RESPIRATORY SYSTEM (II)

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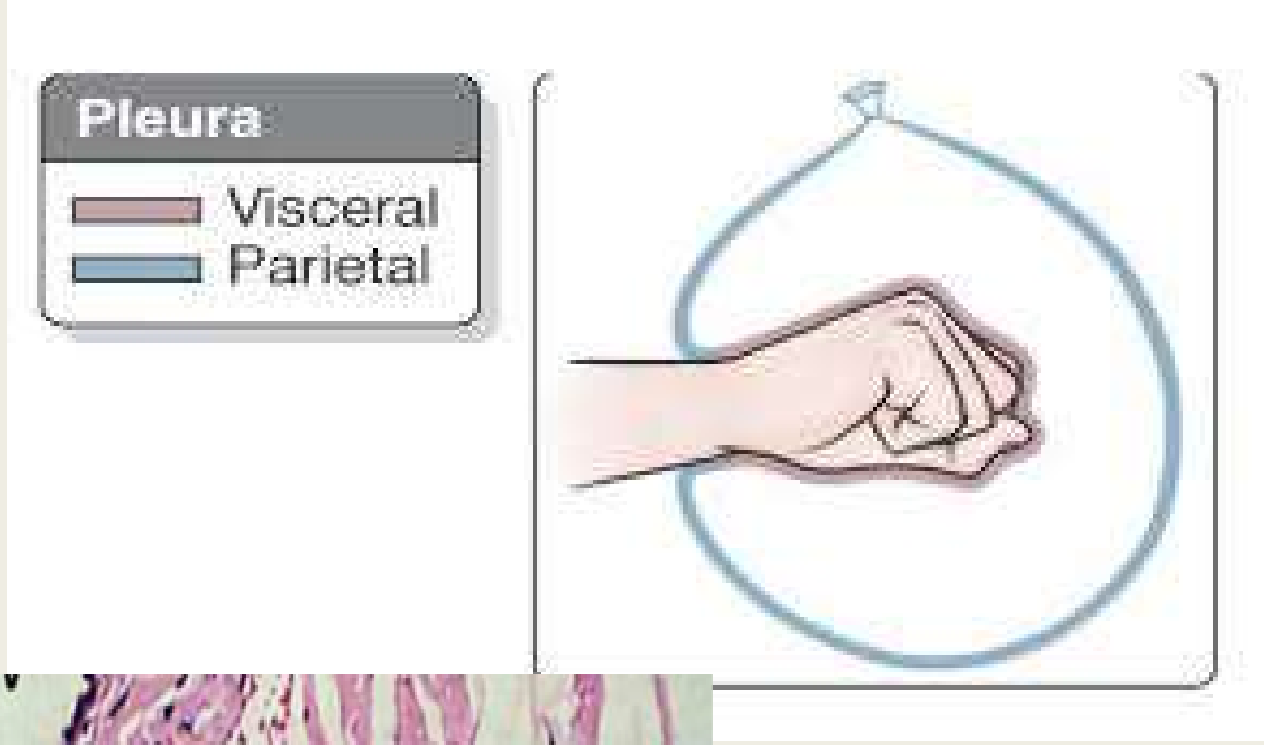
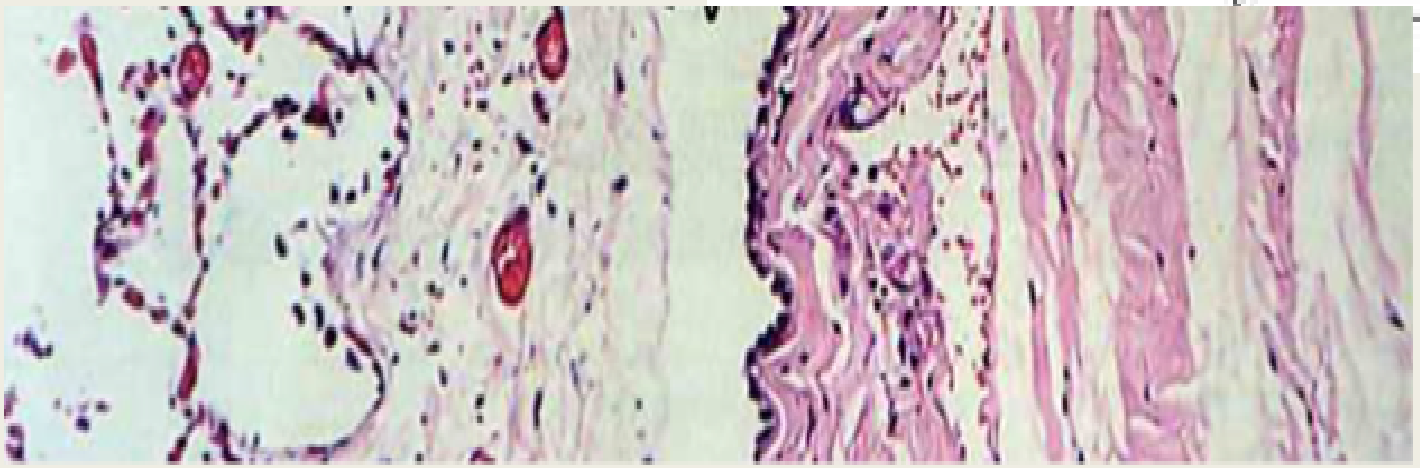
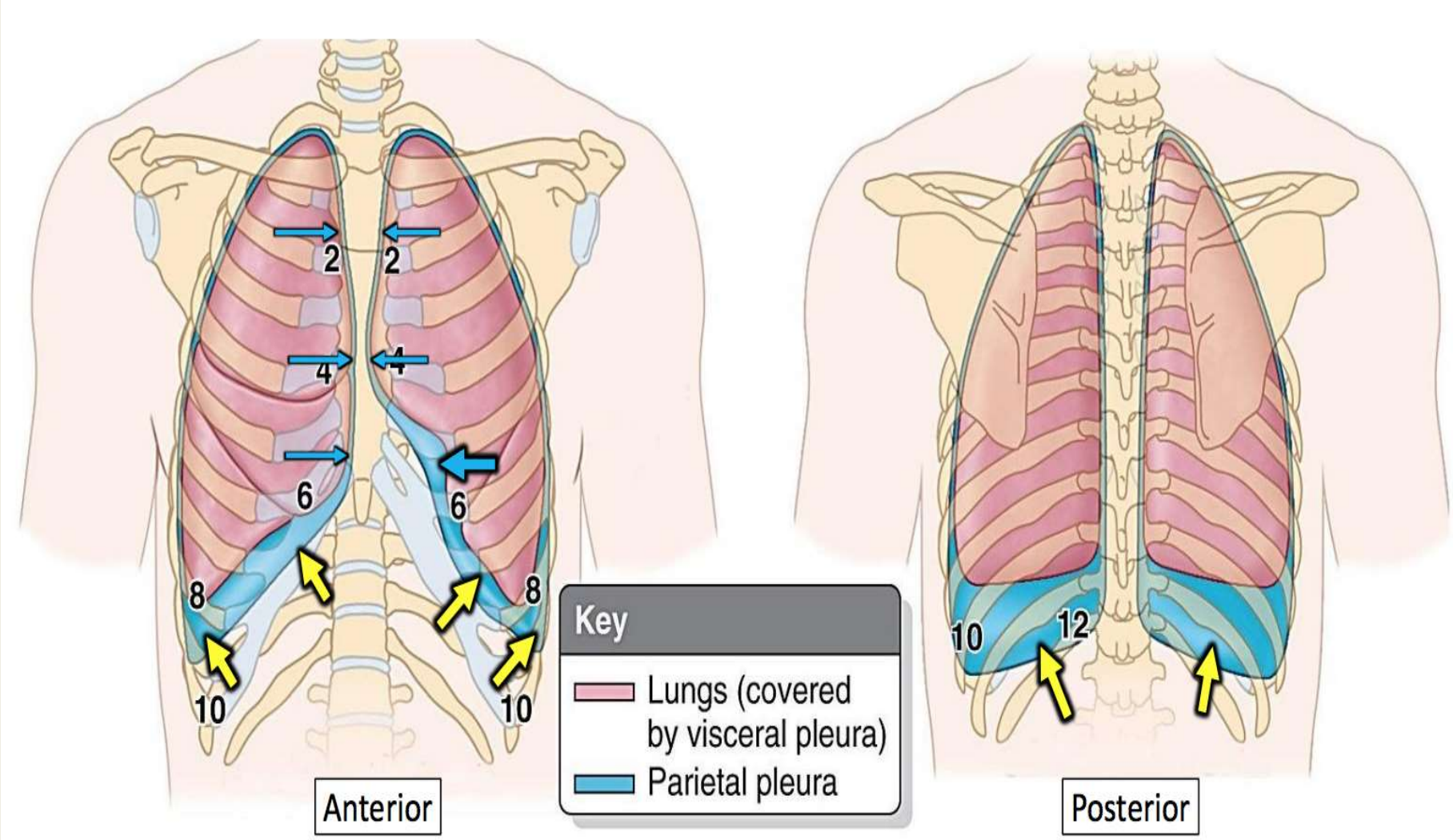
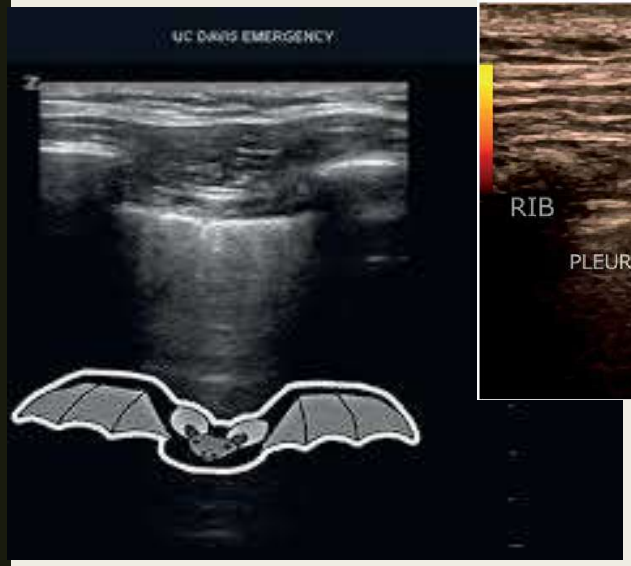
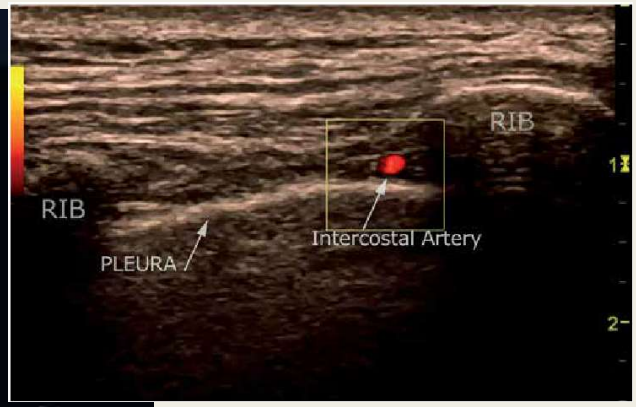
the Recap SEQUENCE

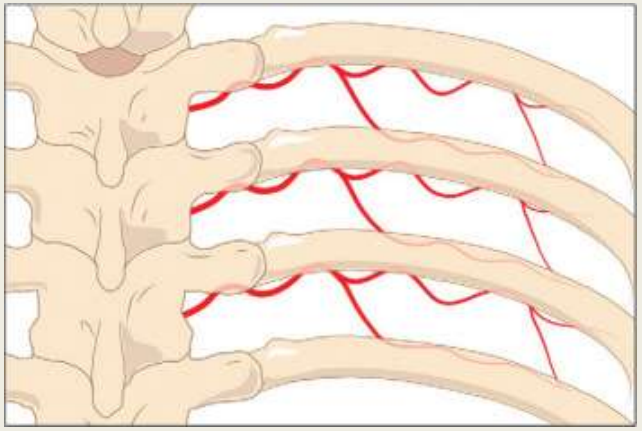


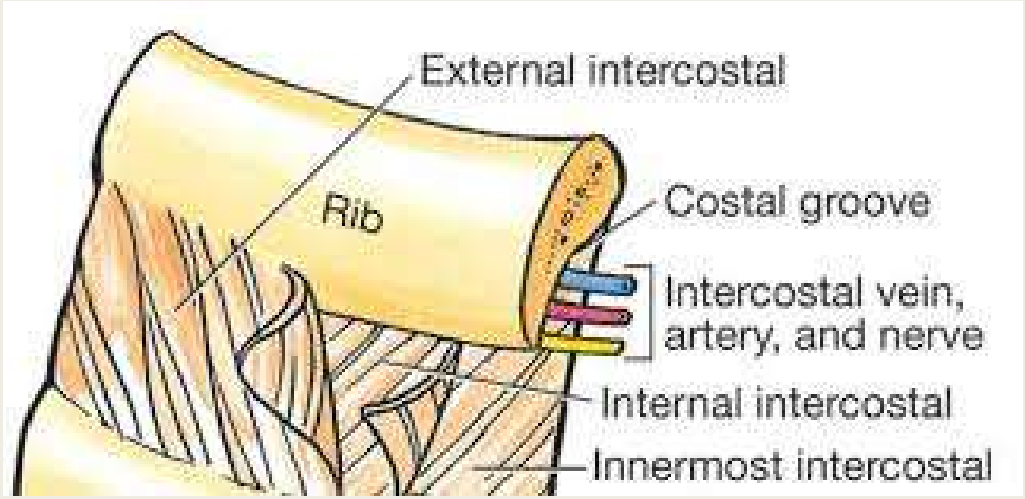



2
2
4
4
6
6
8
8
10
10
Anterior
Key
Lungs (covered by visceral pleura)
Parietal pleura
10
12
Posterior


