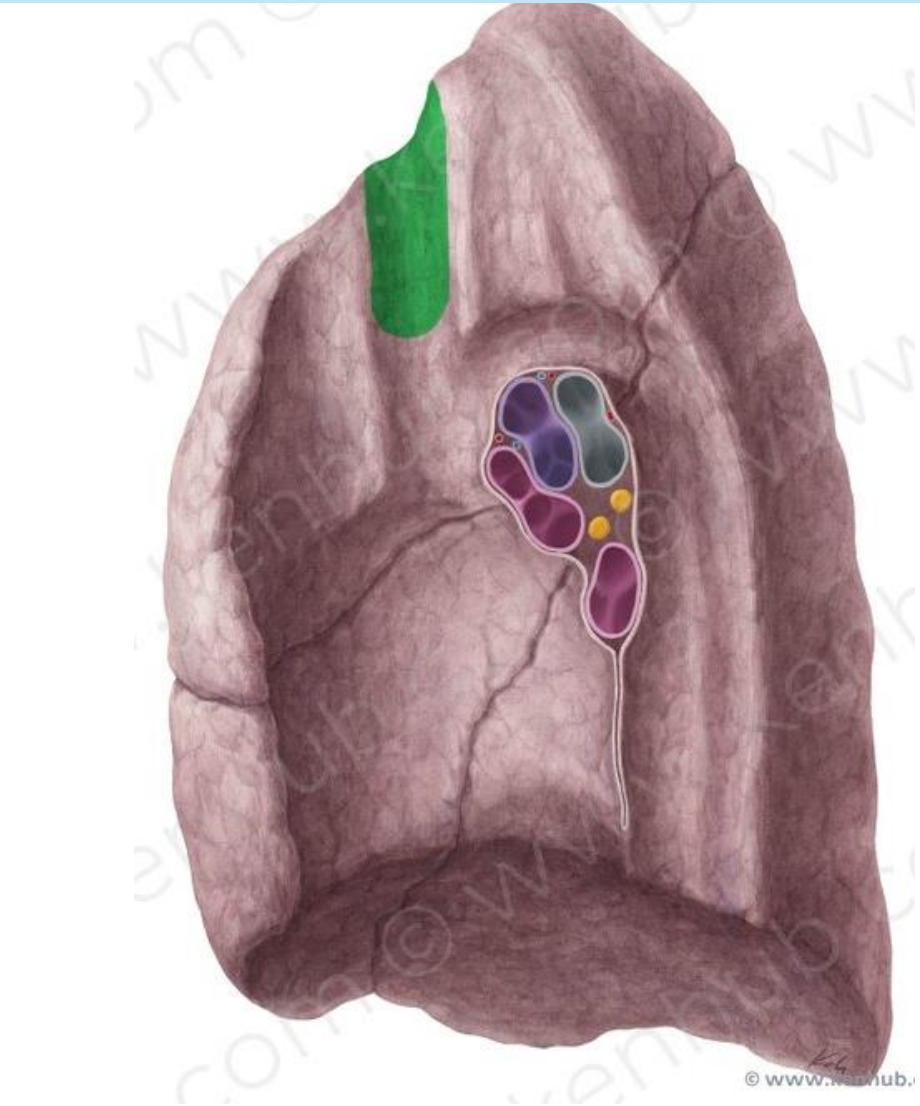
Diaphragmatic surface of right lung

Tracheal impression of right lung

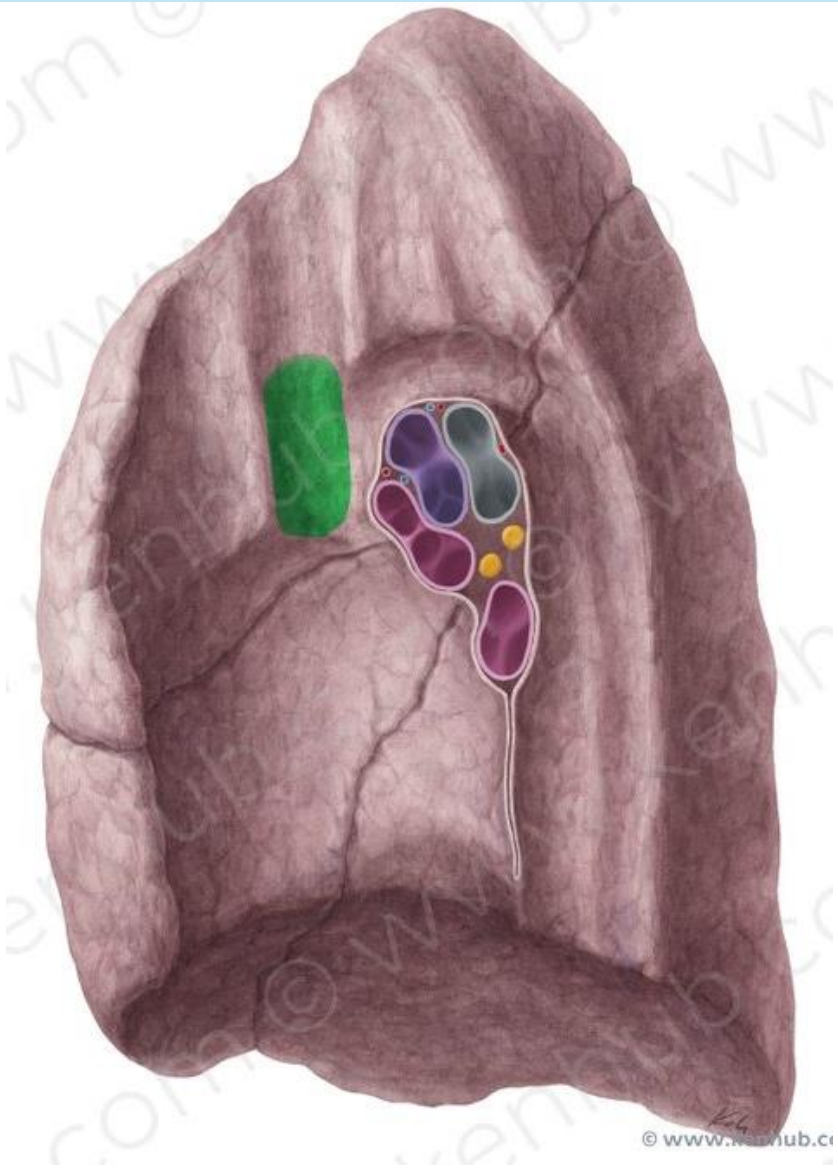
Esophageal impression of right lung



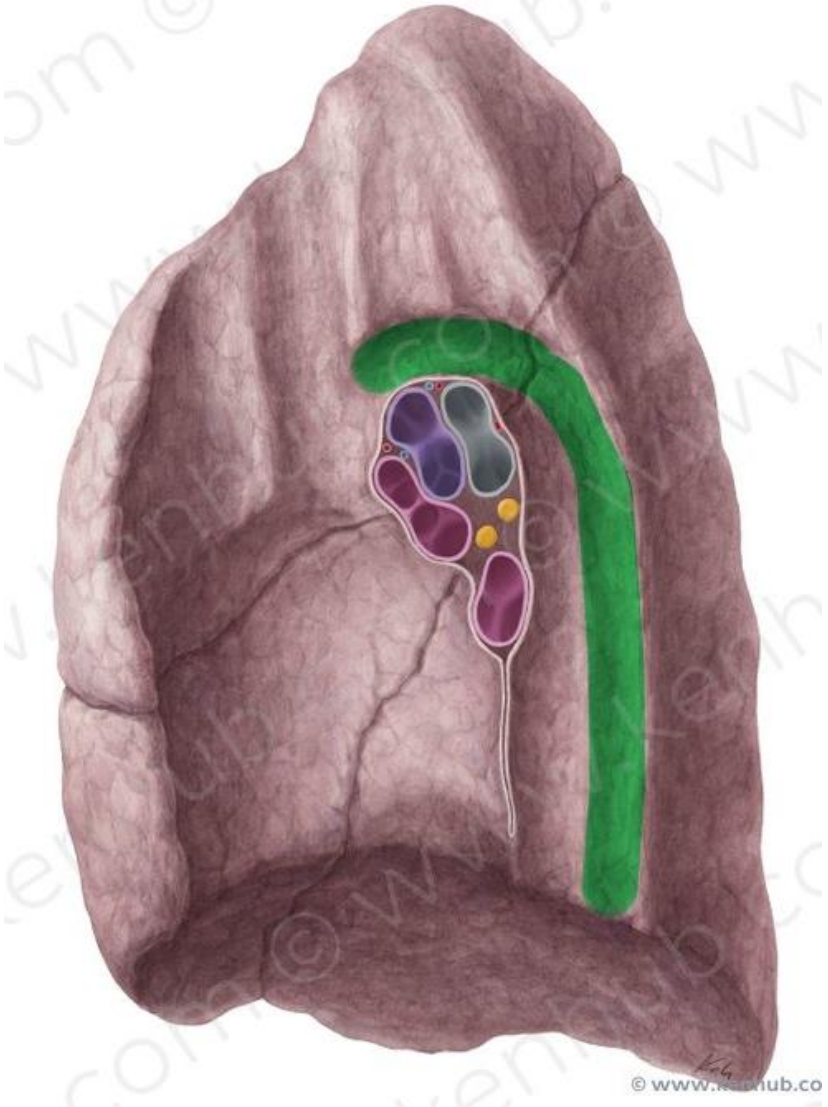
Impression for right brachiocephalic vein of right lung



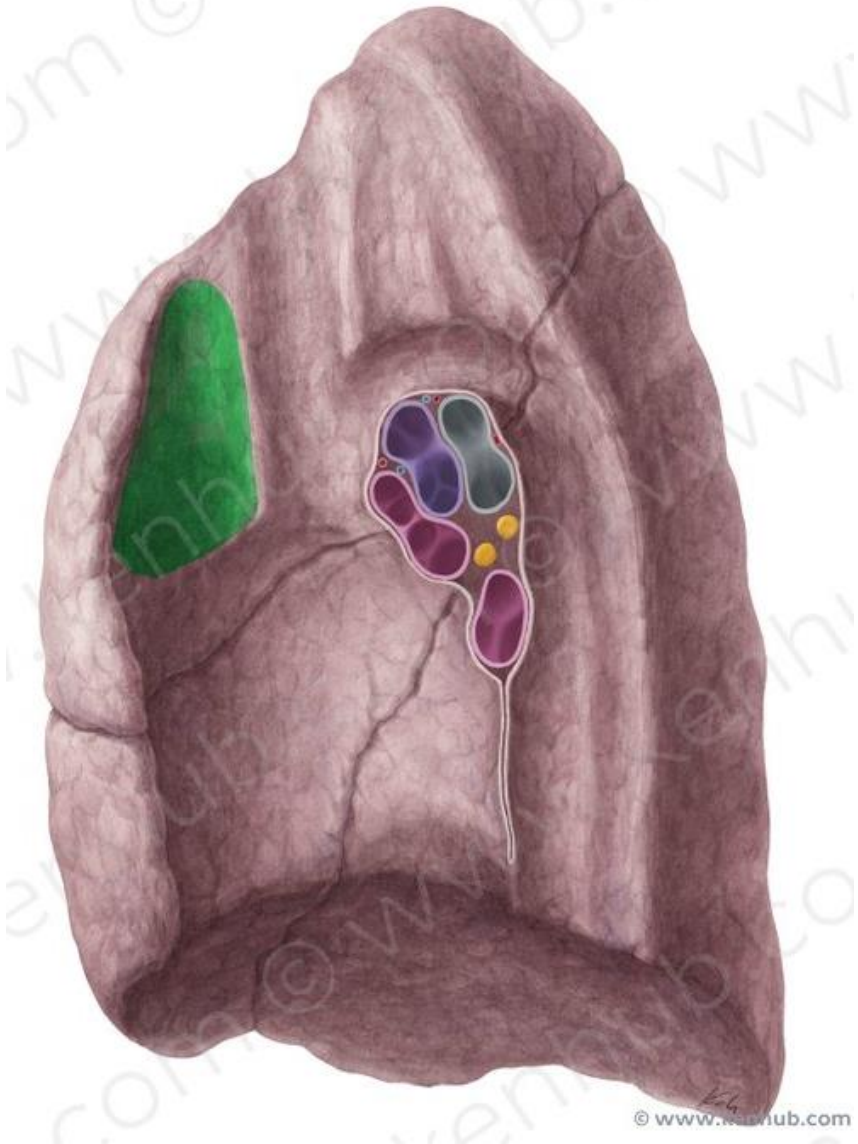
Impression for superior vena cava of right lung



