Pulmonology

Volume - 1

MARROW
Super Speciality

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LUNG ANATOMY AND APPLIED CLINICAL ASPECTS : I

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Introduction

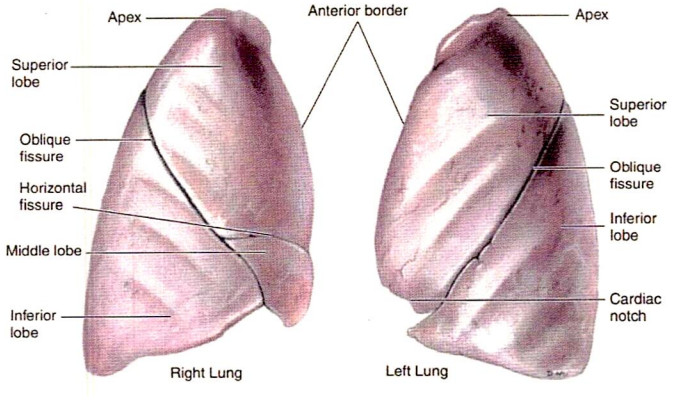
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Right lung is bigger & heavier than left lung.

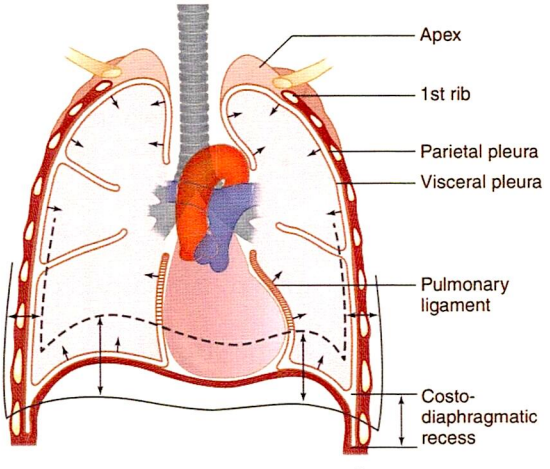
Fissures :

Deep depressions on the lung surface extending to the centre of the lung.
Lined by visceral pleura.
2 fissures on right and 1 fissure on left lung.

- Right horizontal/minor fissure : Between right upper and middle lobes.
- Right oblique fissure/major fissure : Between right middle and lower lobes.
- Left oblique fissure : Between left upper and lower lobes.
- Inferior accessory fissure : Separates median segment of lower lobe from the rest of the lobe.



Fissures of lungs



Expansile property of lungs

Applied aspect :

- Auscultation over infrascapular region and back : To examine lower lung lobes/base of the lungs.
- Chest X ray PA view : Portions of lower lobes are hidden.
- To view lower lobes : Lateral view is preferred.
- During inspiration, lungs can inflate to 5-6 L or by 4-6 cm.

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Pleura

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Covering of lungs.

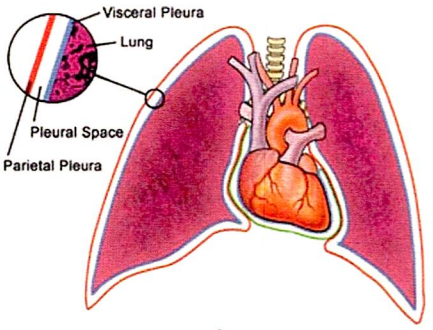
2 layers :

- Outer layer : Parietal pleura.
- Inner layer : Visceral pleura.

Lined by squamous epithelium (mesothelium).

Pleural cavity : Contains 15-20 mL of clear pleural fluid normally.

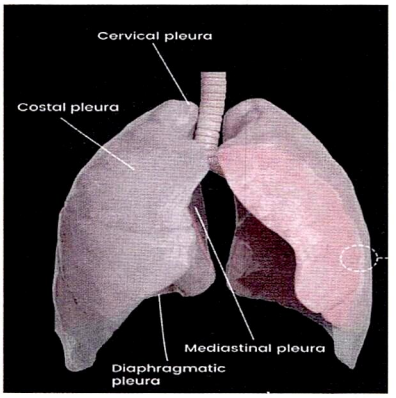
Note : Mesothelioma is a malignant tumour originating from pleura.



Layers of pleura

Parts of parietal pleura :

1. Cervical pleura.
2. Costal pleura.
3. Mediastinal pleura. .
4. Diaphragmatic pleura.



Parts of parietal pleura

Normal pleural fluid :

- Volume : 15 to 20 mL.
- Total count : 1700 cells/mm^3.
- Differential cell count : 75% macrophages, 23% lymphocytes, 1% mesothelial cells.
- Microbiological and cytological analysis : Negative.
- Function of pleural fluid : To reduce friction.

Microfiltration from capillaries → Fluid reaches pleural space → Absorbed by stoma/stomata in parietal pleura → Absorbed into lymphatics.

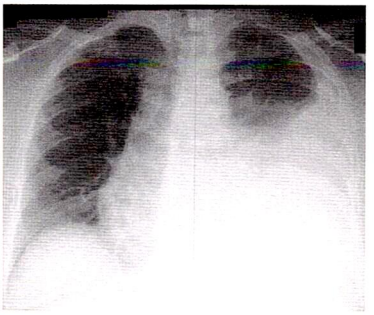
Pleural effusion :

Causes :

1. Increased capillary leak : Inflammation, infection.
2. Poor pleural lymphatic drainage : Mediastinal adenopathy, lymphoma, carcinoma lung, pulmonary tuberculosis.