UC DAVIS EMERGENCY


RIB
RIB
PLEURA
Intercostal Artery




External intercostal
Rib
Costal groove
Intercostal vein, artery, and nerve
Internal intercostal
Innermost intercostal


Rib
Hemithorax
Midline

Pleural space

increases in pleural fluid production cause fluid collections (effusions) in the pleural space

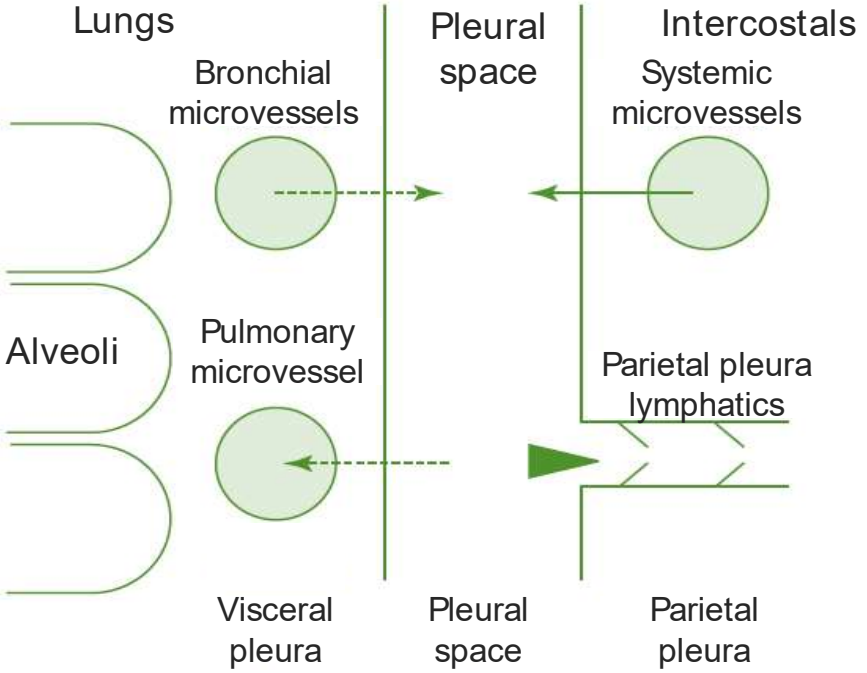
Pleural Fluid Sources and Drainage

Pleural space contains a minimal amount of fluid

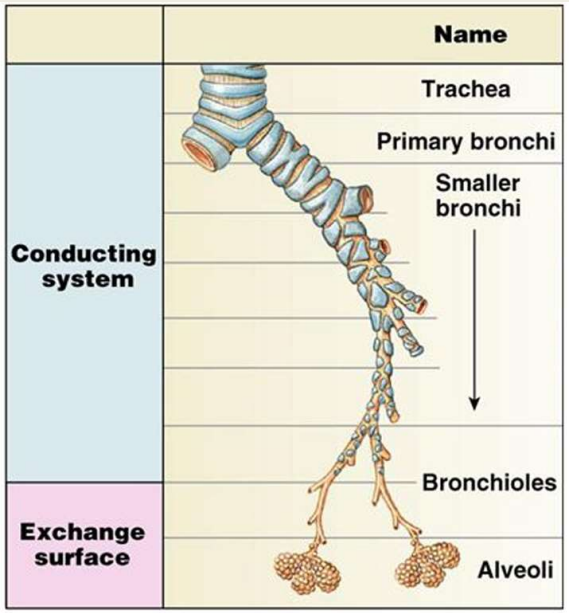
Fluid forms from bronchial and intercostal circulation

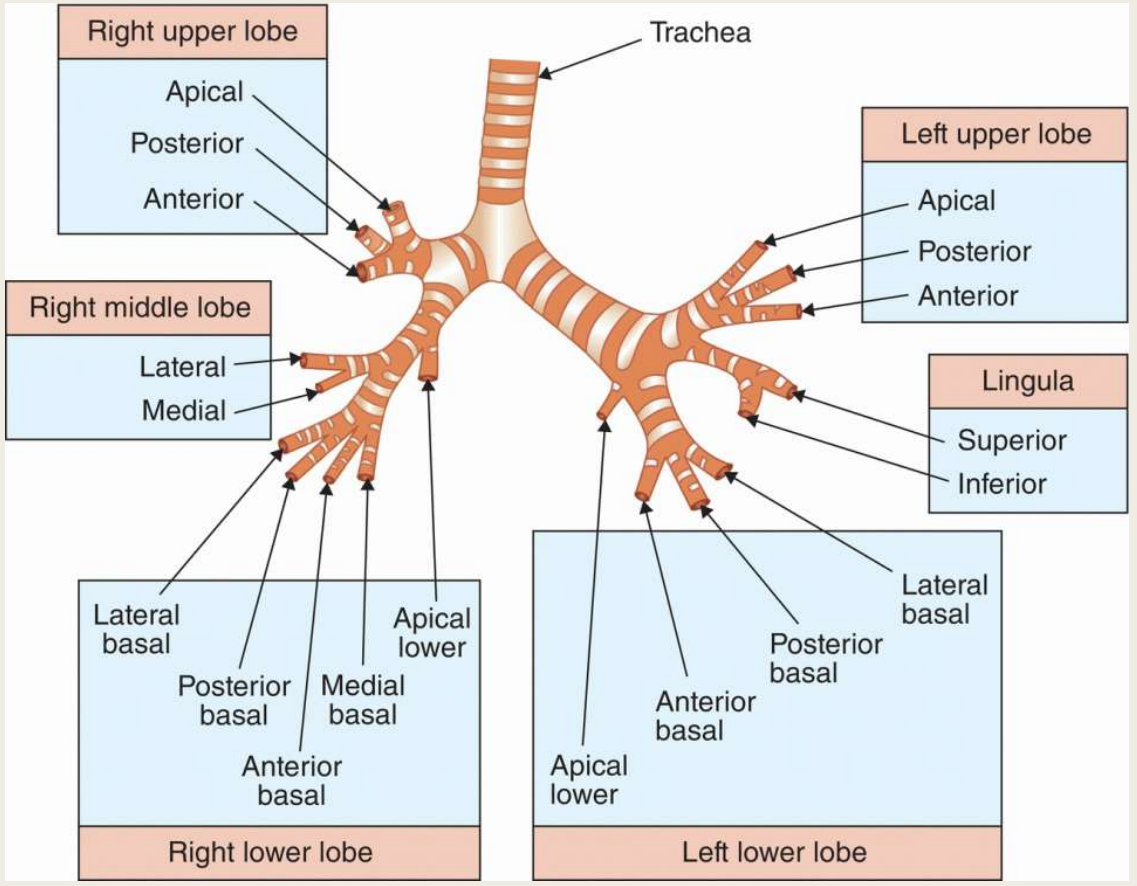
Pleural fluid drains into both parietal pleura and lung lymphatics

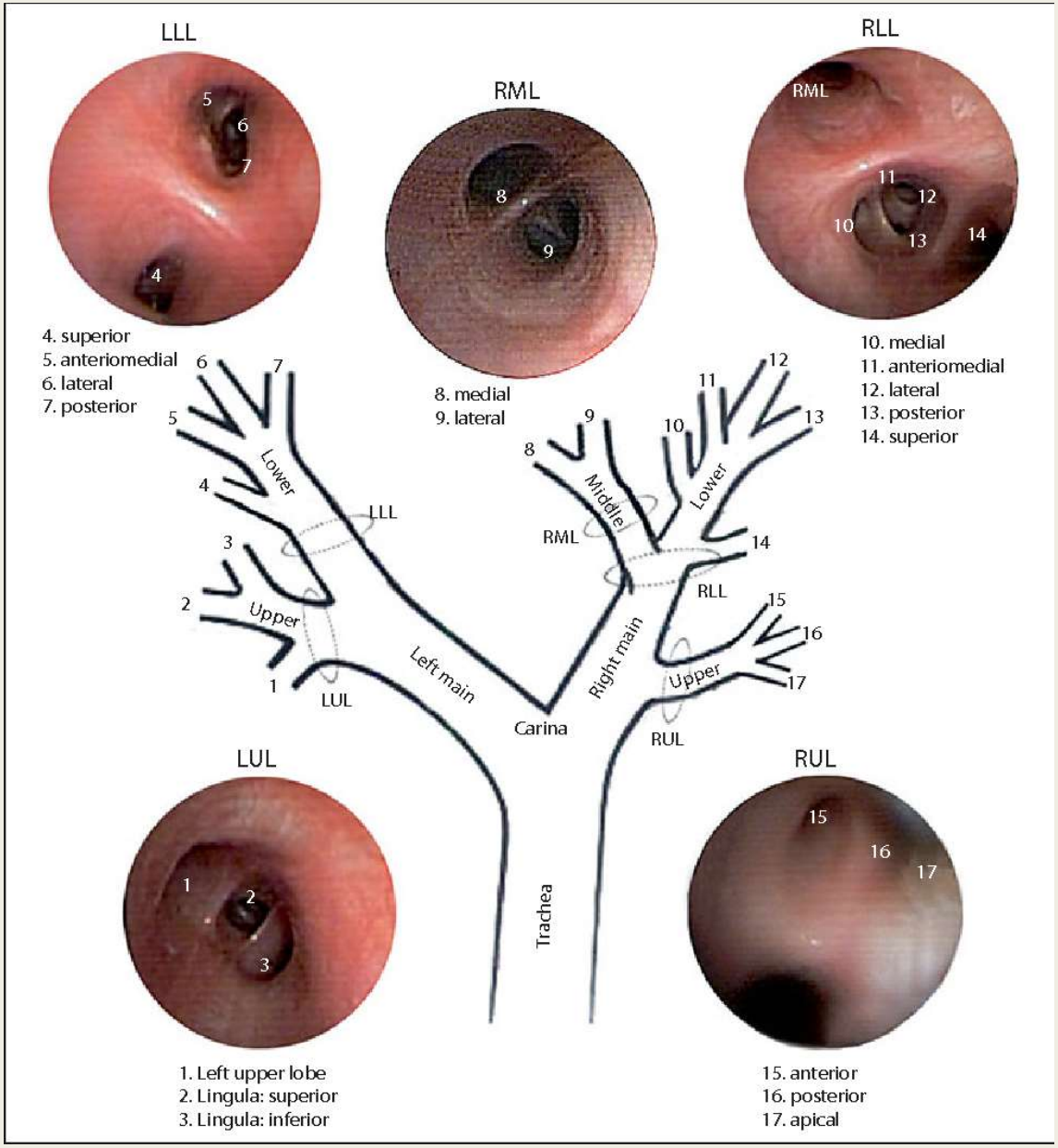
Pleural fluid cycles at 0.4 ml / kg / hour



Bronchial three






LLL
5
6
7
4
4. superior
5. anteriomedial
6. lateral
7. posterior
RML
8
9
8. medial
9. lateral
RLL
RML
11
12
10
13
14
10. medial
11. anteriomedial
12. lateral
13. posterior
14. superior
6
7
5
Lower
4
LLL
3
2
Upper
1
LUL
Left main
Carina
8
9
Middle
RML
10
11
12
13
Lower
14
RLL
Right main
15
16
Upper
17
RUL
Trachea
LUL
1
2
3
1. Left upper lobe
2. Lingula: superior
3. Lingula: inferior
RUL
15
16
17
15. anterior
16. posterior
17. apical