Impression for azygos vein of right lung

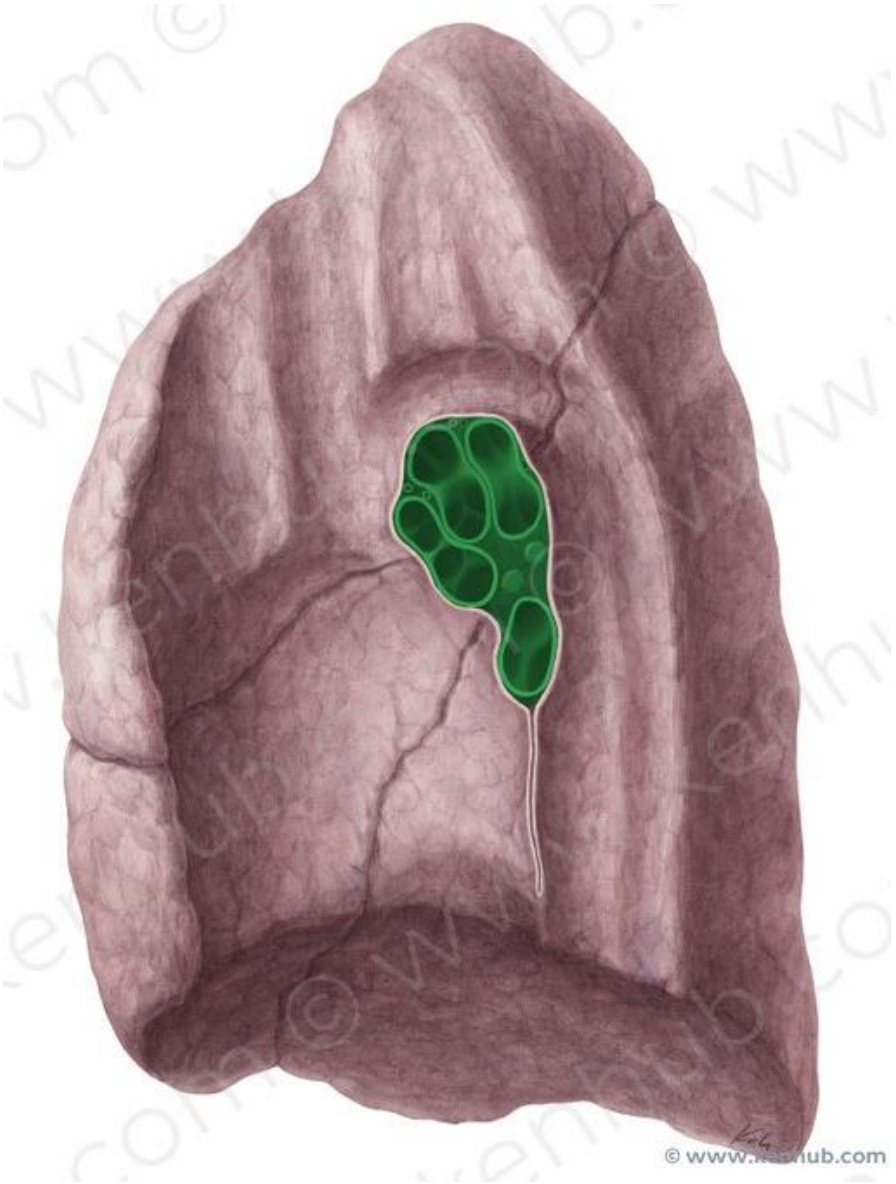


Thymic impression of right lung

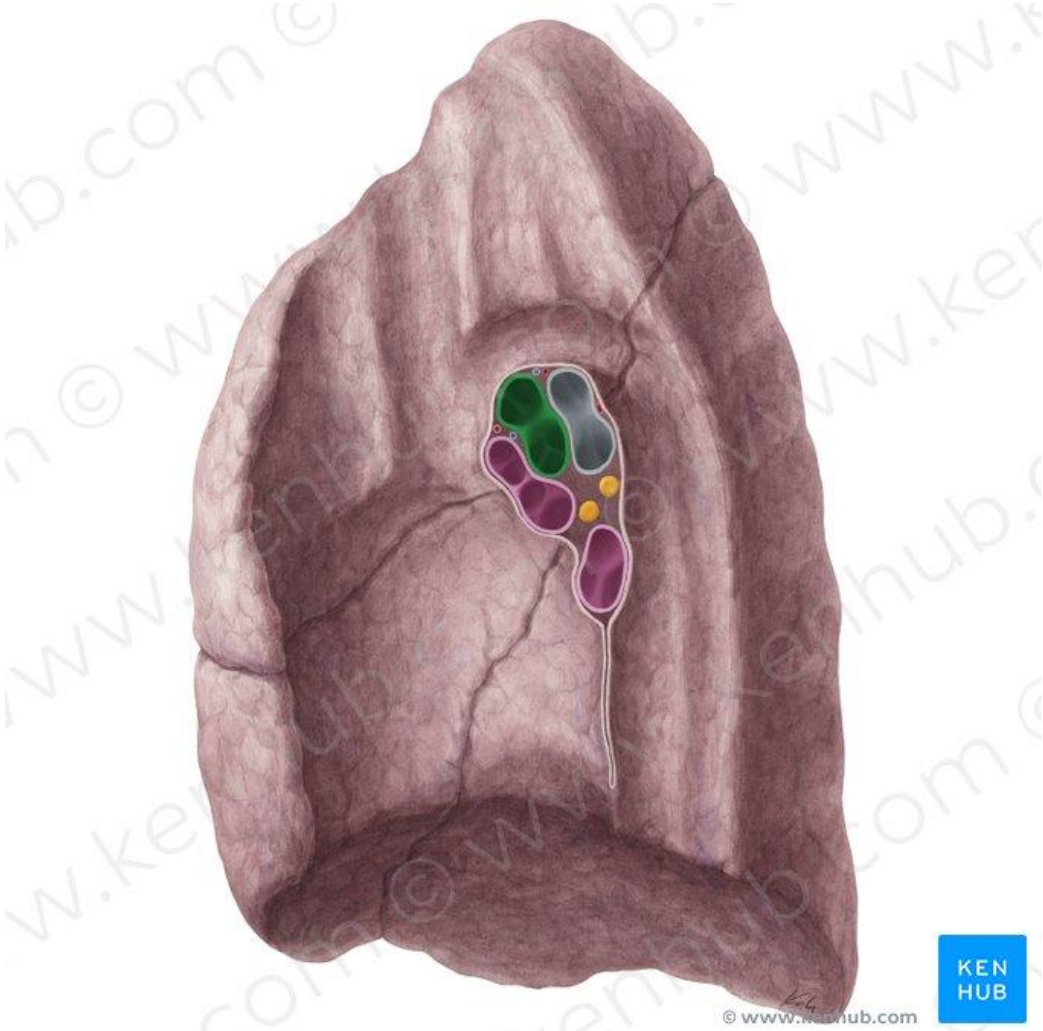


Cardiac impression of right lung

Hilum of right lung



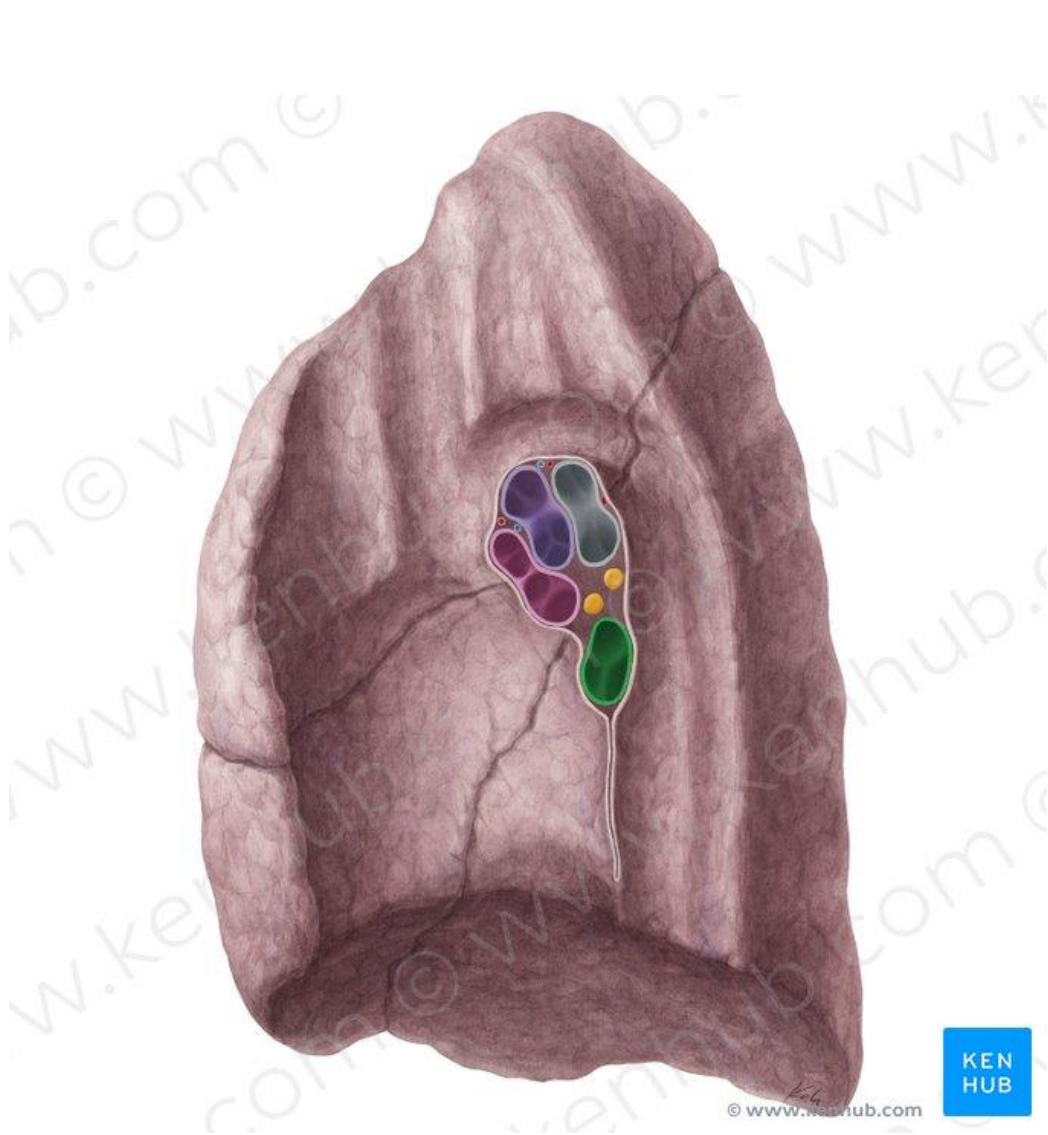
Right pulmonary artery



Right superior lobar bronchus

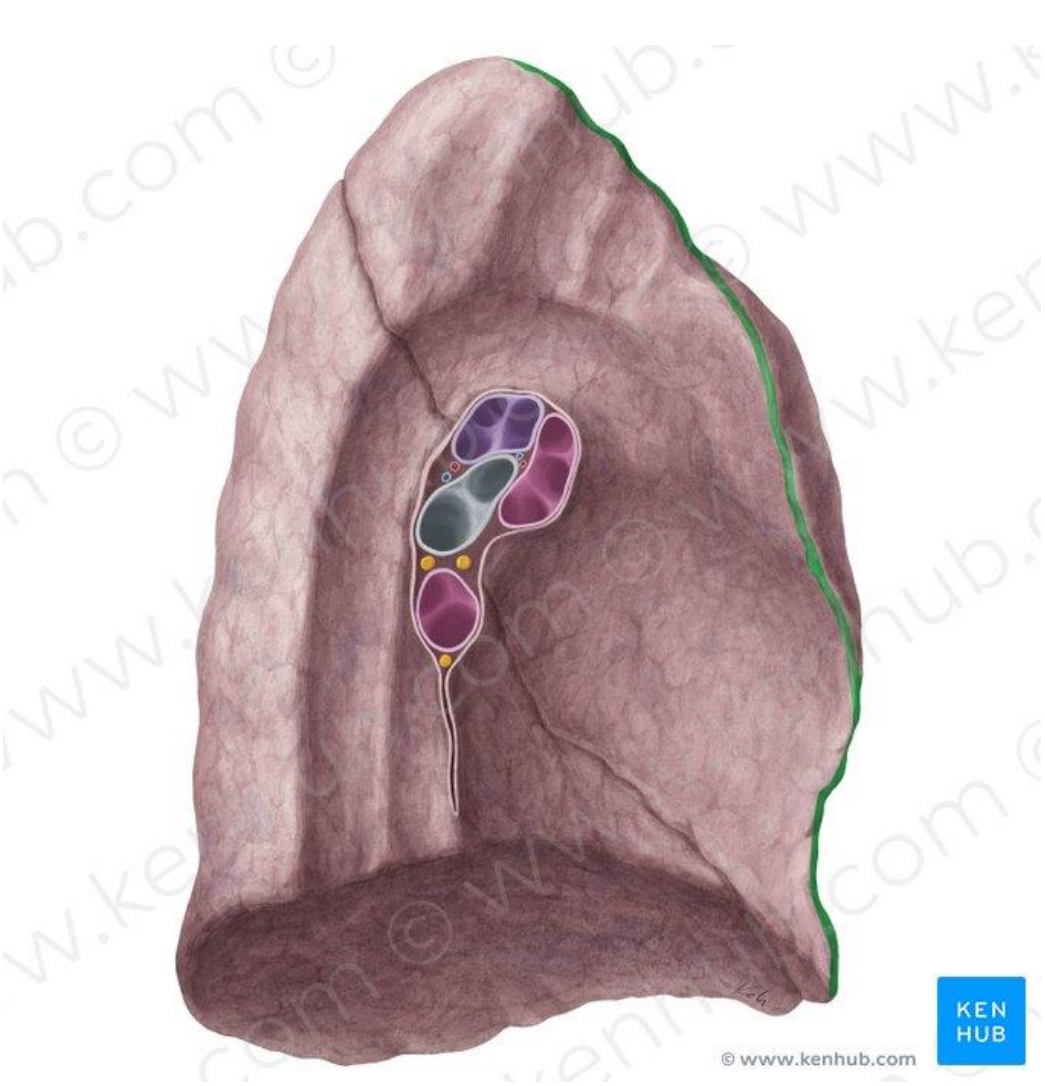
Right superior pulmonary vein

Right inferior pulmonary vein

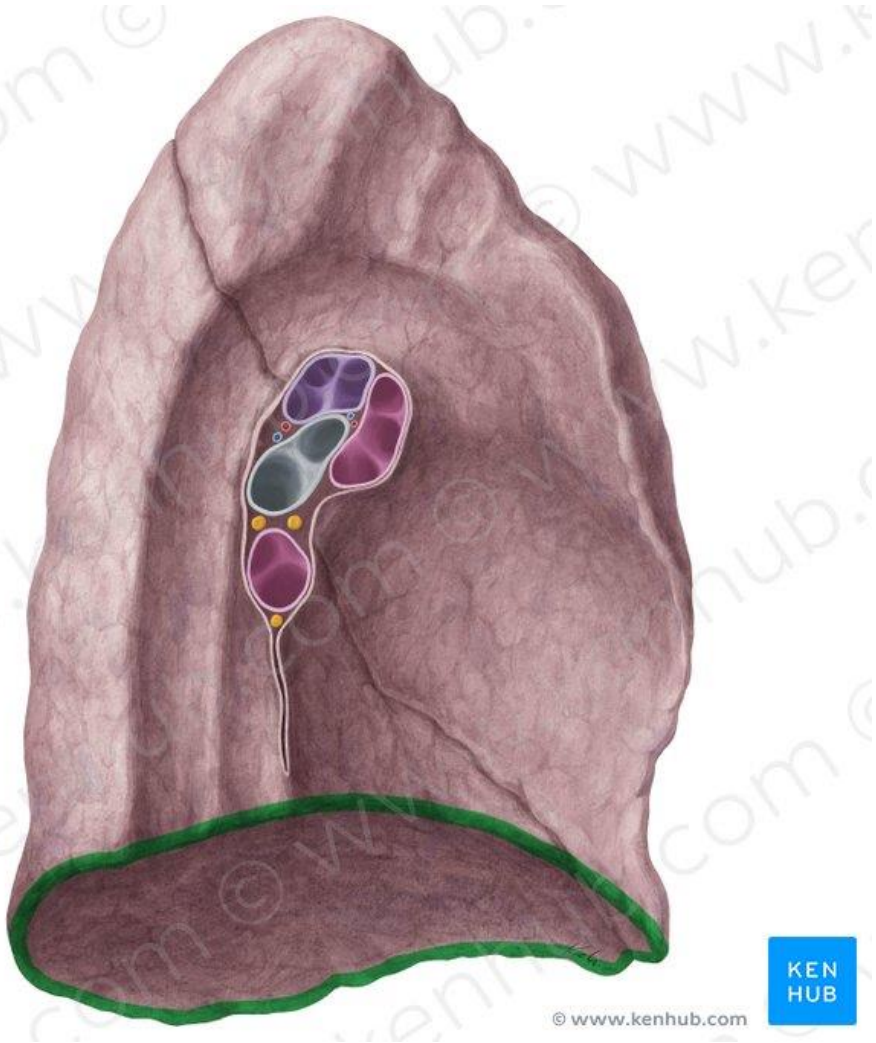


Costal surface of left lung

Anterior border of left lung



Inferior border of left lung

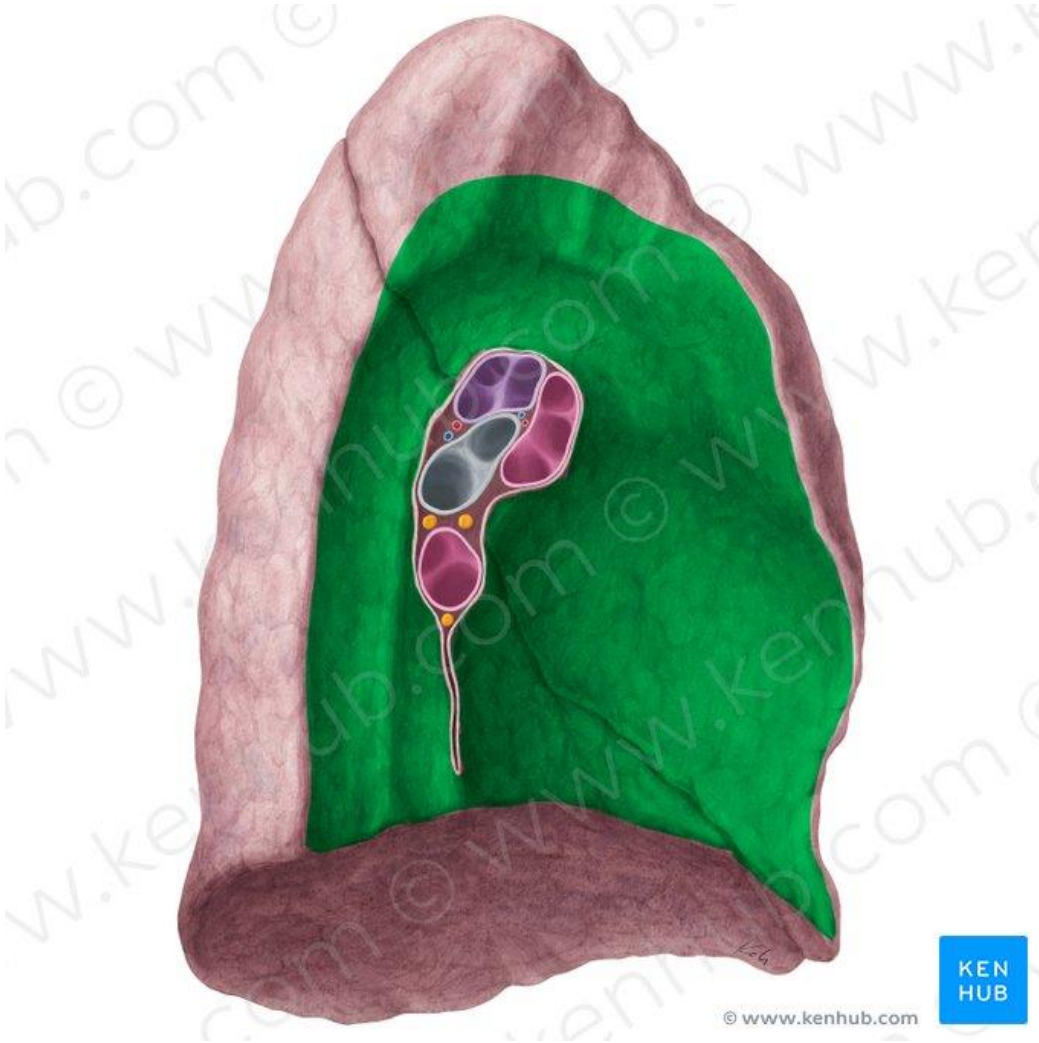


Oblique fissure of left lung

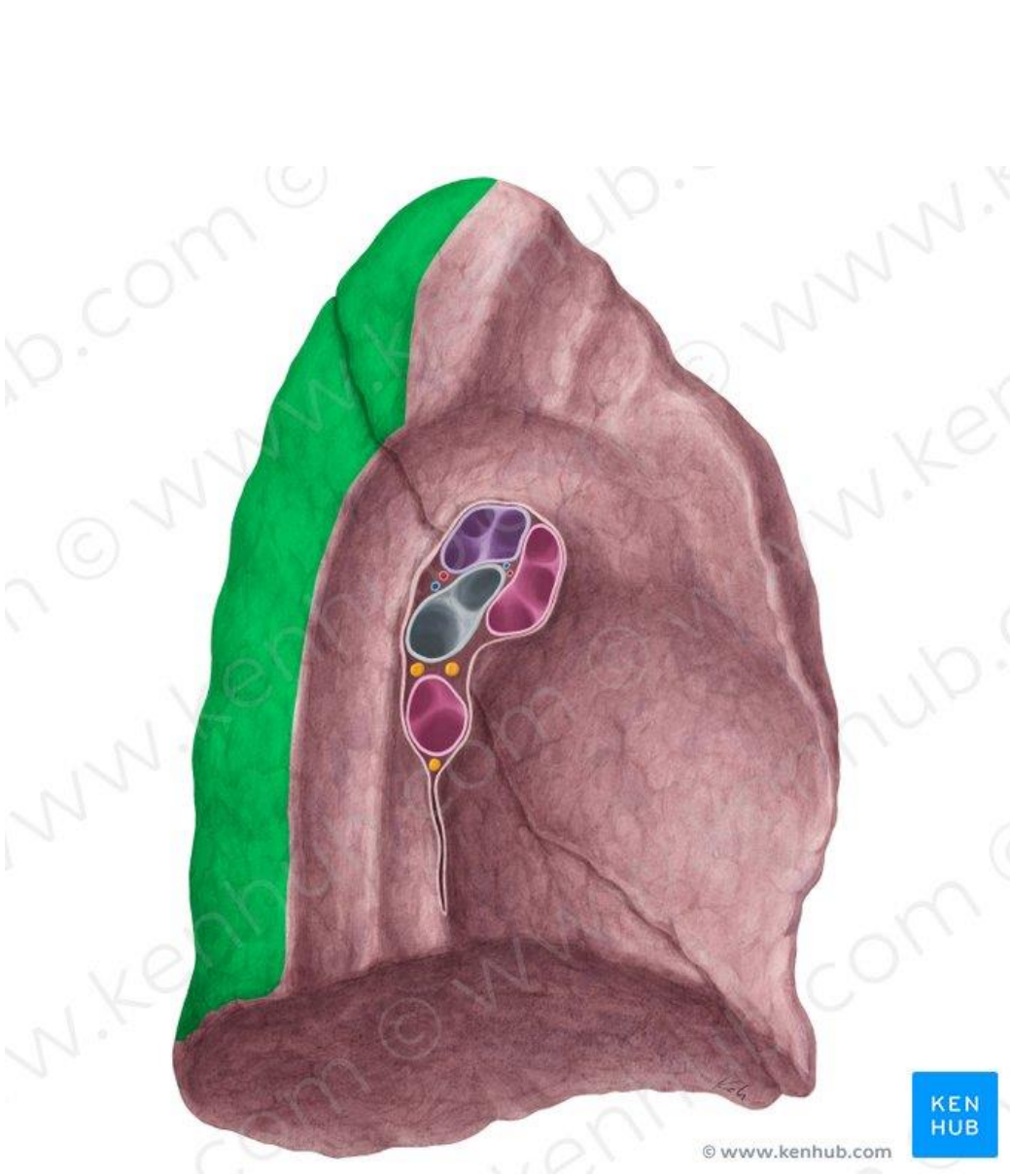
Superior lobe of left lung

Inferior lobe of left lung

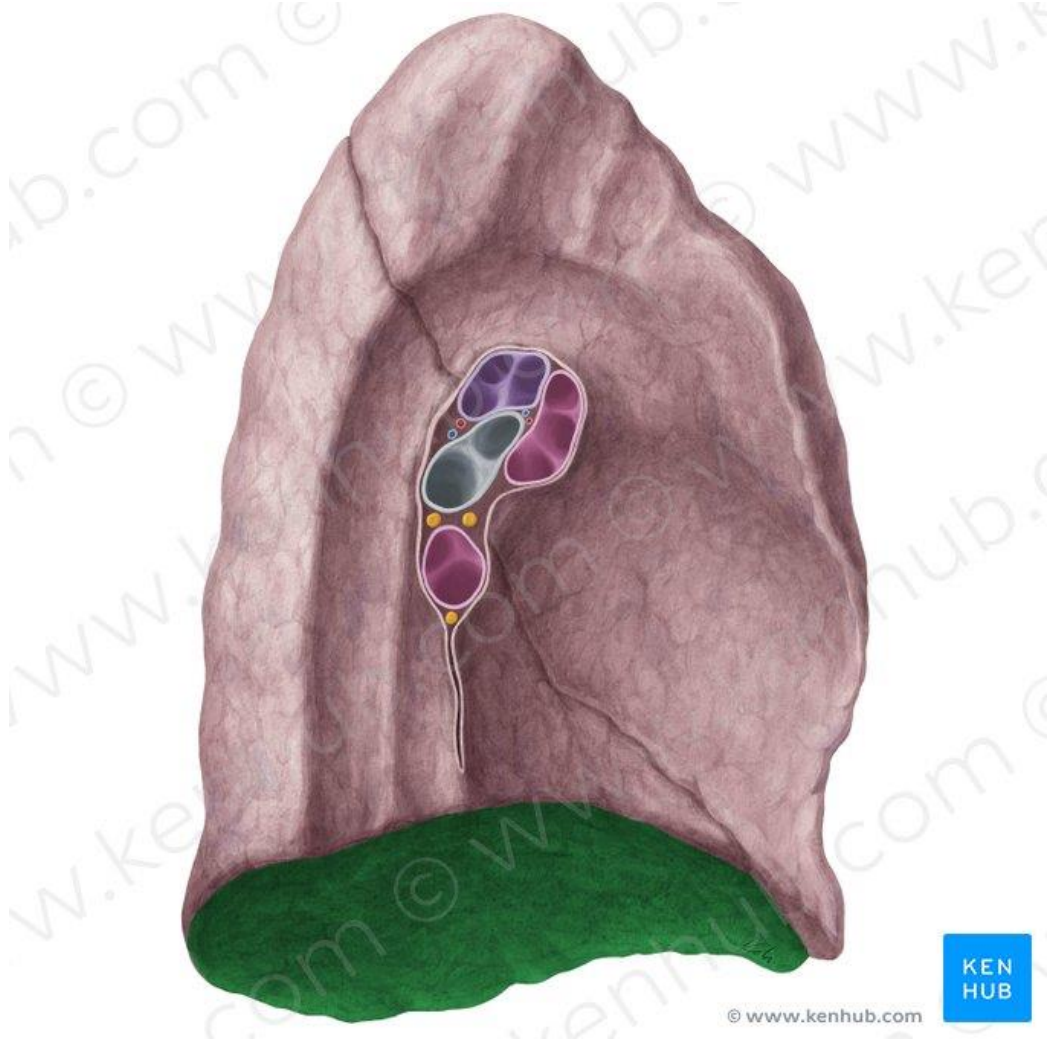
Mediastinal surface of left lung



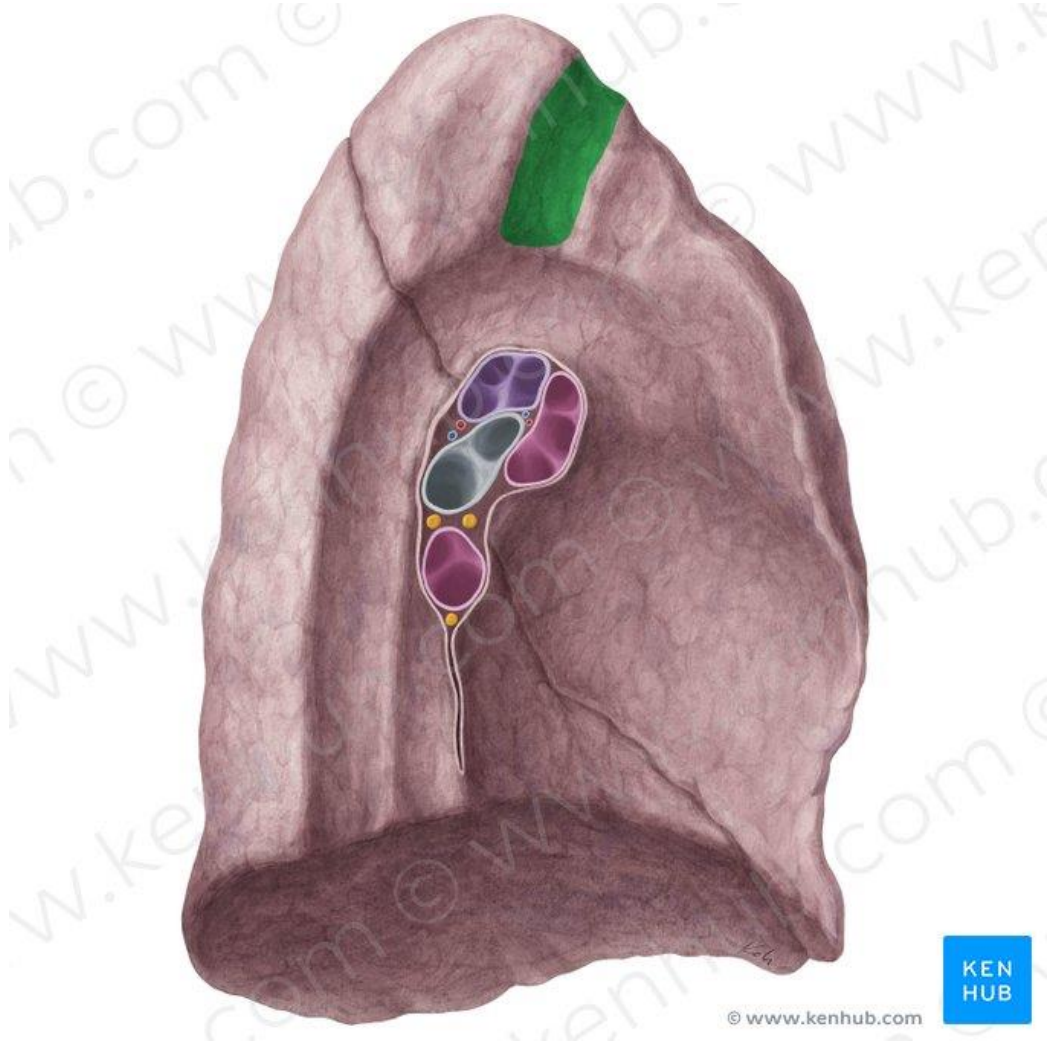
Vertebral surface of left lung



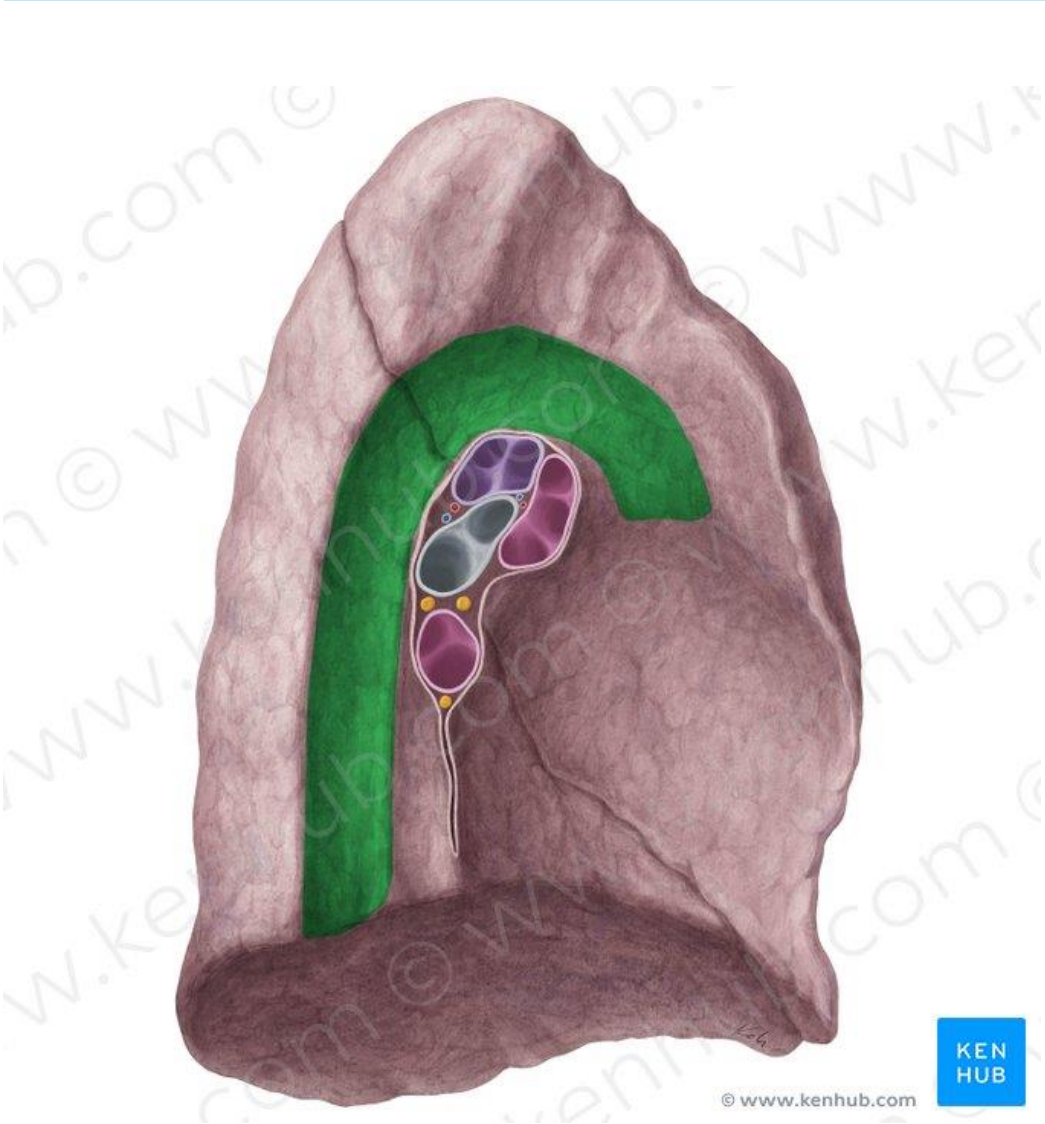
Diaphragmatic surface of left lung



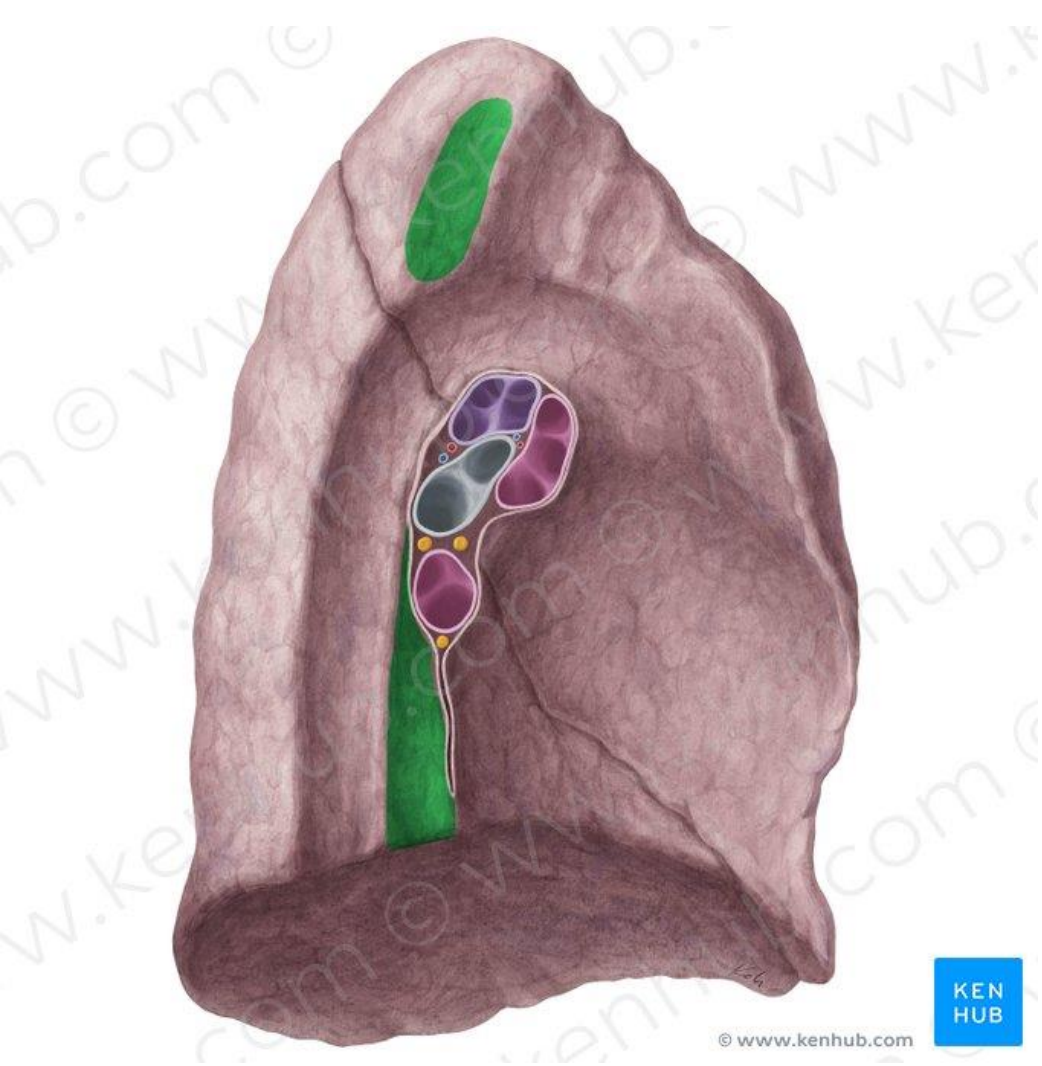
Impression for subclavian artery of left lung



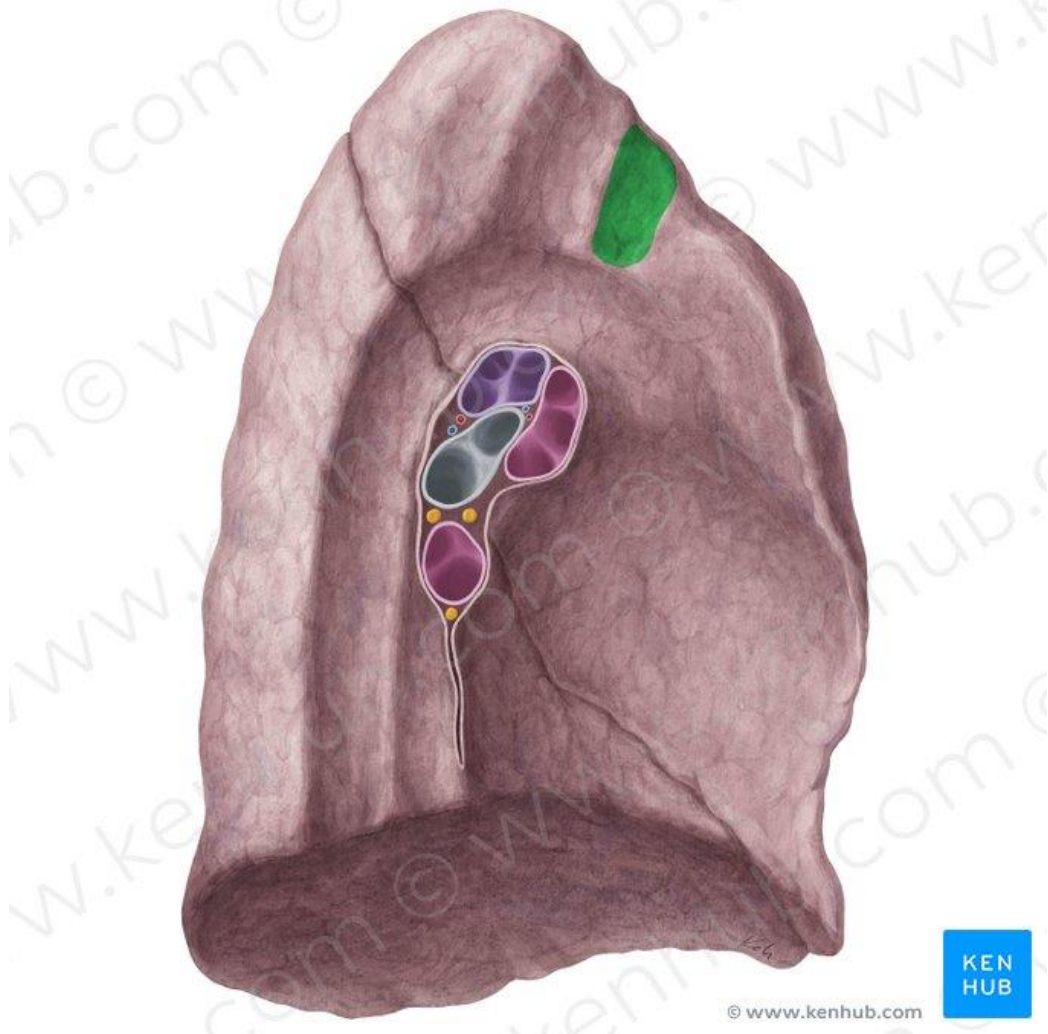
Aortic impression of left lung



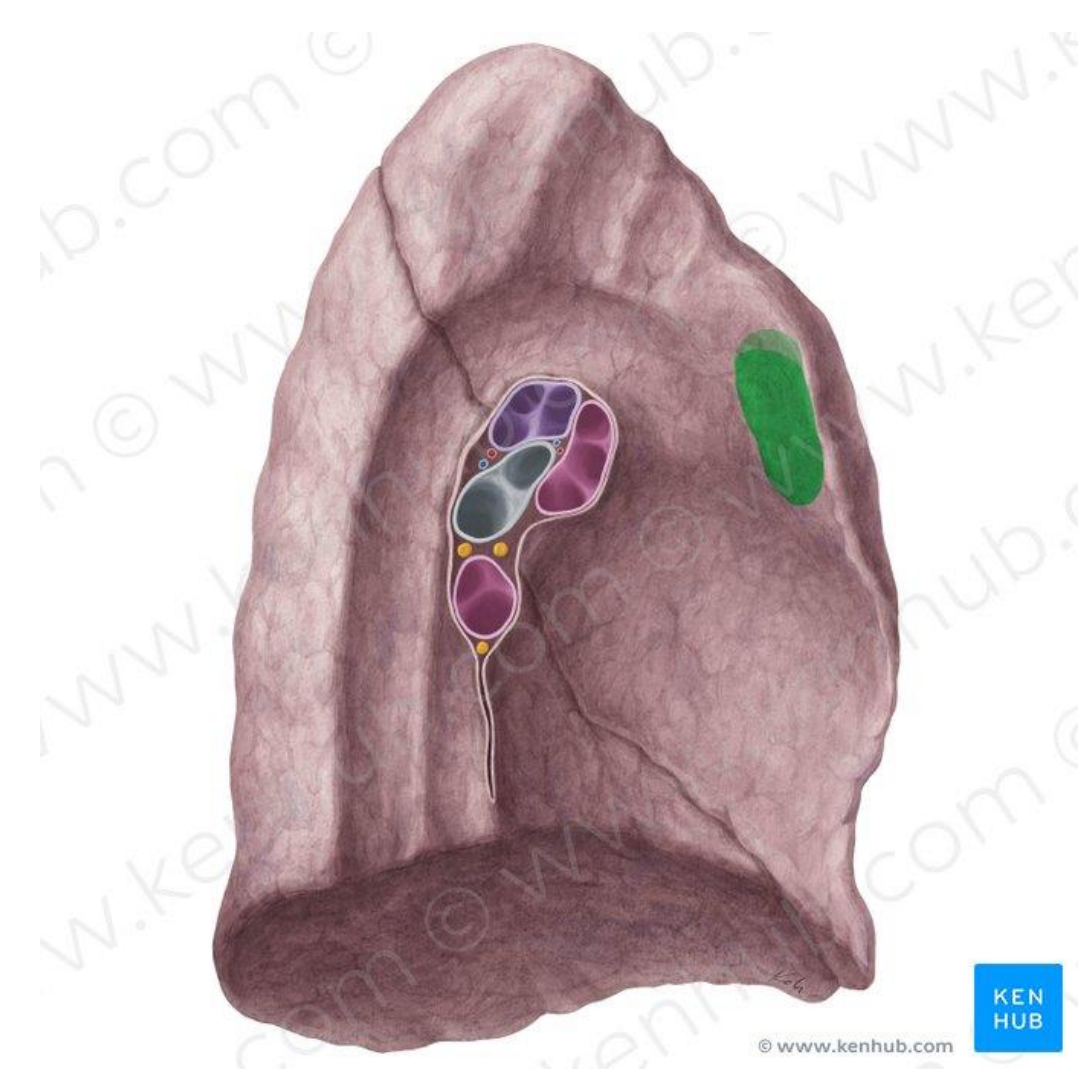
Esophageal impression of left lung



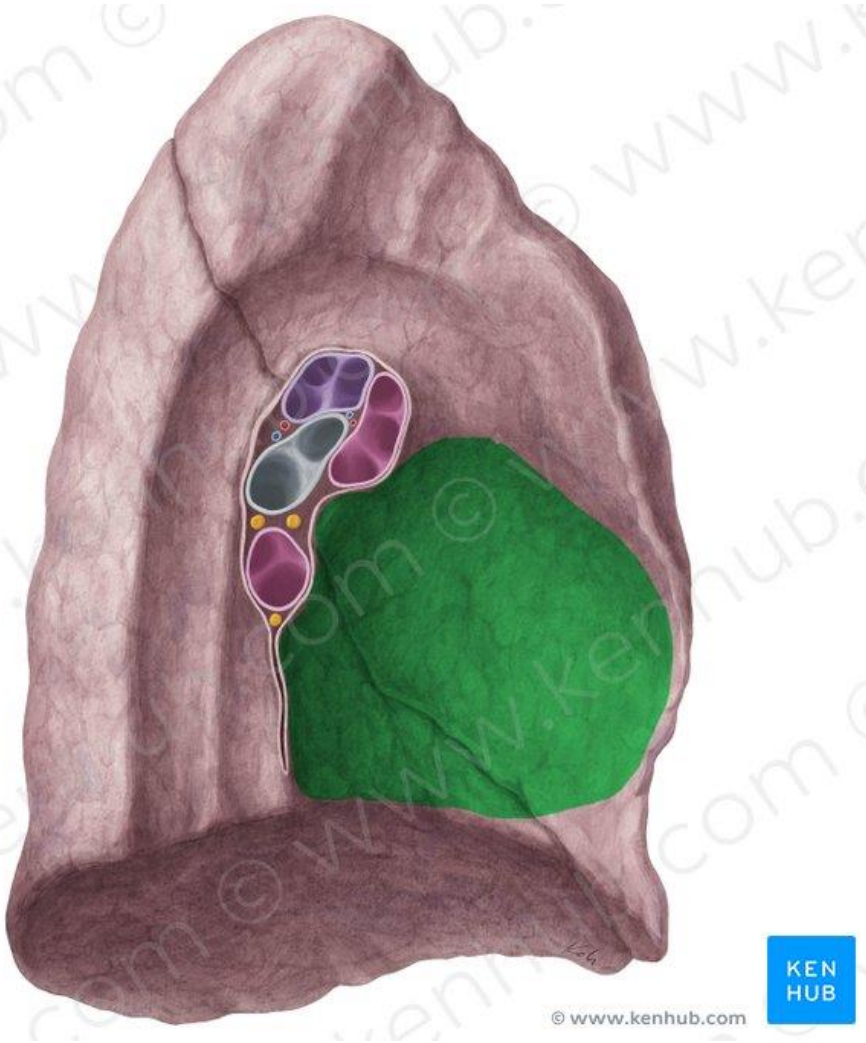
Impression for left brachiocephalic vein of left lung