Chest x ray findings :

- Homogenous opacity.
- Blunting of costophrenic, cardiophrenic angles.
- Loss of heart/diaphragmatic borders.
- Mediastinal shift opposite side.



Chest x ray showing left pleural effusion

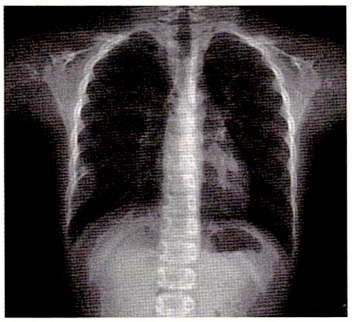
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Pleural fluid analysis :

- Total count, differential count.
- Cytology.
- Nucleic acid amplification test (NAAT).
- Microbiological analysis.
- Adenosine deaminase (ADA).

Medical thoracoscopy :

- Direct visualisation of pleura, pleural cavity.
- Biopsy from parietal pleura for histopathology and NAAT.



Pleural based lesion : Pregnant belly sign

Lateral wall lesions on chest x ray :

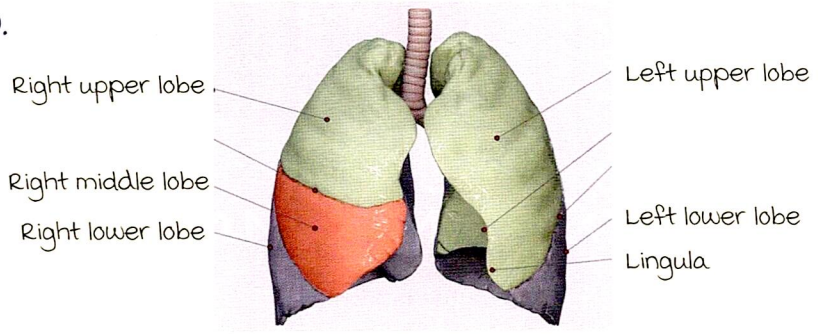
Pleural based lesion : Pregnant belly sign.
Obtuse angle with the chest wall.

Lung parenchymal lesion : Acute angle with the chest wall.

Lobes of the lung

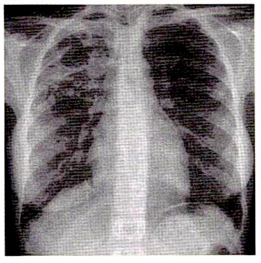
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Right lung : 3 lobes (upper, middle, lower).
Left lung : 2 lobes (upper, lower).

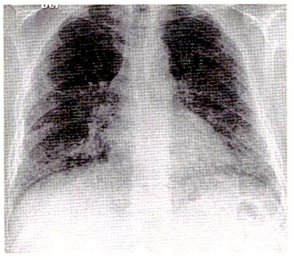


Lobes of lungs

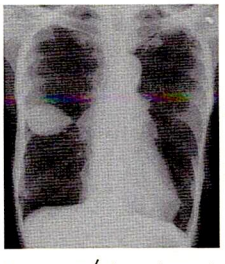
On chest x ray, lung fields are divided into upper, middle and lower zones to decribe lesions.



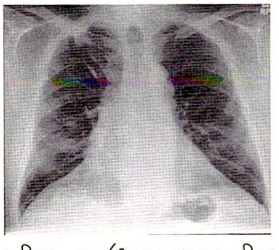
Right upper lobe cavity with consolidation : Pulmonary tuberculosis



Idiopathic pulmonary fibrosis : Reticular opacities in lower and upper zones.



Pseudotumour/phantom tumour : Fluid filled within minor fissure



Azygos fissure (Accessory fissure) : Normal variant in 1-3% population

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Hilum

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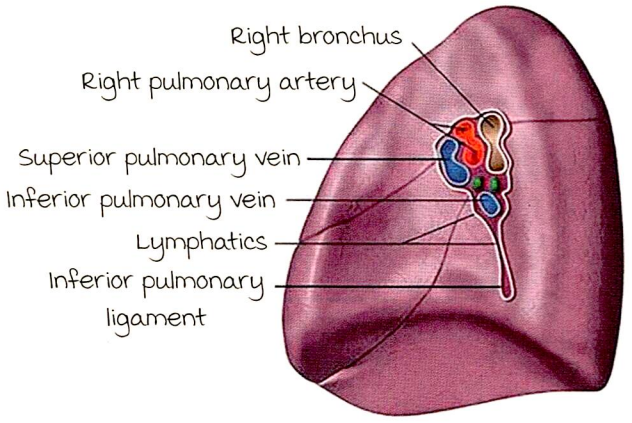
Anatomical location :

Area through which pulmonary arteries, pulmonary veins, bronchi and lymphatics enter the lungs.

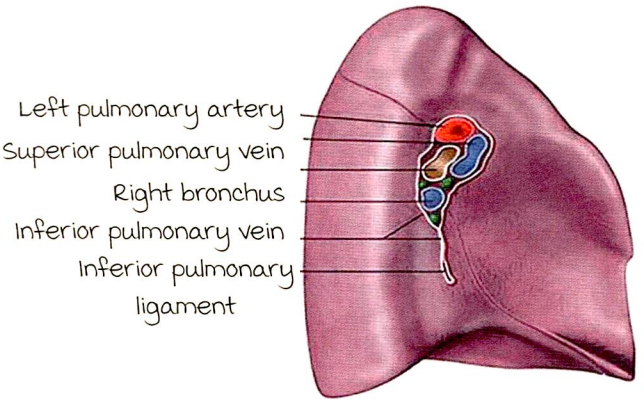
Attaches lungs to the mediastinum.