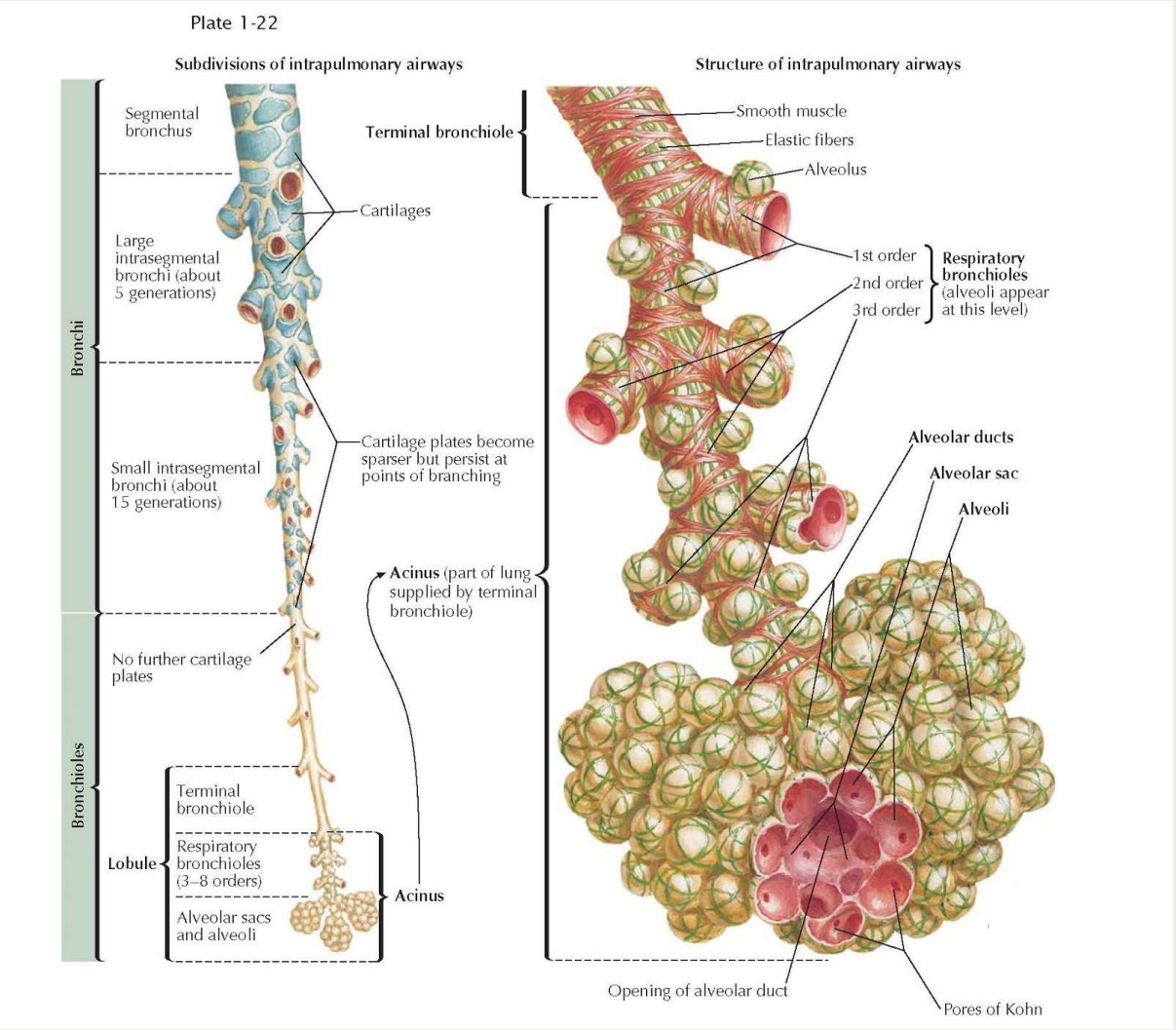
Bronchi

Bronchioles

Terminal bronchioles

Respiratory bronchioles

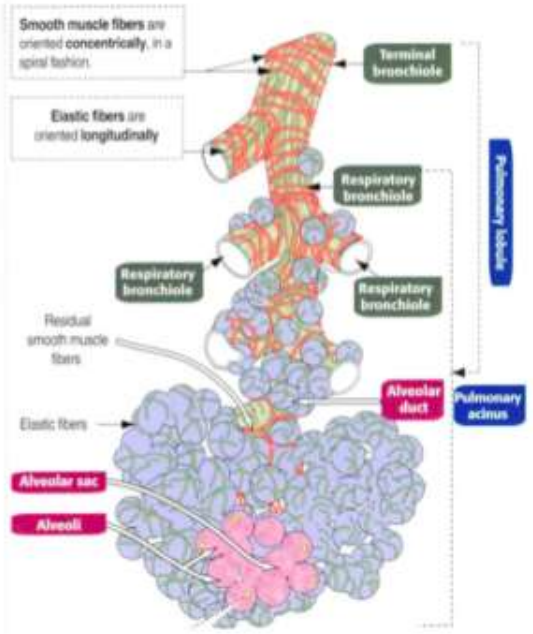
Alveoli

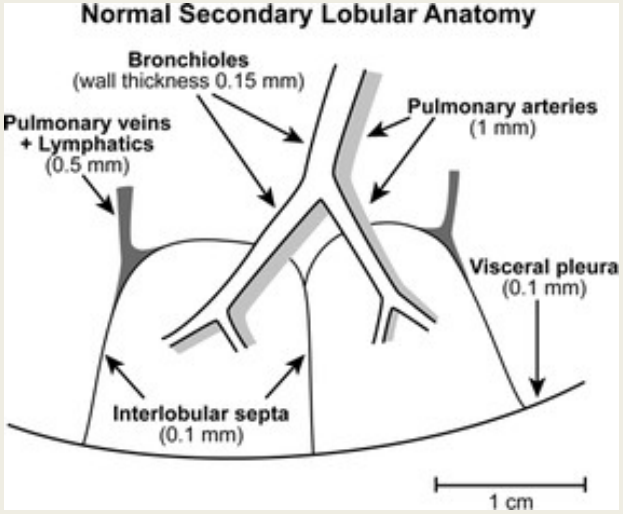


bronchopulmonary segment
portion of lung tissue supplied by a given tertiary (segmental) bronchus

pulmonary lobule
portion of lung tissue supplied by a given terminal bronchiole

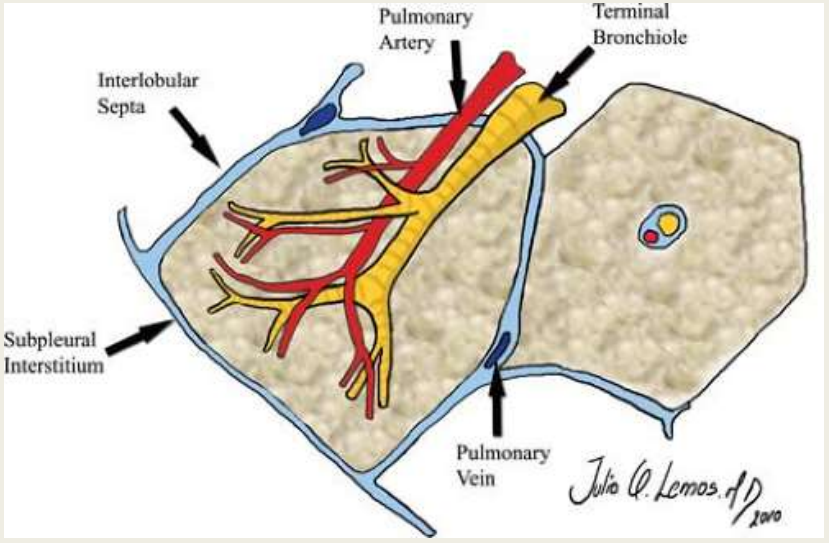
pulmonary acinus
portion of lung tissue supplied by a given respiratory bronchiole

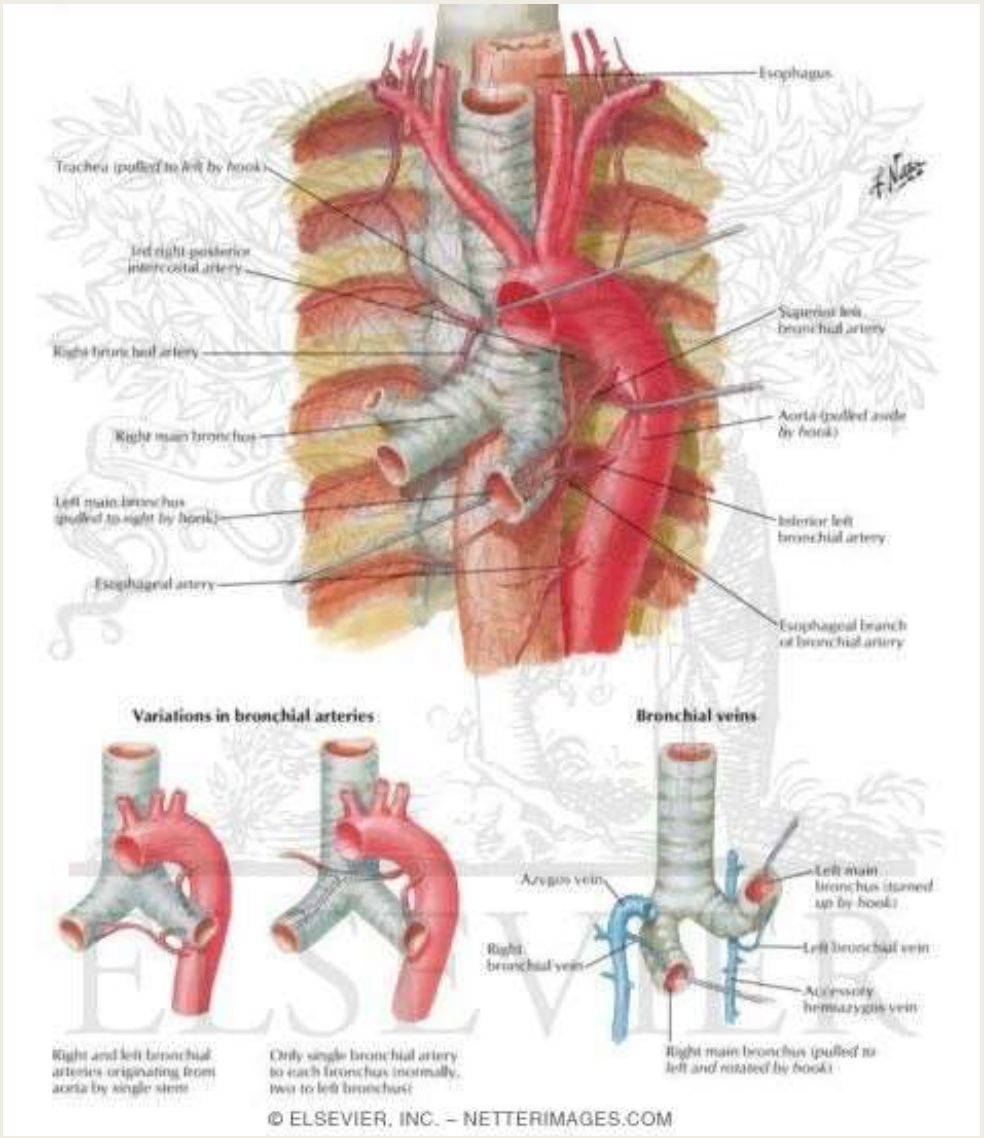




Secondary Pulmonary Lobulule

Supplied by a terminal bronchiole (size - up to 2.5 cm) bounded by fibrous (interlobular) septa and containing internal (interlobular) septa.
Contains up to 12 acini and 30 - 50 primary lobules.
blood supply - pulmonary artery branch
blood drainage - pulmonary veins located at lobule periphery though interlobular septa