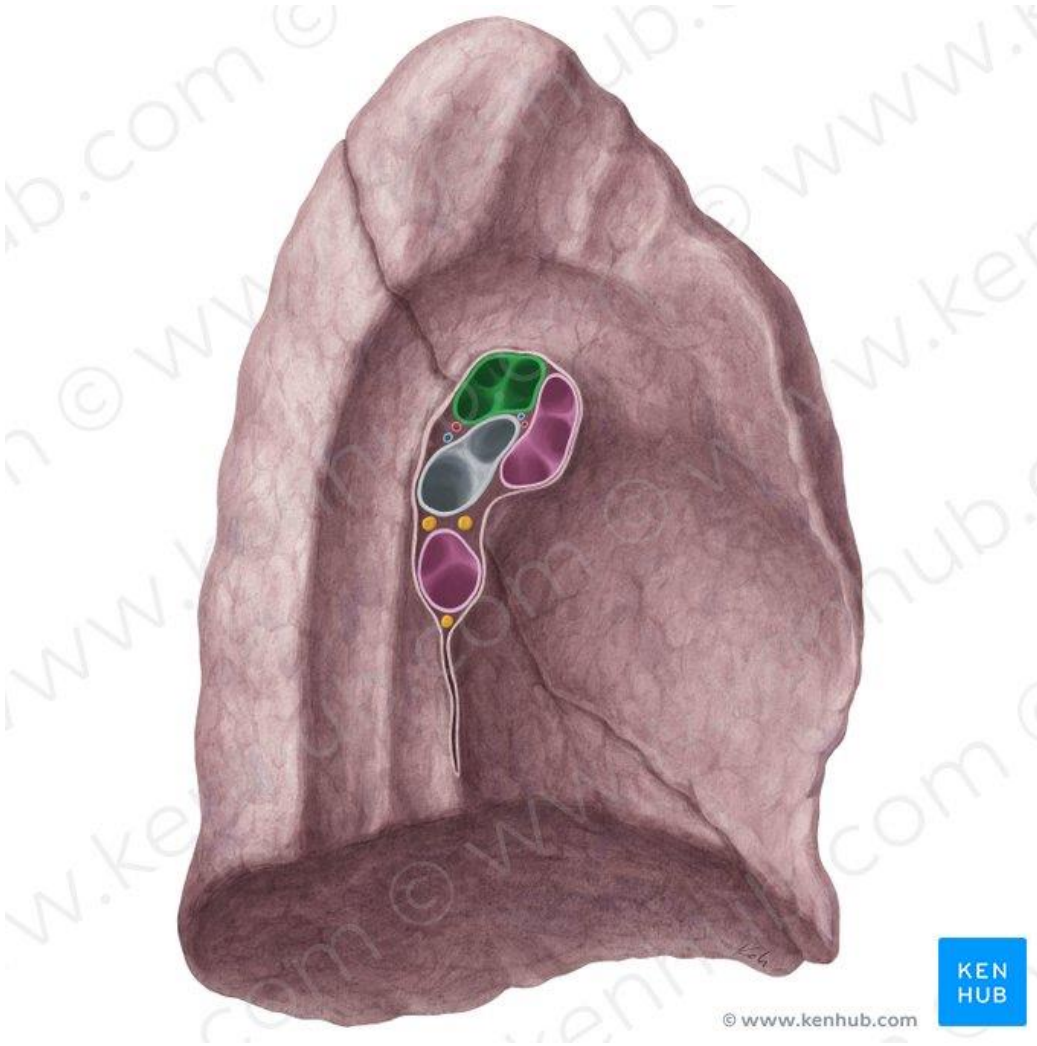
Thymic impression of left lung



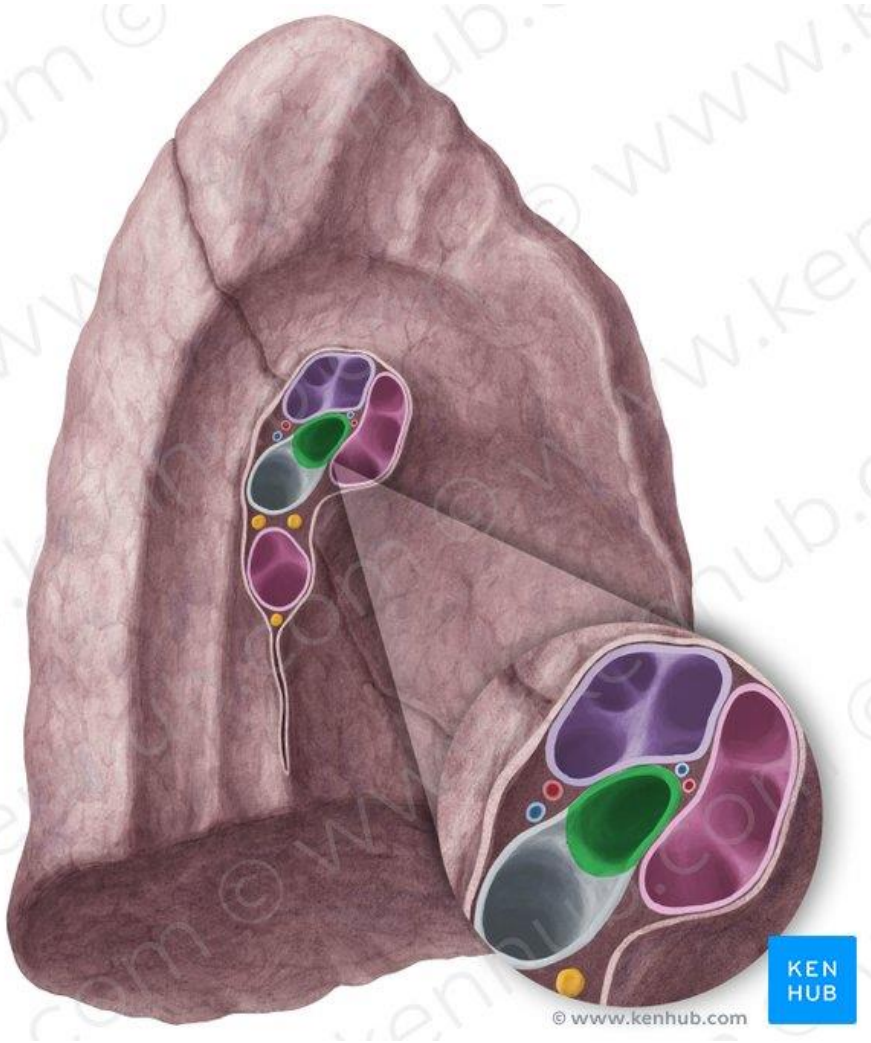
Cardiac impression of left lung



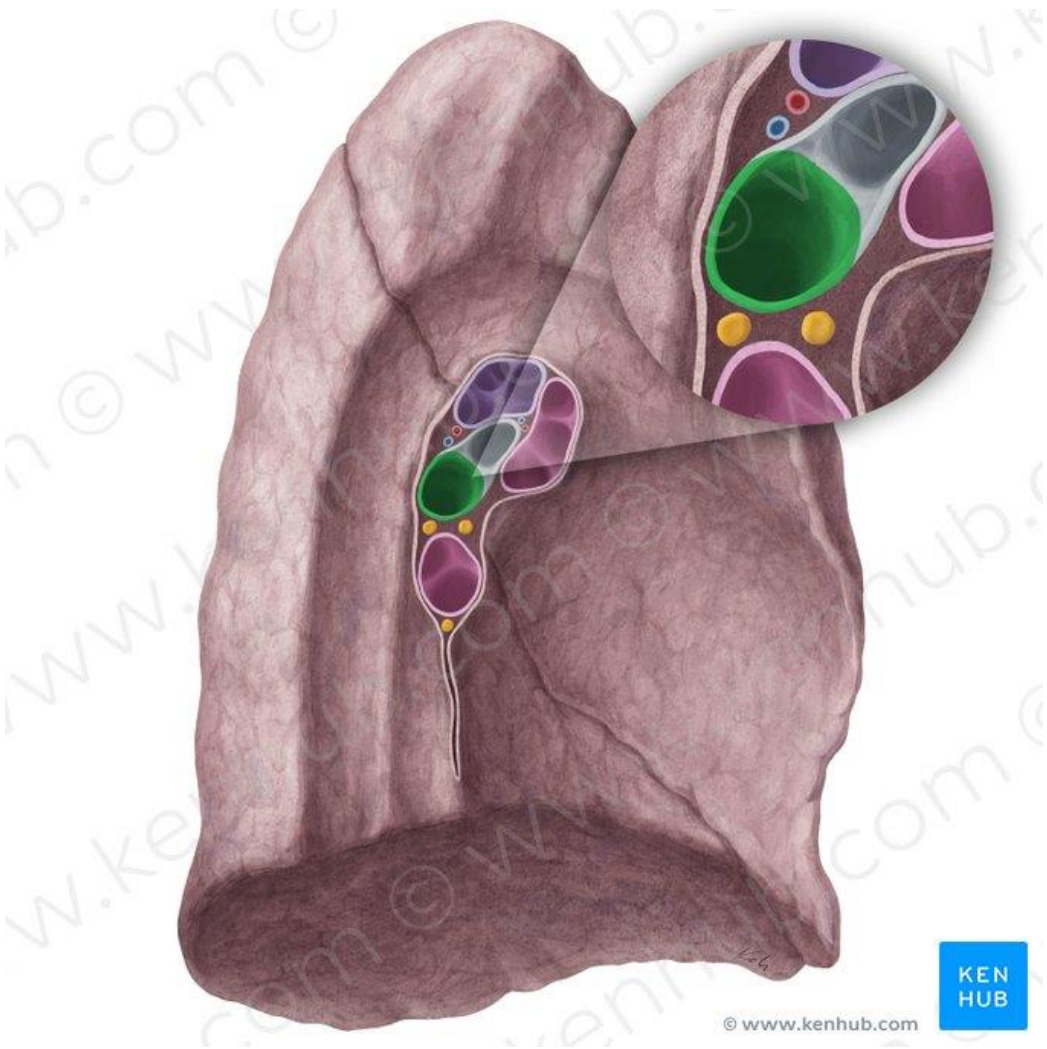
Left pulmonary artery



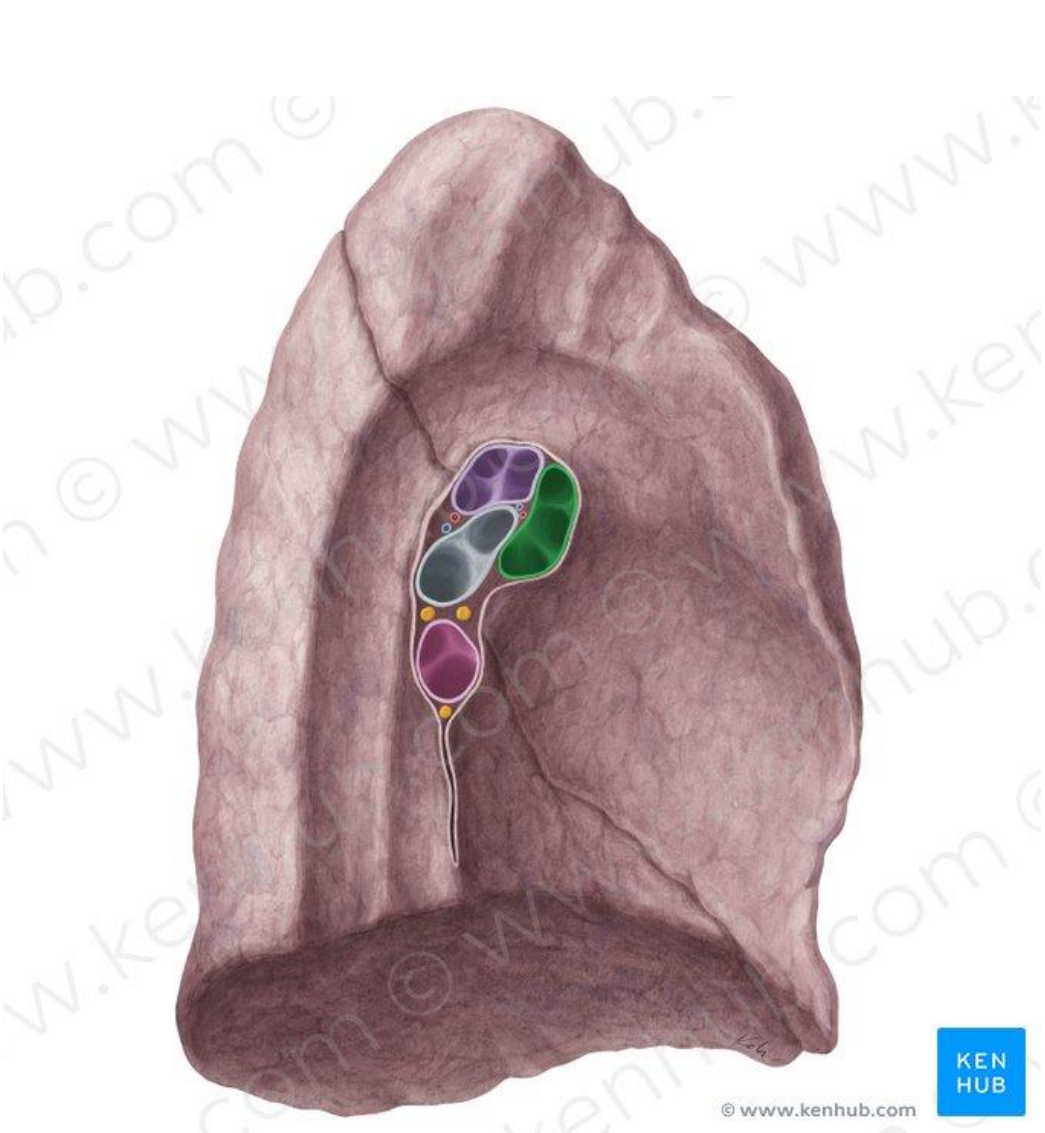
Left superior lobar bronchus



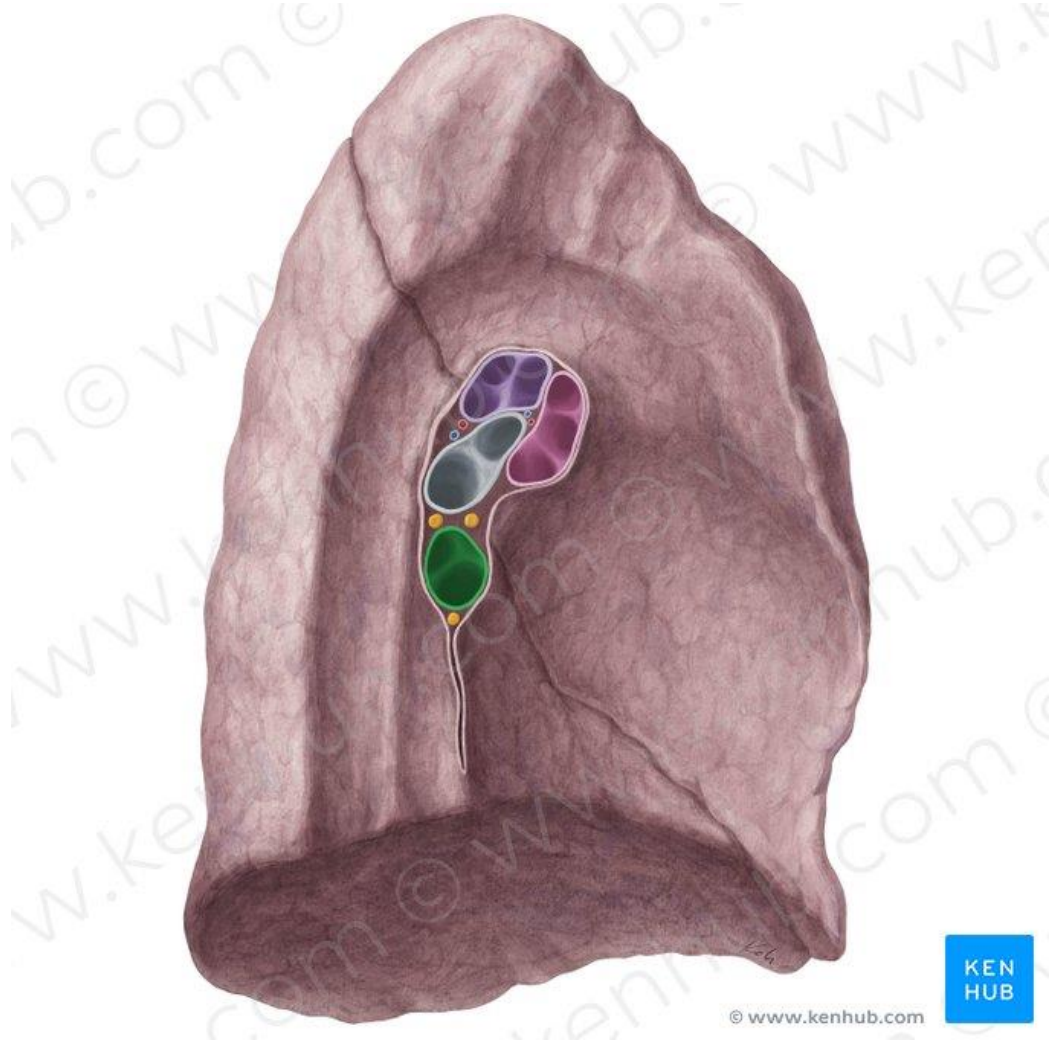
Left inferior lobar bronchus

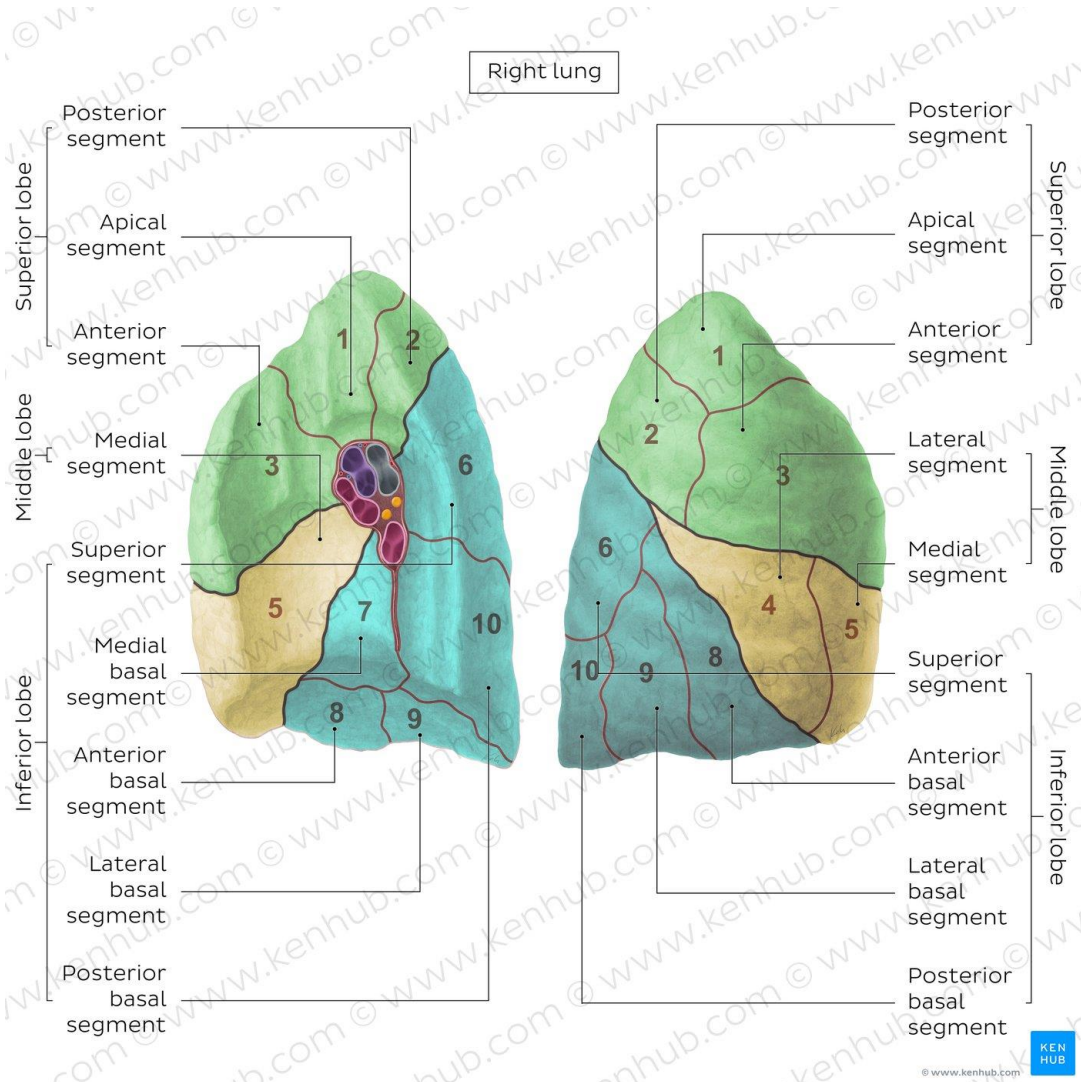


Left superior pulmonary vein



Left inferior pulmonary vein




Right lung
Posterior segment
Apical segment
Anterior segment
Medial segment
Superior segment
Medial basal segment
Anterior basal segment
Lateral basal segment
Posterior basal segment
Superior lobe
Middle lobe
Inferior lobe
1
2
3
6
5
7
10
8
9
Posterior segment
Apical segment
Anterior segment
Lateral segment
Medial segment
Superior segment
Anterior basal segment
Lateral basal segment
Posterior basal segment
Superior lobe
Middle lobe
Inferior lobe
1
2
3
6
4
5
10
9
8
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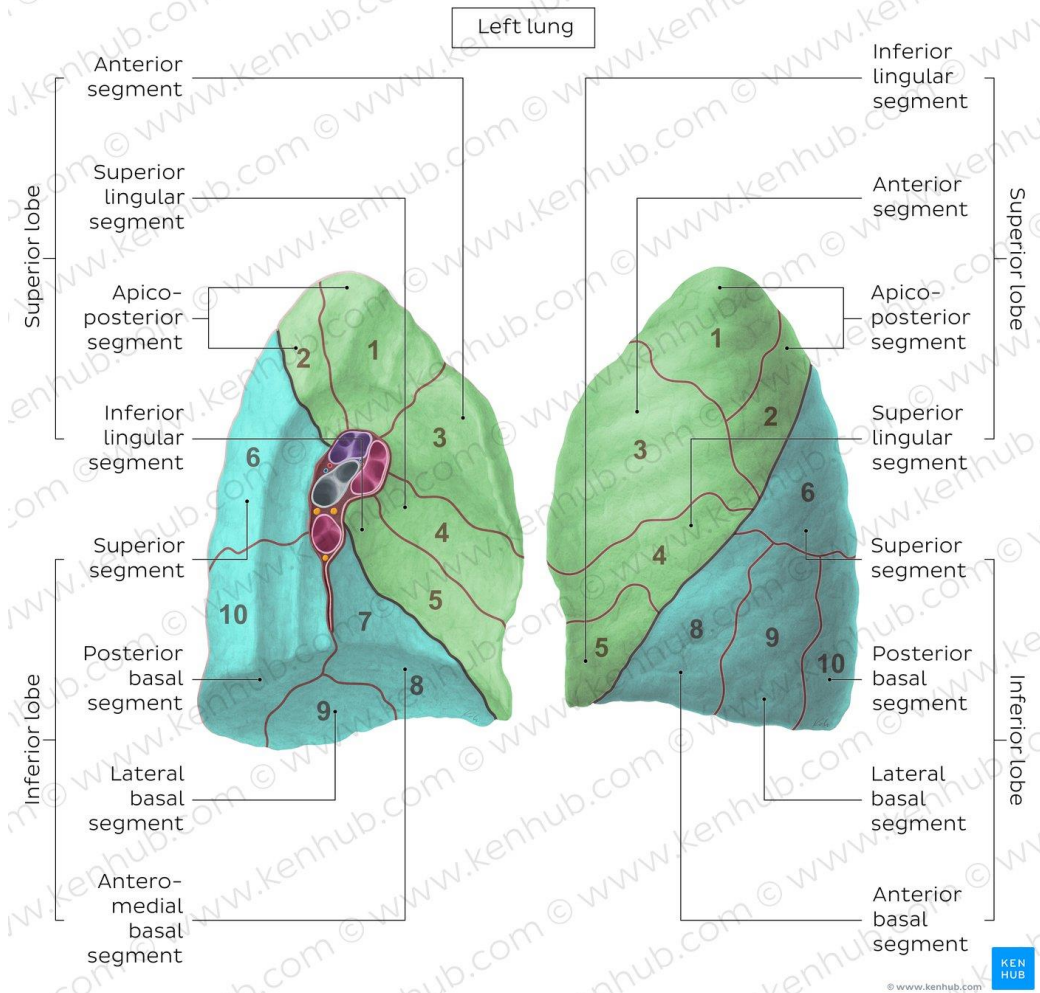
Left lung
Anterior segment
Superior lingular segment
Apico-posterior segment
Inferior lingular segment
Superior segment
Posterior basal segment
Lateral basal segment
Antero-medial basal segment
Superior lobe
Inferior lobe
Inferior lingular segment
Anterior segment
Apico-posterior segment
Superior lingular segment
Superior segment
Posterior basal segment
Lateral basal segment
Anterior basal segment
Superior lobe
Inferior lobe
1
2
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9
10
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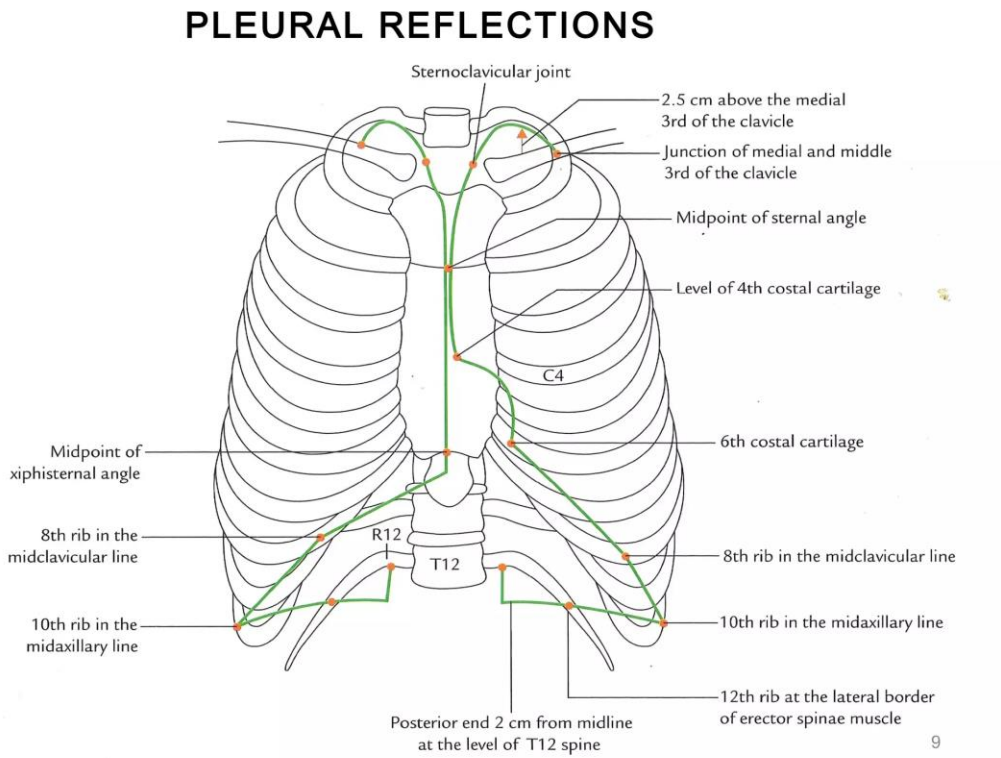
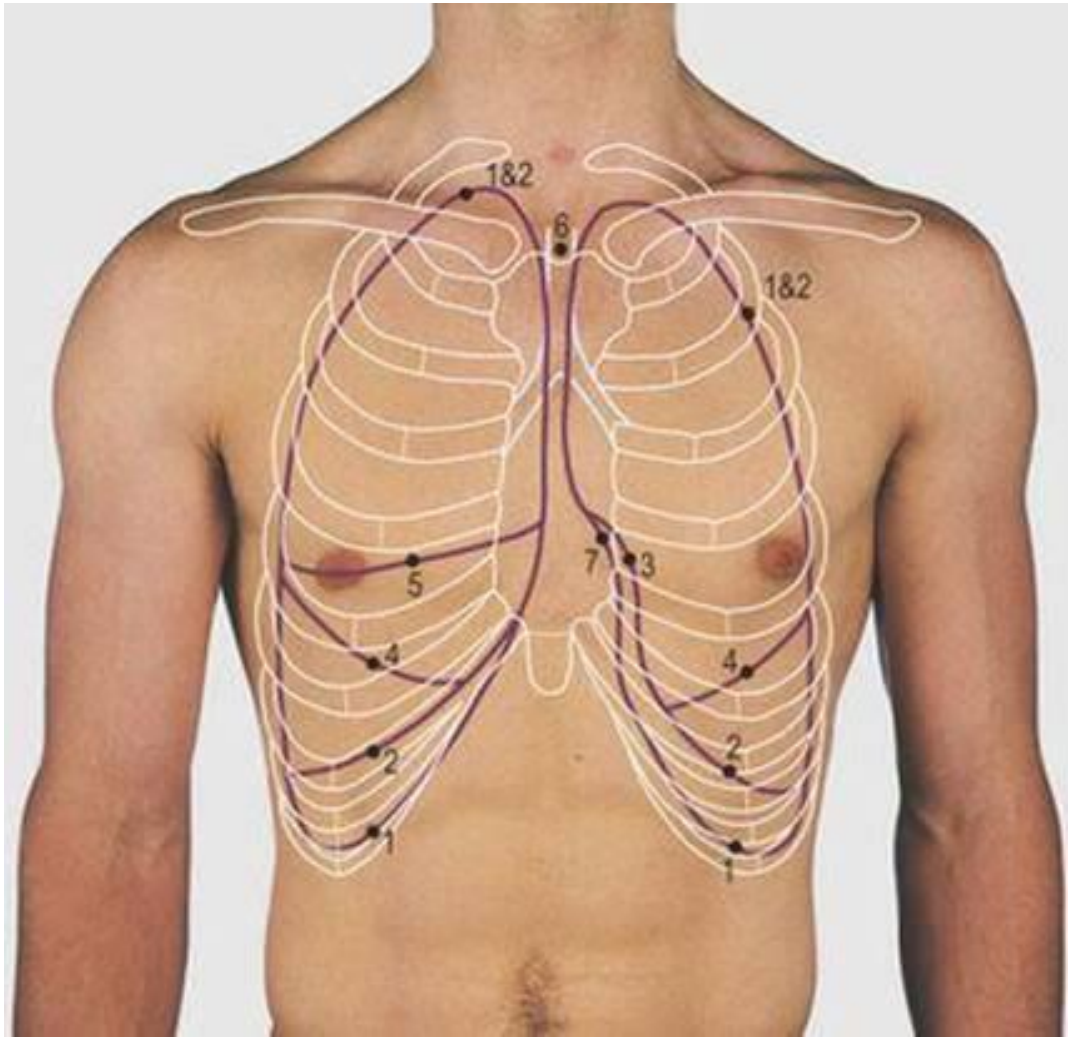
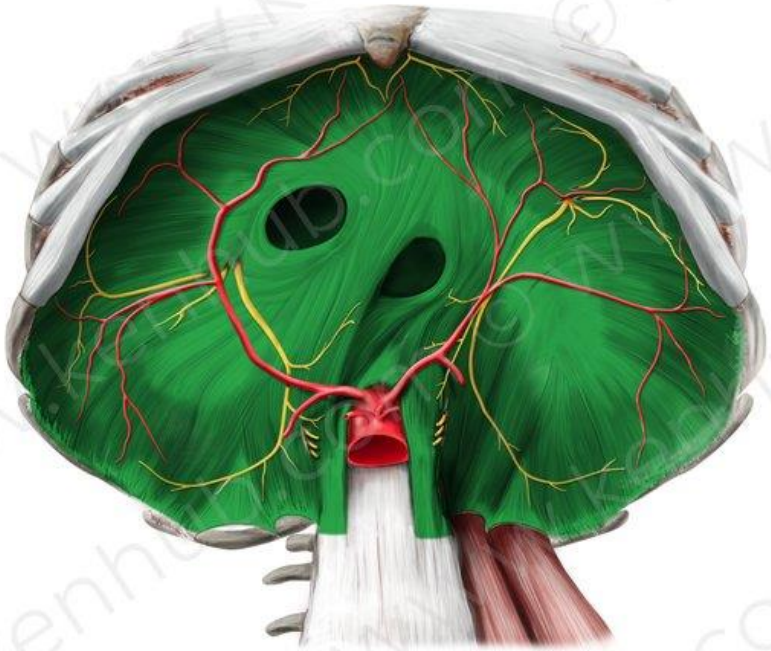
Surface anatomy of pleura