Right hilum : Pulmonary artery lies in front of the bronchus.

Left hilum : Pulmonary artery lies above bronchus (mnemonic : LAA).



Right hilum.



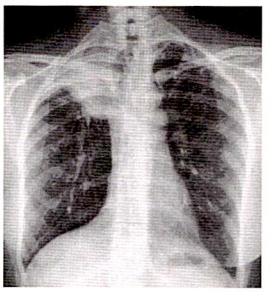
Left hilum.

Left hilum is high than right hilum : Pulmonary artery on left side is above the bronchus.

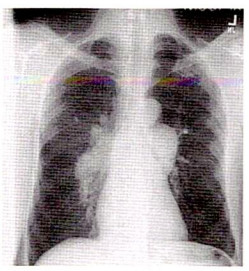
If right hilum is higher than left : Right upper lobe collapse.

Lesions of hilum :

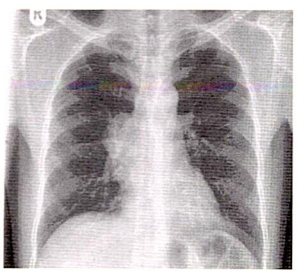
1. Bronchial lesion : Bronchogenic carcinoma.
2. Dilated pulmonary artery : Pulmonary artery hypertension.
3. Pulmonary vein dilatation : Rare.
4. Hilar lymph node.
5. Mediastinal lesion.



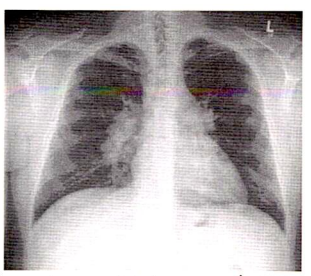
Golden S sign : Right upper lobe collapse.



B/L enlarged pulmonary arteries : Pulmonary artery hypertension.



Opacity in right hilum.



B/L enlarged hilum : B/L hilar lymphadenopathy in sarcoidosis.

Airways

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Trachea divides into right and left bronchus at carina.

Left main bronchus is narrower & longer than right main bronchus.

Right main bronchus divides into :

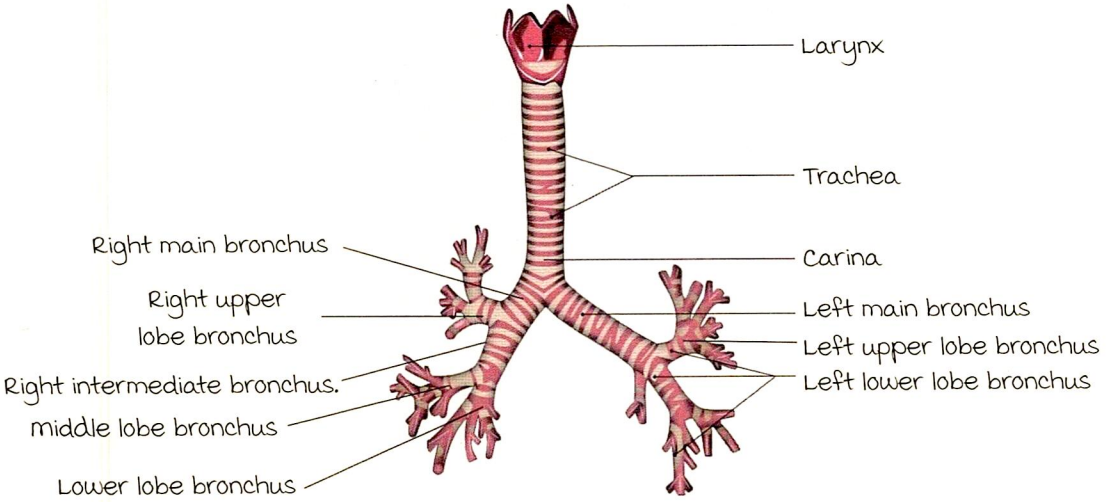
1. Right upper lobe bronchus.
2. Intermediate bronchus : Divides into middle lobe and lower lobe bronchus.

Left main bronchus divides into :

1. Left upper lobe bronchus : Divides into upper lobe and lingular bronchus.
2. Left lower lobe bronchus.(No middle lobe bronchus on left side).

Main bronchus → Lobar bronchi → Divide into segmental bronchus → Subsegmental bronchus.

- Main bronchus : Primary bronchus.
- Lobar bronchus : Secondary bronchus.
- Segmental bronchus : Tertiary bronchus.



Anatomy of airways

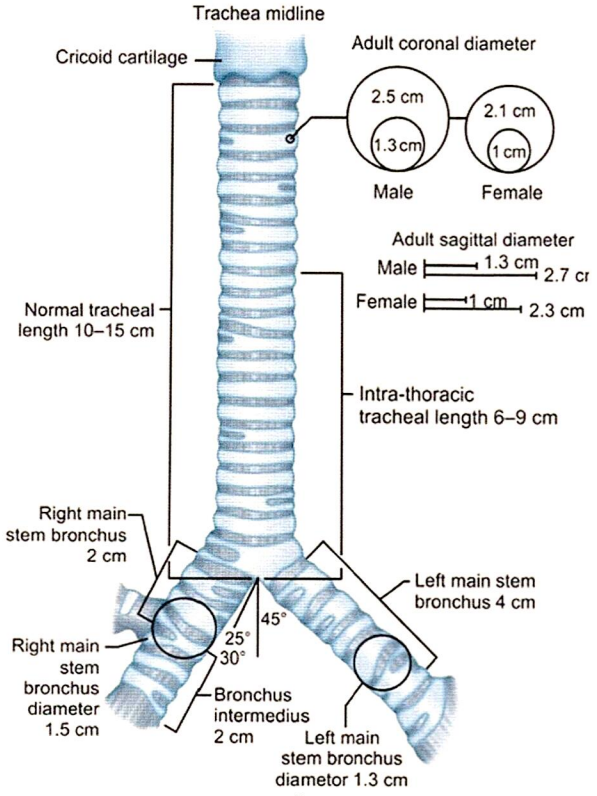
Dimensions of airways :