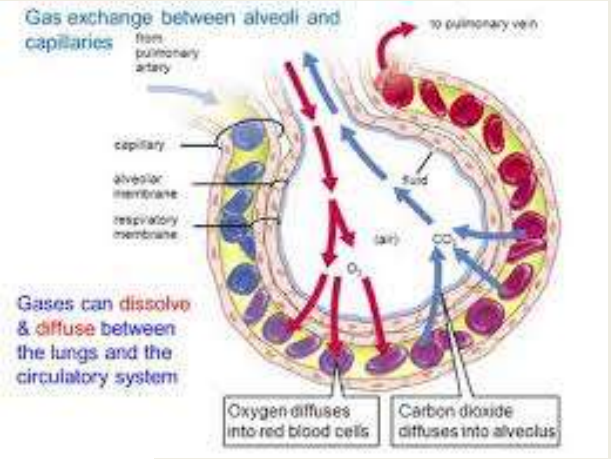


Pulmonary and Bronchial artery supply

Two arterial circulations to the lungs

1. Pulmonary arteries and veins

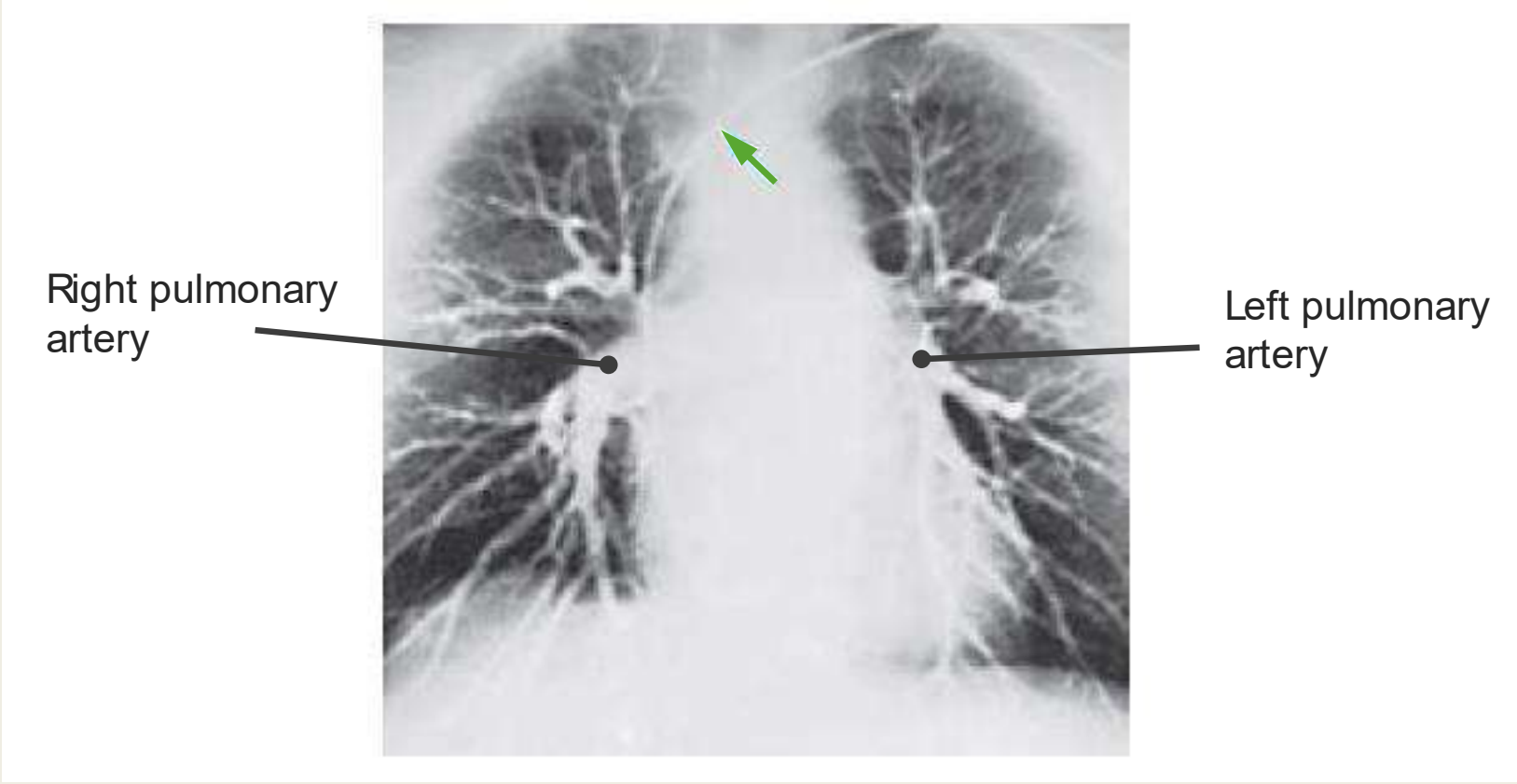
- Arise from the right ventricle and drain into the left atrium
- Involved in gas exchange
- Low pressure system



2. Bronchial arteries and veins

- Arise from the systemic circulation
- Provide oxygenated blood to lung tissue
- High pressure system

Pulmonary artery



Pulmonary Artery

Arise from the right ventricle as the pulmonary trunk

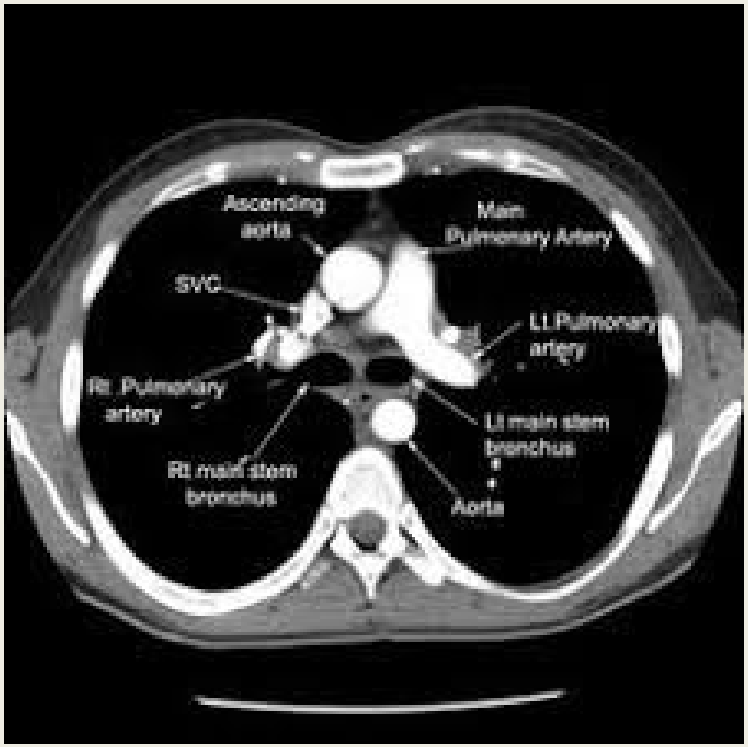
Divides into right and left pulmonary arteries adjacent to the carina

Enter the lung at the hilar

Further divisions follow each bronchial division

Each bronchus therefore has an accompanying bronchial artery

Eventually divide into pulmonary arterioles that form capillary plexi over the alveoli



Pulmonary artery

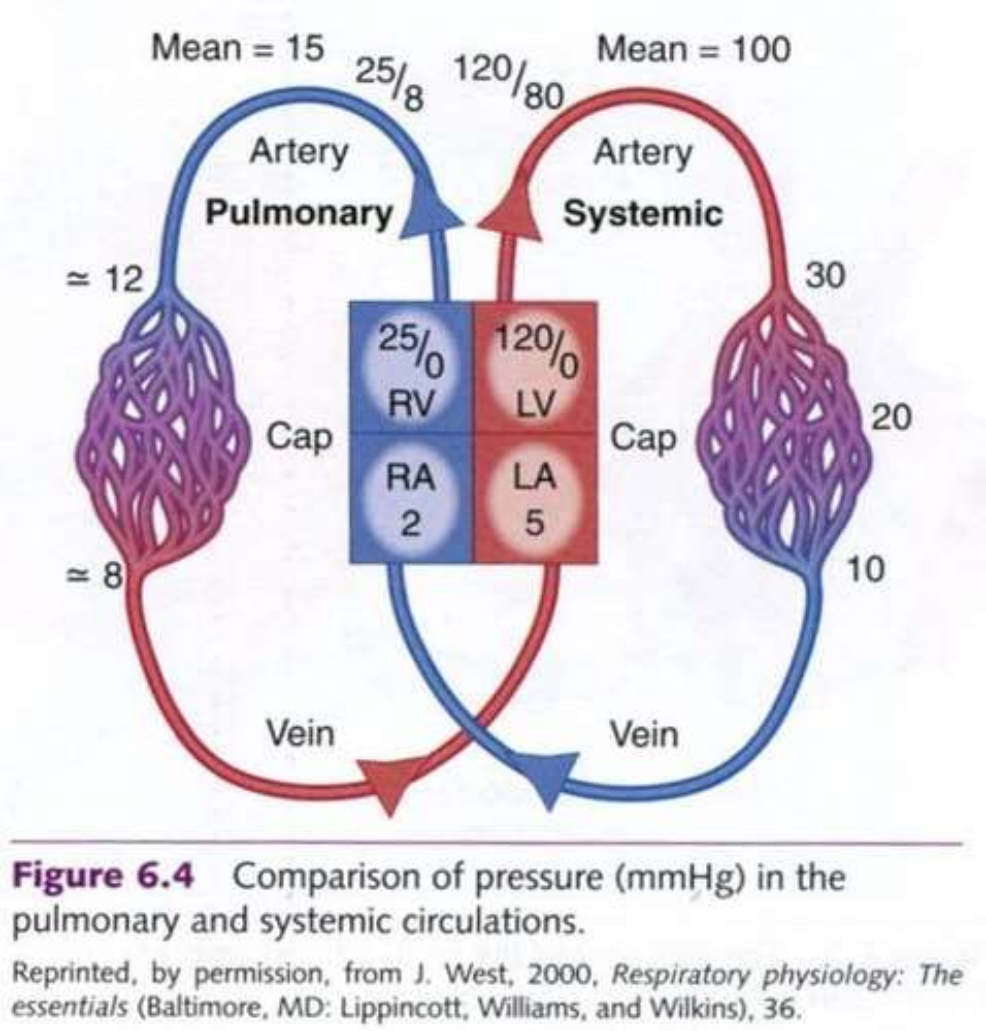
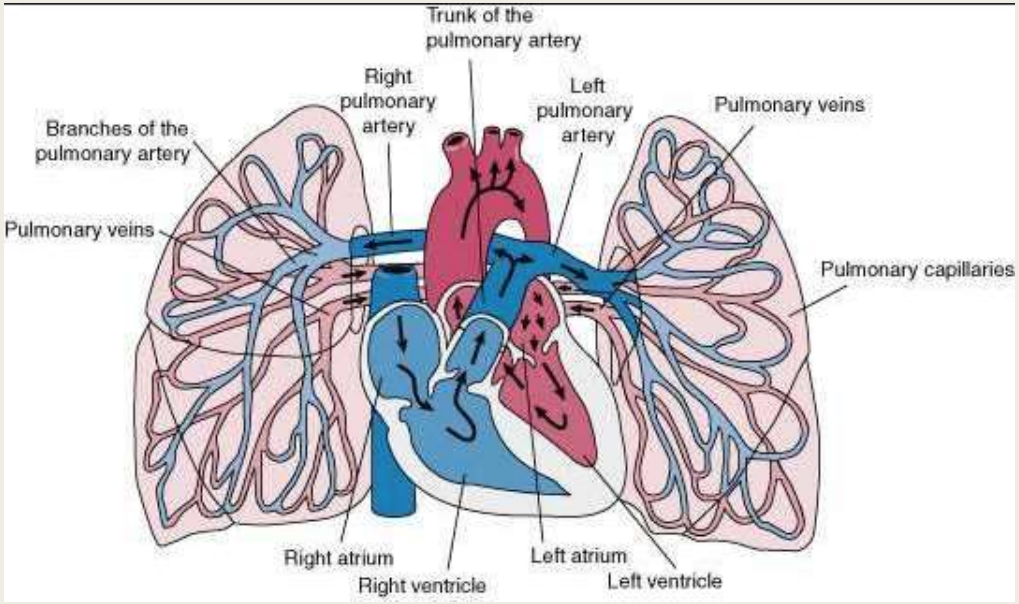


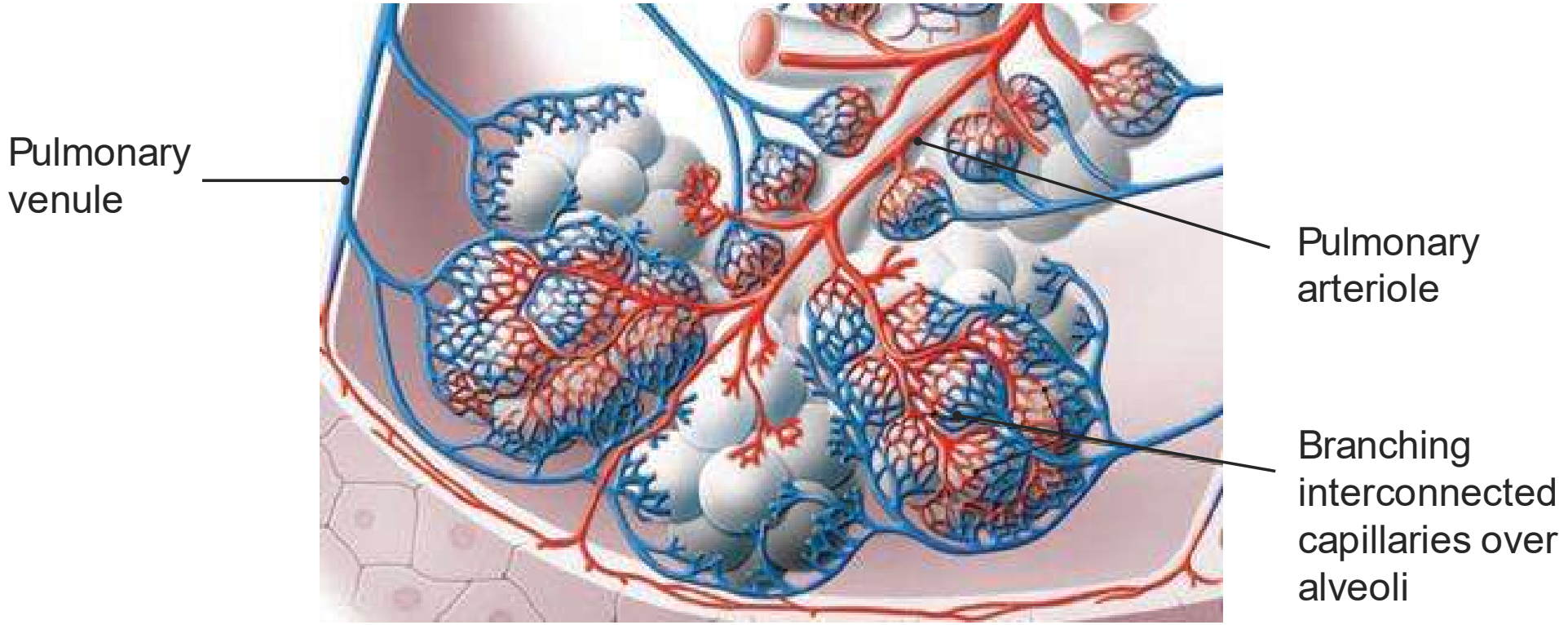
Figure 6.4 Comparison of pressure (mmHg) in the pulmonary and systemic circulations.

Reprinted, by permission, from J. West, 2000, *Respiratory physiology: The essentials* (Baltimore, MD: Lippincott, Williams, and Wilkins), 36.