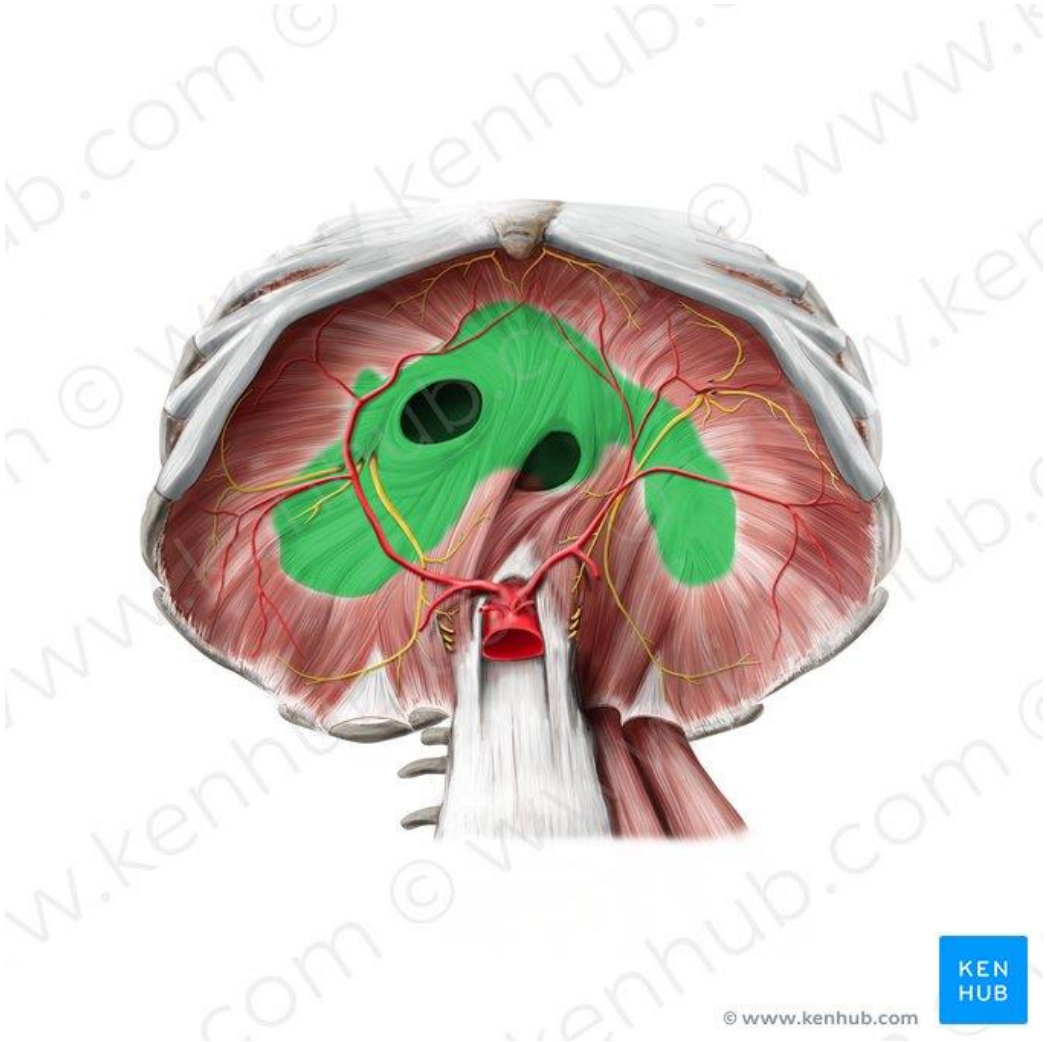
Surface Anatomy of lungs



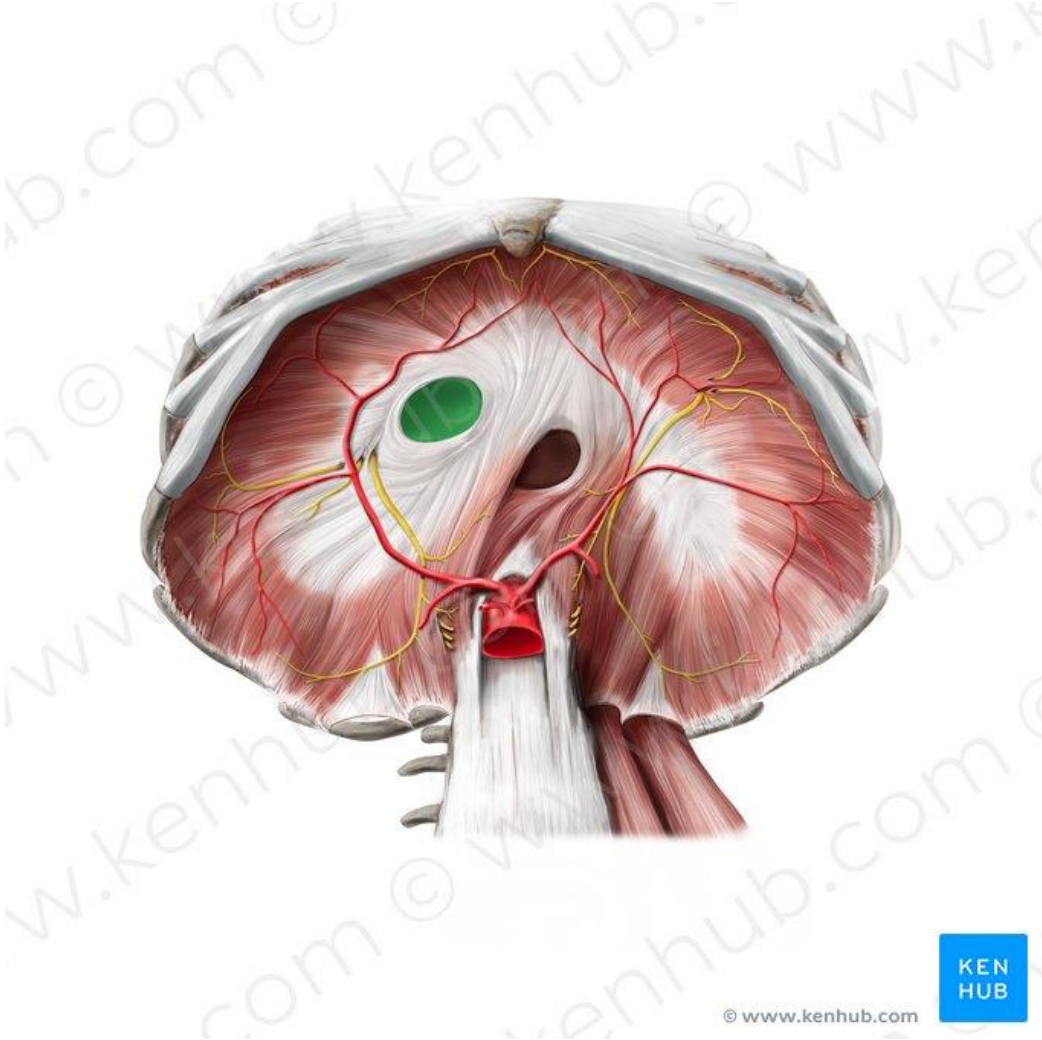
Diaphragm



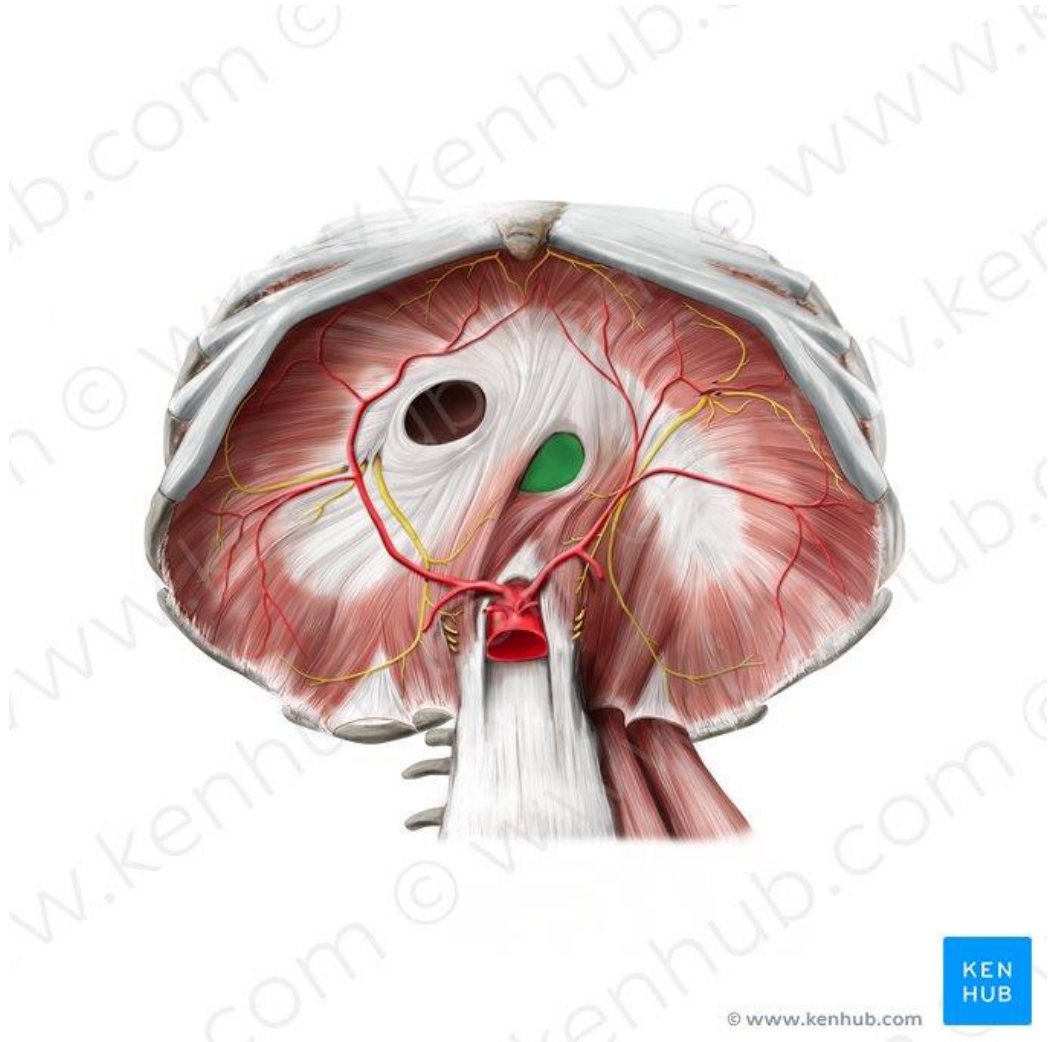
Central tendon of diaphragm



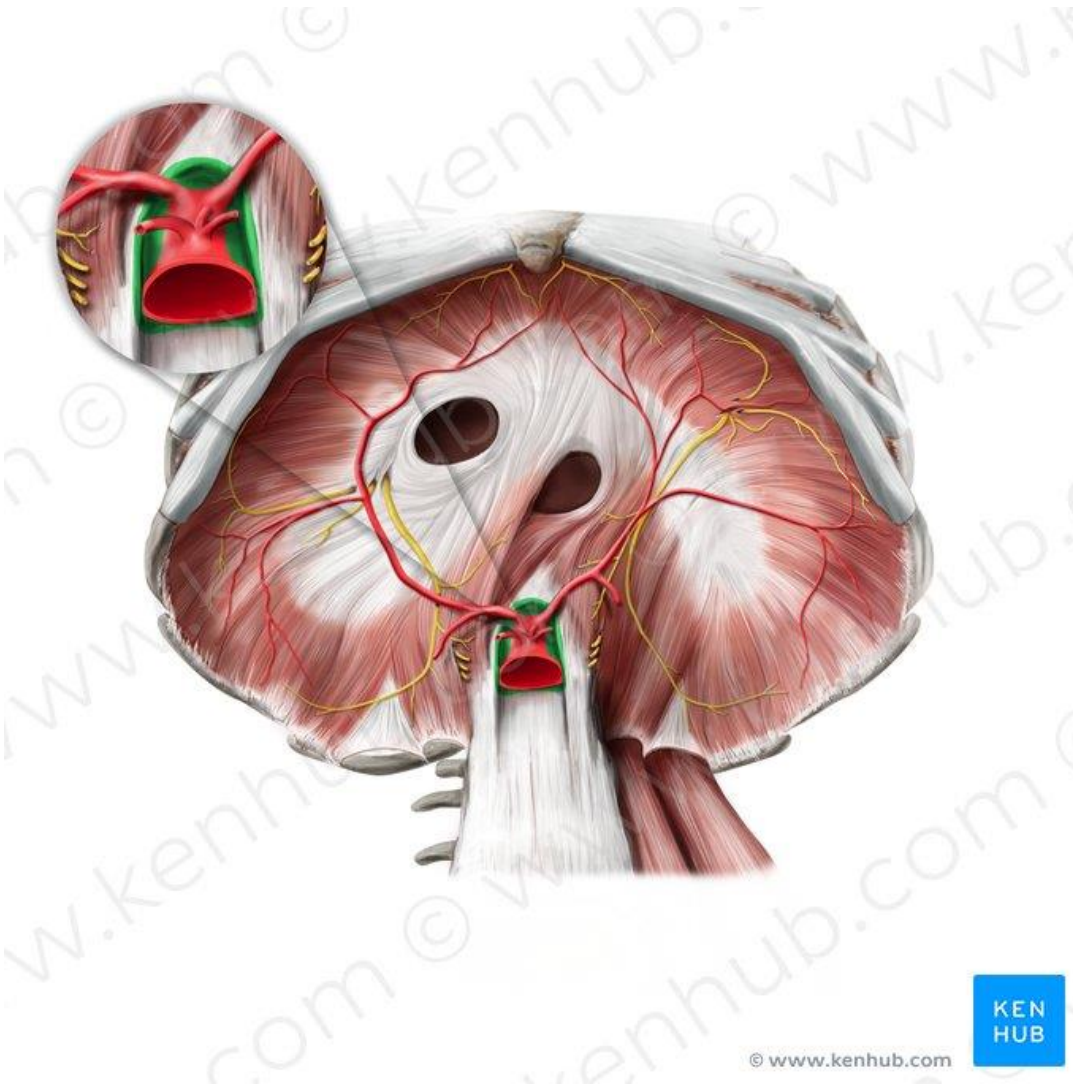
Caval foramen



Esophageal hiatus

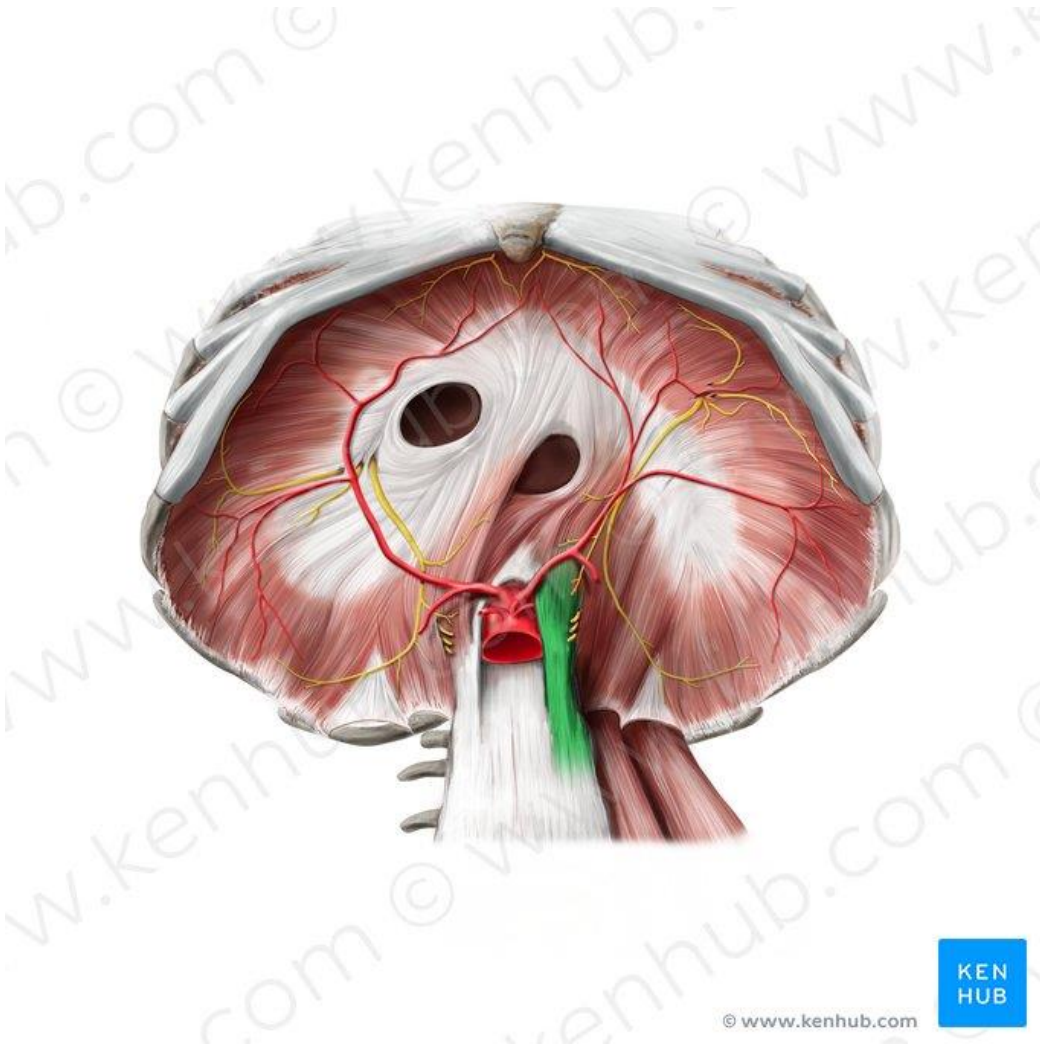


Aortic hiatus

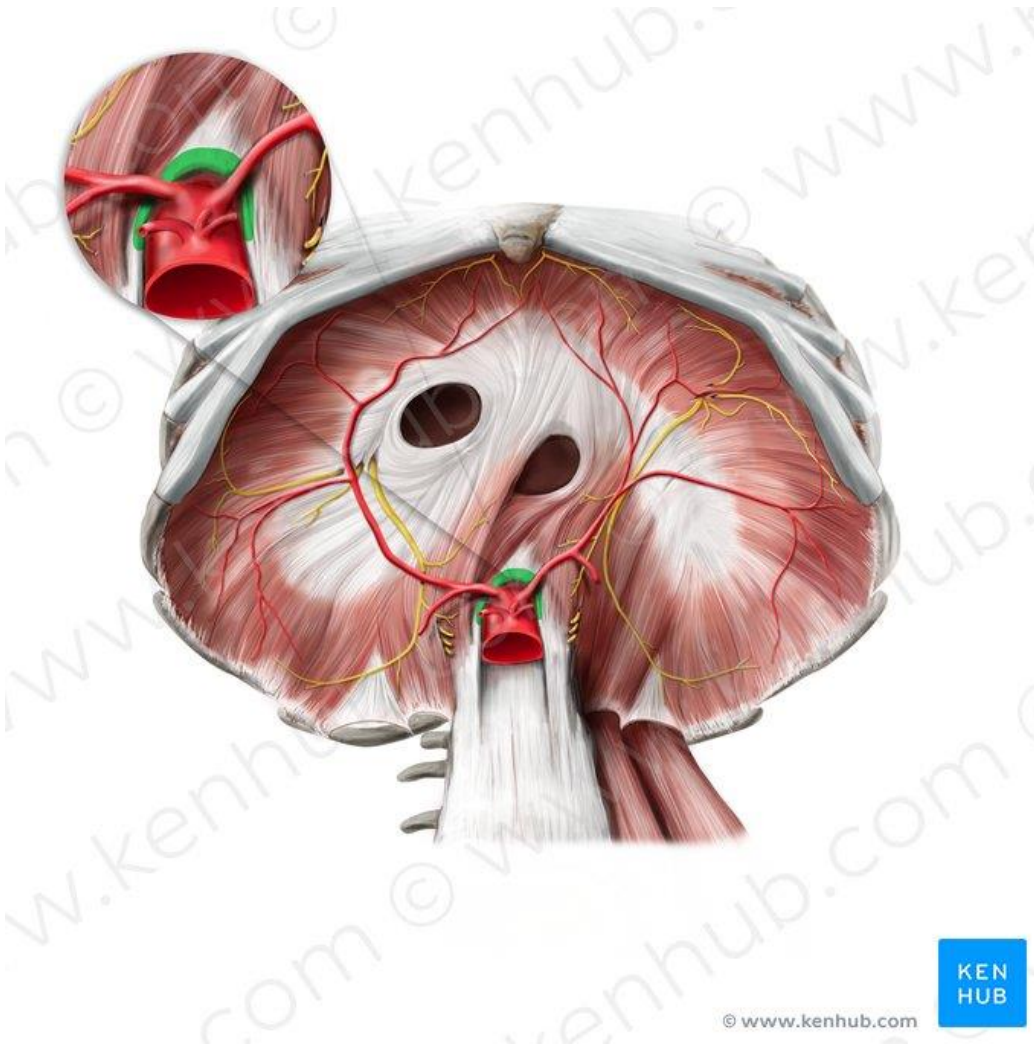


Right crus of diaphragm

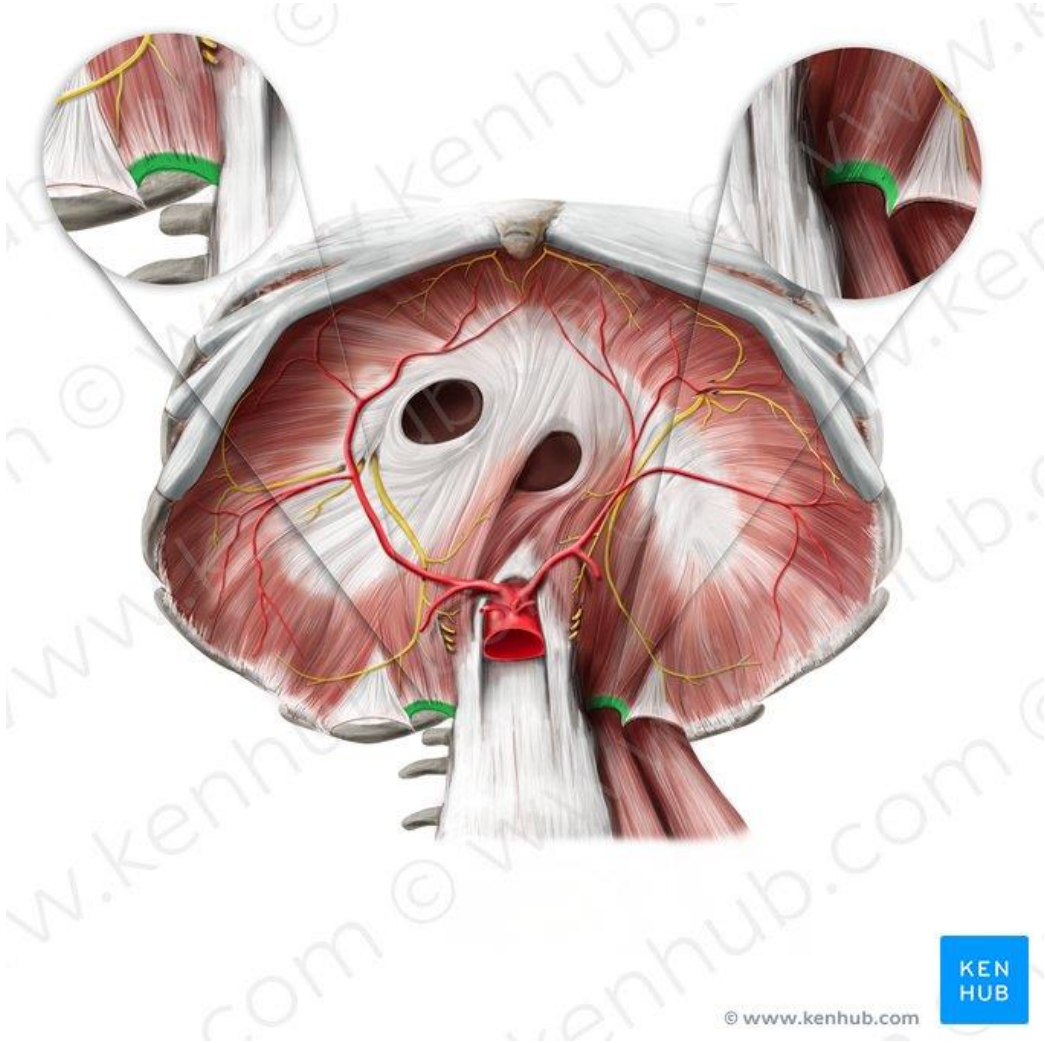
Left crus of diaphragm



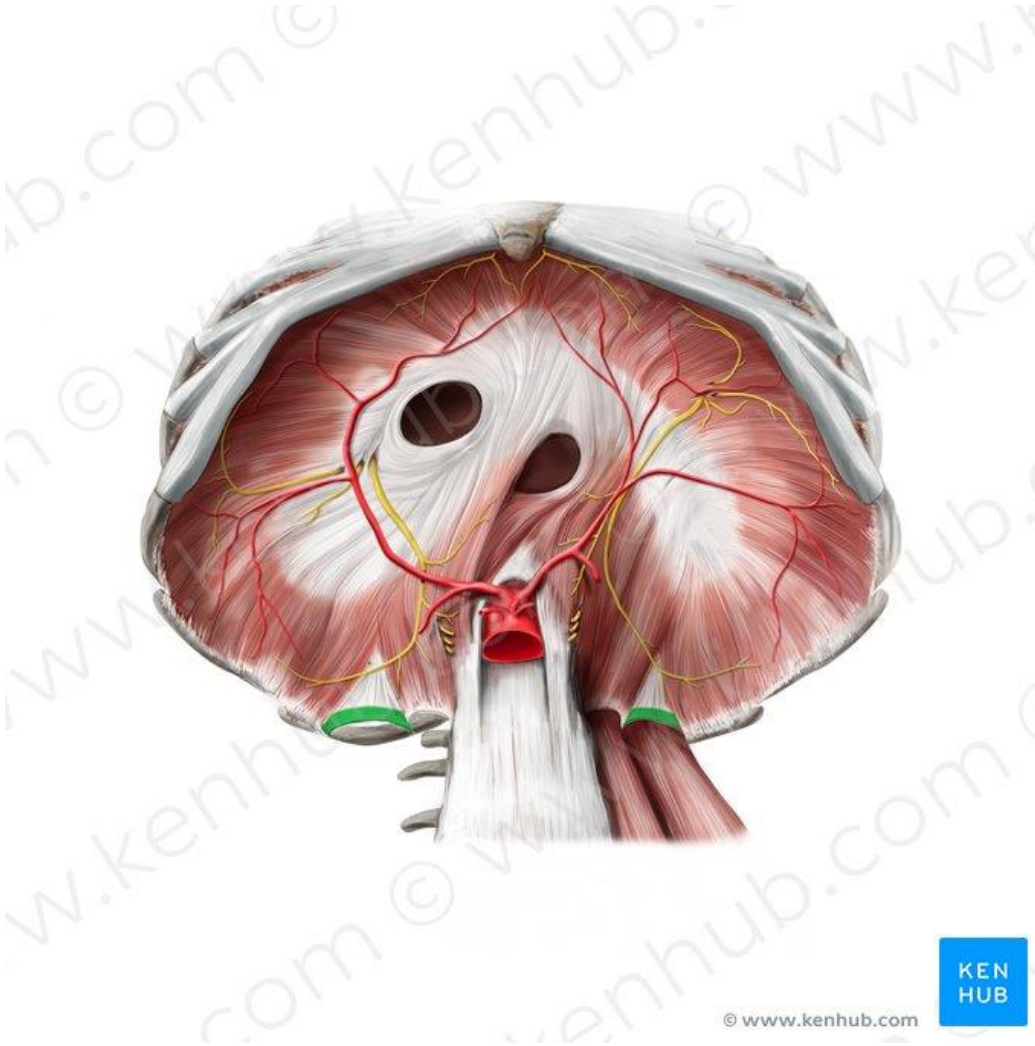
Median arcuate ligament



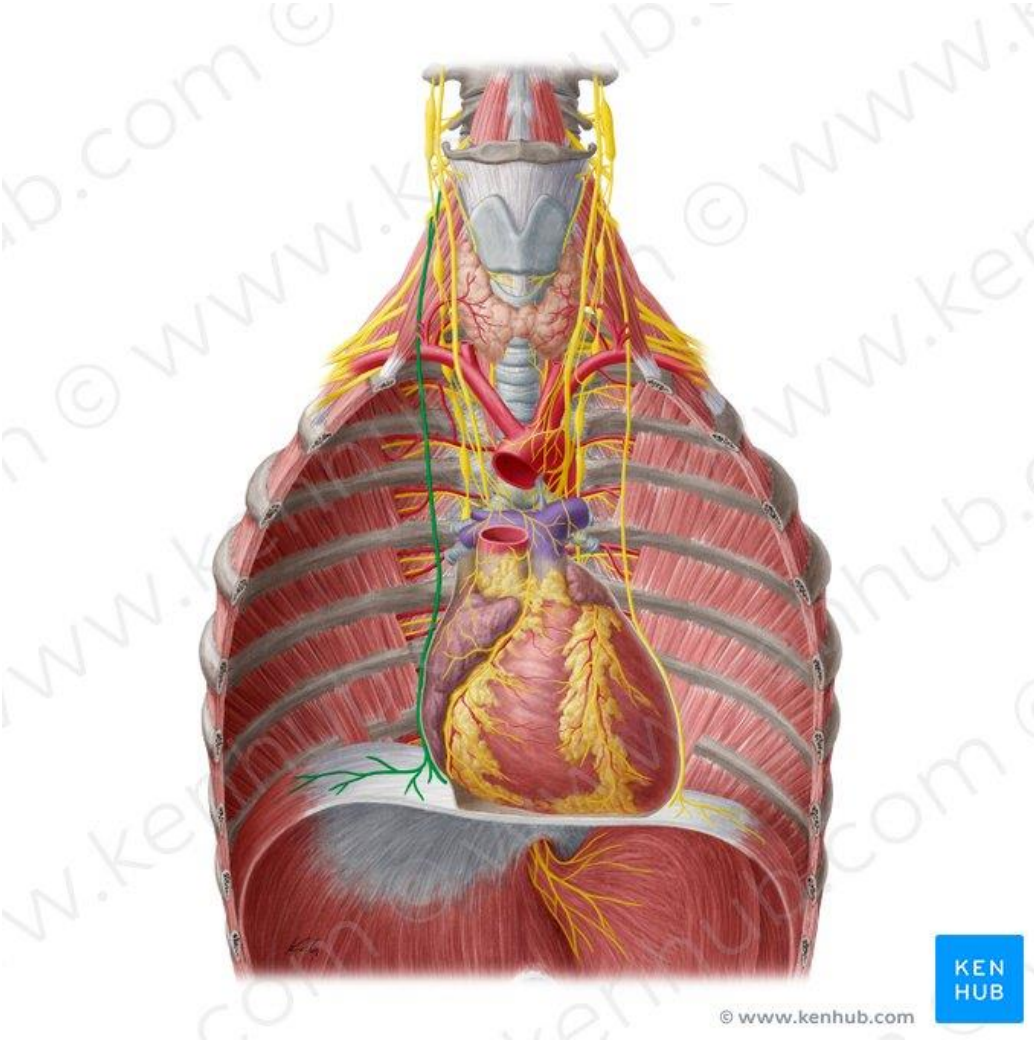
Medial arcuate ligament



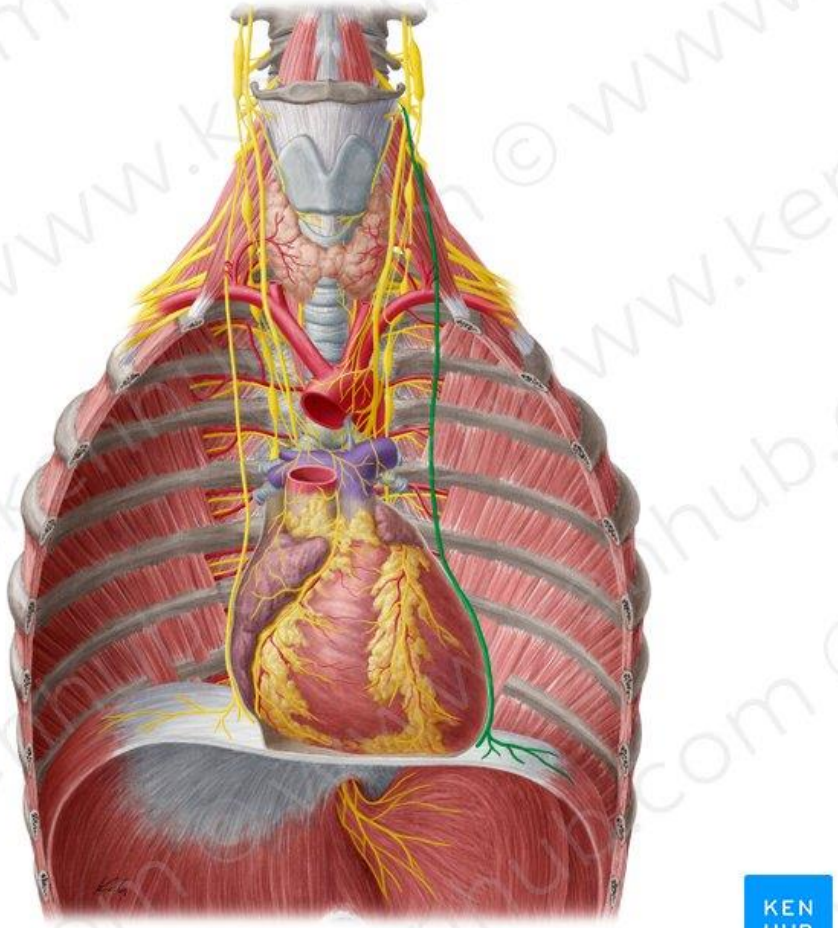
Lateral arcuate ligament



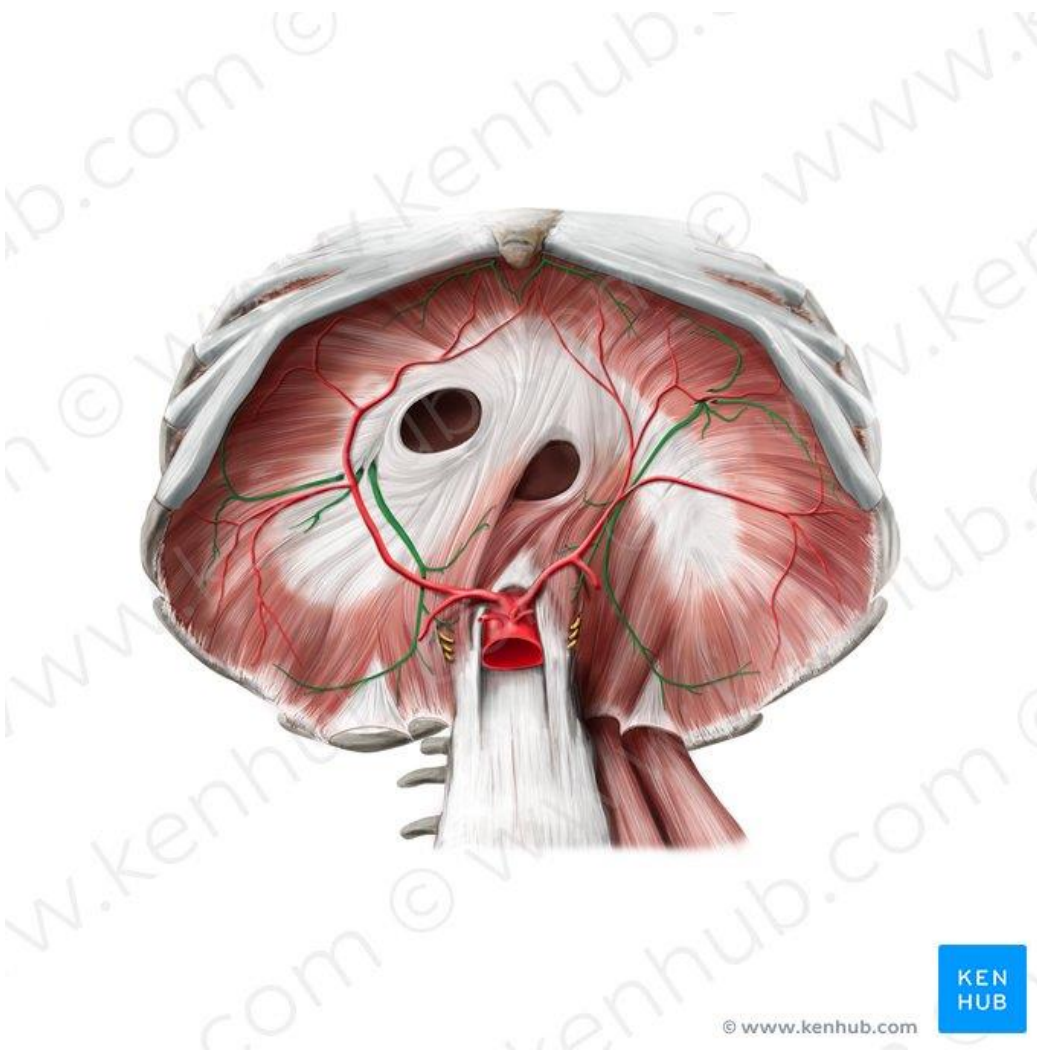
Right phrenic nerve



Left phrenic nerve

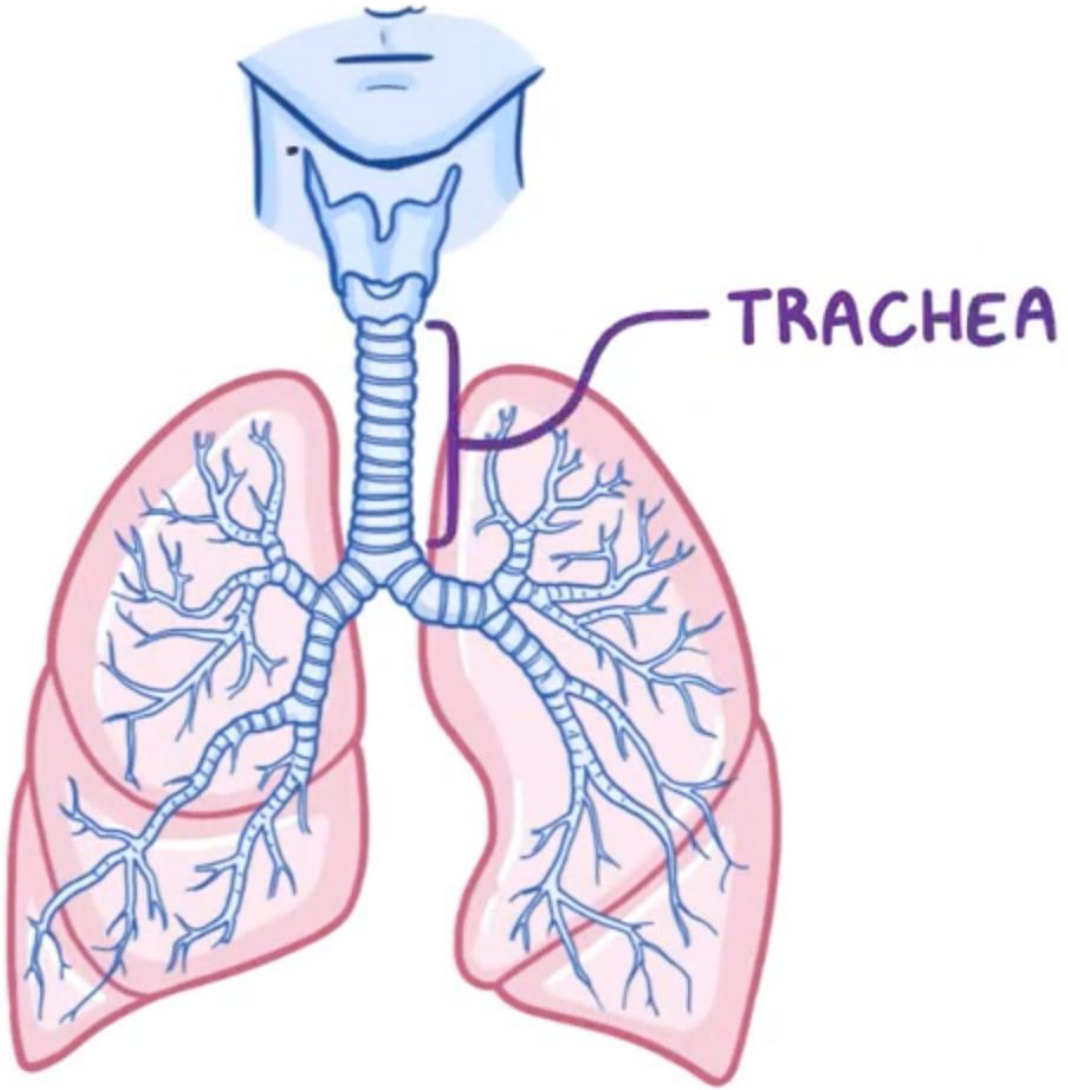


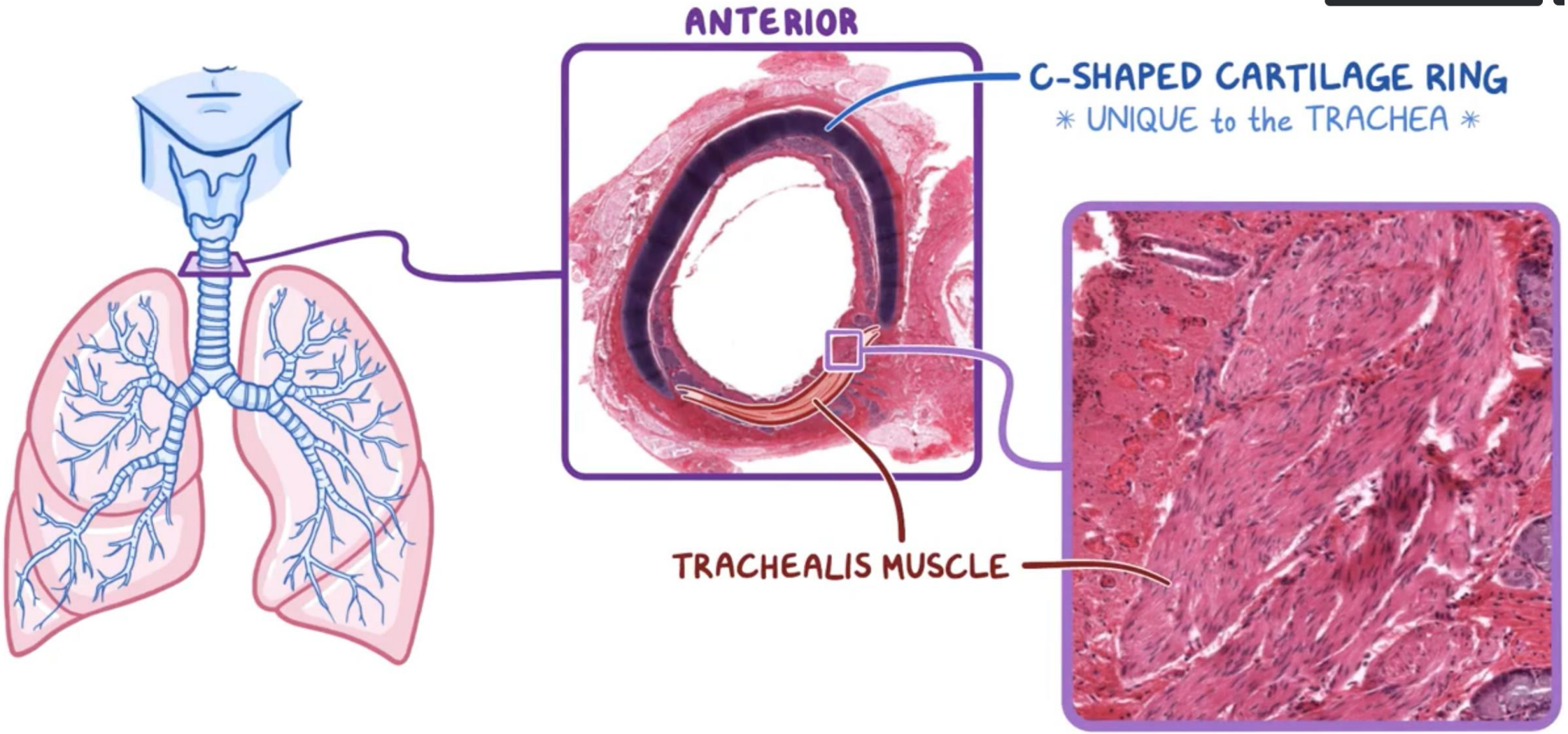
Phrenic nerve



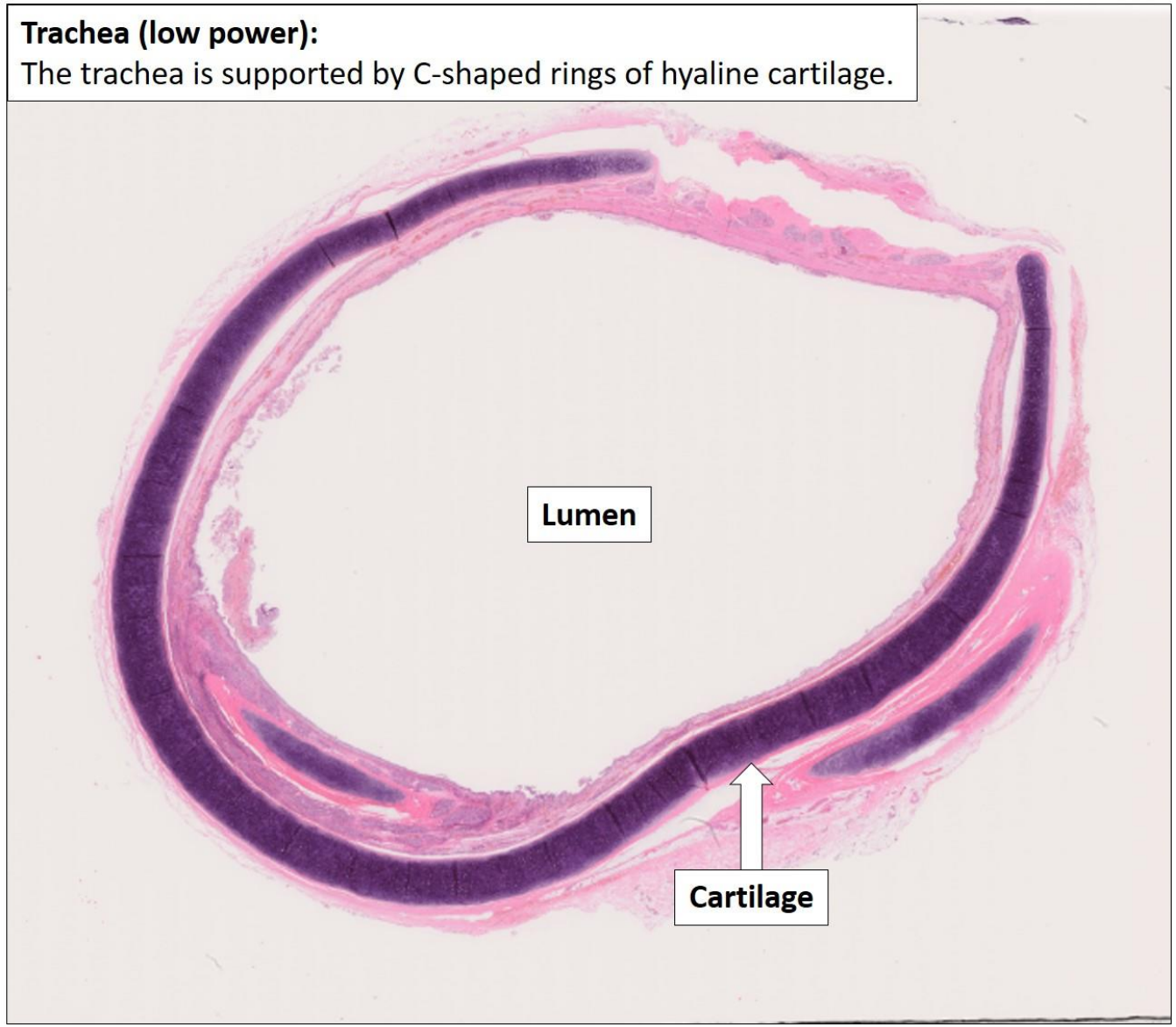
Histology

Trachea

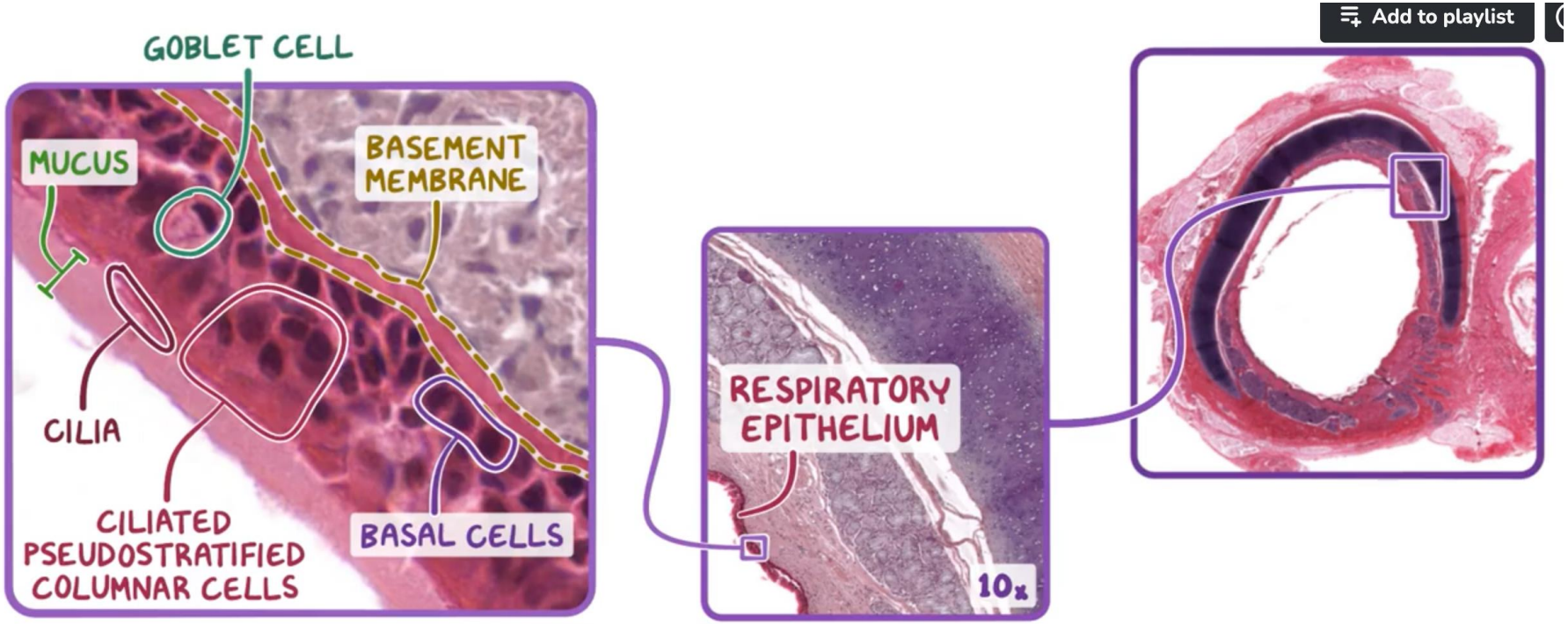




Trachea (low power):
The trachea is supported by C-shaped rings of hyaline cartilage.