- Total length of trachea : 10–15 cm in adults.
- Intrathoracic portion of trachea : 6–9 cm in adults.
- Coronal diameter of trachea : 1.3–2.5 cm in adult male.
  1–2.1 cm in adult female.
- Sagittal diameter of trachea : 1.3–2.7 cm in adult male.
  1–2.3 cm in females.
- Left main bronchus length : 4 cm.
- Right main bronchus length : 2 cm.
- Length of right intermediate bronchus : 2 cm.

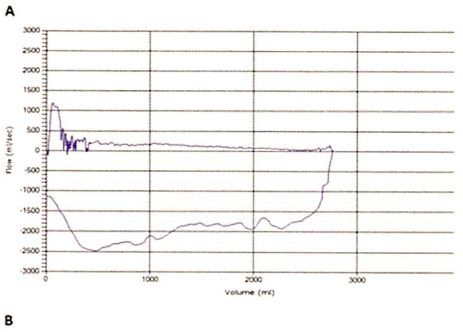
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- Diameter of right main bronchus : 1.5 cm.
- Diameter of left main bronchus : 1.3 cm.
- Right main bronchus makes an angle of 25–30° with midline.
- Left main bronchus makes an angle of 45° with the midline.

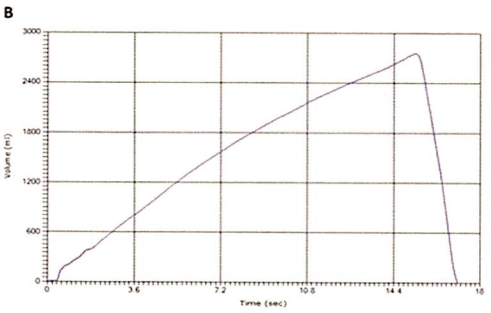
Foreign body goes commonly in right main bronchus : Wider, shorter and more in line with trachea.



Dimension of airways.



Flattening of expiratory loop : Intrathoracic obstruction of trachea.



Flattening of inspiratory loop : Extrathoracic obstruction of trachea.

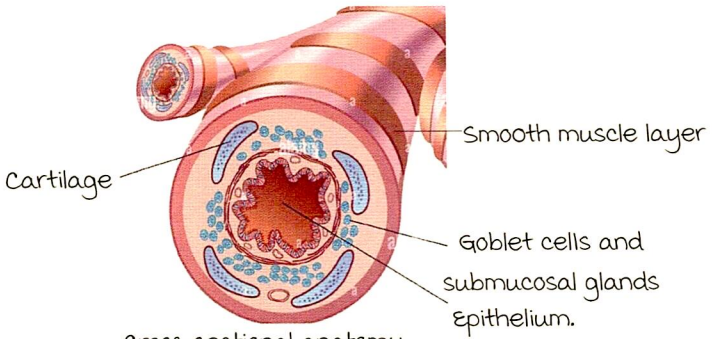
Clinical importance of flow volume curves : Site of obstruction can determine the size of stent required to relieve tracheal obstruction.

Cross sectional anatomy of airways :

Cross sectional anatomy of bronchus :

1. Smooth muscle layer : Criss cross pattern, causes bronchoconstriction on contraction.
2. Connective tissue layer : Incomplete cartilage.
   Goblet cells and submucosal glands.
3. Epithelium : Pseudostratified ciliated columnar epithelium.

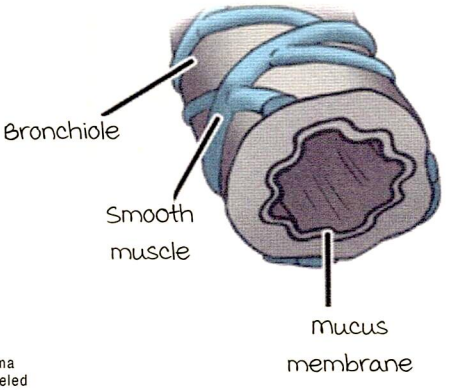
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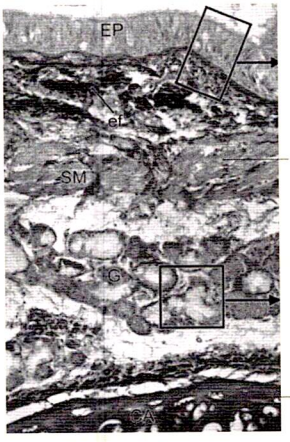
Cross sectional anatomy of bronchus

Cross sectional anatomy of bronchiole :

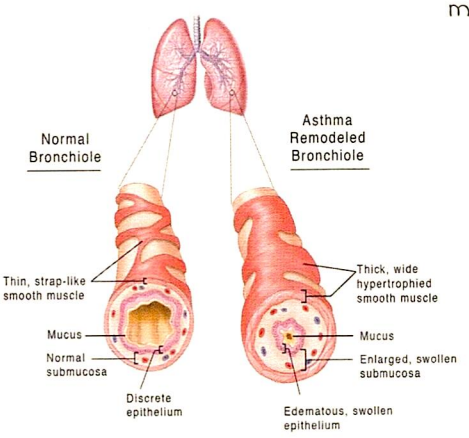
- No cartilage.
- No goblet cells.
- Smooth muscle layer present.