Pulmonary circulation
(Low pressure)

Systemic circulation
(High pressure)


Pulmonary venule
Pulmonary arteriole
Branching interconnected capillaries over alveoli

Pulmonary capillaries merge to form pulmonary venules which in turn form pulmonary veins

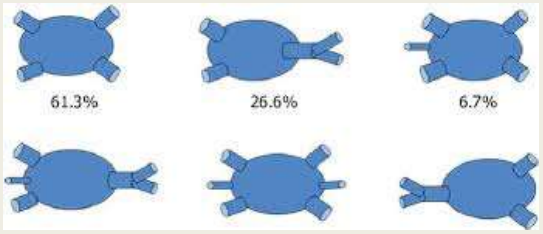
Pulmonary veins accompany the bronchial tree

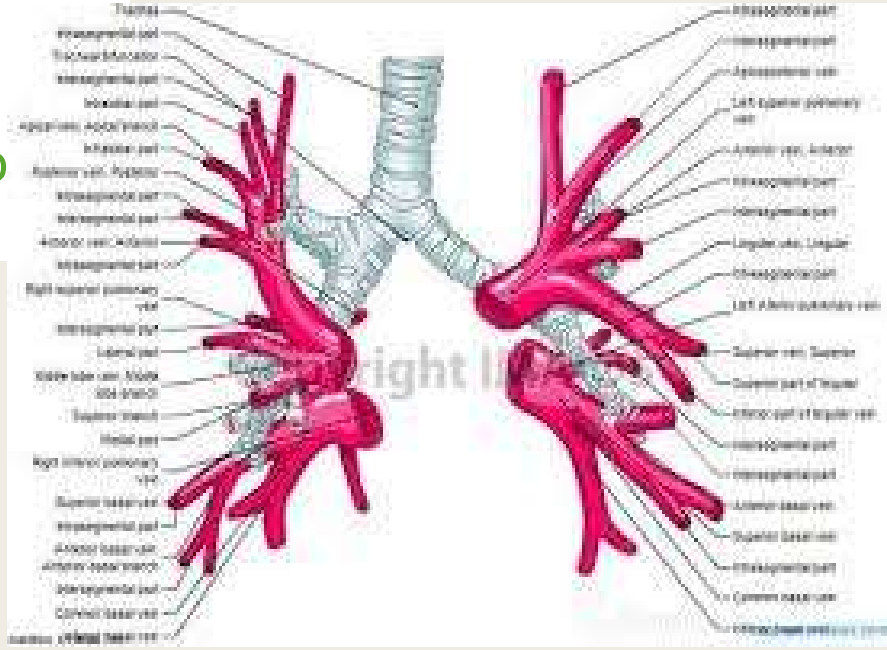
Hence form in reverse a similar branching pattern as pulmonary arteries

Leave the lungs at the hilar as right and left inferior and superior pulmonary veins

The superior pulmonary veins drain directly into the left atrium

2 veins for left atrium each lungs





Bronchial artery

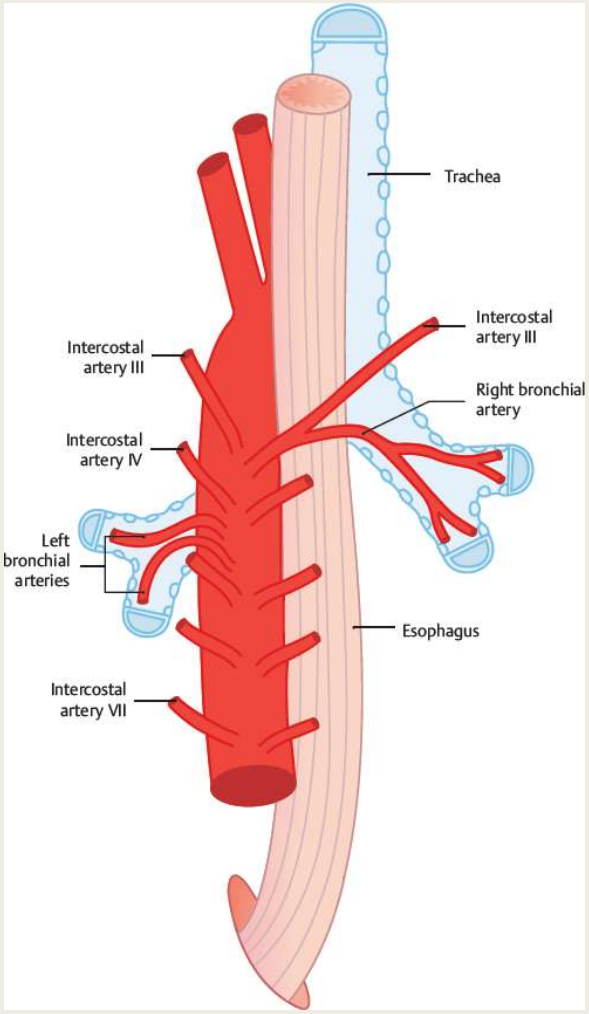
Supply blood to

- Airways down to the level of the terminal bronchioles
- Visceral pleura
- Intrapulmonary blood vessel walls and the lymphatics

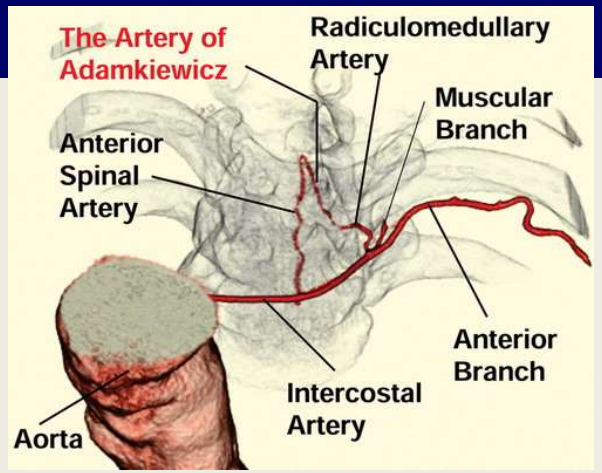
Bronchial artery

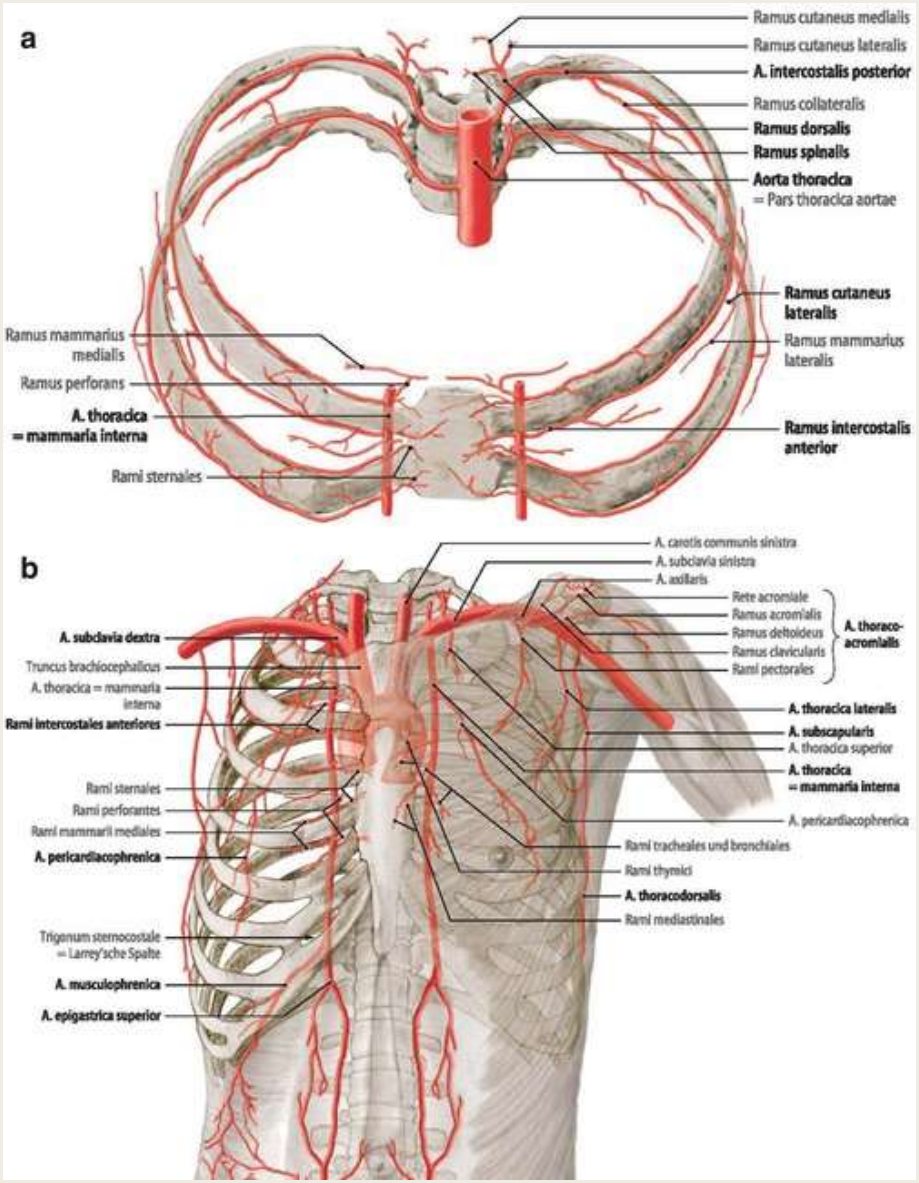
Origins (can be variable)

- Right bronchial artery arises from 3rd or 4th intercostal artery
- Left bronchial artery arises directly from the aorta

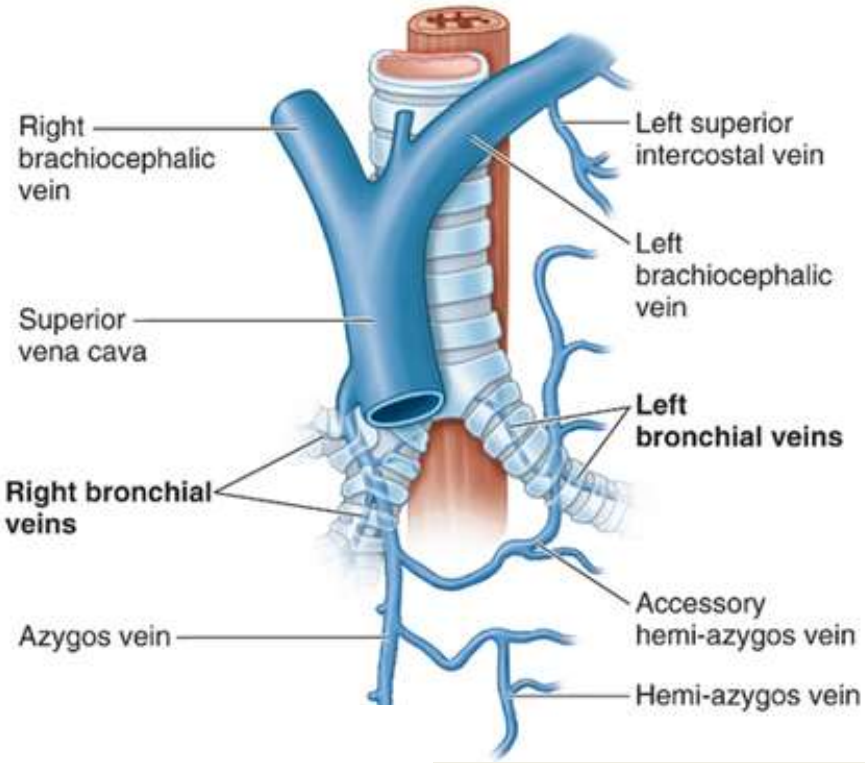


- Sometimes part of blood supply of anterior spinal artery come from bronchial vessels.
- When bronchial artery embolization is performed, consideration must be given to the arterial supply to the spinal cord.
- **Most important is Anterior Spinal Artery.**
- Anterior spinal artery receives contributions from the anterior radiculo medullary branches of the intercostals and lumbar arteries.





