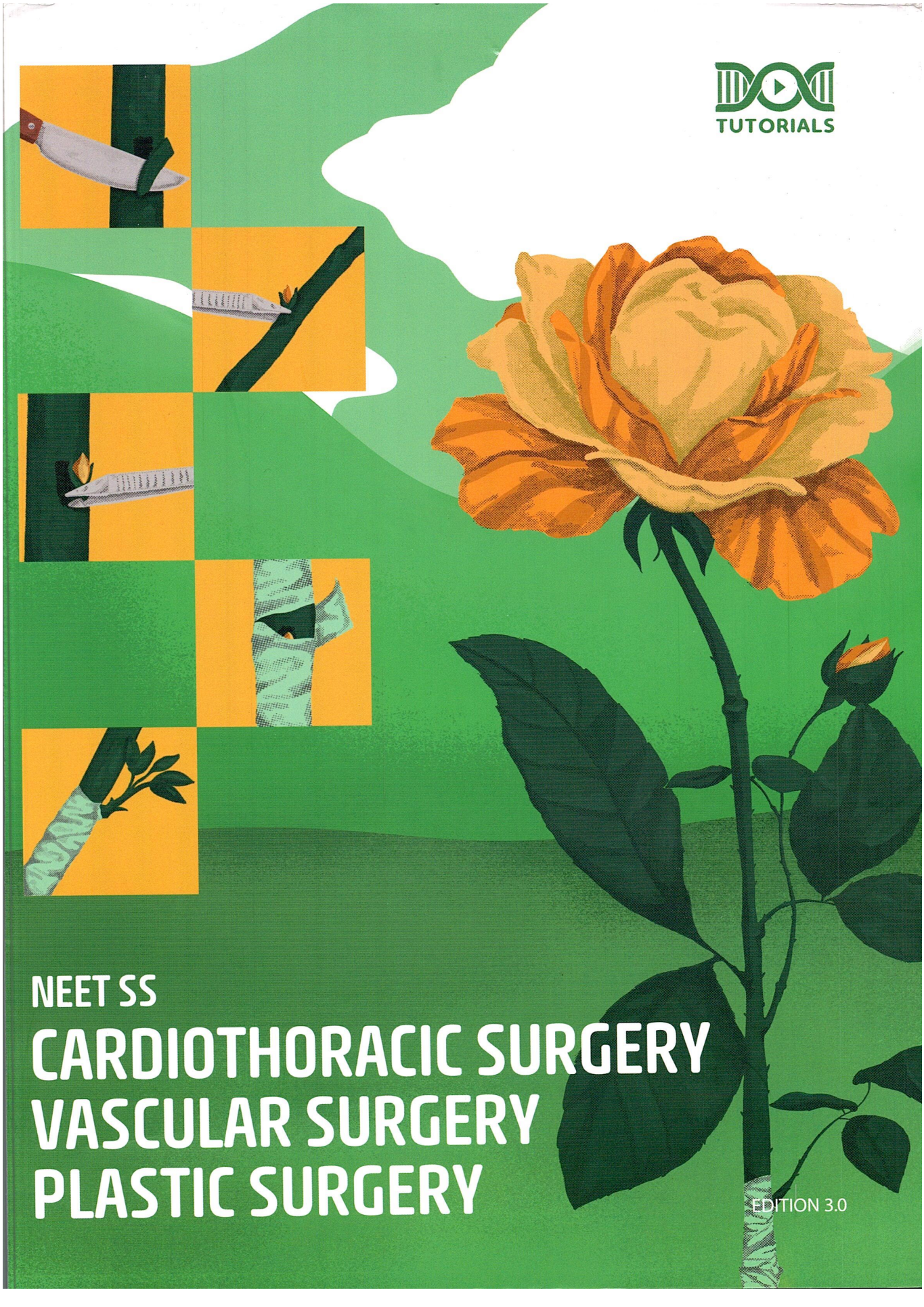


NEET SS

CARDIOTHORACIC SURGERY
VASCULAR SURGERY
PLASTIC SURGERY

EDITION 3.0

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THORAX & RELATED CONDITIONS PART 1