Cross section of bronchiole



Microscopic cross section of airway



Normal bronchiole vs changes in COPD and asthma

Changes in bronchioles in patients of COPD and asthma exacerbation :

- Smooth muscle hypertrophy.
- Narrow lumen.
- Excessive mucus inside lumen.
- Glandular hypertrophy.

Bronchial thermoplasty :

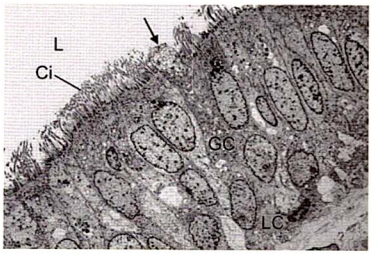
- For treatment of uncontrolled severe asthma.
- Target : Smooth muscle tissue volume is reduced.

Mucociliary escalator :

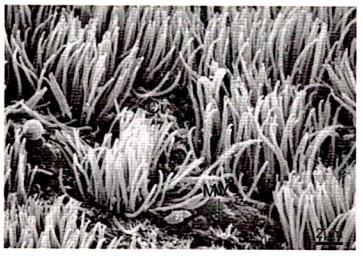
- Protective mechanism of upper airway.
- Epithelium : Pseudostratified ciliated columnar epithelium.
- Goblet cells produce mucus layer over the ciliated epithelium.

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- To and fro movement of cilia (mucociliary escalator) moves mucus towards the pharynx.
- Normal frequency of ciliary movement : 12-20 Hz.
- Foreign bodies lodged in mucus layer is pushed out into the pharynx by mucociliary escalator.



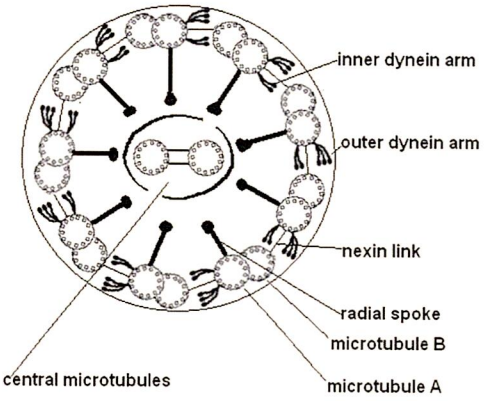
Pseudostraitified ciliated columnar epithelium with goblet cells



Microvilli and cilia on electron microscopy

Structure of cilia :

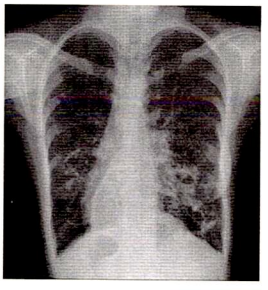
- Perpheral microtubules :
  9 doublets consisting of microtubule A and B.
- Central microtubules : 1 pair.
- Radial spokes connect peripheral microtubules to central microtubules.
- Perpheral doublets are connected by nexin.
- Dyenin : Outer and inner dyenin.
  ATP producing part of the cilia.



Cross section of cilia

Primary ciliary dyskinesia : Immotile cilia syndrome.

- Mutation in ciliary structures.
- Clogging of airways due to secretions → Infections.
- Sinusitis.
- Recurrent lung infections → Bronchiectasis.
- Infertility.
- 50% cases : Situs invertus.
- Kartagener syndrome :
  1. Triad of sinusitis.
  2. Bronchiectasis.
  3. Situs invertus.
- Young syndrome : Kartagener's triad + infertility.



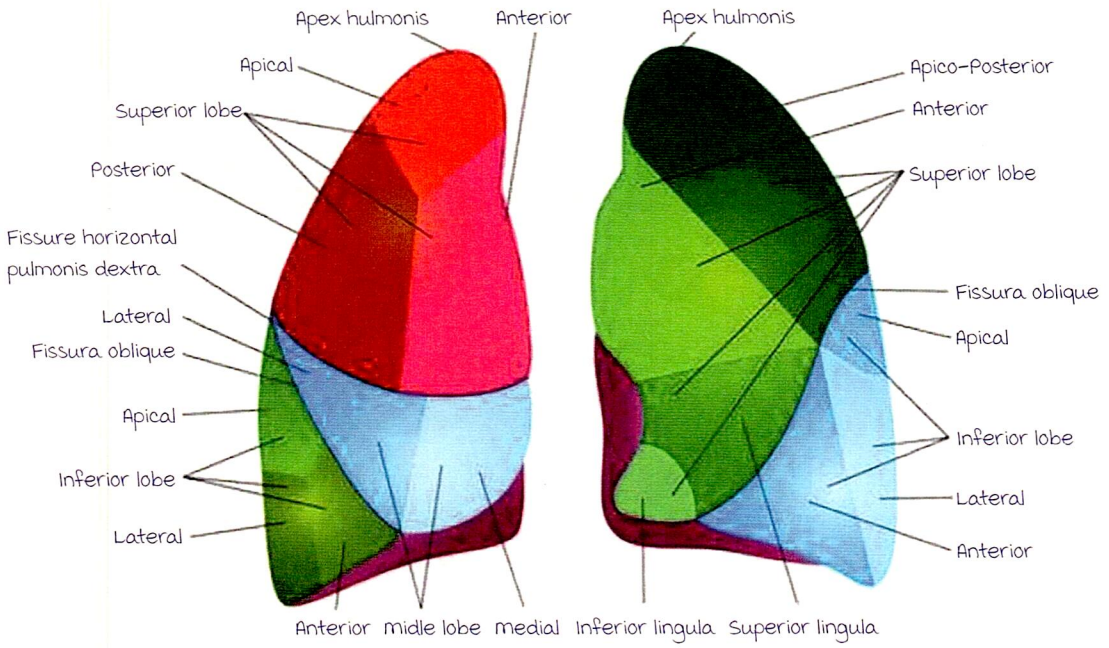
Cystic shadows in B/L lower lobe : Bronchiectasis and situs invertus