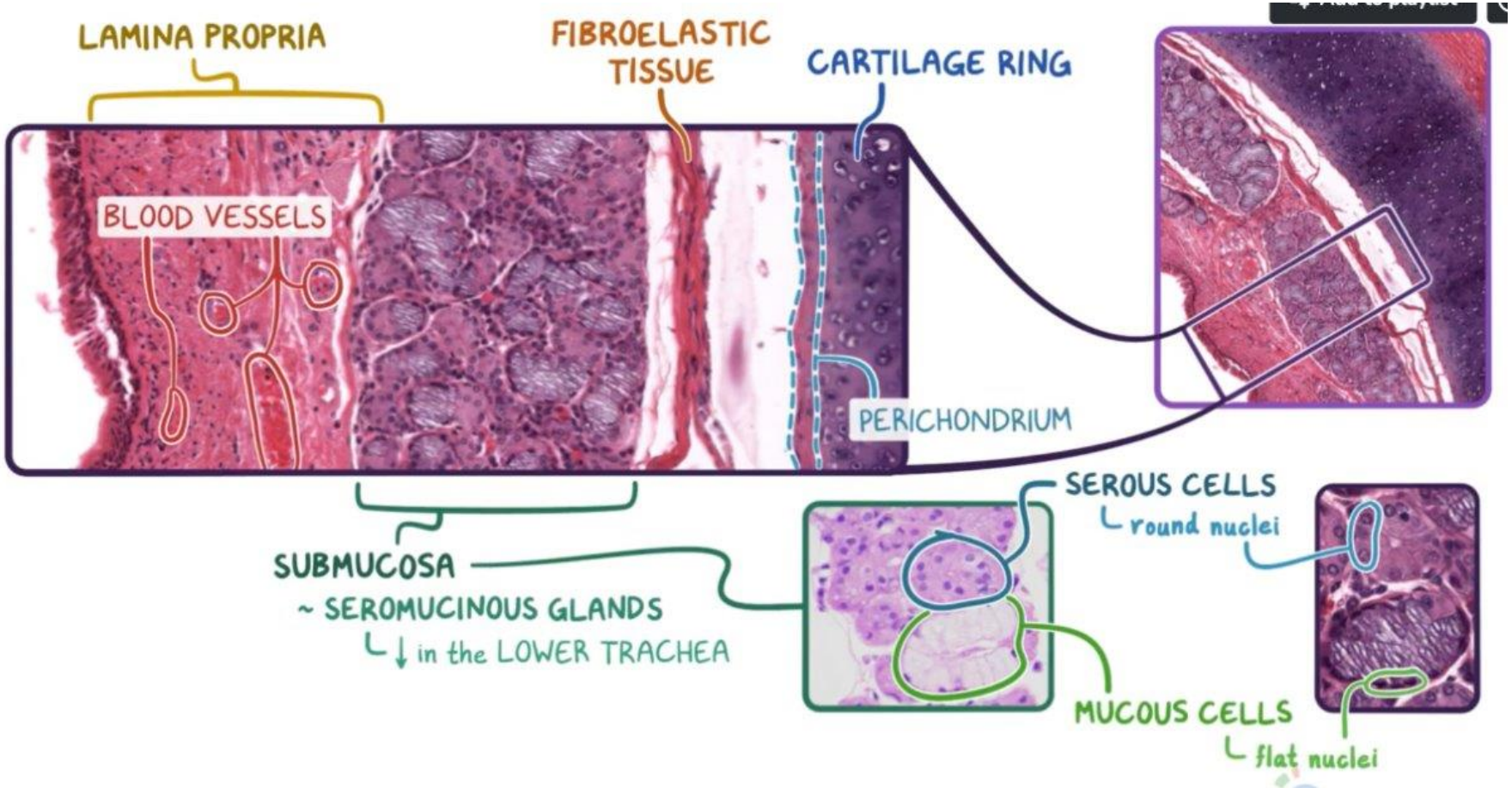
Mucosa: epithelium



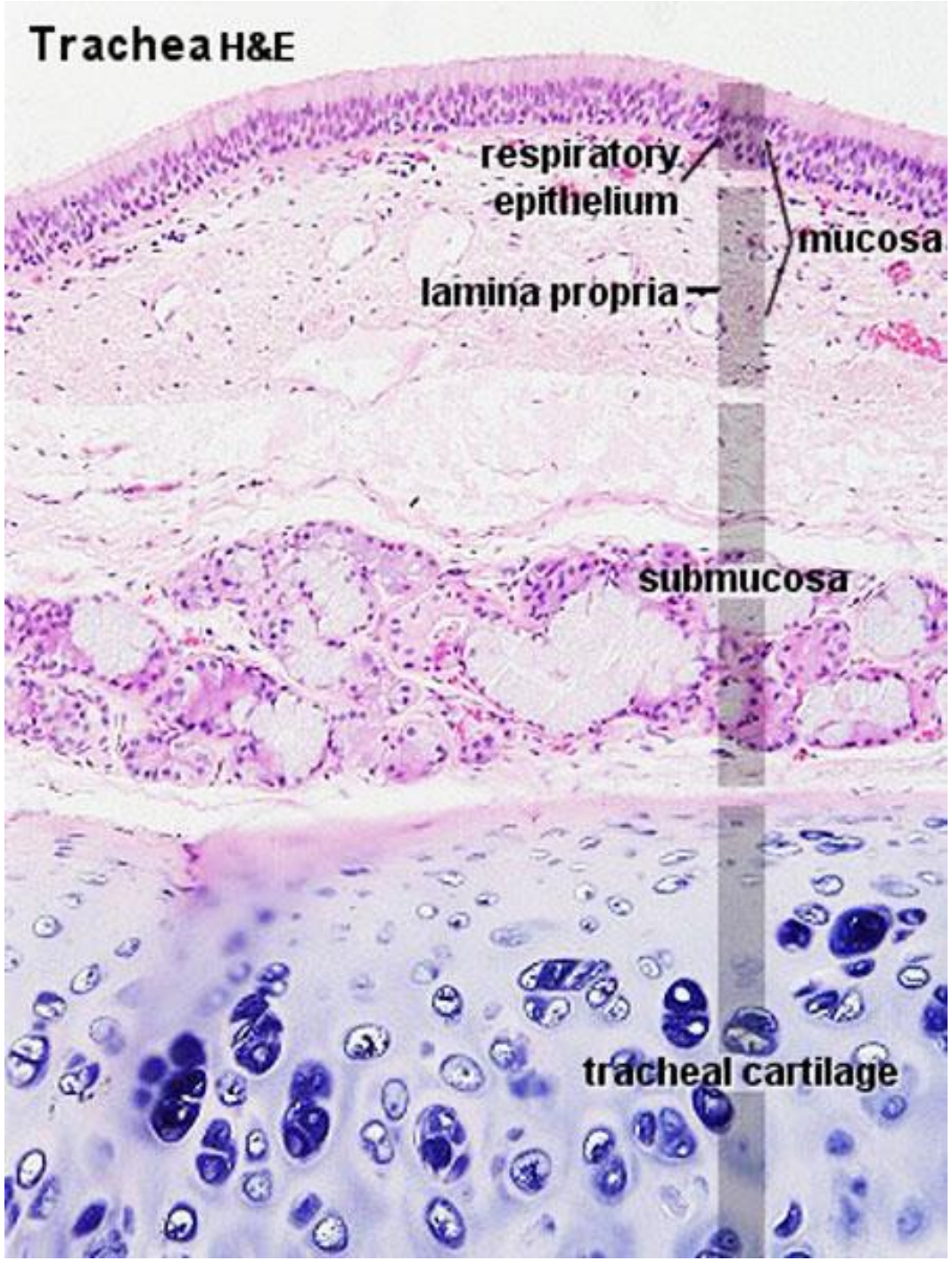
UPPER TRACHEA = ↑ GOBLET & BASAL CELLS

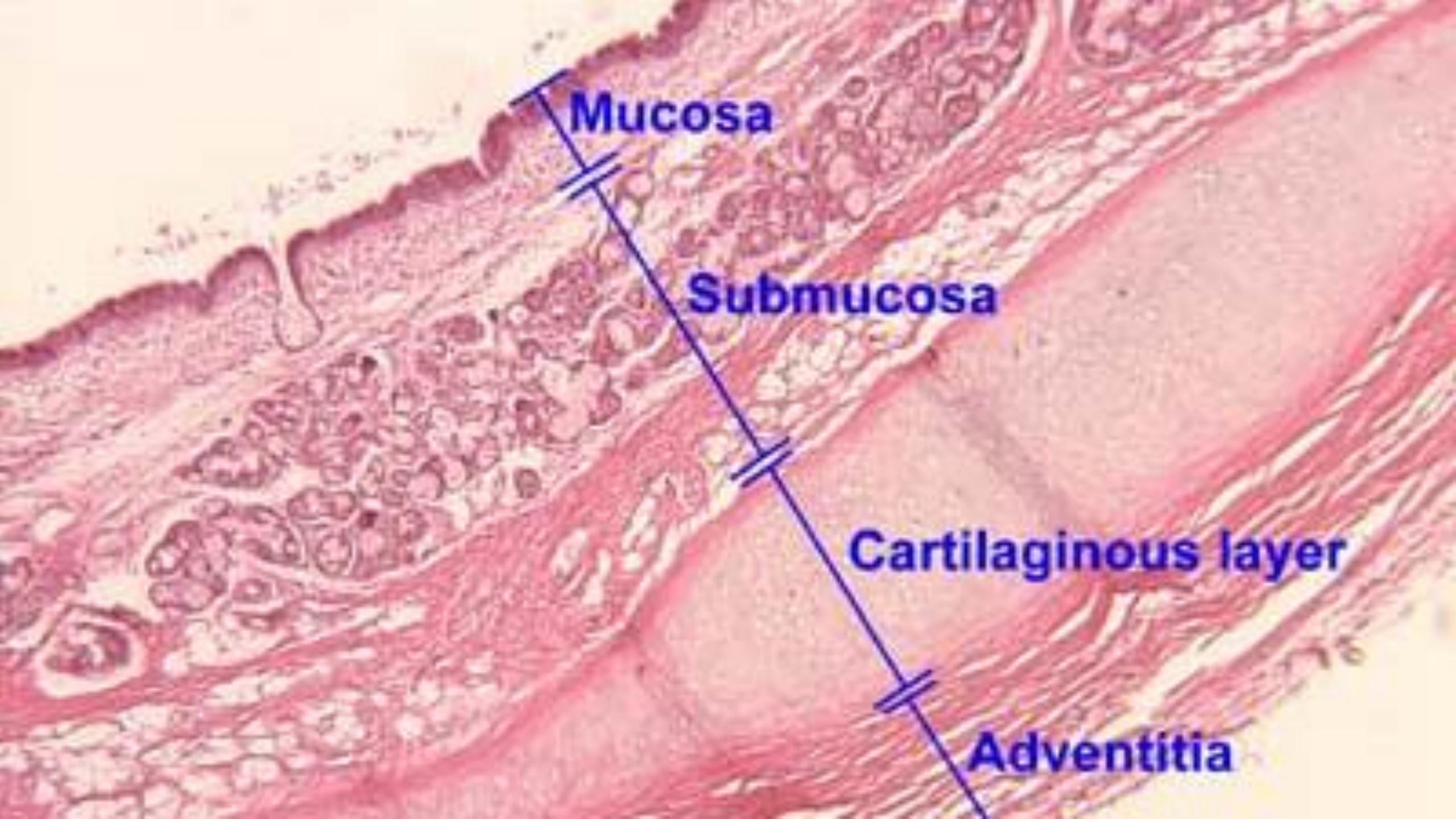
LOWER TRACHEA = ↑ CILIATED COLUMNAR CELLS

Lamina propria, submucosa and cartilage

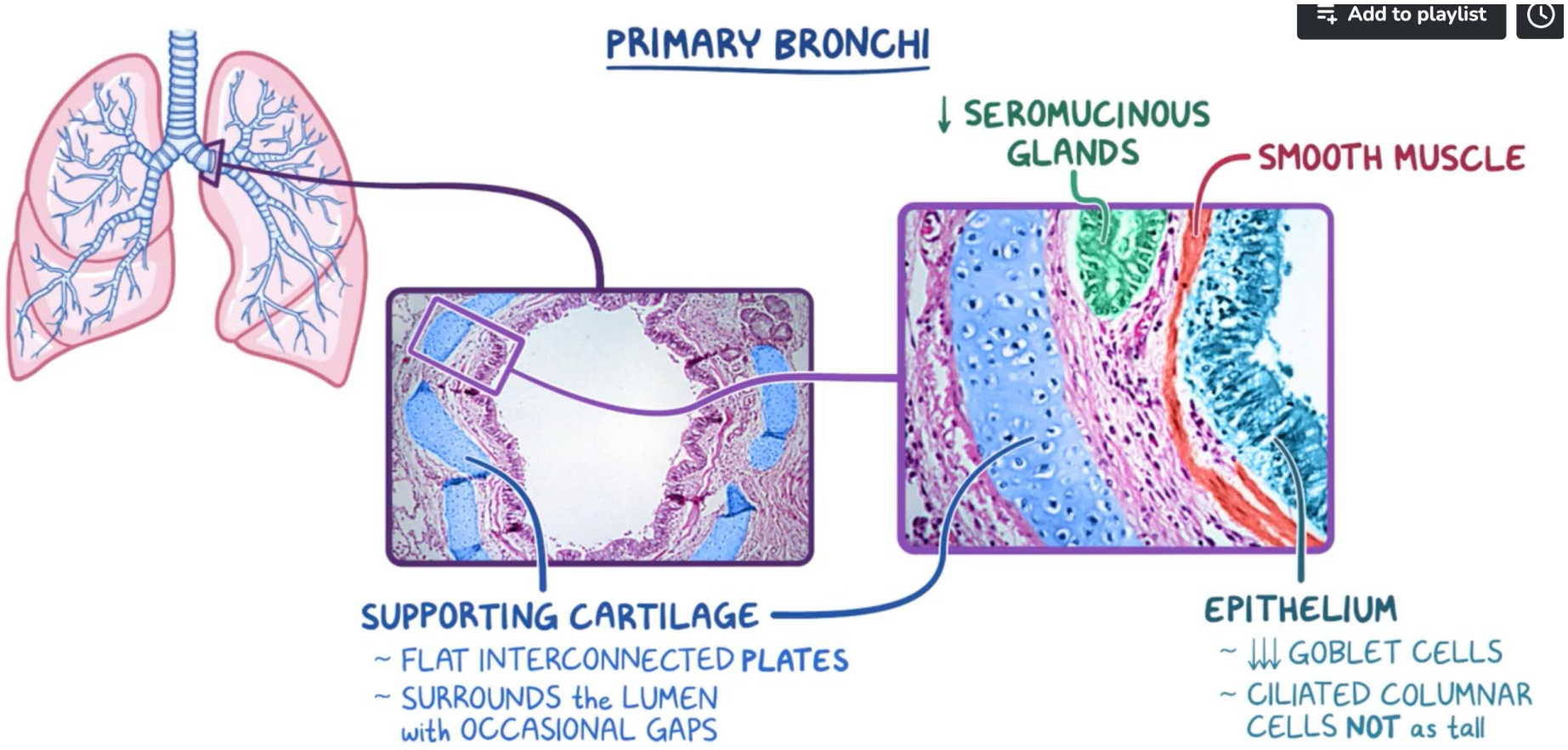


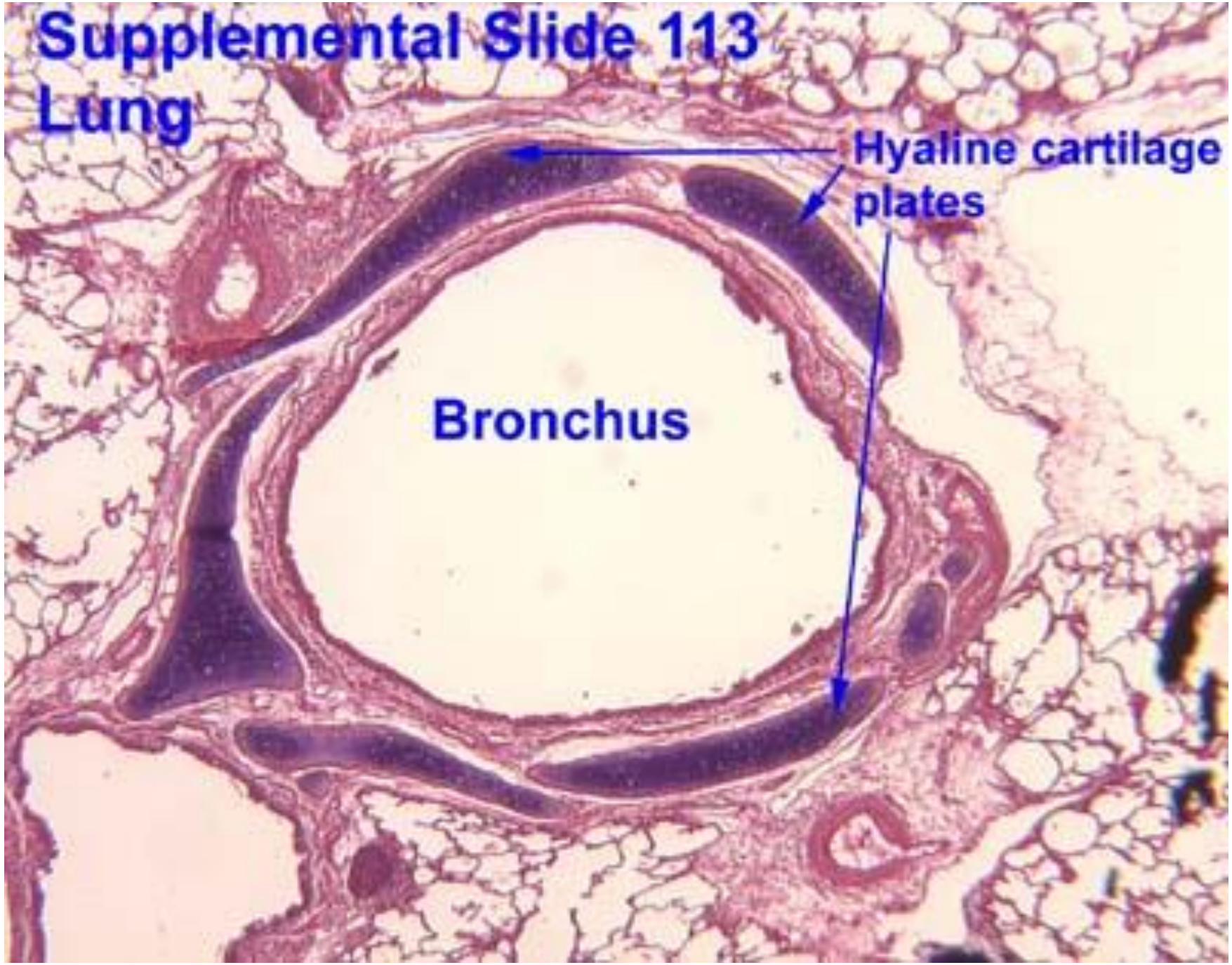
Wall of the trachea



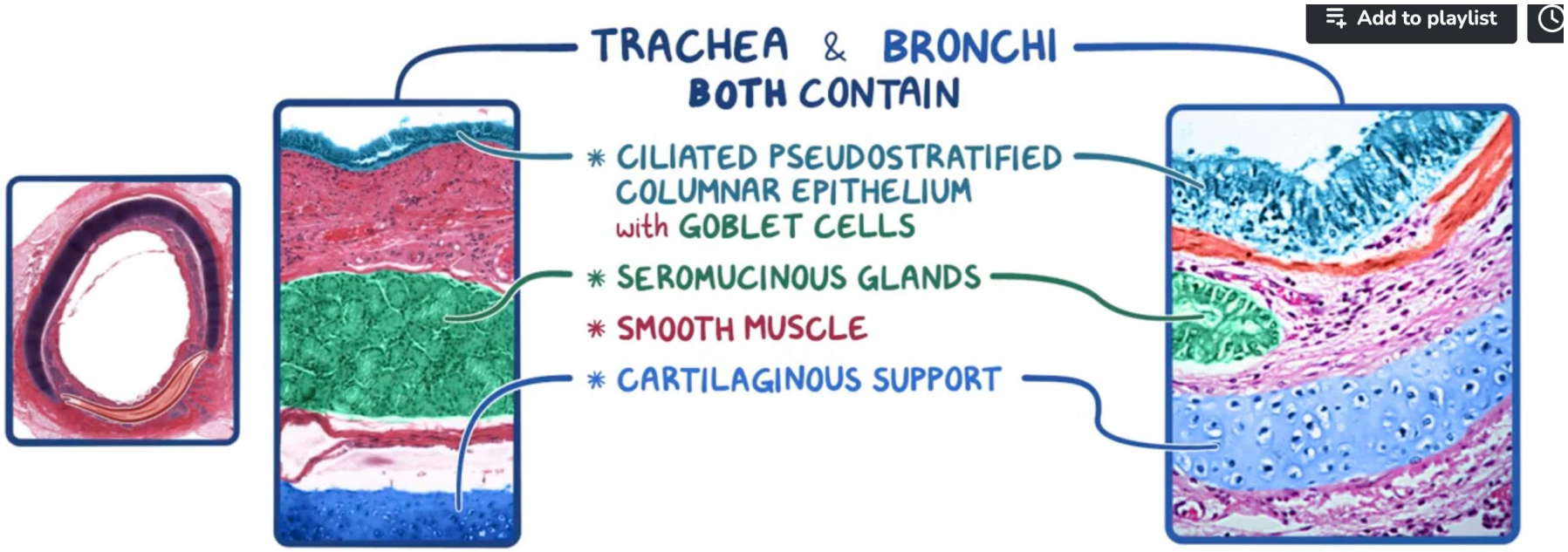

Mucosa
Submucosa
Cartilaginous layer
Adventitia

Bronchi


Add to playlist
PRIMARY BRONCHI
↓ SEROMUCINOUS GLANDS
SMOOTH MUSCLE
SUPPORTING CARTILAGE
~ FLAT INTERCONNECTED PLATES
~ SURROUNDS the LUMEN with OCCASIONAL GAPS
EPITHELIUM
~ ↓↓↓ GOBLET CELLS
~ CILIATED COLUMNAR CELLS NOT as tall


Supplemental Slide 113
Lung
Hyaline cartilage plates
Bronchus

Trachea vs Bronchi

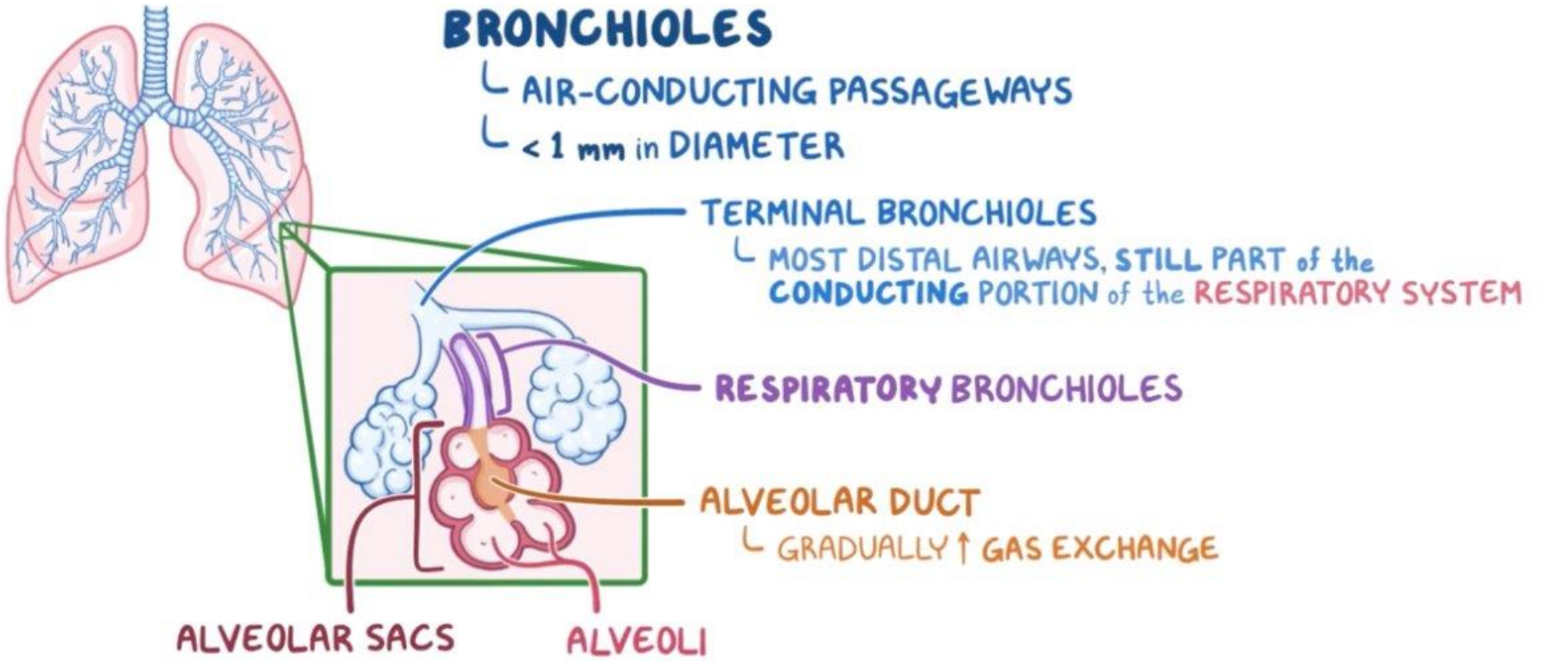


DIFFERENCES INCLUDE:

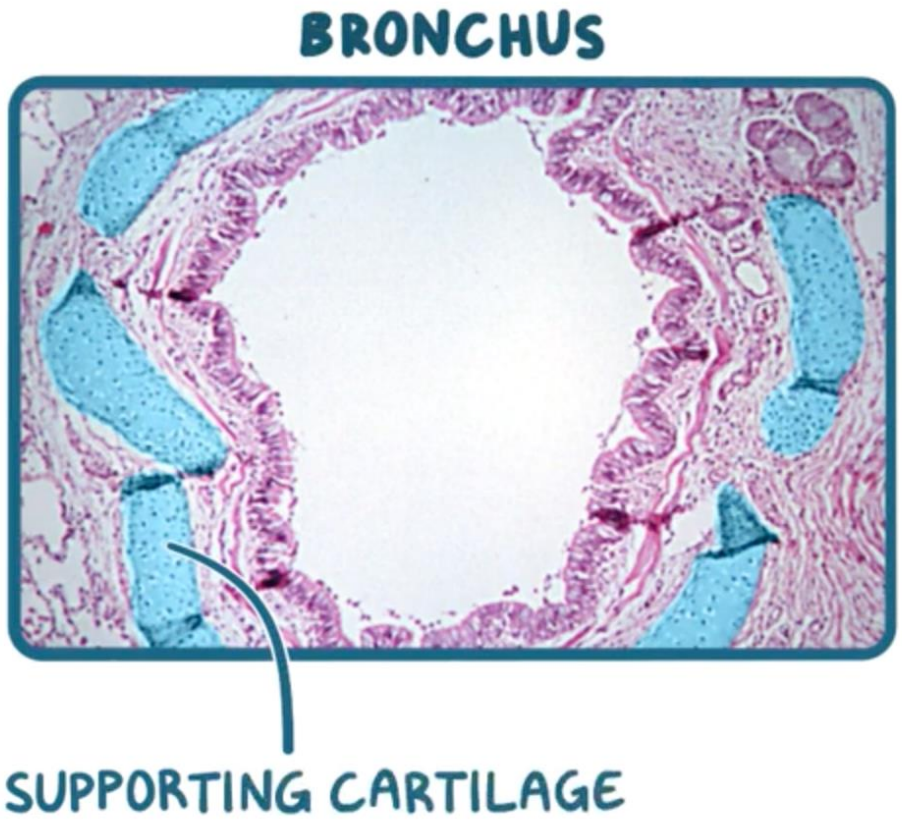
~ **TRACHEA'S** C-SHAPED CARTILAGE RINGS
  └ SMOOTH MUSCLE CONNECTS the TWO ENDS of the RING

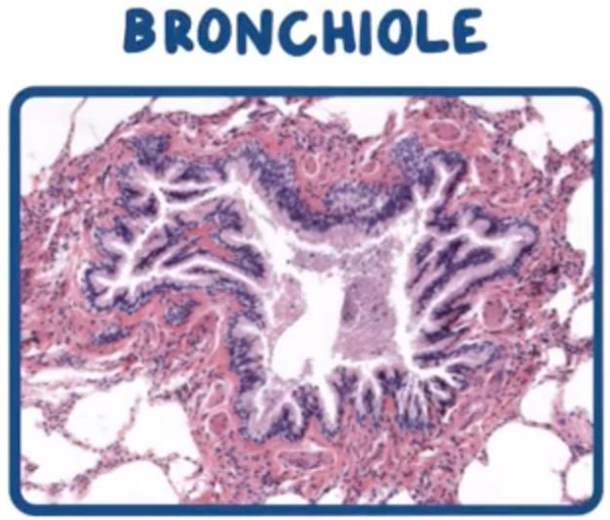
~ **BRONCHI have** INTERCONNECTED CARTILAGE PLATES
~ SHORTER EPITHELIAL CELLS
~ ↓ GOBLET CELLS
~ ↓ SEROMUCINOUS GLANDS