Bronchial veins



Drainage

- Azygous (right) and hemiazygous (left) veins
- Also partially through pulmonary capillaries

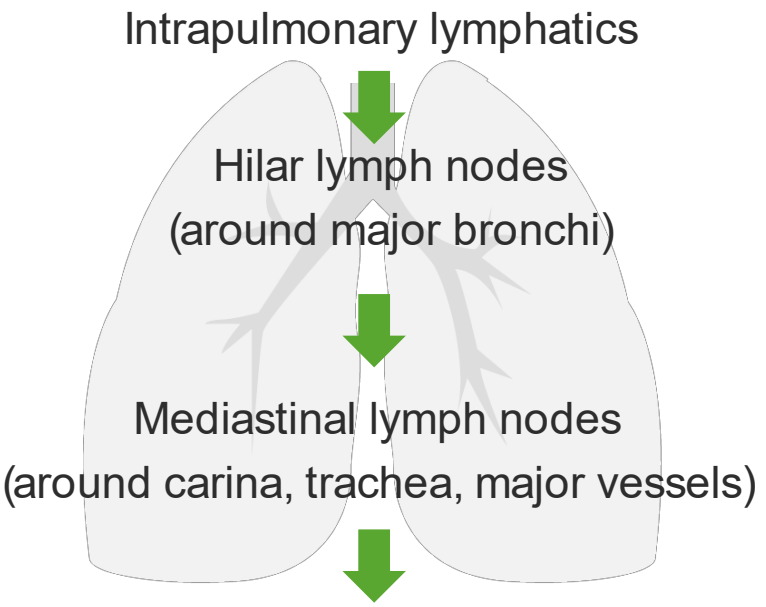
Lymphatics

Lung lymphatics drain

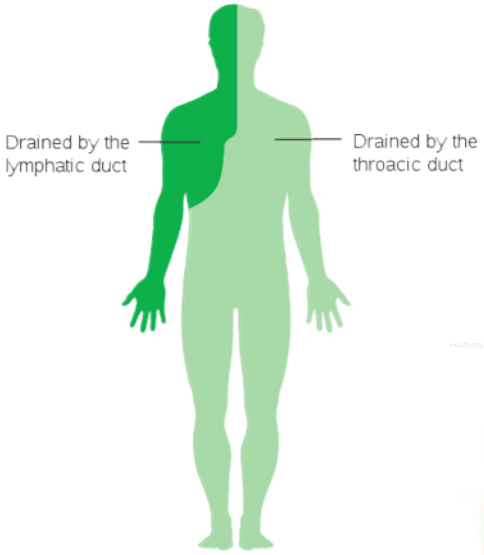
- Lung parenchyma
- Airways
- Visceral pleura

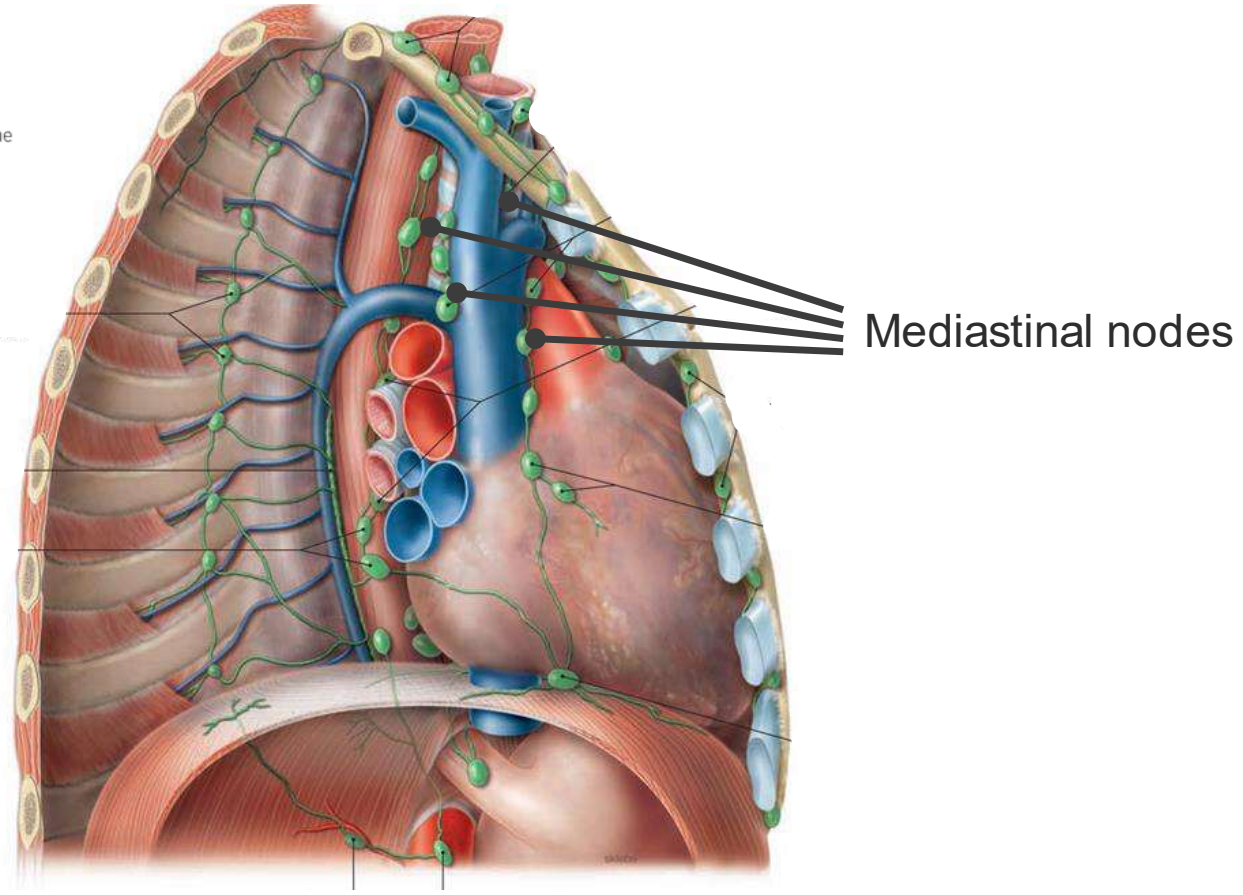
Clinical relevance

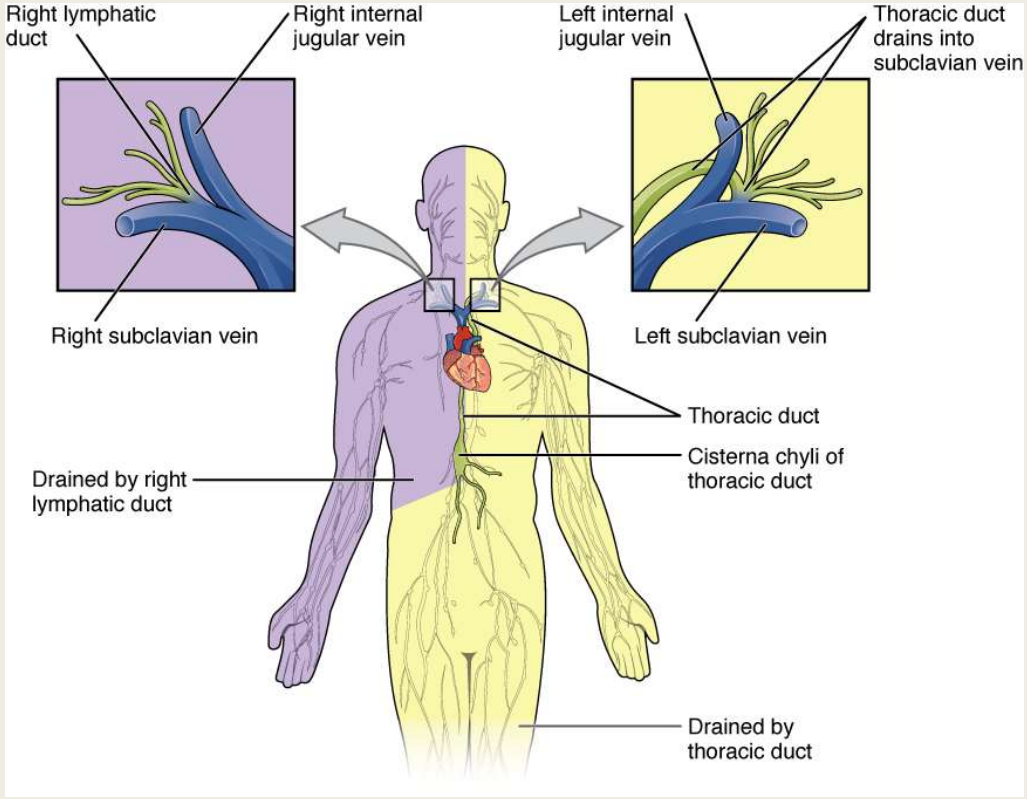
Lymphatic drainage often dictates spread and extent (the stage) of lung cancers

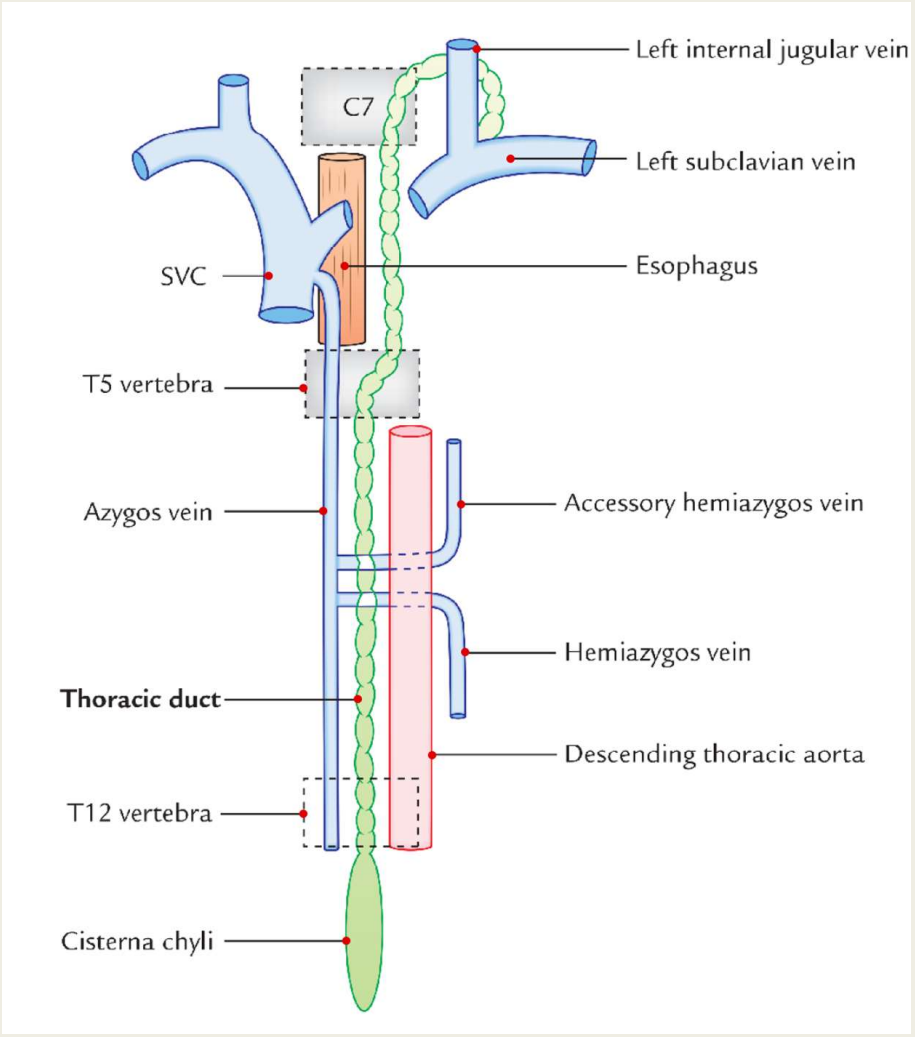


Multiple Nodes Closely Positioned Around Various Large Vessels

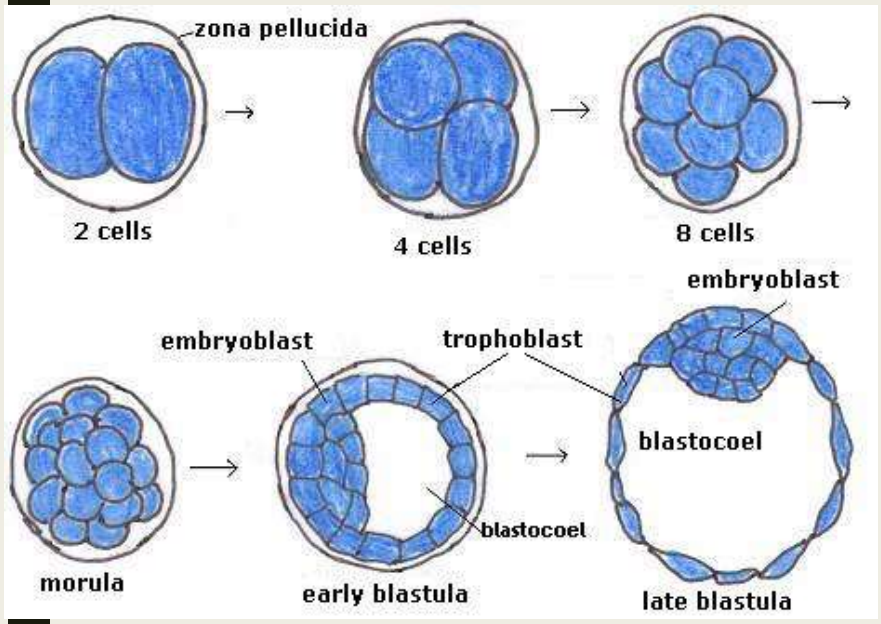


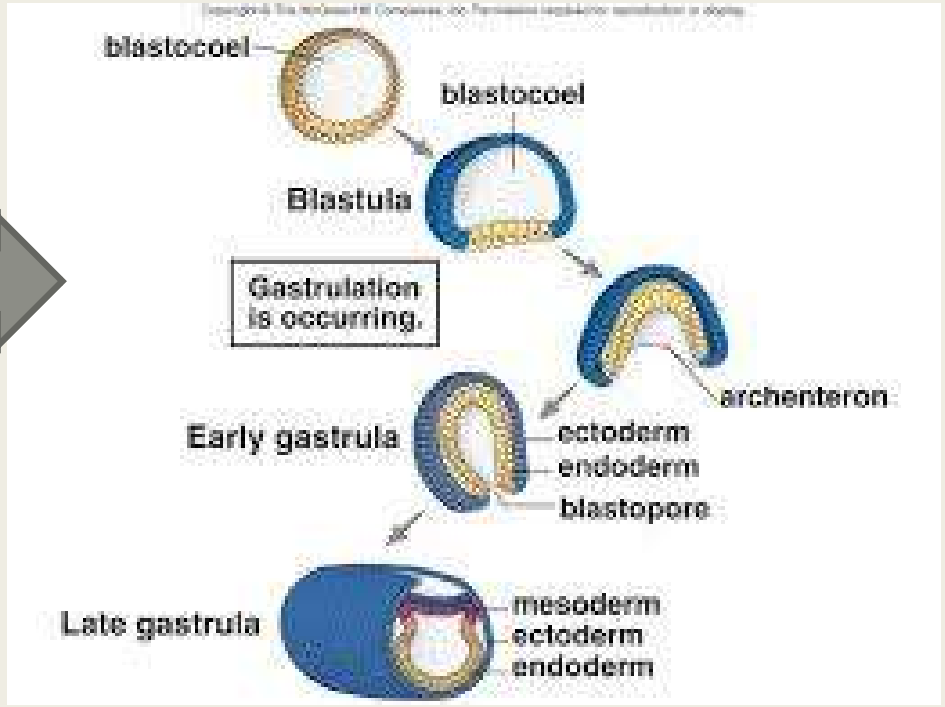



Right lymphatic duct
Right internal jugular vein
Left internal jugular vein
Thoracic duct drains into subclavian vein
Right subclavian vein
Left subclavian vein
Thoracic duct
Cisterna chyli of thoracic duct
Drained by right lymphatic duct
Drained by thoracic duct