LUNG ANATOMY AND APPLIED CLINICAL ASPECTS : II

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Segments of the lung

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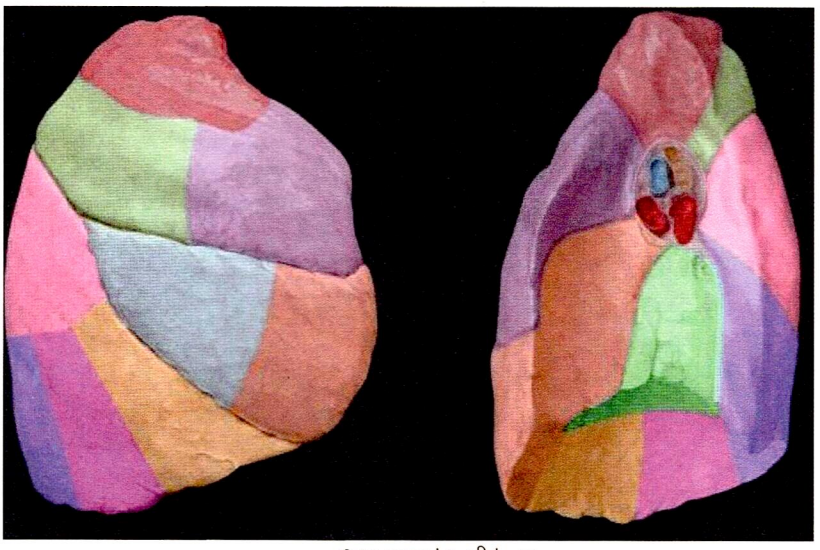


Part of lung	No. Of segments	Name of segments
Right upper lobe	3	Anterior, apical and posterior.
Right middle lobe	2	Medial and lateral.
Right lower lobe	5	Apical, anterior, posterior, medial and lateral.
Left upper lobe	4	Apicoposterior, anterior, superior lingula and inferior lingula.
Left lower lobe	4	Apical, anterior, posterior and lateral.

Bronchopulmonary segments :

- Basic functional anatomical unit of lung, with it's own bronchial artery, vein and lymphatic channels.
- Each segment is supplied by a segmental/tertiary bronchus along with a tertiary branch of pulmonary artery.
- Pyramidal in shape, apex directed towards hilum and base is directed towards pleural surface.

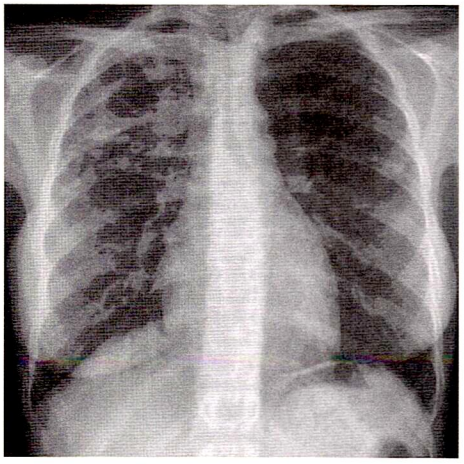
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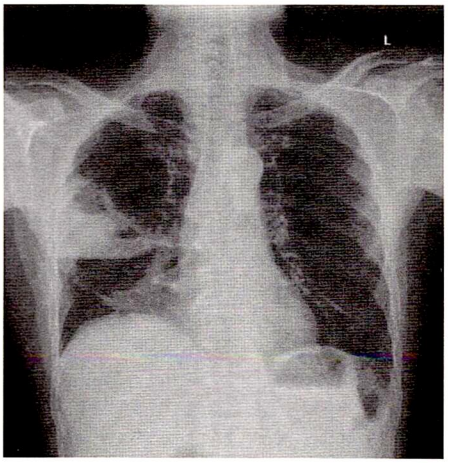
Segments of lung.

Clinical significance :

- Each segment can be surgically resected without affecting the function of adjacent segments.
- Certain diseases commonly affect specific segments :
  a. Apical and posterior segments of right upper lobe : Tuberculosis.
  b. Anterior segment of right upper lobe : Lung cancer.
  c. Posterior basal segment of left lower lobe : Intra-pulmonary lung sequestration.
  d. Posterior segment of right upper lobe and superior segment of right lower lobe in supine position : Aspiration/lung abscess.
  e. Basal segments of both lower lobe can also be affected by aspiration.



TB : Apical and posterior segments of right upper lobe.



Lung abcess : Posterior segment of right upper lobe.