Bronchioles

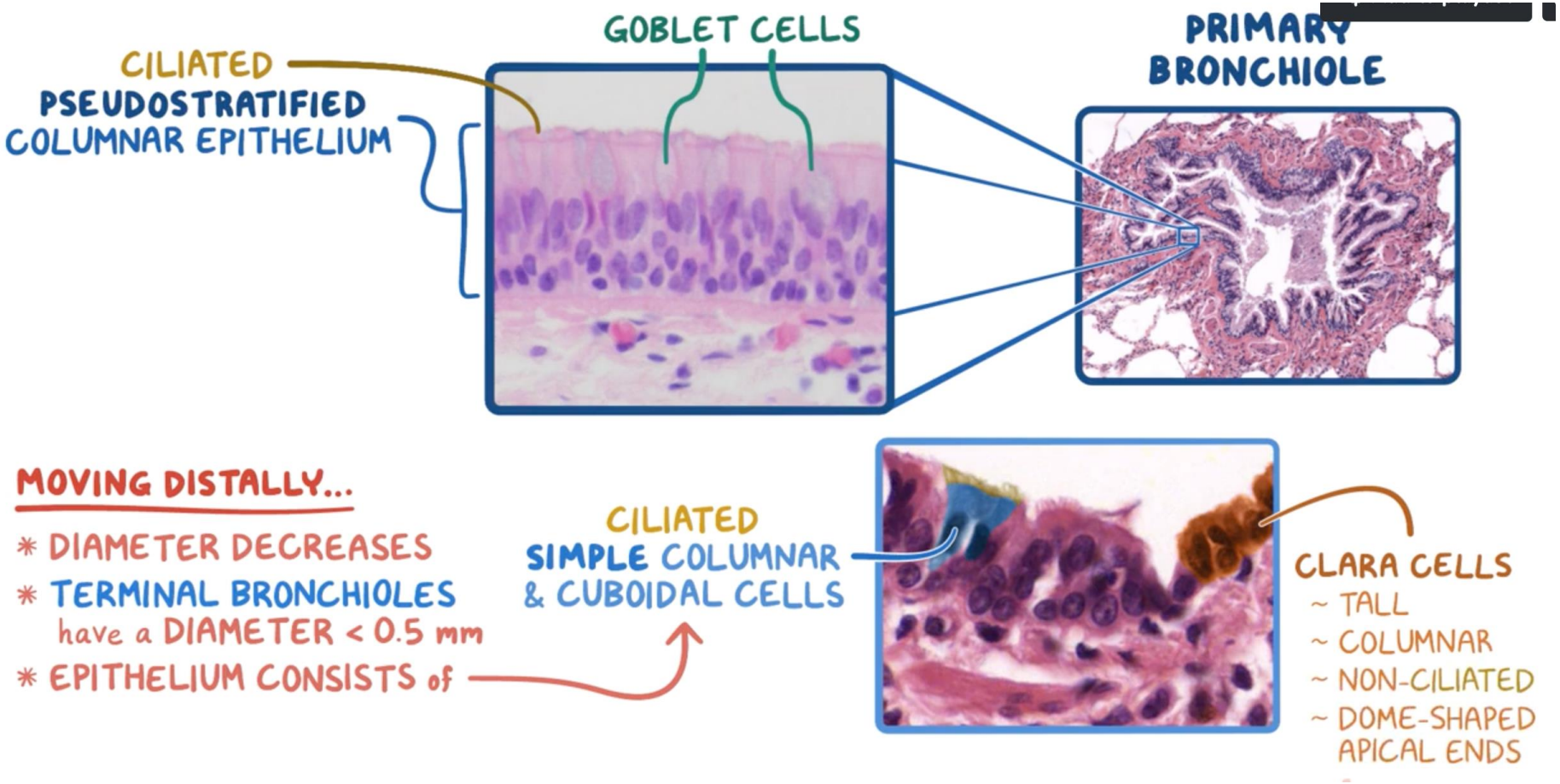


Bronchi vs Bronchioles

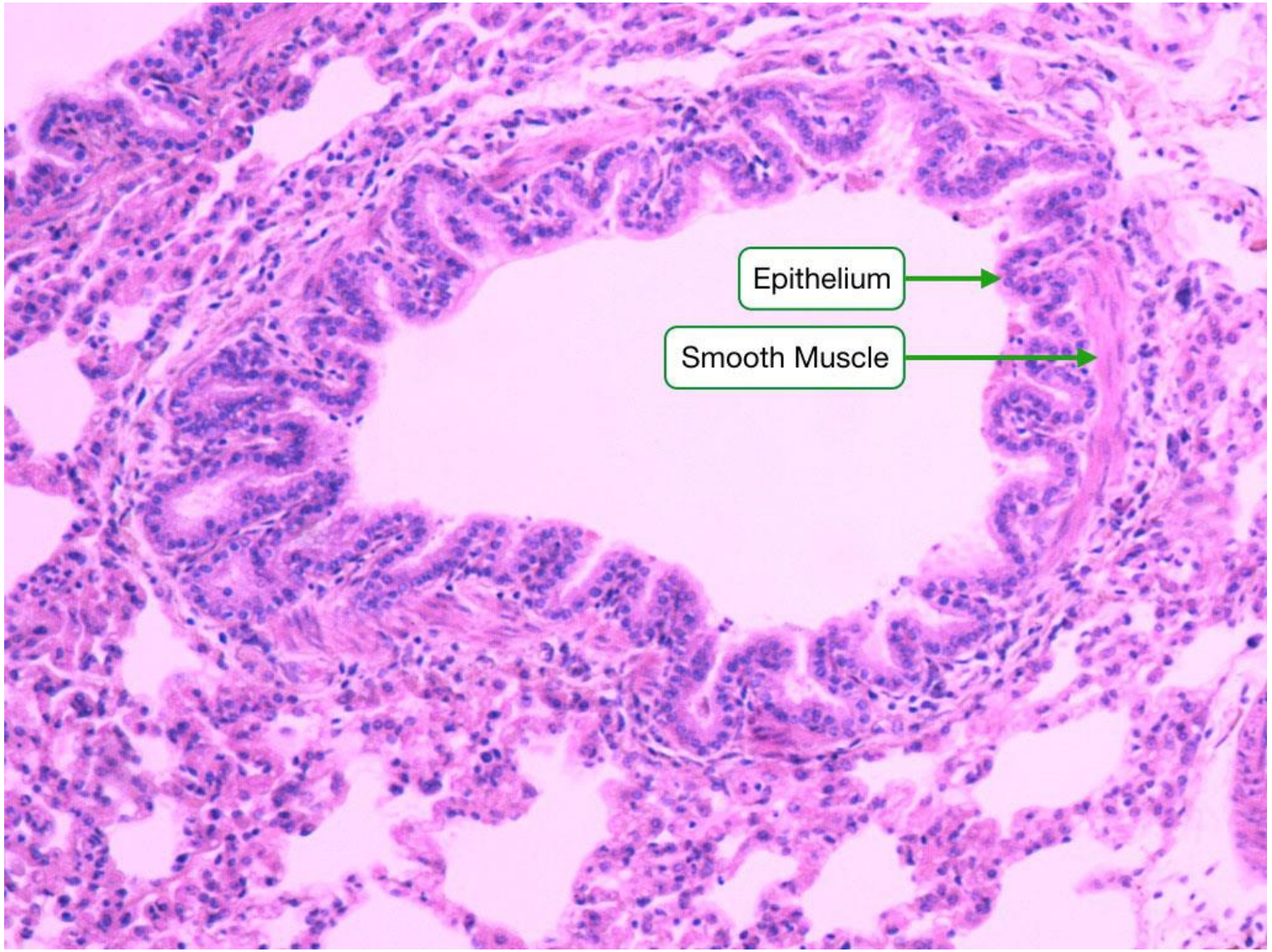


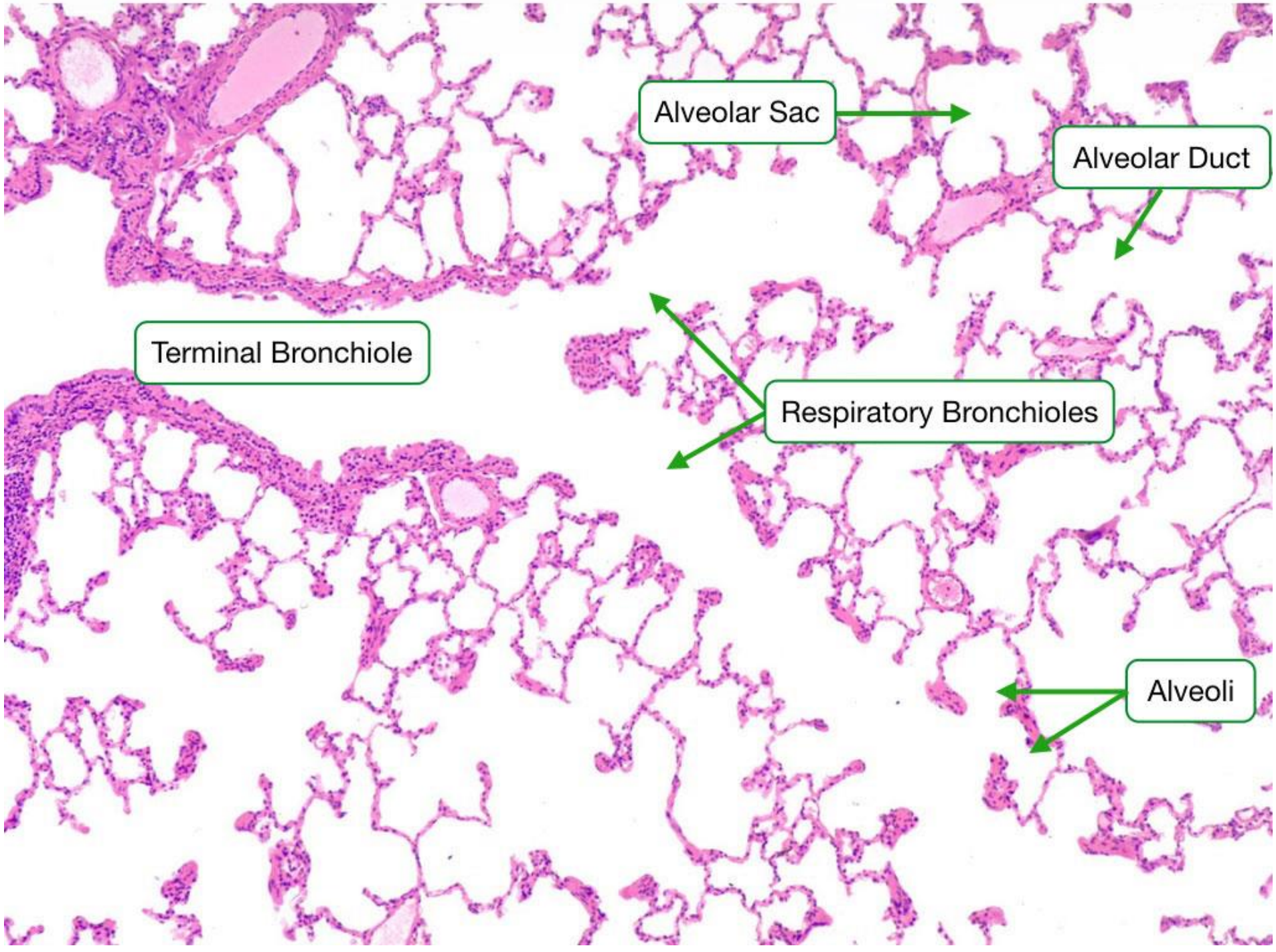


Primary bronchioles

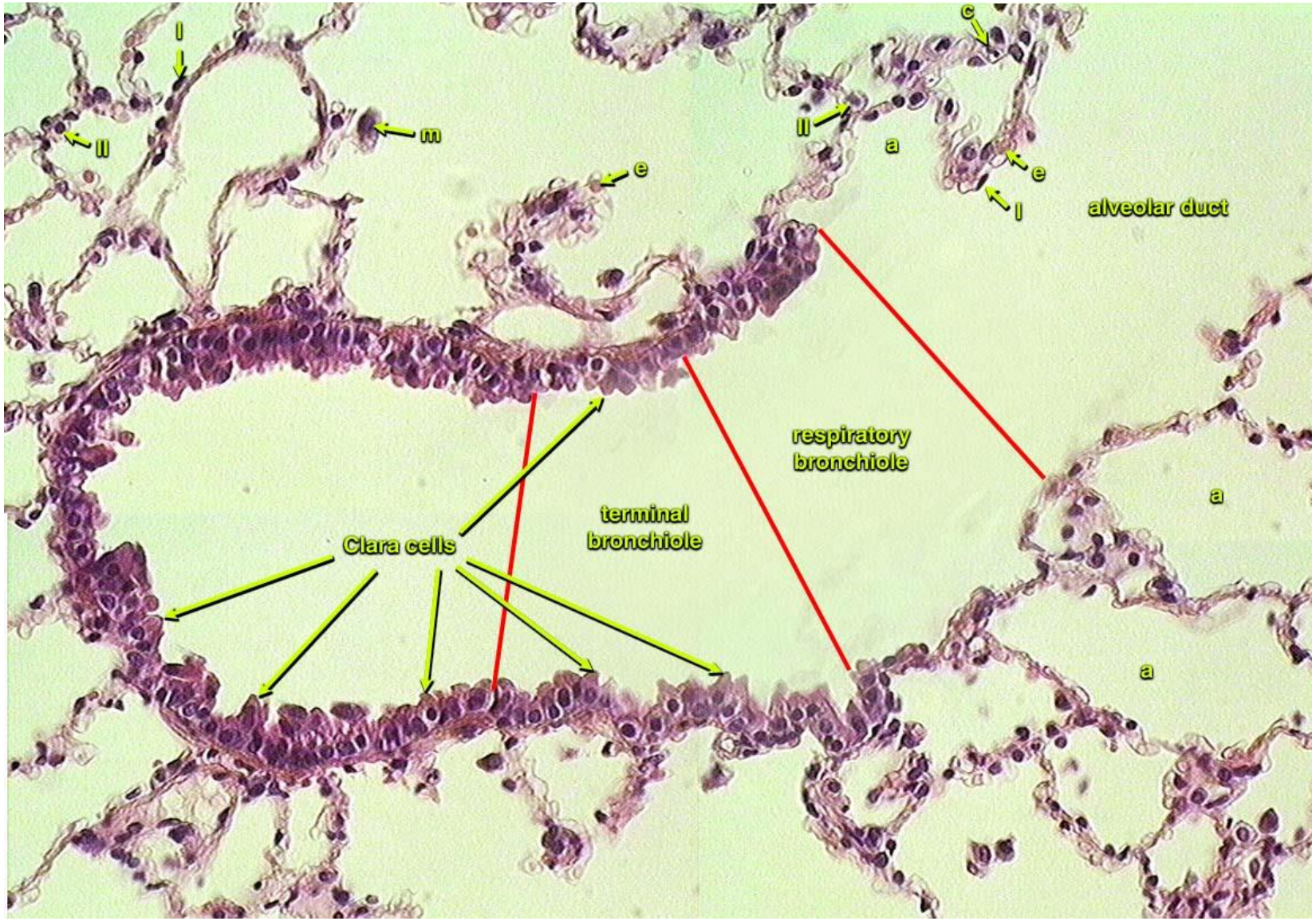


Primary bronchiole

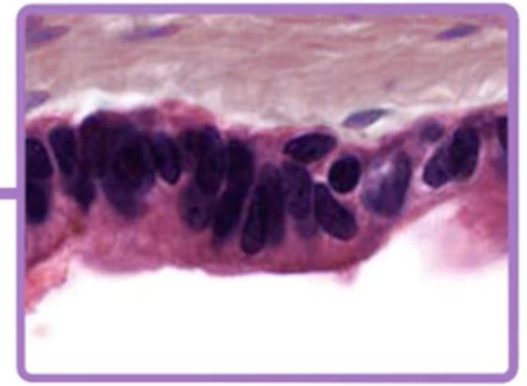



Alveolar Sac
Alveolar Duct
Terminal Bronchiole
Respiratory Bronchioles
Alveoli

Terminal bronchioles

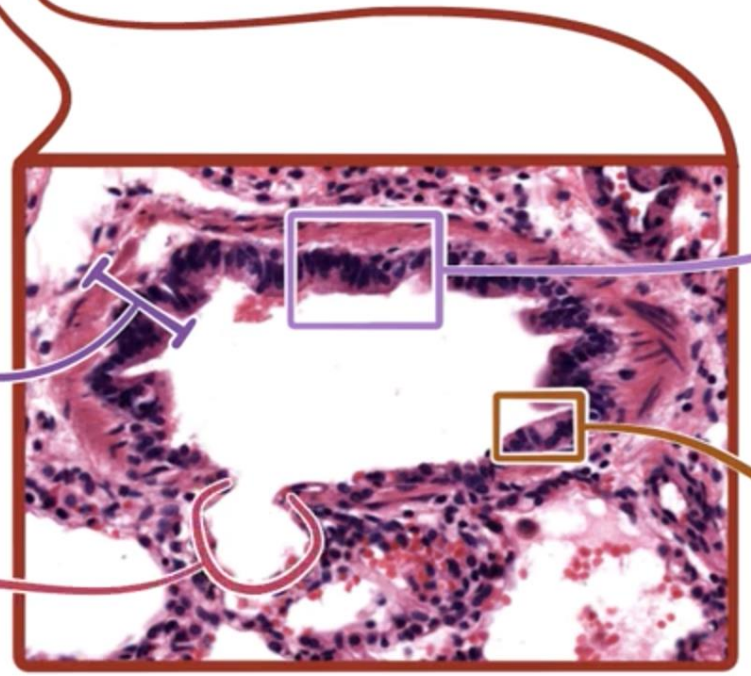


RESPIRATORY BRONCHIOLES

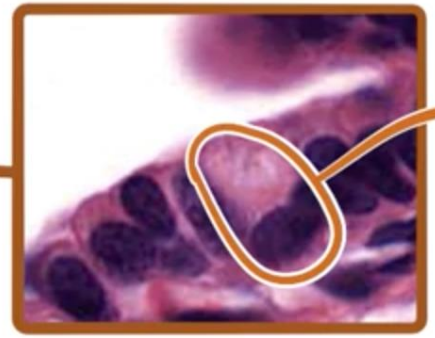


SIMPLE CUBOIDAL & COLUMNAR EPITHELIUM

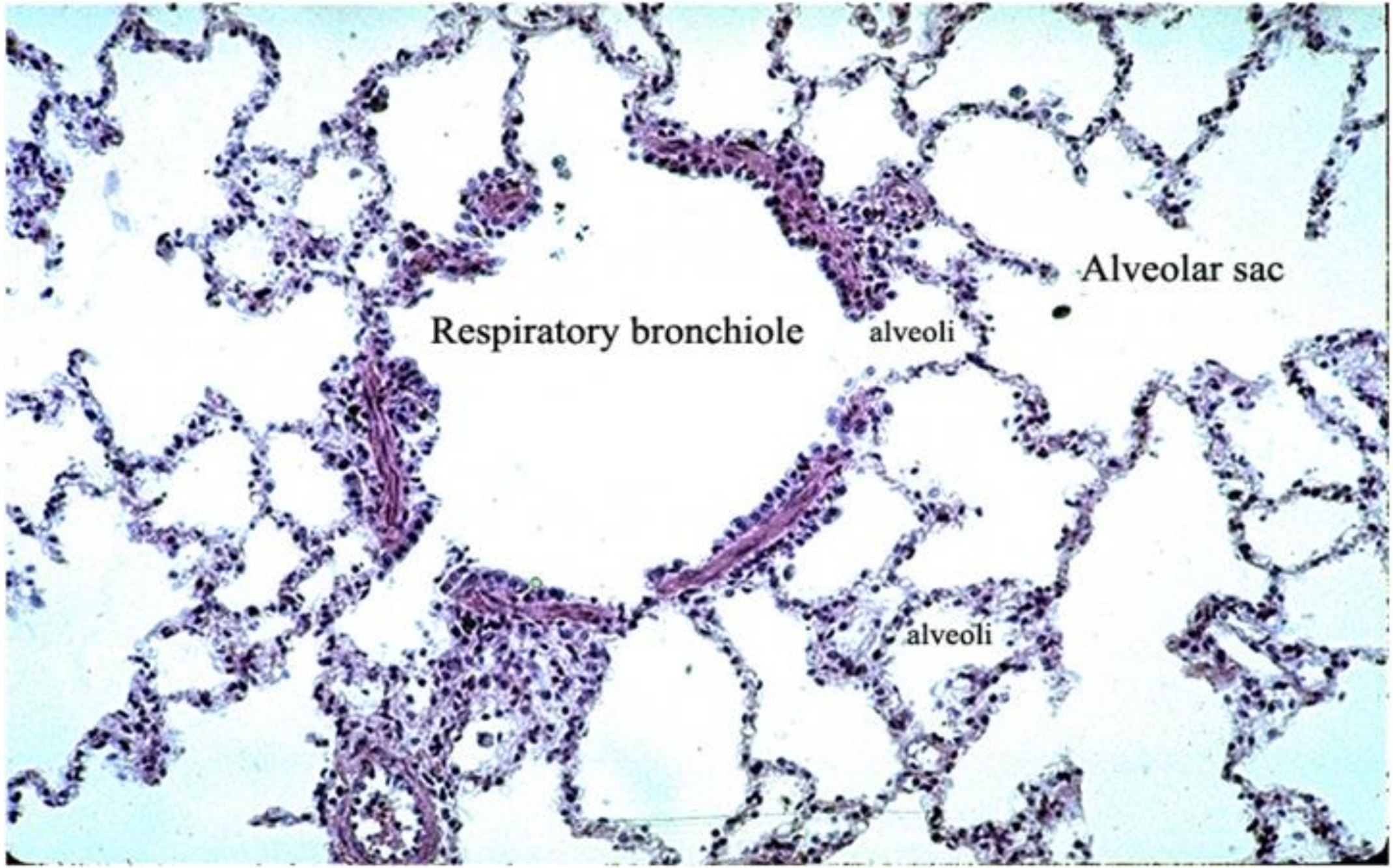
THINNER WALLS



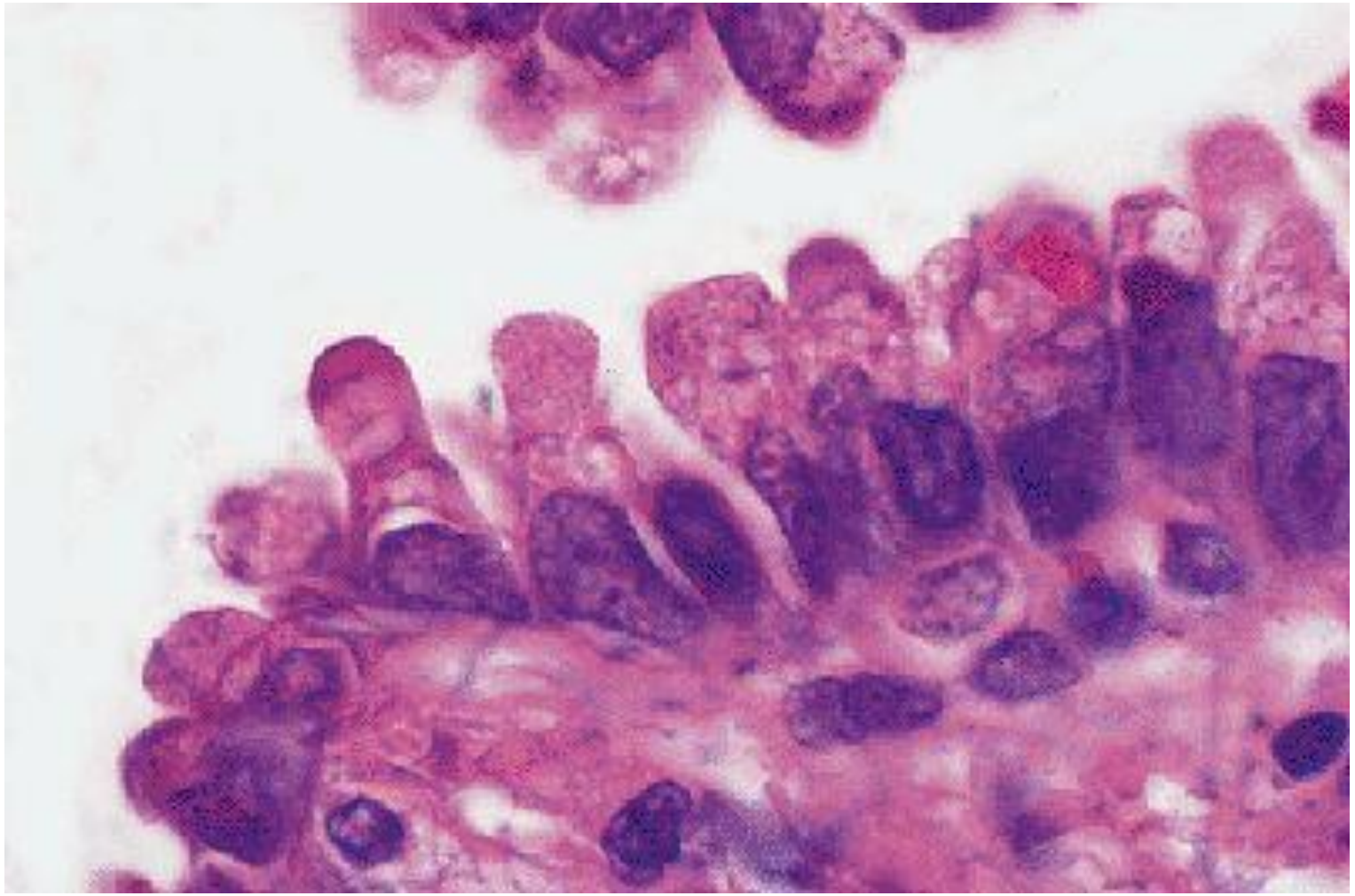
SMALL NUMBER of ALVEOLI



CLARA CELL


Alveolar sac
Respiratory bronchiole
alveoli
alveoli

Clara cells

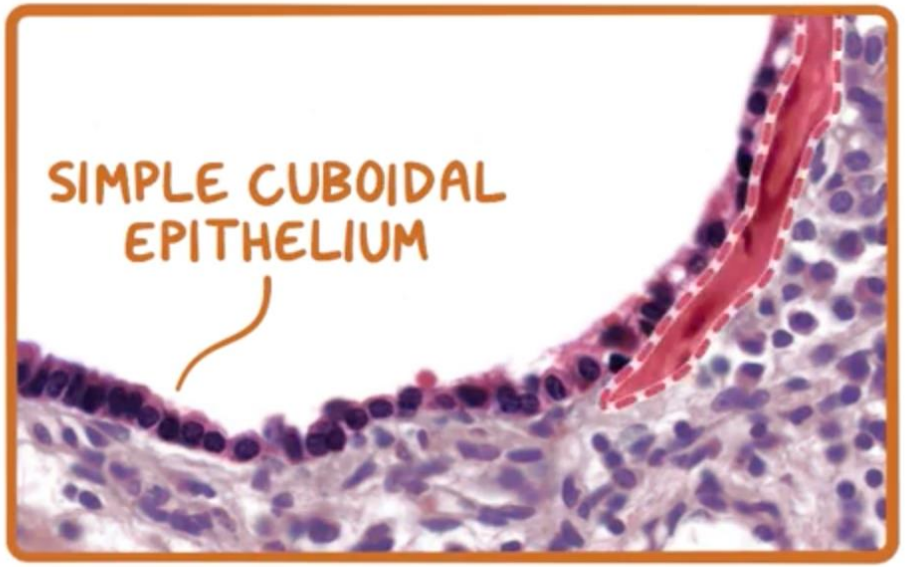


ALVEOLAR DUCTS

~ LINEAR AIRWAYS

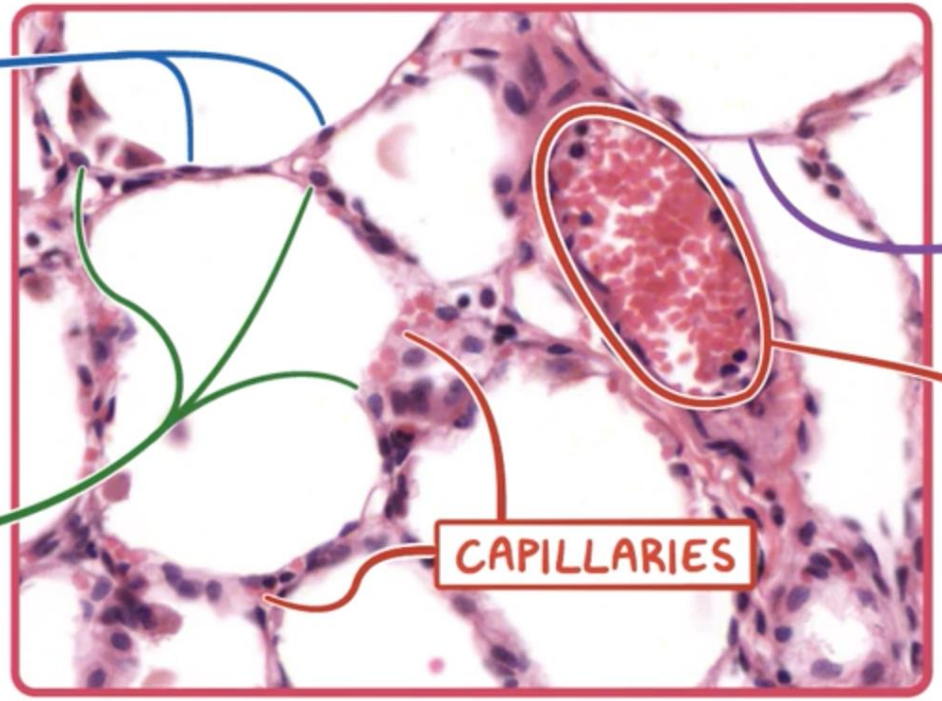
~ MULTIPLE ALVEOLI ALONG the DUCT

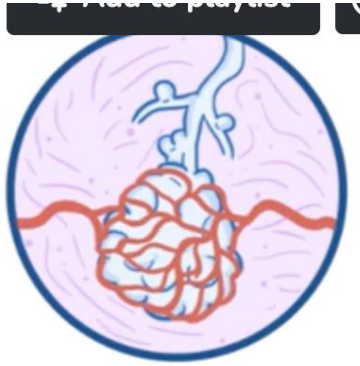
SMOOTH MUSCLE

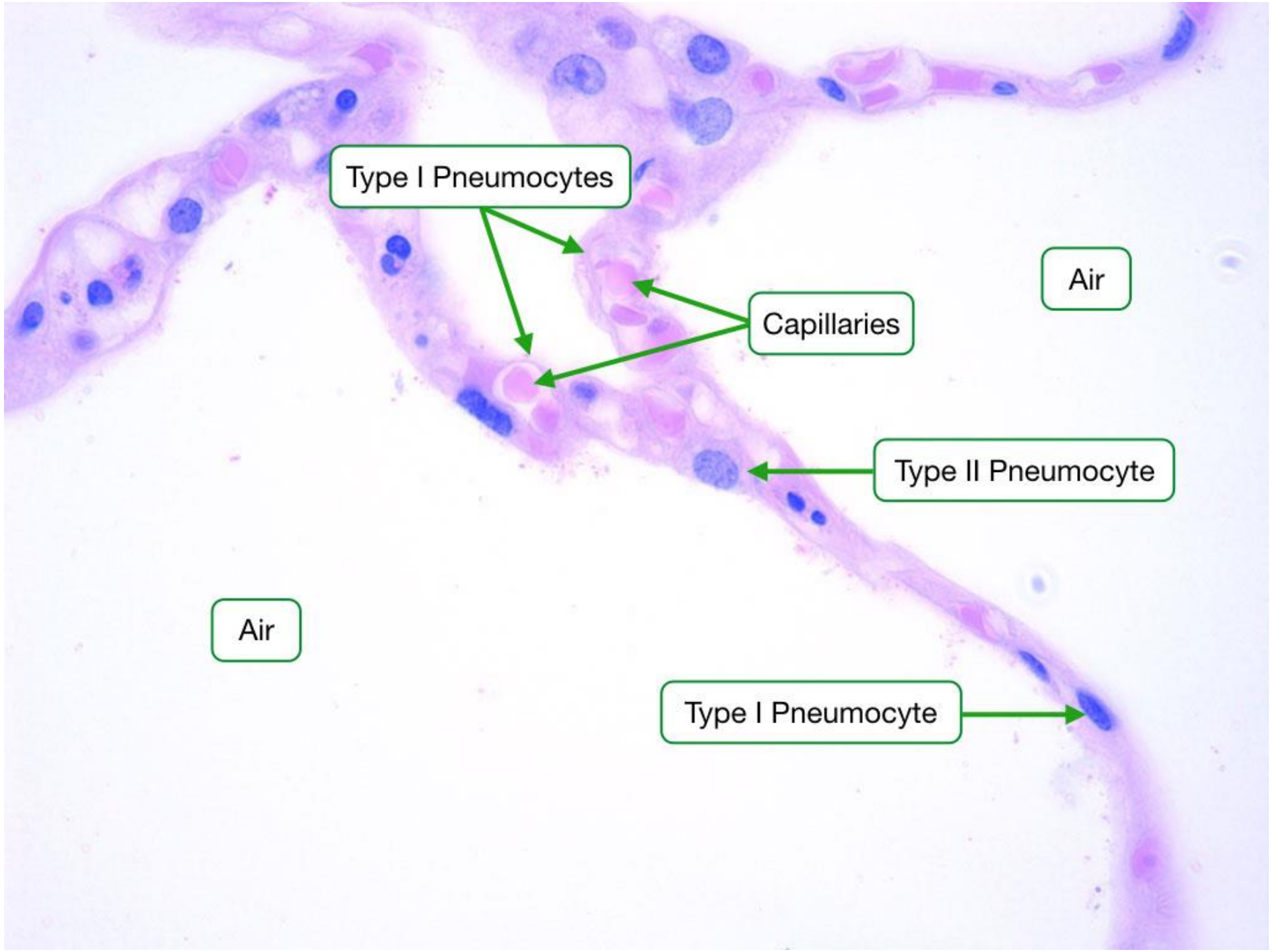


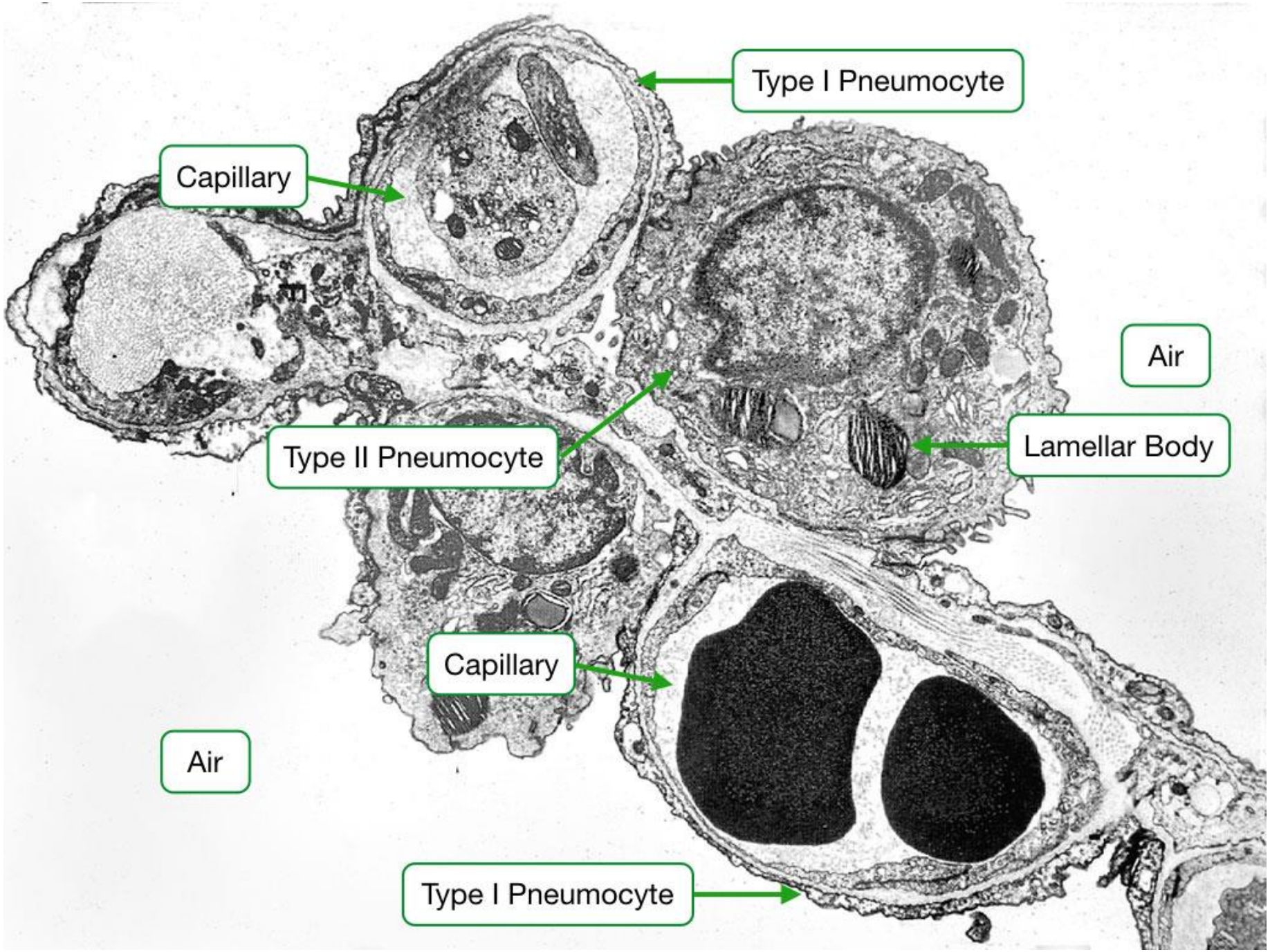
ALVEOLI

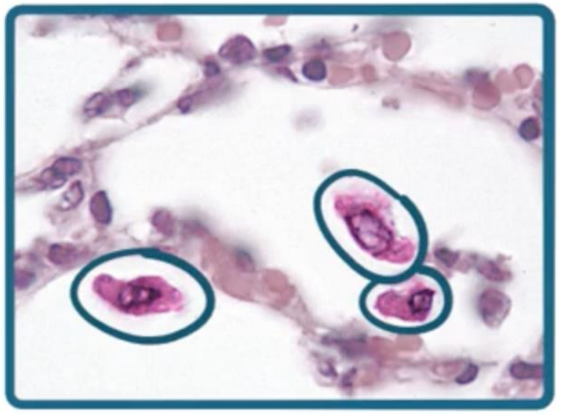
* DIAMETER ~200 μm
* SURFACE EPITHELIUM
  - TYPE I PNEUMOCYTES
    - ~ 95% of SURFACE AREA
    - ~ LARGE
    - ~ FLAT
    - ~ ELONGATED NUCLEI
    - ~ CYTOPLASM can be < 80 nm
    - ~ TIGHT JUNCTIONS BETWEEN CELLS
  - TYPE II PNEUMOCYTES
    - ~ 5% of SURFACE AREA
    - ~ usually LOCATED near the INTERSECTIONS
    - ~ TIGHT JUNCTIONS BETWEEN CELLS
    - ~ SYNTHESIZE SURFACTANT
    - ~ REGENERATE BOTH TYPES of PNEUMOCYTES
    - ~ HYPERPLASIA is a MARKER for INJURY & REPAIR






Type I Pneumocytes
Air
Capillaries
Type II Pneumocyte
Air
Type I Pneumocyte


Type I Pneumocyte
Capillary
Air
Type II Pneumocyte
Lamellar Body
Capillary
Air
Type I Pneumocyte