Left internal jugular vein
C7
Left subclavian vein
SVC
Esophagus
T5 vertebra
Azygos vein
Accessory hemiazygos vein
Hemiazygos vein
Thoracic duct
Descending thoracic aorta
T12 vertebra
Cisterna chyli

Embriology of Respiratory tract





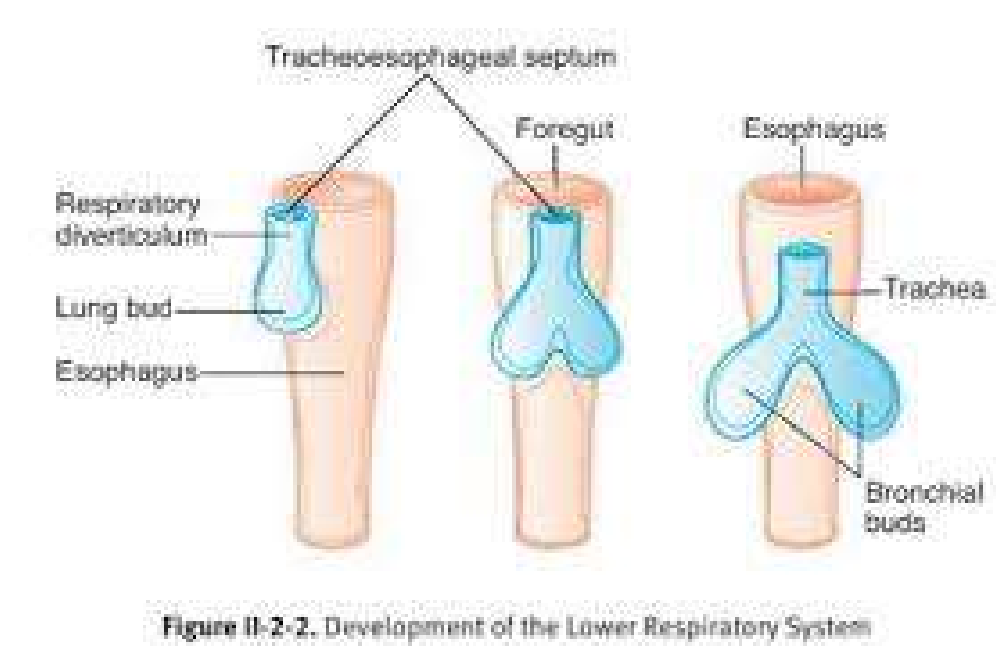
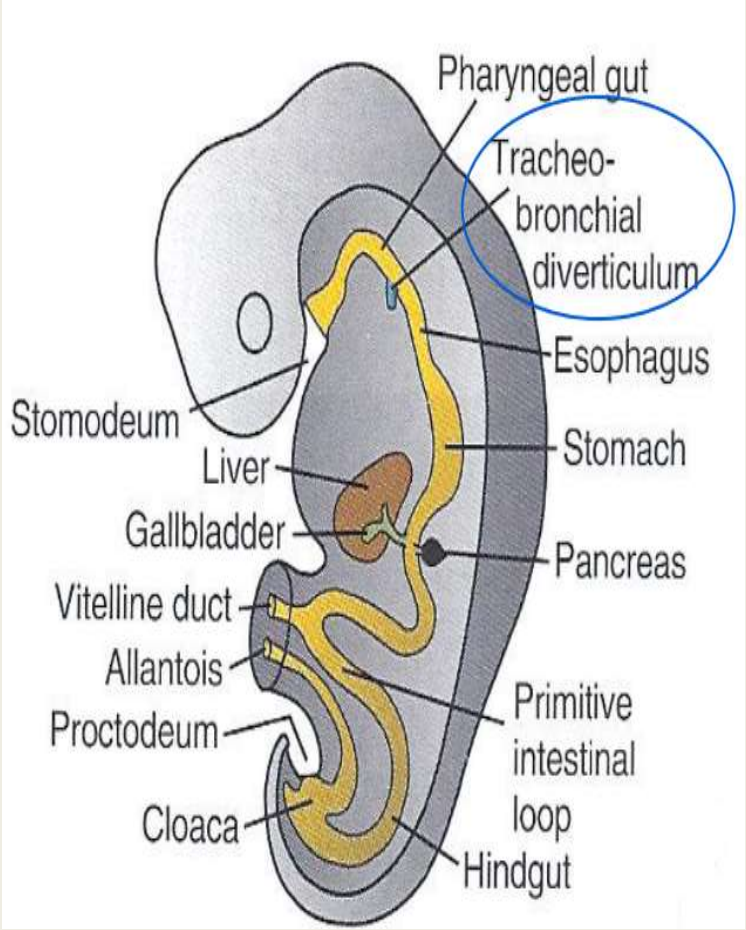


Figure II-2-2. Development of the Lower Respiratory System

At week 4 of development, Respiratory diverticulum appears as a bud from ventral wall of the foregut.



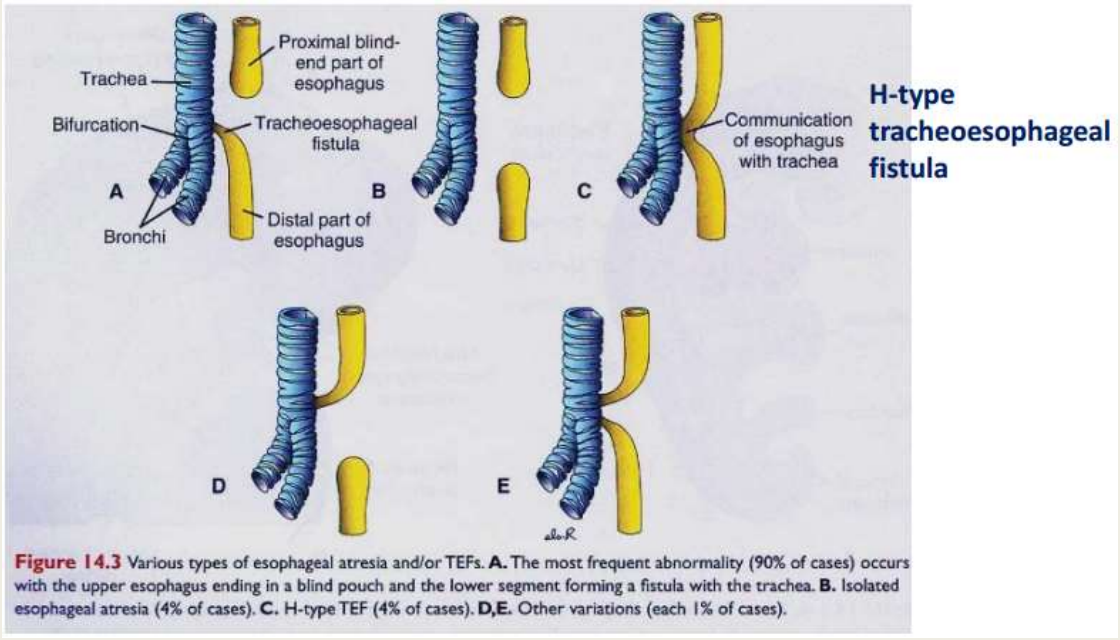


Figure 14.3 Various types of esophageal atresia and/or TEFs. **A.** The most frequent abnormality (90% of cases) occurs with the upper esophagus ending in a blind pouch and the lower segment forming a fistula with the trachea. **B.** Isolated esophageal atresia (4% of cases). **C.** H-type TEF (4% of cases). **D,E.** Other variations (each 1% of cases).

Esophageal atresia with or withouttracheoesophageal fistulas (TEFs)

Due to abnormalities in partitioning of esophagus and trachea by the tracheoesophageal septum

Tracheoesophageal septum divides the foregut into a dorsal portion

At week 5 left and right lung buds push into the pericardioperitoneal canals (pleural cavity)

At week 6 pleuroperitoneal foramen closes.
At week 8 enlargement of liver stops descent of heart and lungs

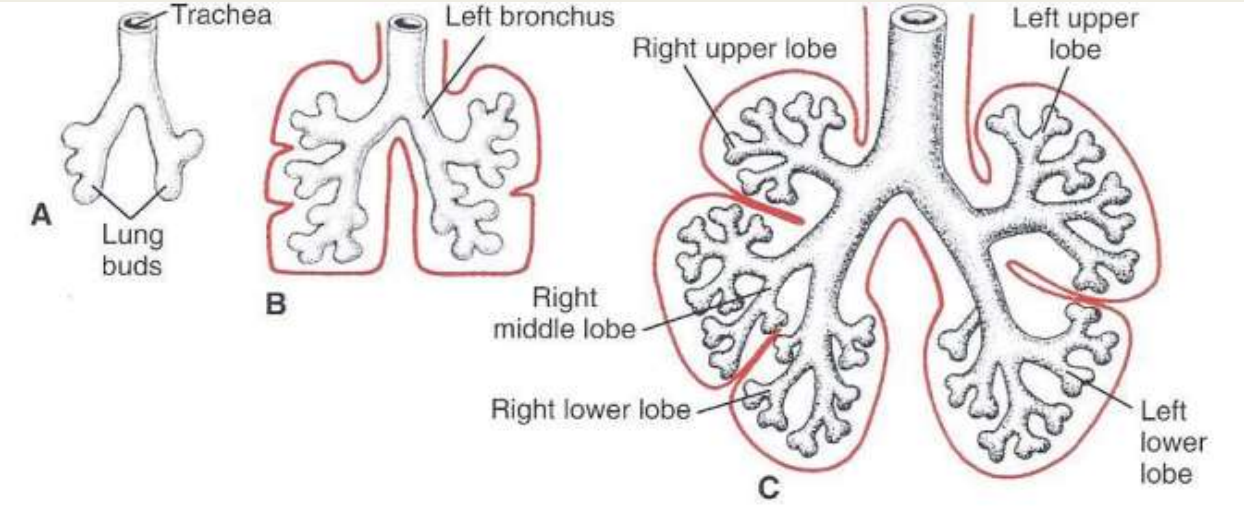


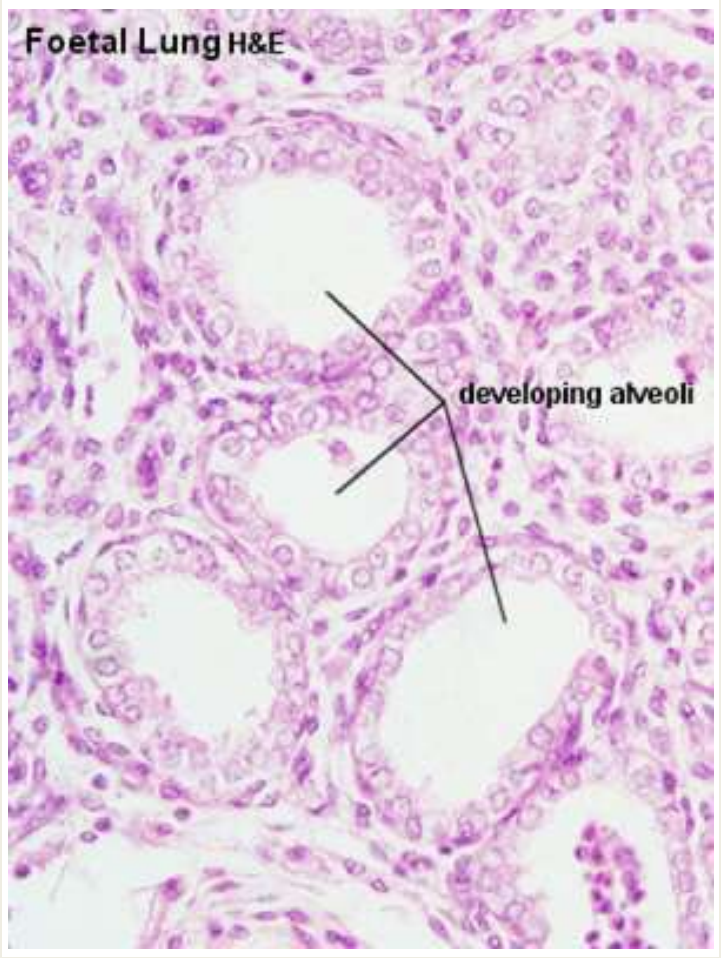
Figure 14.5 Stages in development of the trachea and lungs. **A.** 5 weeks. **B.** 6 weeks. **C.** 8 weeks.