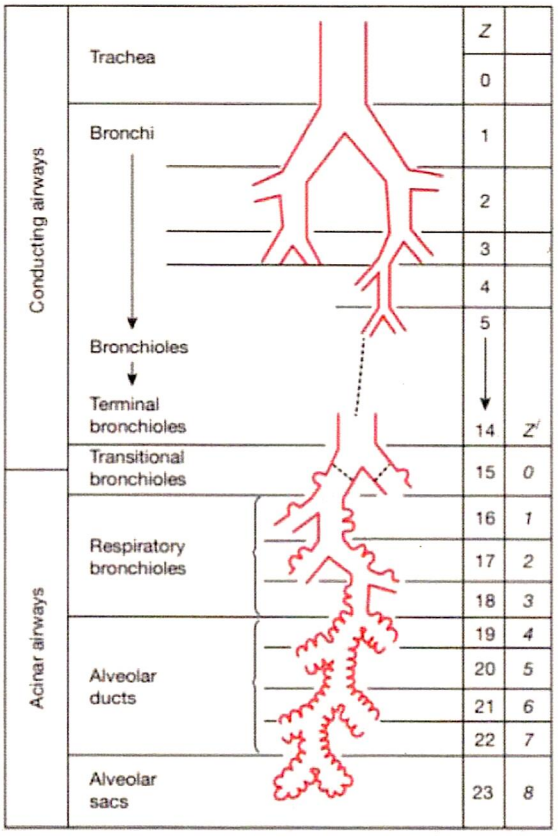
Divisions of airways

00:14:06

----- Active space -----

Types :

1. Conduction zones :
   - 1st 14 generations of airways.
   - Only involved in conduction of air alone (Terminal bronchiole included).
   - AKA anatomical deadspace.
2. Acinar airways/terminal respiratory unit :
   - Last 8 generations of airways.
   - Involved in gas exchange.
   - Acinus : Parenchymal unit in which all airways have alveoli attached to their wall and thus participate in gas exchange.

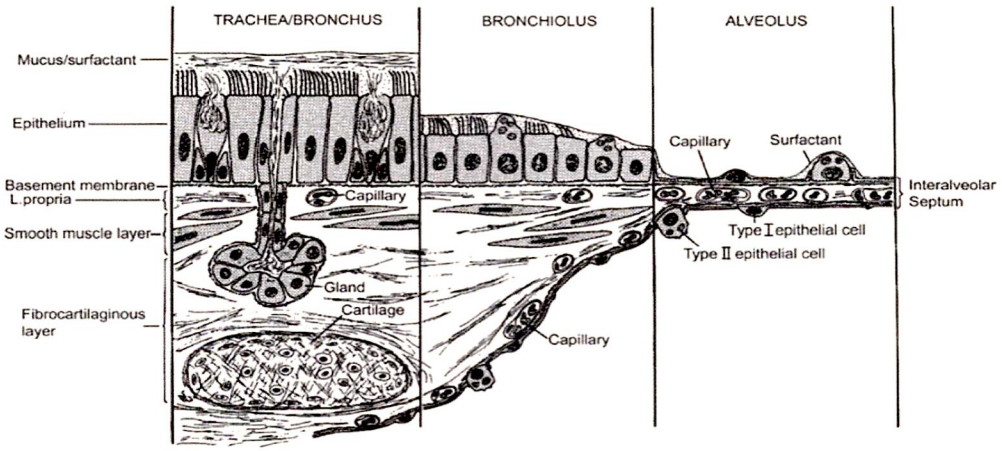


Bronchiole :

- Silent zone of lung.
- Bronchiole is a non cartilaginous airway < 2mm in diameter.
- Terminal bronchiole → Respiratory bronchiole → Alveolar duct and alveoli.
- Upto and including terminal bronchiole is the conducting zone → Involved in conducting air not in gas exchange.
- From the respiratory bronchiole onwards : Respiratory zone starts.

----- Active space -----

Airway Generation	Generations	Characteristic	Role	TRU
Trachea	0	Cartilaginous	Conducting	
Bronchi	1–3	Cartilaginous	Conducting	
Bronchioles	4–13	Membranous	Conducting	
Terminal bronchioles	14	Membranous	Conducting	
Respiratory bronchioles	16–18	Partially membranous	Partially conducting and gas exchange	Yes
Alveolar ducts	19–22		Gas exchange	Yes
Alveoli	23		Gas exchange	Yes

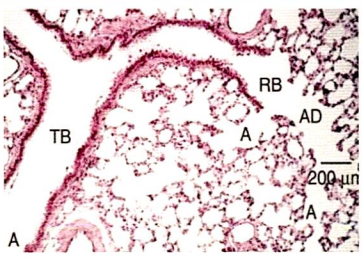


Bronchus vs bronchiole :

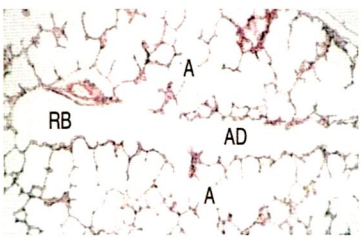
Bronchus	Bronchiole
• Cartilaginous rings present • Ciliated columnar epithelium. • Goblet cells present. • Submucosal glands present. • Smooth muscle present.	• No cartilage. • Ciliated cuboidal epithelium. • No goblet cells. • No gland, Instead club cell present. • Smooth muscle present.

Club cell :

- Previously known as clara cell.
- Non-ciliated cell in bronchiole.
- Function :
  a. Produces CCSP (Club cell secretory protein).
  b. Produces surfactant components.
  c. Xenobiotics.