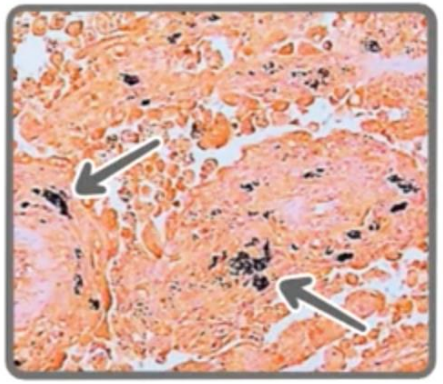


ALVEOLAR MACROPHAGES

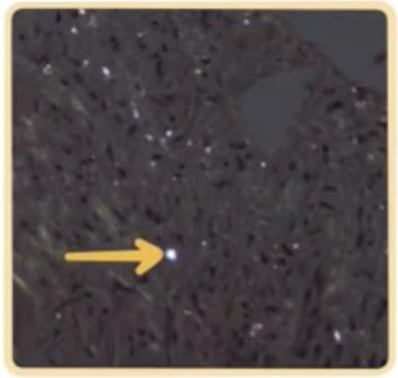
* MAIN PHAGOCYTES of the ALVEOLAR SURFACE
* SMOKERS, COAL MINERS, STONEMASONS, & PEOPLE LIVING in URBAN AREAS

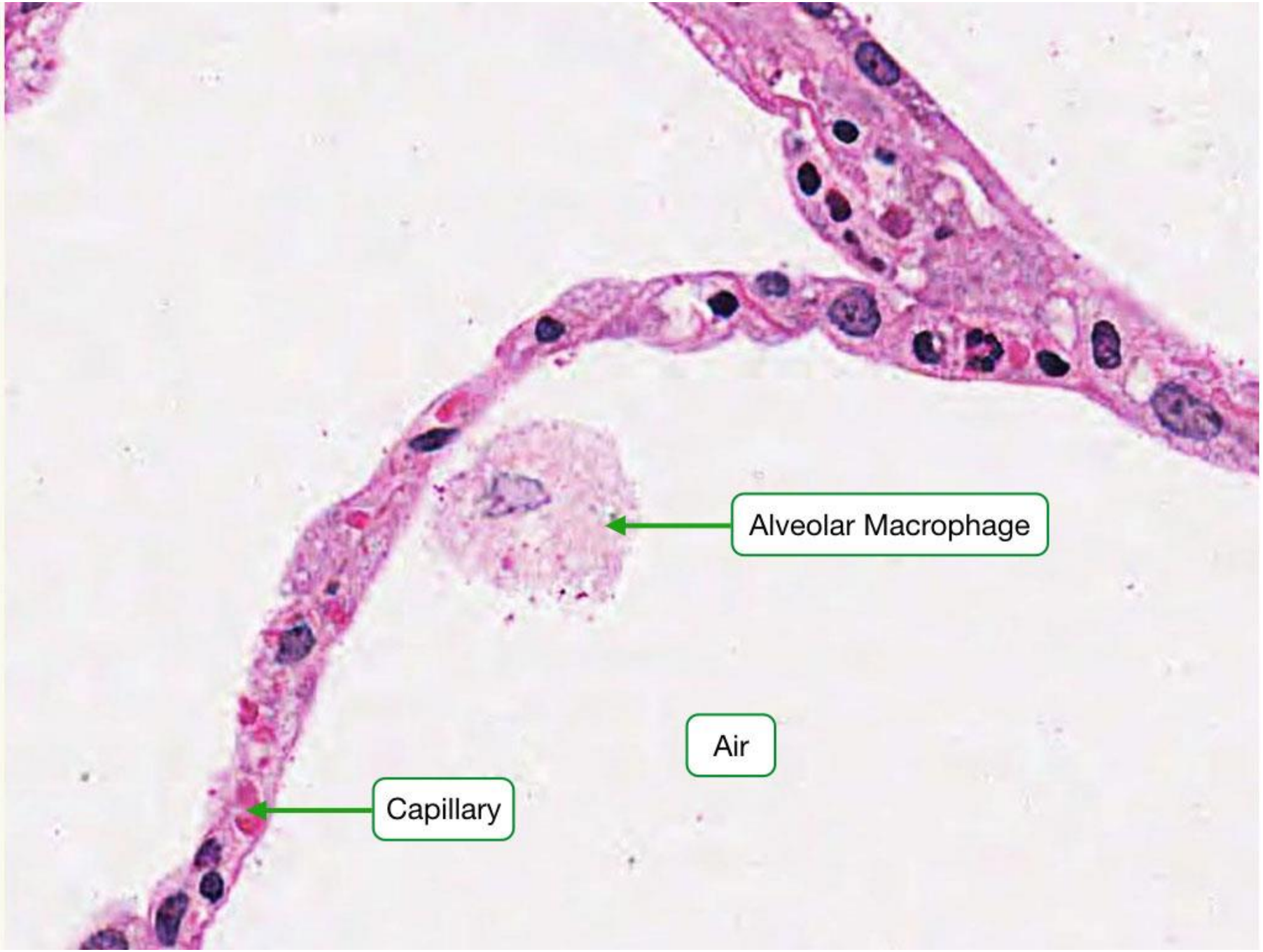
→ **MACROPHAGES** FILLED with

CARBON PARTICLES (ANTHRACOTIC PIGMENTS)



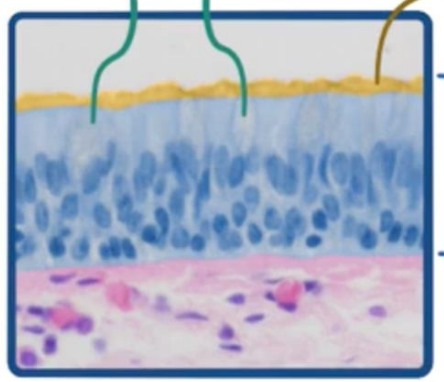
BIREFRINGENT NEEDLE-LIKE SILICA PARTICLES




Alveolar Macrophage
Air
Capillary

GOBLET CELLS

CILIATED PSEUDOSTRATIFIED COLUMNAR EPITHELIUM

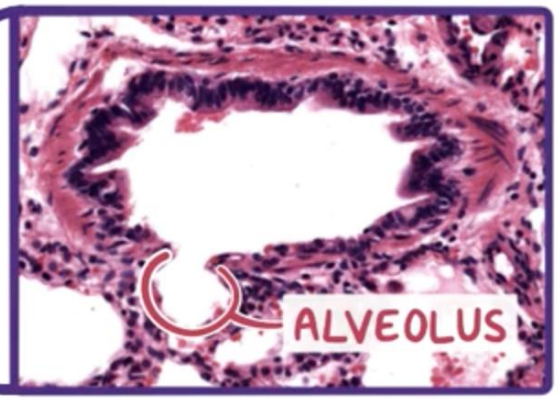


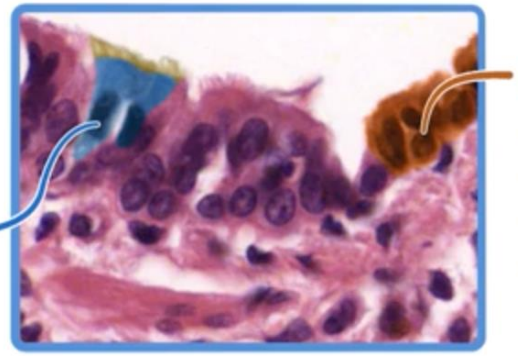
PRIMARY BRONCHIOLE

MOVING DISTALLY

* DIAMETER DECREASES
* EPITHELIUM TRANSITIONS to CILIATED SIMPLE COLUMNAR & CUBOIDAL CELLS

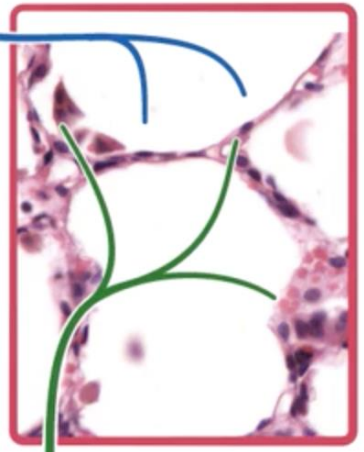
RESPIRATORY BRONCHIOLES



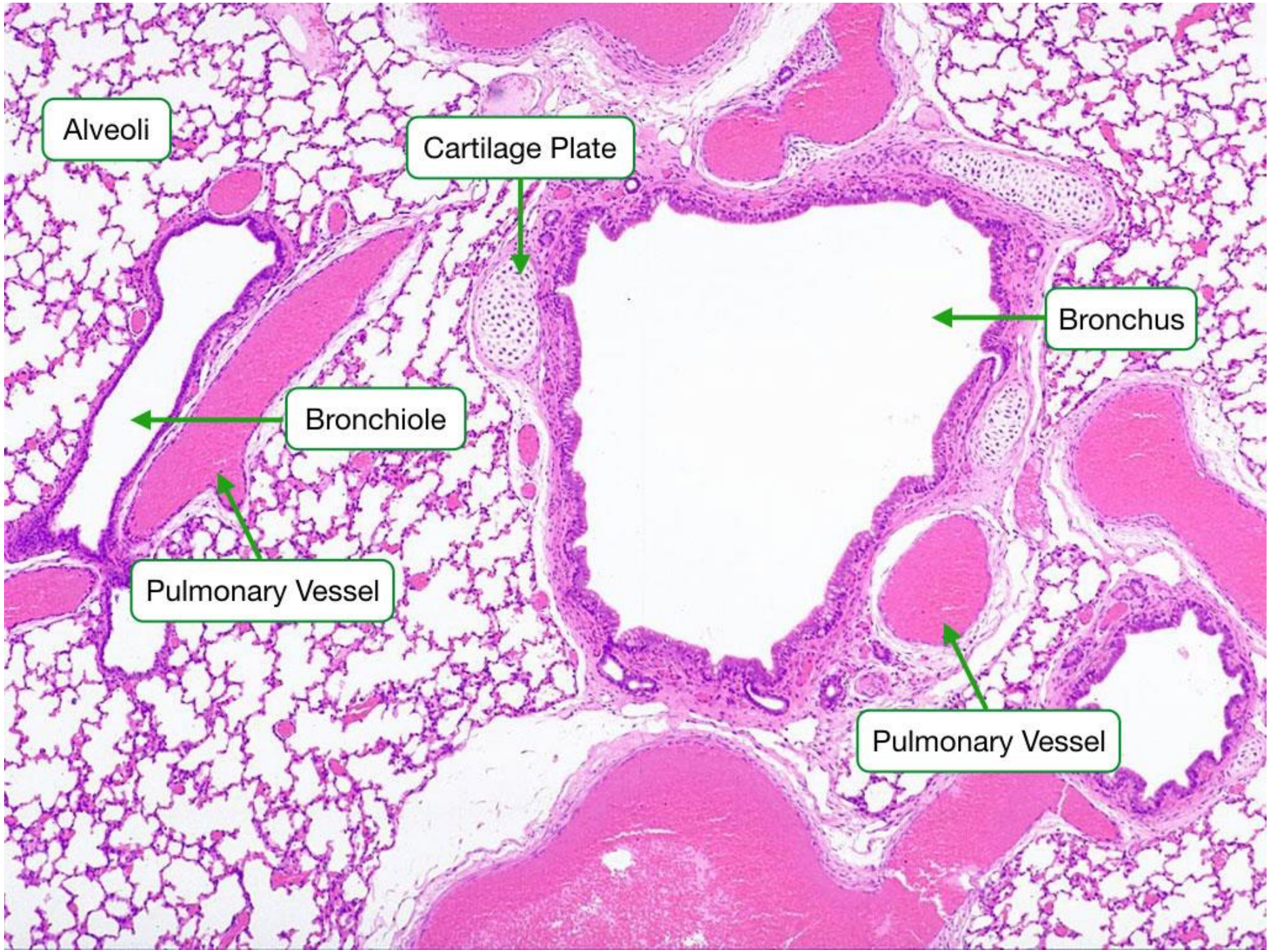


CLARA CELLS
~ TALL
~ NON-CILIATED
~ COLUMNAR
~ DOME-SHAPED APICAL ENDS

TYPE I PNEUMOCYTES
~ LARGE FLAT CELLS
~ ELONGATED NUCLEI
~ 95% of SURFACE AREA



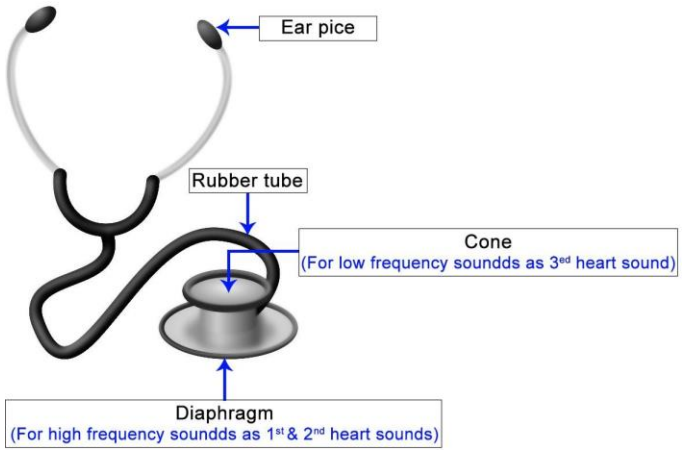
TYPE II PNEUMOCYTES
~ CUBOIDAL CELLS
~ LOCATED near INTERSECTIONS
~ HYPERPLASTIC when there's INJURY


Alveoli
Cartilage Plate
Bronchus
Bronchiole
Pulmonary Vessel
Pulmonary Vessel

Physiology

Auscultation of heart sounds

Materials:



Procedure:

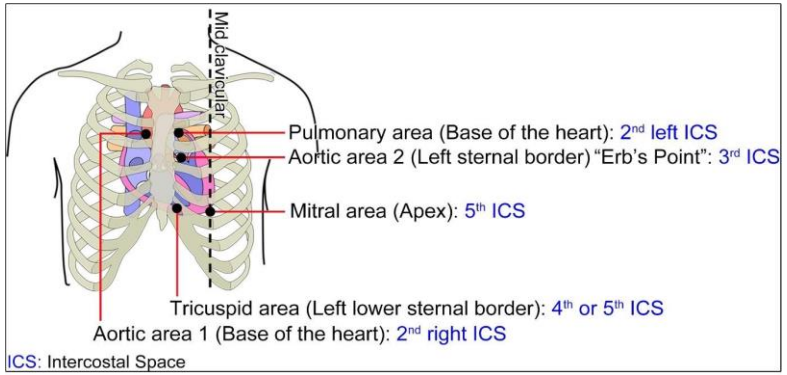
1-The subject lies in **supine position**

2-The doctor stands on the right side of the subject

3-Locate the apex beat: Which is usually located in the left 5th intercostal space in mid -clavicular line (gently press the pulp of your finger to palpate the region of apex) the **lowest** and the **outermost** point at which the finger is forced up, is the region of apex beat.

4-Then place the stethoscope on the following 4 positions:

1. Mitral area (apex beat)
2. Tricuspid area (**lower end of sternum**)
3. Pulmonary area (second left intercostal space)
4. Aortic area (second right intercostal space)



Heart sounds

First Heart Sound:

-Due to Closure of mitral & tricuspid valves

-Best heard on mitral & tricuspid area

-Occurs during isometric contraction phase & early maximal ejection phase

-Length = 0.16 second

Second heart sound:

-Closure of semilunar valves. (pulmonary and aortic valves)

- **Aortic component** best heard on aortic area while **pulmonary component** best heard on pulmonary area

-Occurs during isometric relaxation phase

-Length = 0.1second

Third heart sound:

(Pathological)

- It is heard due to increased gush of blood from atrium to ventricle or due to flappy ventricular wall (in heart failure)

-May be present normally in children

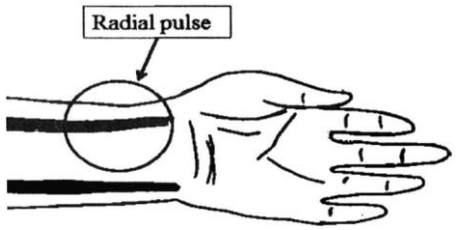
Fourth heart sound:

(Pathological)

-Due to **vigorous atrial contraction** due to increase the end diastolic pressure of the ventricle on the top of ventricular hypertrophy (as in systemic hypertension or pulmonary hypertension)

Causes of tachycardia		Causes of bradycardia
1. Anxiety 2. Exertion	**Physiological**	1.Sleep 2.Athletes
1. Fever 2. Anemia 3. Thyrotoxicosis (Hyperthyroidism)	**Pathological**	Hypothyroidism
1. Atropine 2. Thyroxin	**Drugs**	1.Digitalis 2.β- blockers

Arterial pulse



Technique:

-Place the **middle 3 fingers** over the wrist, at the base of thumb.

-Points to be observed:

❶ Rate : -Normal heart rate : 60 - 90 beats per minute (bpm)

-More than 100 = Tachycardia

-Less than 60 = Bradycardia

❷ Rhythm : -Normal : Regular

-May be irregular: As in (atrial fibrillation, extra systole)

❸ Volume : -Big pulse volume : As in fever, severe anemia

-Small volume : As in heart failure, shock

❹ Condition of arterial wall : Compress the radial artery by the index then roll the artery under the middle finger:

-In the young person you cannot feel it

-But in old age it is felt as cord like structure due to atherosclerosis

Hess capillary fragility test

Steps:

1- Tie cuff of sphygmomanometer around the arm

2- Raise pressure to **80 mmHg** (to prevent venous return)

3- Keep pressure for **15 minutes** then release the pressure

4- Count number of petichae on cubital fossa in **5 cm circle**

5- If petichae:
- -Less than 3 = Normal
- -More than 3 = Increased capillary fragility

Causes of increased capillary fragility:

- Defect in capillary wall:
  - -Old age
  - -Vitamin C deficiency
  - -Allergy
  - -Toxins
- Thrombocytopenia

Measurement of Arterial Blood Pressure (ABP)

Arterial blood pressure (ABP):

Is defined as pressure exerted by the blood on the wall of arteries

$$\text{Arterial blood pressure} = \frac{\text{Systolic pressure}}{\text{Diastolic pressure}}$$

$$\text{ABP} = \frac{\text{SBP}}{\text{DBP}}$$

Systolic blood pressure (SBP) : -Is the maximum pressure in the arteries during systole

-The normal systolic pressure ranges between 90- 150 mmHg

Diastolic blood pressure (DBP) : -Is the minimum pressure in the arteries during diastole

-The normal diastolic pressure ranges between 60- 90 mmHg

-Depends on the peripheral resistance (diameter of arterioles)

Pulse pressure: : Is the difference between systolic and diastolic pressures

Pulse pressure = Systolic Pressure - Diastolic Pressure

Mean systemic arterial blood pressure:

-The average pressure in the arteries throughout the cardiac cycle

-The force moving blood to the tissue throughout the cardiac cycle

-MSAP = Diastolic Pressure + ⅓ Pulse Pressure

Material:

-Blood pressure is measured **indirectly** by the use of sphygmomanometer

-Sphygmomanometer consists of:
- -Rubber bag
- -Hand pump
- -Mercury manometer
- -Mercury reservoir

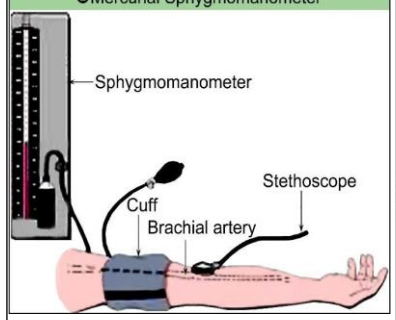
-Blood pressure is **most commonly measured** in the **brachial artery**:

❶ Convenient place for measurement

❷ At approximately at the same

❶Digital Sphygmomanometer

❷Mercurial Sphygmomanometer



❸Aneroid Sphygmomanometer

Methods: -Sitting or recumbent position

-The arm is supported horizontally at the level of heart

Palpatory Method

1- Put the cuff around the upper arm with its lower edge **3 cm** above the elbow

2- Palpate the radial pulse at the wrist

3- Close the valve

4- Inflate the cuff slowly

5- Note the pressure when radial pulse disappears

6- Deflate the cuff slowly to reduce the pressure in the cuff (by opening the valve to let air out of the beg)

7- Note the pressure at which the radial pulse reappears. (this the systolic blood pressure)

NB: 1- The palpatory method measures **only** the systolic pressure

2- **Inaccurate**

Auscultatory method

1- Put the cuff around the upper arm with its lower edge **3 cm** above the elbow.

2- Palpate the brachial pulse at the (cubital fossa **medial to the tendon of biceps**)

3- Placed the stethoscope over the brachial artery

4- Close the valve

5- Inflate the cuff slowly to raise the pressure in the cuff above the systolic pressure (measured by the palpatory method) by 30 mmHg

6- Deflate the cuff slowly to reduce the pressure in the cuff (by opening the valve to let air out of the beg)

7- Note the pressure at which sound appears. (this the systolic blood pressure)

8- You will be able to hear four phases of sounds changes called **korotkoff sounds**:

1. Phase 1 : Sharp and clear sound
2. Phase 2 : The sound become softer
3. Phase 3 : The sound become louder & clear
4. Phase 4 : The sound become muffled (decreased)

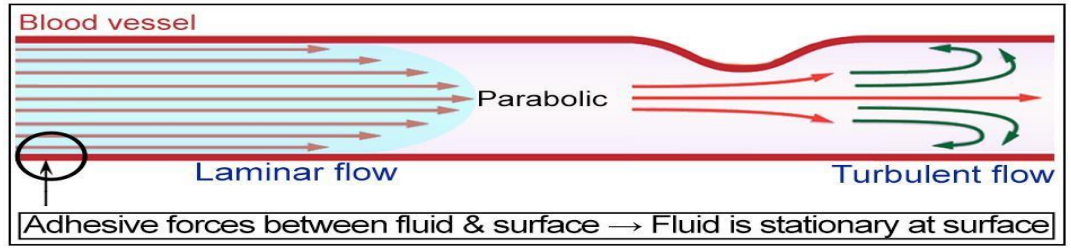
9- The first sound heard represent the systolic pressure.

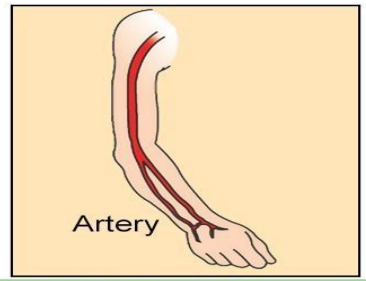
10- The point of complete disappearance of the sound represents the diastolic pressure.

Remarks:
- The cuff should be applied directly on bare arm (not on clothes)
- Do not put the diaphragm of the stethoscope underneath the cuff
- Do not inflate or deflate the cuff very rapidly or very slowly
- The arm should be at the heart level and supported

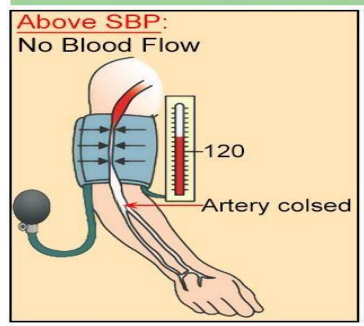
- **Auscultatory gap:** (sound may disappear between the systolic & diastolic and then reappear)

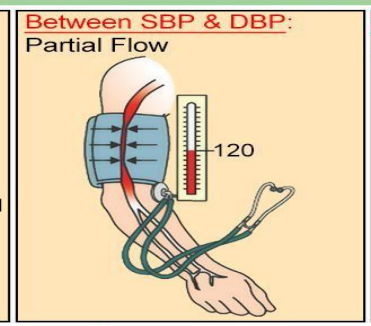
NB:
- Hypertension: (persistent elevation of diastolic blood pressure > 90 mmHg or systolic >150 mmHg)
- Hypotension: (decline of systolic blood pressure < 90 mmHg or diastolic < 60)

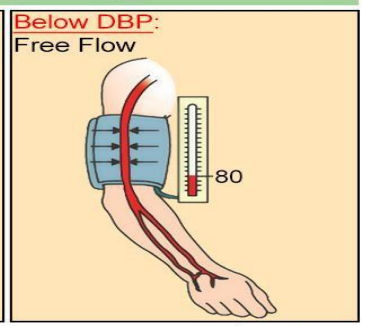


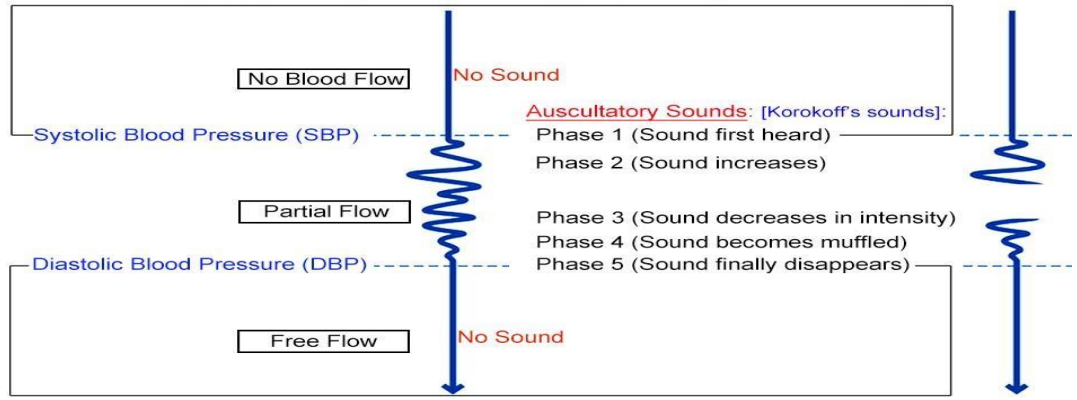


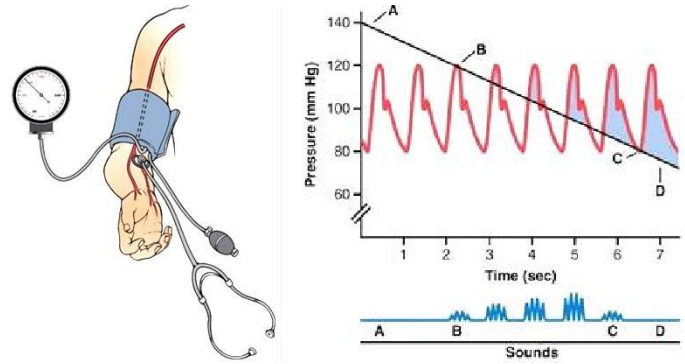
If ABP "Arterial Blood Pressure" $^{120}/_{80}$











Auscultatory method for measuring systolic and diastolic arterial pressures

Uses of sphygmomanometer:

❶ Measuring of arterial blood pressure (ABP)

❷ Diagnosis of latent tetany

❸ Hess test in vascular purpura

❹ Hemostasis

Uses of Stethoscope:

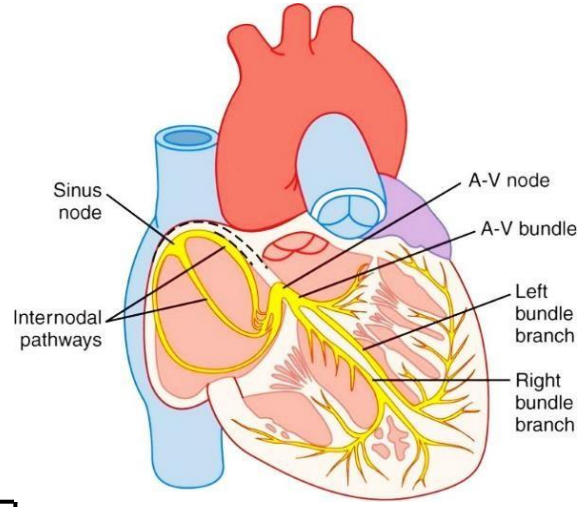
❶ Measurement of arterial blood pressure (ABP)

❷ Heart sounds

❸ Chest sounds

❹ Intestinal sounds

ECG (*Electrocardiogram*)



Definition: Is the recording of the heart electric activity

Conductive system of heart:

-Action potential generated at SA node

-Conducted through intra nodal fibers to the atria then to AV node

-Slowest in the AV node

-Conducted through bundle of his which divides into left and right bundle branches

-The bundle branches divide into:

-Purkinje fibers that conduct excitation wave to all regions of the right

-Left ventricles (action potential is fastest in the purkinje system)

NB: Significance of slow conduction in AV node:

❶ Allowing time for ventricular filling before ventricular contraction

❷ Protect the ventricles from abnormal atrial high rhythm

Types of electrode:

1- Exploring electrode: Electrode put on area having potential deference & find reading

2- Indifferent electrode: -Electrode put on area having zero potential

-It is formed by uniting potential of 3 electrodes on:

-Right arm

-Left arm

-Left foot

To resistance of 5000 ohm

Lead: When **2 electrodes** are connected together they form a **lead**

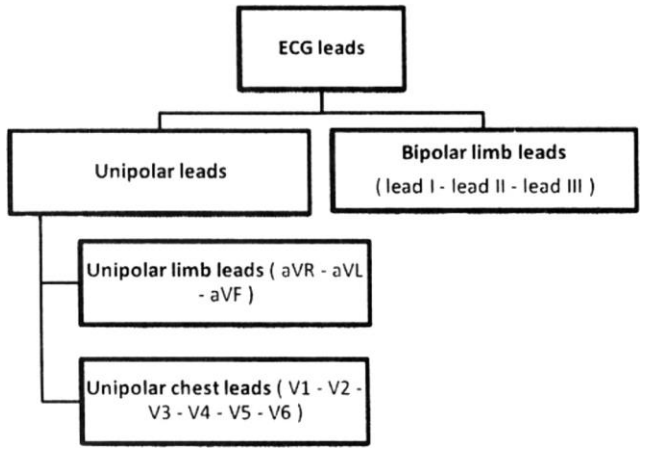
Types of leads: ❶ Bipolar leads: -Lead formed of 2 exploring electrode

-**EX**: Bipolar limb leads

❷ Unipolar leads: -Lead formed of:

- Exploring electrode
- The other is indifferent electrode

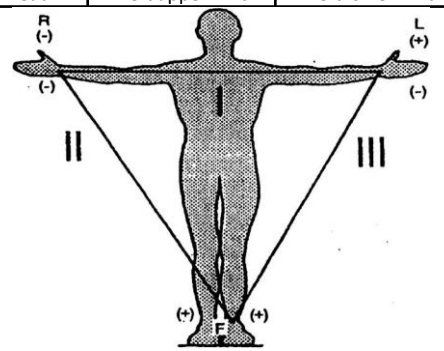
-**EX**: Unipolar limb leads, unipolar chest



Bipolar Limb Leads:

(*Standard*)

Lead	Electrode	
	-ve	+ve
❶ Lead I	Right upper limb	Left upper limb
❷ Lead II	Right upper limb	Left lower limb
❸ Lead III	Left upper limb	Left lower limb



The Einthoven triangle

Unipolar Limb Leads

(*Augmented*)

Lead	Electrode	
	indifferent	+ve
❶ aVR	-Left upper limb -Left lower limb	-Right upper limb
❷ aVL	-Right upper limb -Left lower limb	-Left upper limb
❸ aVF	-Right upper limb -Left upper limb	-Left lower limb

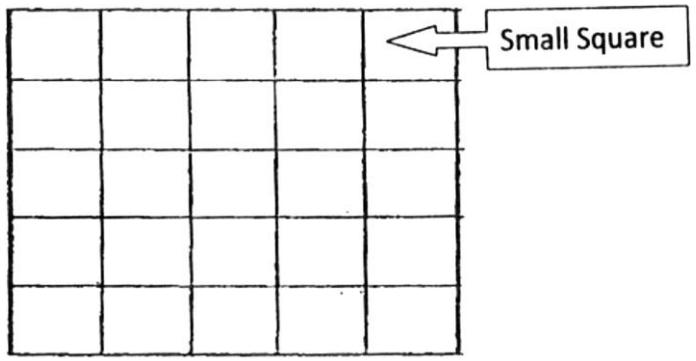
Unipolar chest leads
1. V_1 : Right 4th intercostal space adjacent to sternum
2. V_2 : Left 4th intercostal space adjacent to sternum
3. V_3 : Between V3 and V4
4. V_4 : 5th intercostal space mid clavicular line
5. V_5 : Left 5th intercostal space anterior axillary line
6. V_6 : Left 5th intercostal space mid axillary line

ECG paper Horizontally: -1 Small square = 0.04 second

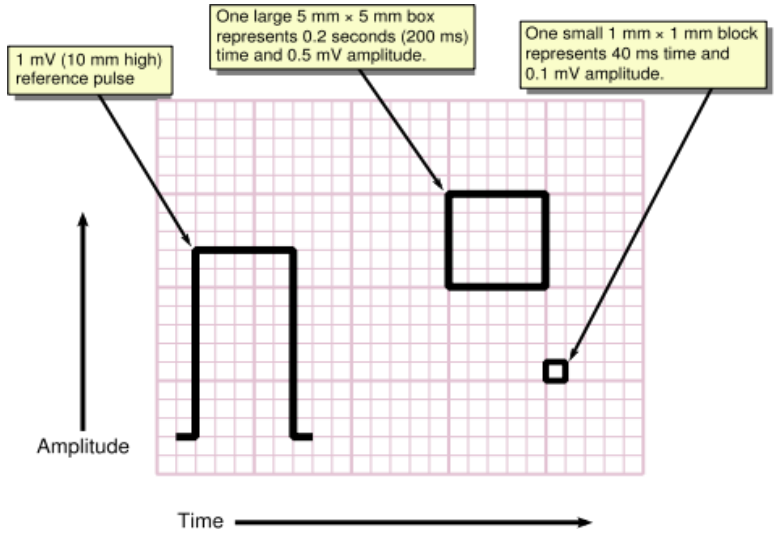
-1 Big square = 0.2 second

-5 Big square = 1second

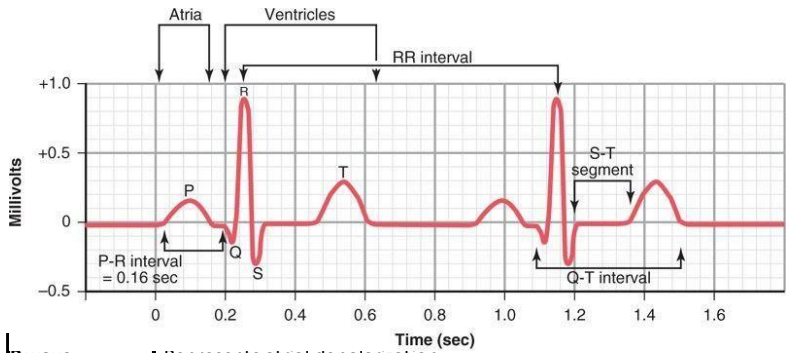
-300 Big square = 1minute



(Large square)



Components of normal ECG



P wave: -Represents atrial depolarization

-Duration : 3 Small squares

-Amplitude : 2.5 Small squares

P-R segment: -Represents delay in AV node

-Start from end of P wave to beginning of QRS complex

-Isoelectric

P-R interval: -P wave + PR segment

-Duration : 3 - 5 small squares

-Is decreased (increased conduction velocity though AV node) by stimulation of sympathetic nervous system

-Is increased (decreased conduction velocity through AV node) by stimulation of parasympathetic nervous system

-Prolonged pathologically in heart block

QRS complex : -Represents ventricular depolarization

-Duration: -Less than 2.5 small squares

-Components : -Q wave :(1st -ve wave in the complex)

- R wave :(1st +ve wave in the complex)
- S wave :(1st -ve wave after "R")

ST segment:
- Represents plateau of ventricular repolarization
- Start by the end of QRS [at a junctional point (J point)]
- Ends by merging smoothly to T wave
- Normally: Isoelectric

T wave: Represents the descending limb of ventricular repolarization

ST interval : ST segment + T wave

QT interval :
- Start by beginning of QRS
- Ends by end of T wave

ECG analysis:

❶ Rhythm:
- Measure successive R-R intervals
- If fixed = regular rhythm
- If variable =irregular rhythm

❷ Rate:
- In case of **irregular** rhythm: Number of R in 30 big square (6 second) × 10
- If regular :

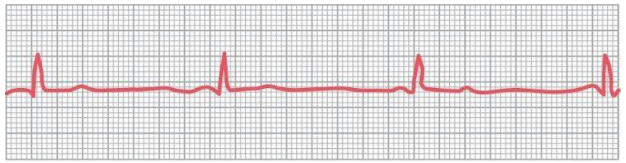
$$\text{Heart rate} = \frac{300}{\textit{Number of } \textbf{big} \textit{ squa1·e between 2 successive R}}$$

$$\text{Heart rate} = \frac{1500}{\textit{Number of } \textbf{small} \textit{ square between 2 successive R}}$$

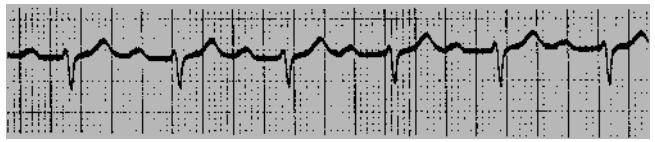
NB:
- Normal heart rate: (60 -100 beats / min)

-Tachycardia: (heart rate > 100 beats / minute)

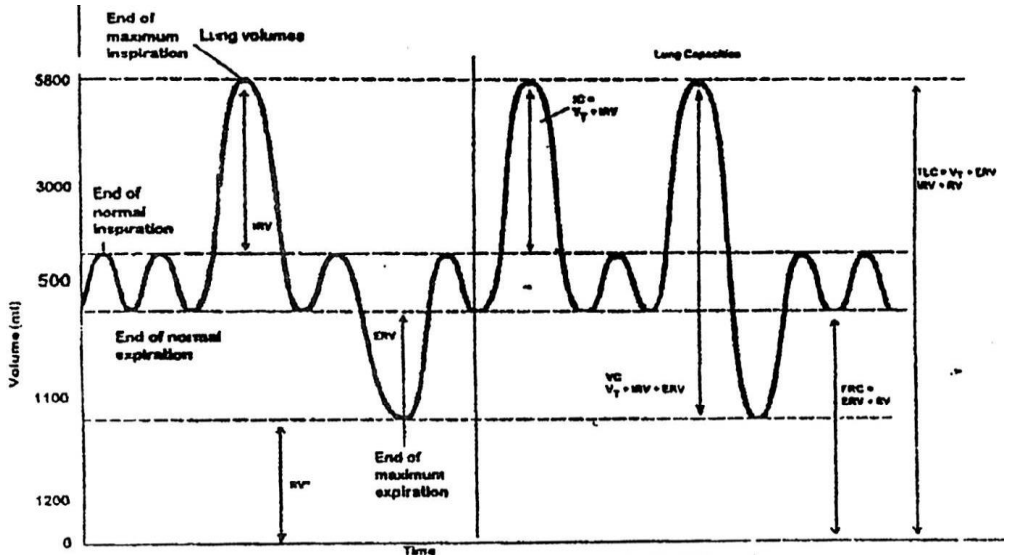
-Bradycardia: (heart rate < 60 beats / minute)



-Prolonged PR interval: (more than 5 small squares)



Lung volumes and capacities



Lung volumes:

- **Tidal volume**

  It is the volume of air that can be inspired by normal breathing after the end of normal expiration (500 ml)

- **Inspiratory reserve volume:**

  It is the volume of air that can be inspired by maximal inspiration after the end of normal inspiration (3000 ml)

- **Expiratory reserve volume:**

  It is the volume of air that can be expired by forced expiration after the end of normal expiration

- **Residual volume:**

  It is the volume of air that remains in the lung after the end of forced expiration (1200), it is increased in emphysema

Lung Volumes & Capacities

[A] Static Lung Volumes & Capacities

❶ Lung Volumes

[1] Tidal Volume (TV):

- It is the volume of air inspired or expired each respiratory cycle during rest
- **Normal standard**: **500 cc**

[2] Inspiratory Reserve Volume (IRV):

- It is the maximum volume of air which can be inspired by deep inspiration after a normal inspiration.
- **Normal standard: 3000 cc**

[3] Expiratory Reserve Volume (ERV):

- It is the maximum volume of air which can be expired by forced expiration after a normal expiration
- **Normal standard: 1100 cc**

[4] Residual Volume (RV):

- It is the volume of air remaining in the lung after maximal expiration
- Measurement by: Dilution principle
- **Normal standard: 1200 ml**

Significance of residual volume:

❶ Physiological: 1) It maintains aeration of blood between breaths

2) It prevents marked changes in the concentration of CO_2 & O_2 with each respiration

❷ Clinically: The ratio between RV and TLC:

- Normally: Is less than 30%
- If it is more than 30%: This denotes obstructive lung disease
- In diseases that make expiration difficult as in bronchial asthma and emphysema, the residual volume increases and the ratio rises above 30% → 70%.