Lung development stages

Stage	Human	Features
Embryonic	week 4 to 5	lung buds originate as an outgrowth from the ventral wall of the foregut where lobar division occurs
Pseudoglandular	week 5 to 17	conducting epithelial tubes surrounded by thick mesenchyme are formed, extensive airway branching
Canalicular	week 16 to 25	bronchioles are produced, increasing number of capillaries in close contact with cuboidal epithelium and the beginning of alveolar epithelium development
Saccular	week 24 to 40	alveolar ducts and air sacs are developed
Alveolar	late fetal to 8 years	secondary septation occurs, marked increase of the number and size of capillaries and alveoli

Endoderm - tubular ventral growth from foregut pharynx
Mesoderm - mesenchyme of lung buds

Pseudoglandular stage
Lungs have appearance of a glandlike structure. stage is critical for the formation of all conducting airways.
lined with **tall columnar epithelium**
more distal structures are lined with **cuboidal epithelium**



Canalicular stage
differentiation of epithelium results in the formation of the future air-blood tissue barrier.
Surfactant synthesis and the canalization of the lung parenchyma by capillaries begin.
Gas exchange regions can be distinguished from the future conducting airways of the lungs

Saccular stage
Most peripheral airways form widened "airspaces", termed **saccules**.
Saccules widen and lengthen the airspace (by the addition of new generations).
Alveolar Cells Type II begin to secrete **surfactant**, levels of secretion gradually increase to term. Vascular three also grows in lenght and diameter

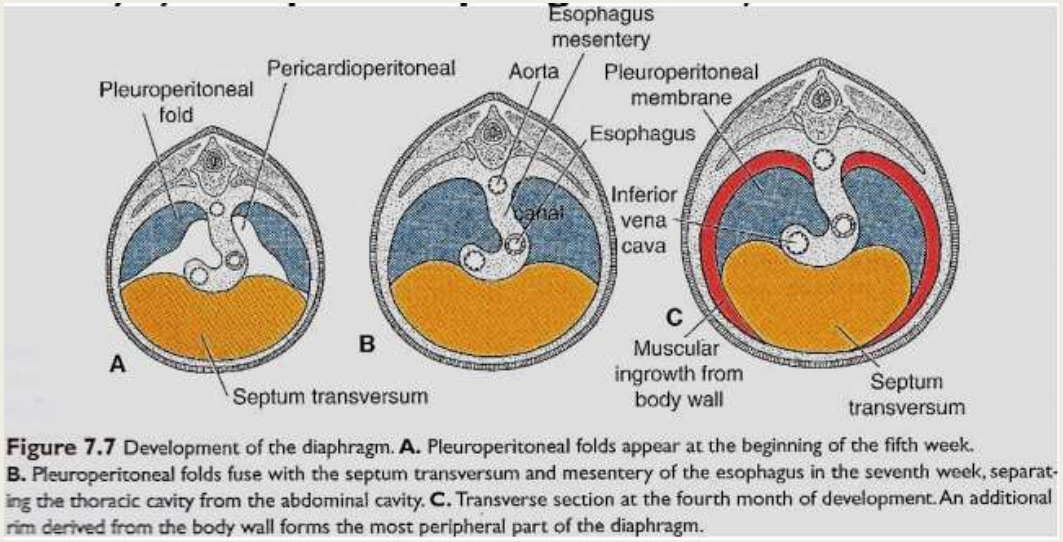
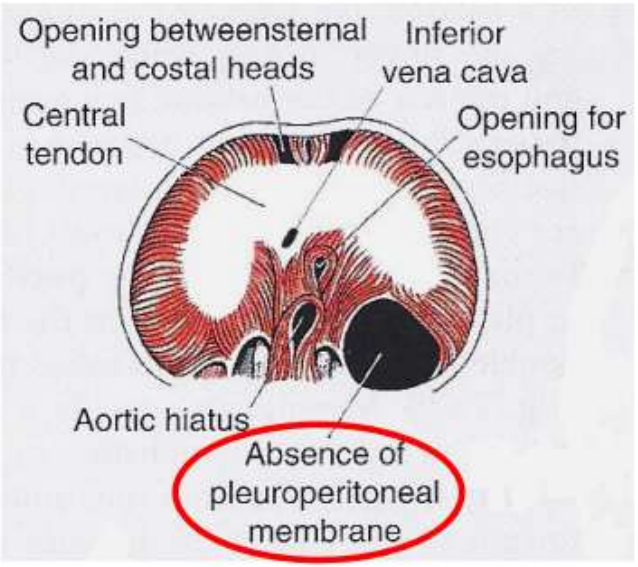
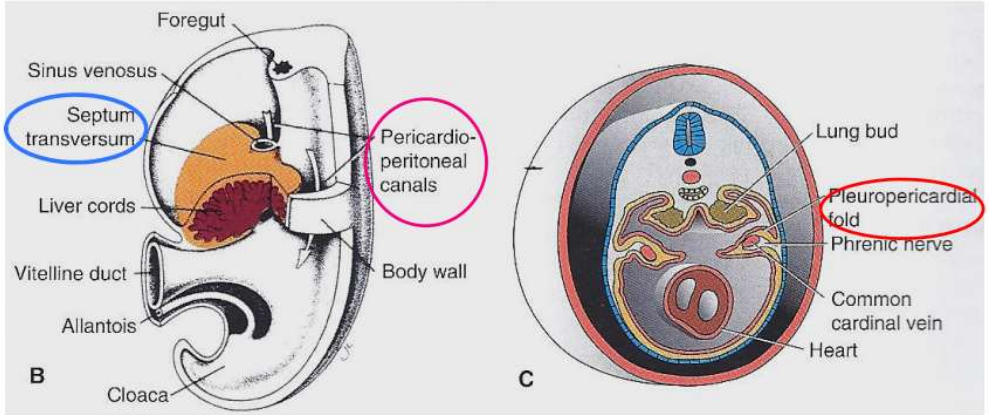
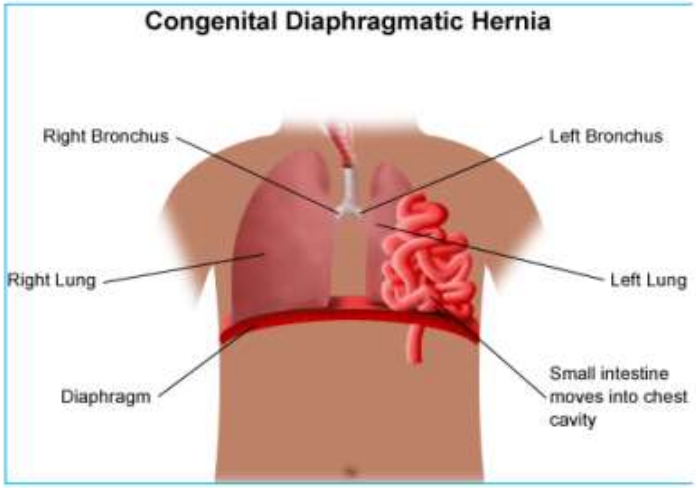


Figure 7.7 Development of the diaphragm. **A.** Pleuroperitoneal folds appear at the beginning of the fifth week. **B.** Pleuroperitoneal folds fuse with the septum transversum and mesentery of the esophagus in the seventh week, separating the thoracic cavity from the abdominal cavity. **C.** Transverse section at the fourth month of development. An additional rim derived from the body wall forms the most peripheral part of the diaphragm.



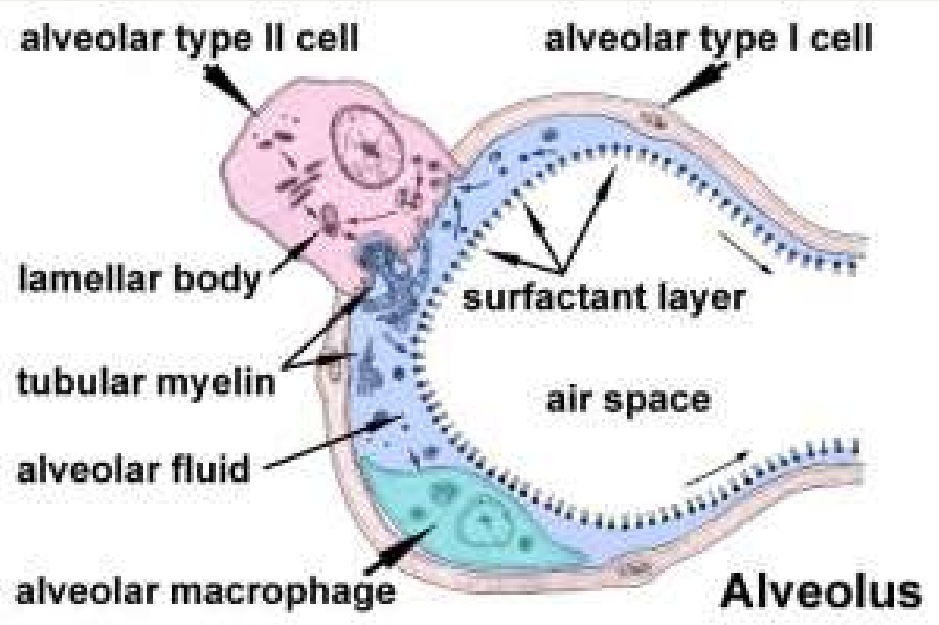


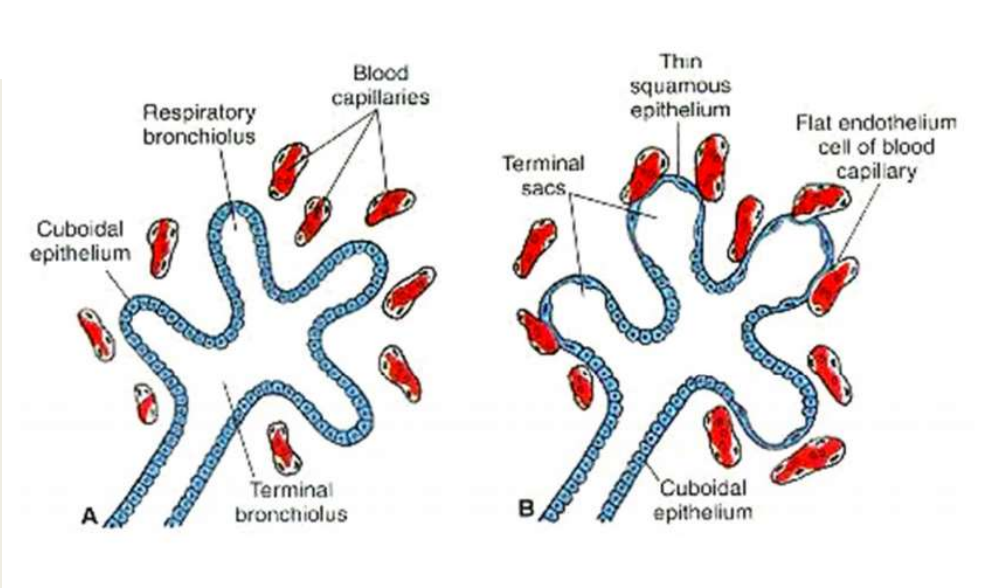
B. Portion of an embryo at approximately 5 weeks with parts of the body wall and septum transversum removed to show the pericardioperitoneal canals. Note the size and thickness of the septum transversum and liver cords penetrating the septum. **C.** Growth of the lung buds into the pericardioperitoneal canals. Note the pleuropericardial folds.



- **Alveolar stage**
- **Alveolar period (late fetal) before birth** - the number of terminal sacs increase. Type I pneumocytes become thinner so that surrounding caipllaries protrude into the alveolar sacs. **Mature alveoli are not present before birth.Before birth, the lungs are full of fluid. The amount of surfactant in the fluid increases particularly during the last 2 weeks before birth.**

- **Alveolar period - after birth** **After birth**, although the alveoli increase somewhat in size, growth of the lungs after birth is due primarily to an increase in the number of respiratory bronchioles and alveoli. Only 1/6 of the adult number of alveoli are present at birth. The remaining alveoli are formed during hte first 10 years of postnatal life through the continuous formation of new primitive alveoli.





Type I pneumocytes become thinner and connected to blood capillaries

RDS: manifestazioni cliniche

Distress respiratorio:
tachipnea,
gemito espiratorio,
retrazioni toraciche
(sottocostali,
intercostali, xifoidea),
alitamento pinne nasali

When surfactant is insufficient, alveoli will collapse during expiration. A common cause of death in the premature infant. In these cases, partially collapsed alveoli contain a fluid with a high protein content