Terminal bronchiole



Respiratory bronchiole

Secondary pulmonary lobule

00:23:35 ----- Active space -----

Features :

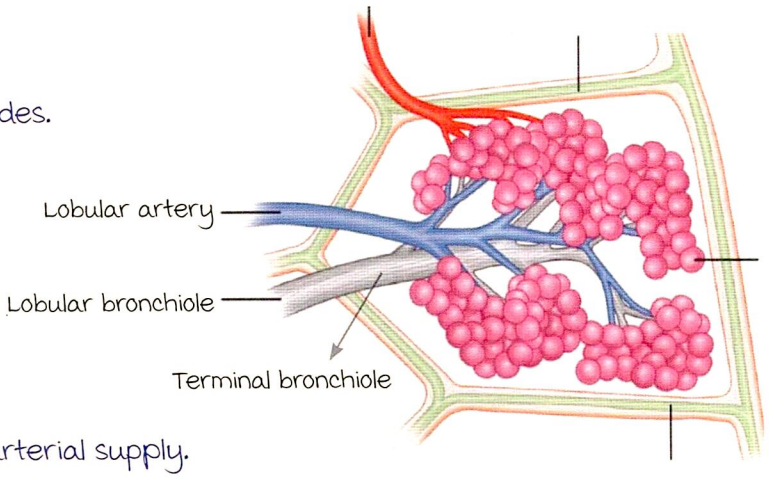
Functional unit of lung.

Enclosed by connective tissue septa on all sides.

Contains 3-5 terminal bronchioles.

Interlobular septum made of :

- Connective tissue septa.
- Lymphatic channels.
- Pulmonary veins.



Broncho-arterial unit :

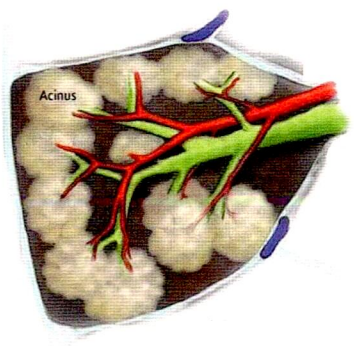
- Each lobule has its own bronchiole and arterial supply.

Dimensions and geometry :

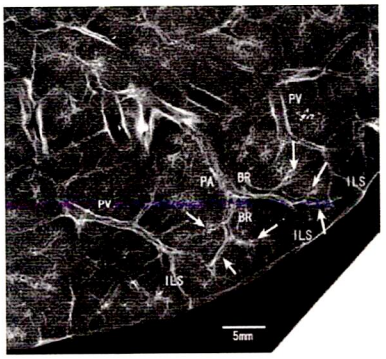
- Pentagonal in shape.
- Size : 5-2 cm.
- 30 acini present.
- 1500-4000 alveoli present.

Components :

- Septal structures :
  a. Consists of lymphatic channels and veins.
  b. 0.1 mm thickness in the periphery.
  c. Diseases causing its thickening : Pulmonary edema, lymphangitis carcinomatosis.
- Centrilobular structures : Include bronchiole, lymphatics and 3° artery enclosed in connectve tissue sheath called bronchovascular bundle.
- Lobular parenchymal structures :
  a. Consists of acinus and alveoli.
  b. Peripheral lymphatics



Centrilobular structures



CT picture

----- Active space -----

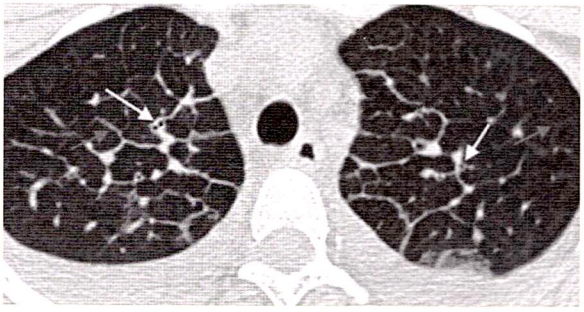
Distribution of diseases in secondary pulmonary lobule :

Perilymphatic spread :

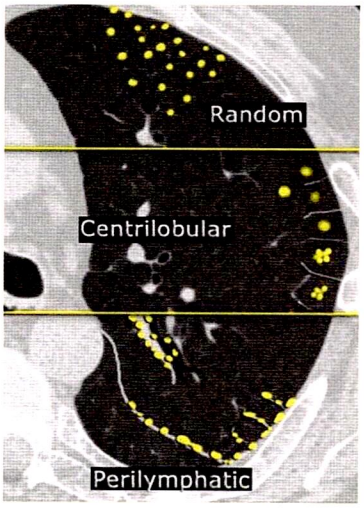
- Spreads alon bronchovascular bundle and interlobular septa.
- Sarcoids, lymphangitis carcinomatosis and silicosis.

Centrilobular spread :

- Higher predisposition to central part.
- Hypersensitivity pneumonitis (mosaic attenuation), respiratory bronchiolitis ABPA and centrilobular emphysema.



Pulmonary edema



Distribution of nodules

Primary pulmonary lobule :

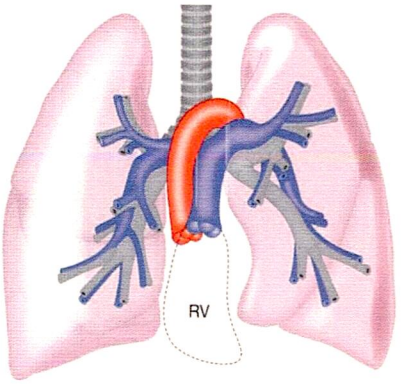
- Lung unit distal to respiratory bronchioles.
- Composed of alveolar ducts, alveolar sacs and alveoli.
- Each secondary pulmonary lobule : Composed of 30–50 primary lobules.
- Cannot be identified by HRCT.

Vessels of lung

00:41:38

Artery :

- Main pulmonary artery :
  Divides into right and left pulmonary artery.
- RPA lies anterior to right main bronchus and behind aorta.
- RPA divides parallel to bronchial divisions.
- LPA lies above the left main bronchus.



Veins : Superior and inferior pulmonary veins.