❸ Medicolegal:

- RV can be expelled by opening the chest wall
- When the chest wall is opened and the lung is allowed to collapse, however, the lungs still contain some air (**minimal air**)

Minimal air:

- It is the volume of air (few ml) remaining in the lungs after opening the chest and complete collapse of lungs
- It is sufficient for floatation of lungs in water
- It is absent in babies born dead: Thus, their lungs sink when put in water.
- While in babies born alive and then killed, their containing minimal air, so, they float in water

❷ Lung Capacities — *Summation of more than one volume*

[1] Inspiratory Capacity (IC):

- It is the maximal volume of air that can be inspired by deep inspiration after normal expiration
- It equals: TV + IRV
- **Normal standard: 3500 cc**

[2] Functional Residual Capacity (FRC):

- It Is the volume of air remaining in the lung after normal expiration (ie at the resting expiratory level)
- It equals: ERV + RV
- **Normal standard: 2300 cc**

[3] Vital Capacity (VC):

- Definition: It is the maximal volume of air that can be expired after a maximal inspiration
- It equals: IRV + TV + ERV
- **Normal standard: 4600 cc**
  - In males : 2.5 Liters/square meter
  - In females : 2 Liters/square meter
- Measurement: By spirometer
- Significance: It indicates the strength of respiratory muscle & lung elasticity and it determines the ability of the person to perform hard work So, it can be taken as a measure **for physical fitness**
- Factors affecting vital capacity:

❶ Physiological factors

1) Increases in:

Athletes because chest muscles are well developed

→ more distension of chest → more distension of lungs → more air comes in → more vital capacity

2) Decrease in:

1. Females
2. Old age
3. Recumbent position
4. Pregnancy [prevents free descent of diaphragm]

❷ Pathological factors

- Chest wall diseases:
  1. Muscle paralysis
  2. Myositis
  3. Bone or rib fracture
- Lung diseases:
  1. Obstructive: Bronchial asthma
  2. Restrictive: Pneumonia
- Increase amount of blood: Lt side H.F
- Diaphragm: Any condition interfere with diaphragm:
  1. Pregnancy
  2. Enlarged liver or spleen

[4] Total Lung Capacity (TLC):
- It is the maximal volume of air present in the lung after a maximal inspiration
- It equals: IRV + TV+ ERV + **RV**
- **Normal standard: 5800cc**

[B] Dynamic Lung Volumes & Capacities

These tests measure volumes per unit time

❶ Timed Vital Capacity (Forced Expiratory Volume "FEV"):

Definition: The fraction of vital capacity expired **in eg first second (FEVl)** using the maximal expiratory effort

Normal standard:
FEVl (forced expiratory volume in 1st second) = 80% of the vital capacity
FEV2 (forced expiratory volume in 2nd second) = 90% of the vital capacity
FEV3 (forced expiratory volume in 3rd second) = 97% of the vital capacity

Measurement: Using spirometer

Significance:
- In restrictive lung disease:
  1. Decrease FEV1
  2. Decrease FVC
  3. **Normal or increase FEV1%**
- In obstructive lung disease:
  1. Decrease FEV1
  2. Normal FVC
  3. **Decrease FEV1%**

❷ Maximal Breathing Capacity (MBC):

Definition: It is the maximal volume of air inspired **or** expired **per minute** using the **deepest** and **fastest** respiratory effort

Normal standard:
- In males : 80-170 liter/min
- In females : 60-120 liter/min

Measurement: By spirometer for **15 seconds only** [to avoid fatigue &alkalosis]. Then the result is **multiplied by 4**

Significance: ……..[as that of vital capacity]

Factors affecting MBC: ……. [the same factors affecting vital capacity]

Breathing reserve (BR) = MBC – RMV

RMV (respiratory minute volume) is the volume of air inspired or expired per minute during rest

RMV is also called pulmonary ventilation

Dyspnic index (DI):

Definition: DI is a ratio between Breathing Reserve (BR) & the Maximal Breathing Capacity (MBC)

It equals: $DI = \frac{MBC - RMV}{MBC} \times 100 = \frac{BR}{MBC} \times 100$

Normal standard:
- DI is more than 90%
- If it is less than 70%, dyspnea (difficult breathing) is present.

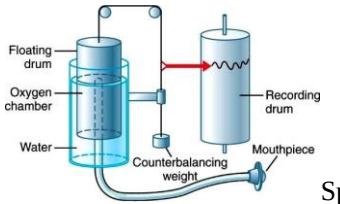
❸ Maximal Flow Rate:

Definition: The maximal **velocity** of expired air using the maximal expiratory effort

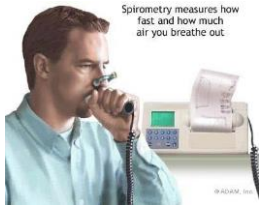
Normal standard: 10 liter/sec

Measurement: By the **peak flow meter**

Significance: It is decreased in bronchial asthma



Spirometer



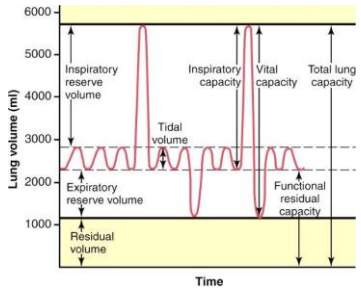
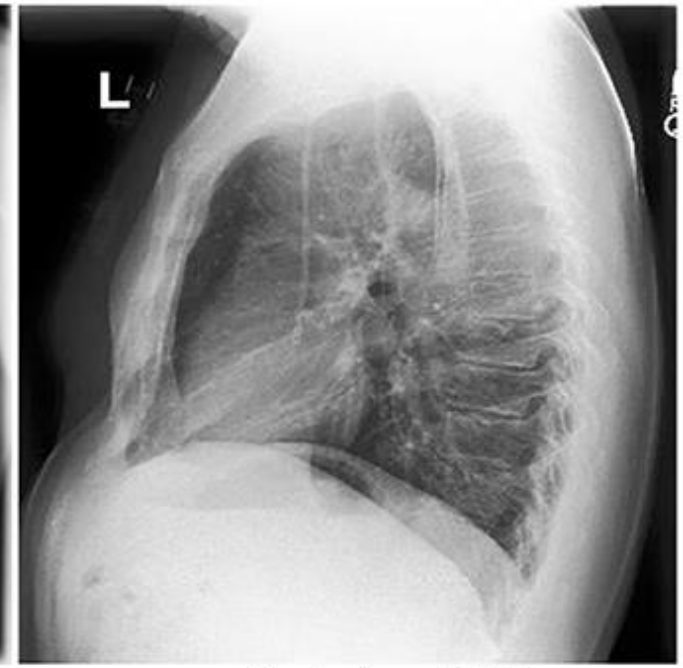


Diagram showing respiratory excursions during normal breathing and during maximal inspiration & maximal expiration

Early clinical exposure

PA view	AP view
Standard frontal Chest projection	Alternative frontal projection to the PA
X-ray beam traverses the patient from posterior to anterior	X-ray beam traverses the patient from anterior to posterior
Needs full aspiration and standing position from patient	Can be performed patient sitting on the bed
Best practice to examine lungs, mediastinum and thoracic cavity	Best practice for intubated and sick patients
Heart size appear normal	Heart size appear magnified
Images are of higher quality and a better option to assess heart size	Not a good option to assess the size of heart

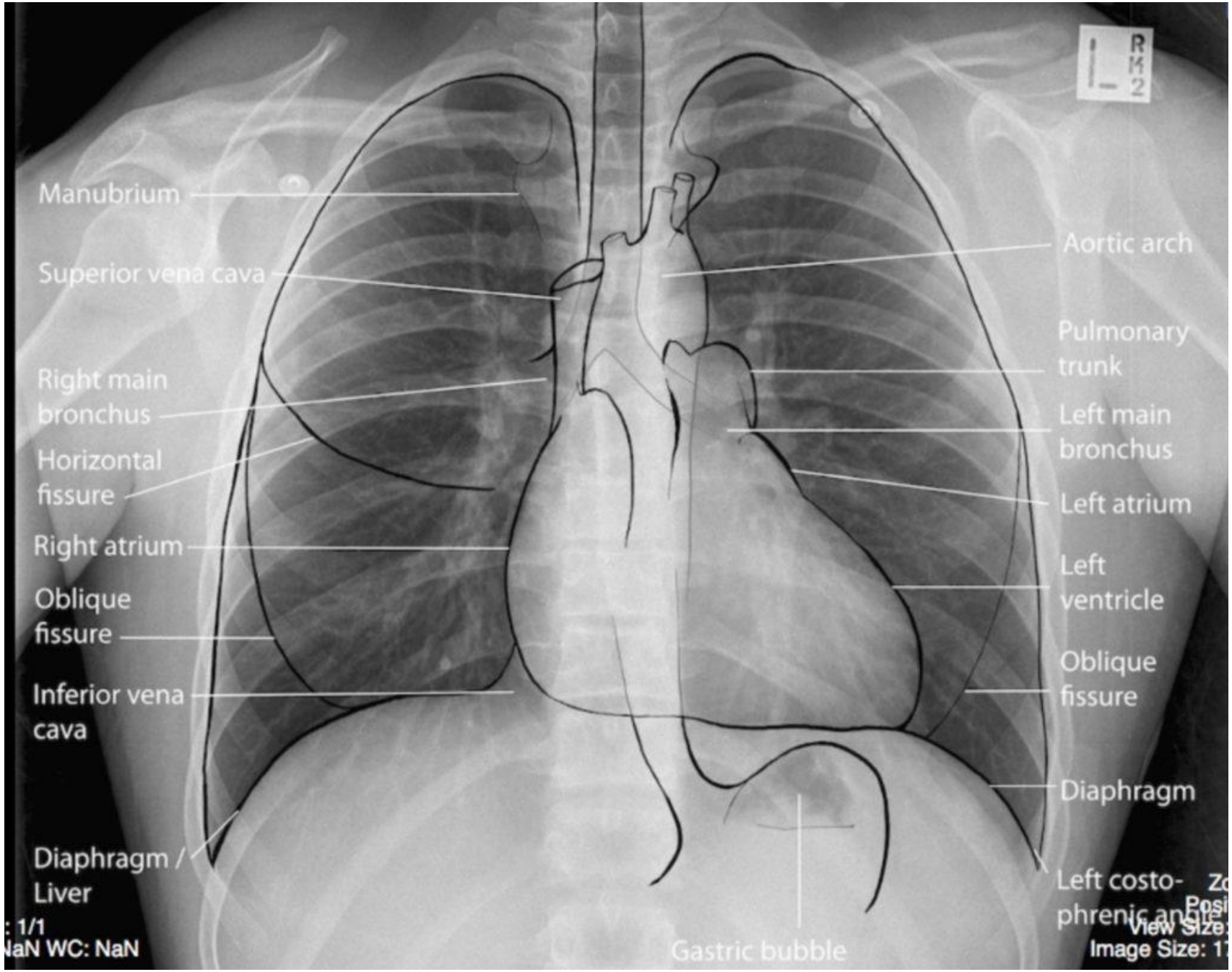


A AP view

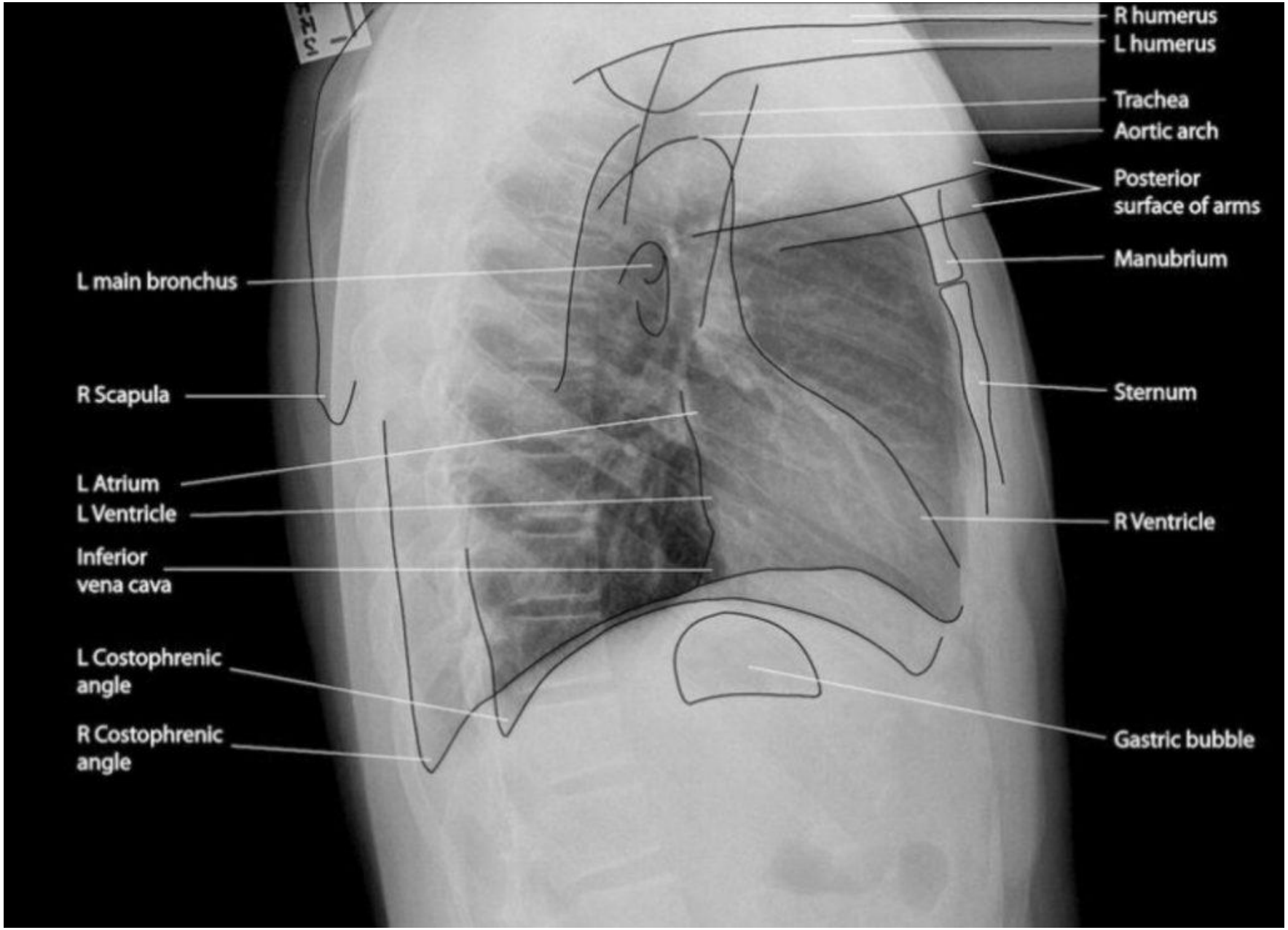
B PA view

C Lateral View

Normal Chest X ray PA- view



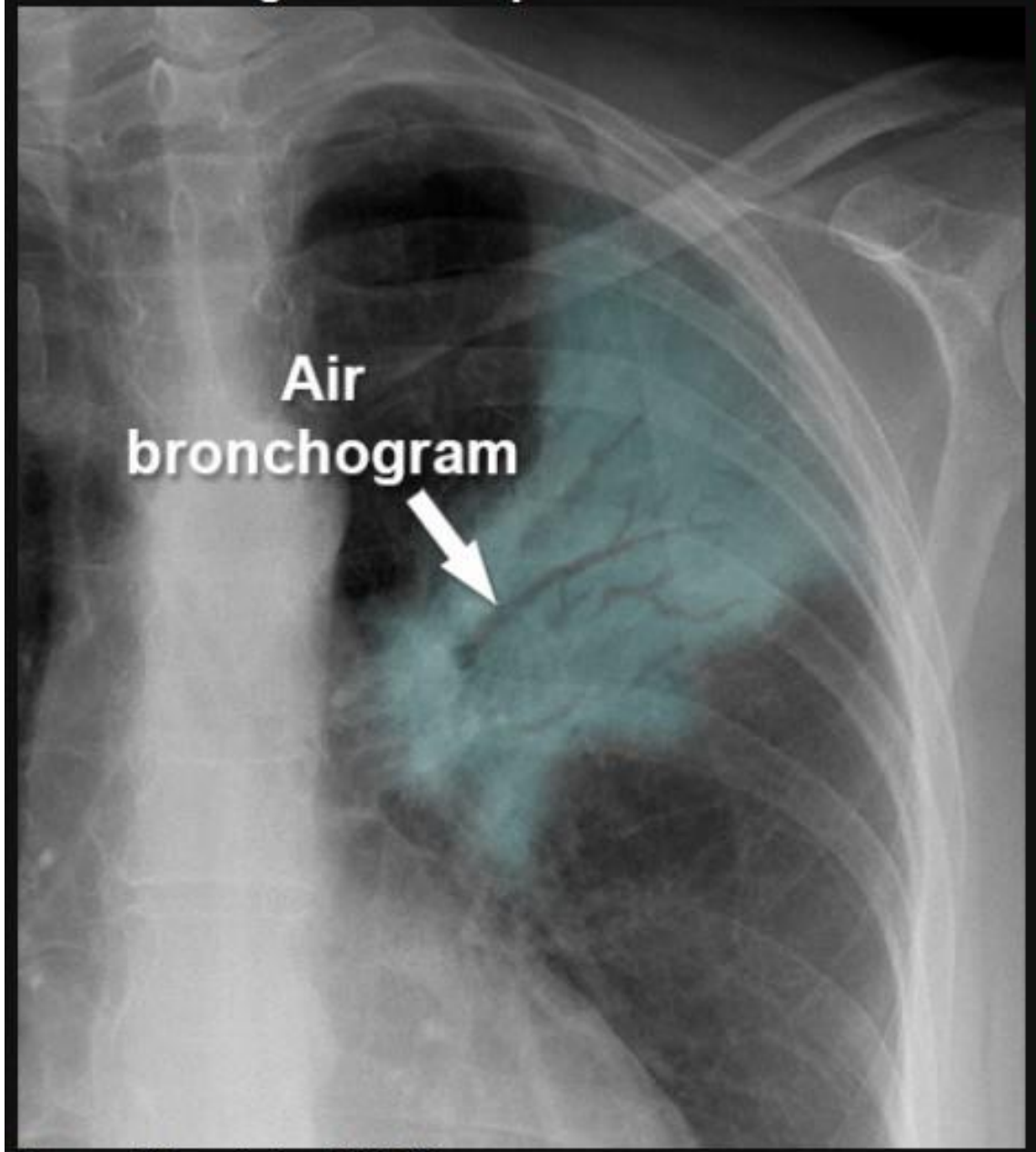
Normal Chest X ray lateral - view



Common radiological features of pneumonia

1. There is a dense opacity within the right upper lobe of the lung (arrowed)
2. There are also air-bronchogram lines
3. There is increase in the number of bronchovascular markings
4. There is some loss of definition of the upper right heart border (silhouette sign).

Air bronchogram - Example 1

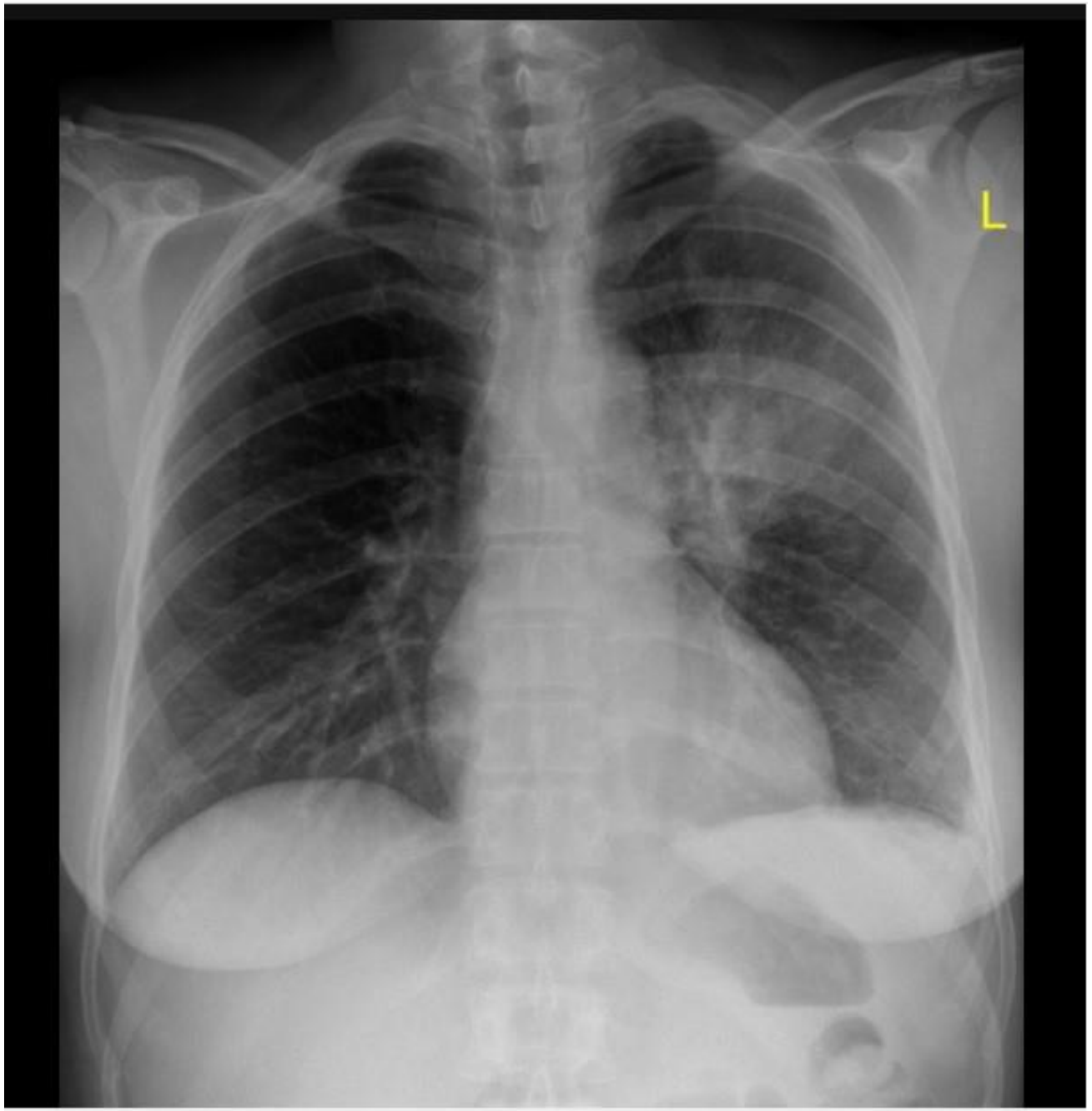


Hover on/off image to show/hide findings

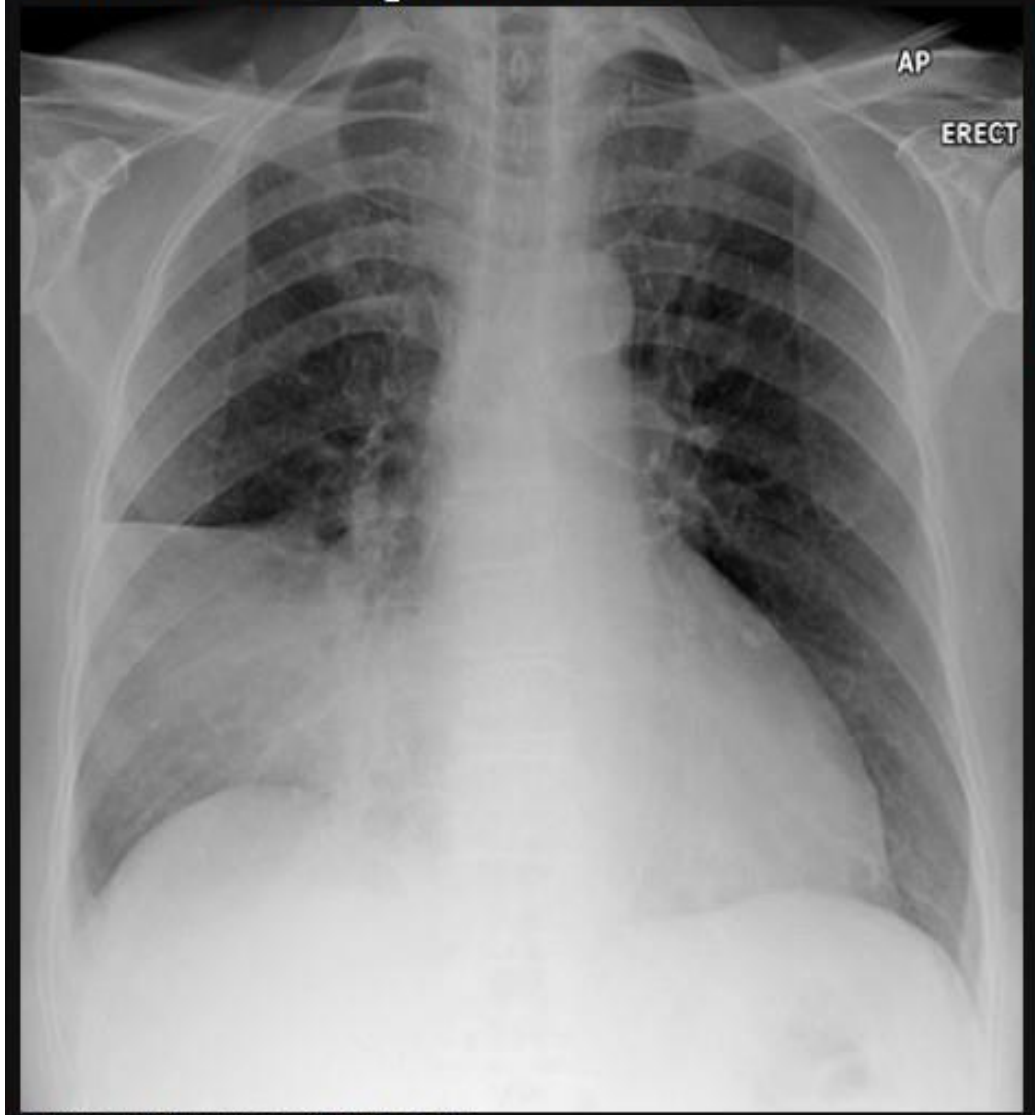
Air bronchogram - Example 1

- 'Air bronchogram' is a characteristic sign of consolidation – here is an example in a patient with pneumonia
- The black lines represent patent airways within consolidated lung (highlighted area)

Left upper lobe consolidation pneumonia



Consolidation - Right middle lobe

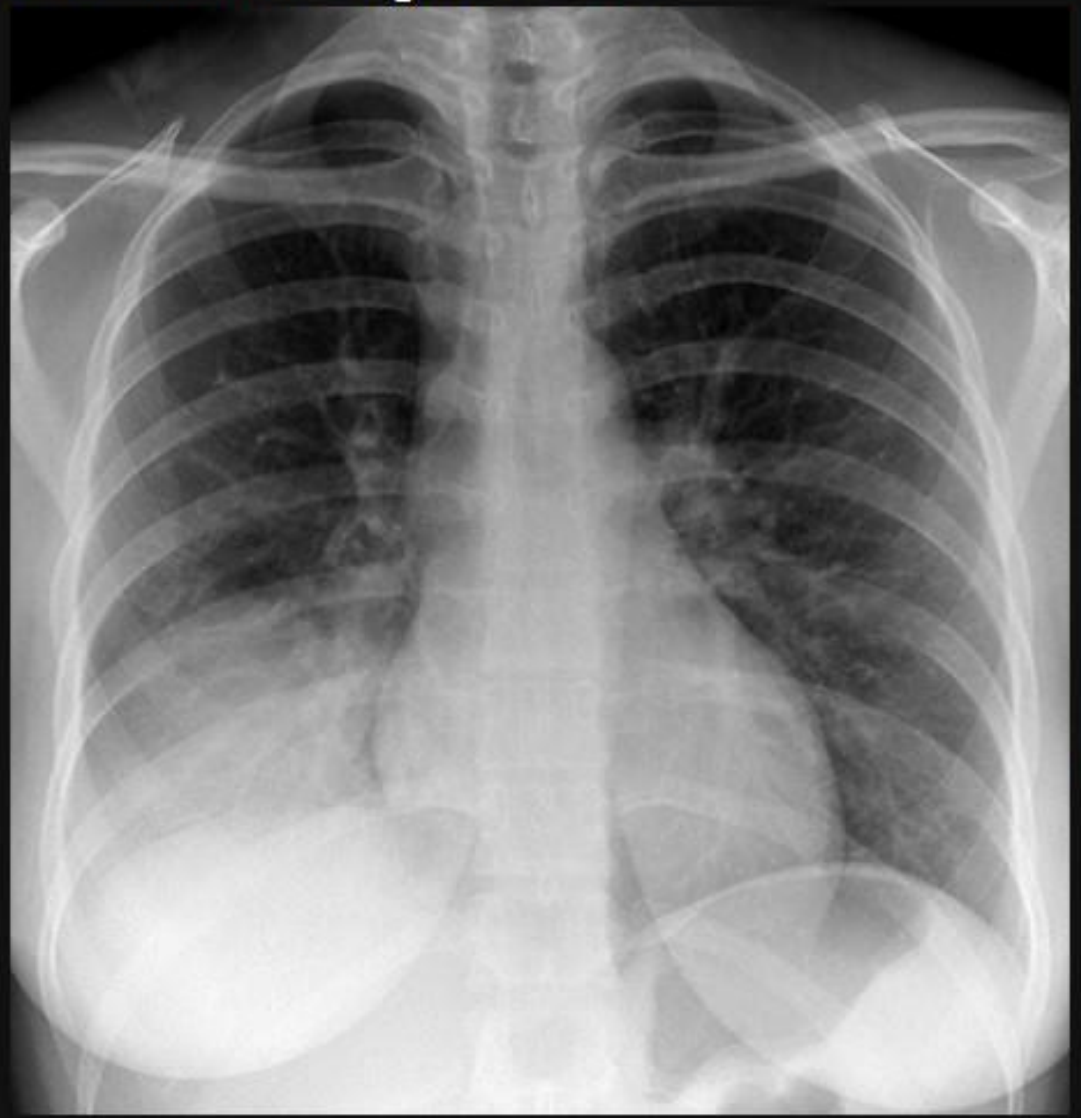


Hover on/off image to show/hide findings

Consolidation - Right middle lobe

- The right middle lobe is located below the horizontal fissure which confines the area of consolidation in this image
- The right middle lobe is also next to the right heart border which is obscured in this image

Consolidation - Right lower lobe



Hover on/off image to show/hide findings

Consolidation - Right lower lobe

- Both this image and the image above could correctly be described as showing consolidation of the right lower zone
- It is possible to determine that the consolidation in this image is in the right lower lobe rather than the middle lobe
- The right lower lobe is located adjacent to the right hemidiaphragm which is not clearly visible in this image
- The right heart border is still visible which indicates that the consolidation is not in the middle lobe
- These images demonstrate examples of the silhouette sign
- Read more about the silhouette sign

Consolidation - Right upper lobe

Consolidation - Right upper lobe

- Consolidation may be limited to a particular lobe of the lung
- This image shows consolidation of the right upper lobe which is confined inferiorly by the horizontal fissure
- If the consolidation is due to infection, then the term ‘lobar pneumonia’ is correctly used
- Lobar pneumonia is usually caused by typical organisms – such as *Streptococcus pneumoniae*