Mechanisms of Respiration

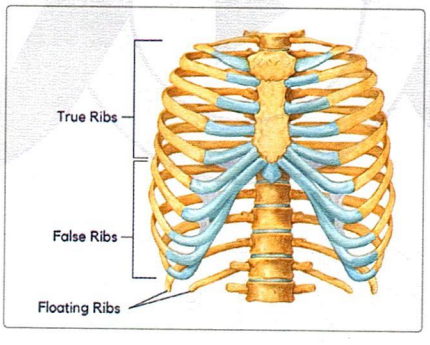
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- The mechanics of breathing rely on specific **primary and secondary muscles:**
- **Primary Muscles of Respiration**
  - Diaphragm
  - Intercostal muscles (occupying II intercostal spaces):
  - External intercostals
  - Internal intercostals
  - Transverse/innermost intercostals
- **Secondary/Accessory Muscles:**
  - These include the **levator costarum, serratus posterior, cervical muscles (sternocleidomastoid and scalene muscles).** These muscles typically become involved during increased respiratory effort, such as in cases of pneumonia.

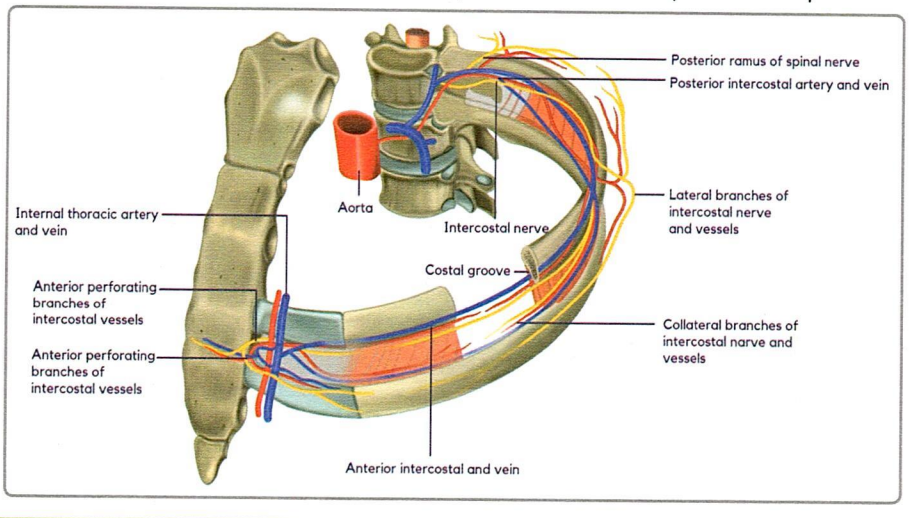
Anatomy of the Structures for Respiration

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- Ribs are classified based on their attachment to the sternum:
  - **True Ribs (1-5):** Attach directly to the sternum.
  - **False Ribs (6-10):** Attach to the sternum via the costal arch.
  - **Floating Ribs (11-12):** Have no sternal attachment.

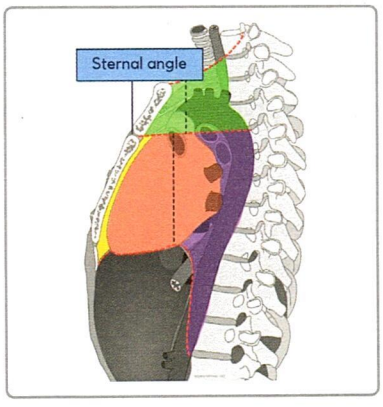


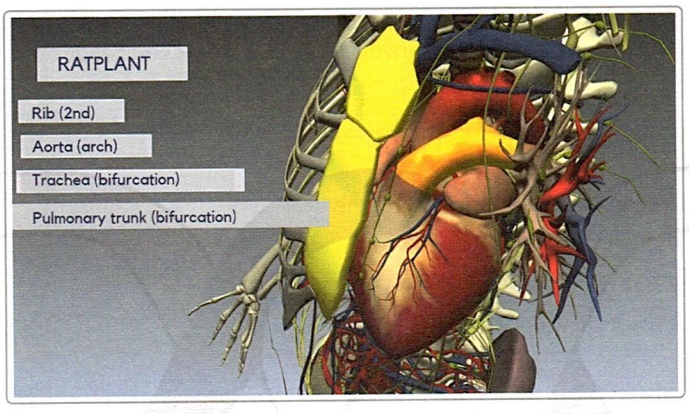
- The **first rib** is uniquely short, flat, and dense, forming the **thoracic inlet** and extending from the T1 vertebra to the manubrium.
- Regarding surgical procedures like ICD (intercostal drainage) placement, it is vital to avoid the **intercostal bundles.** These bundles typically travel along the **lower edge of the rib anteriorly,** though they move toward a central location within the intercostal space as they move toward the posterior aspect.



Sternal Angle (Angle of Louis)

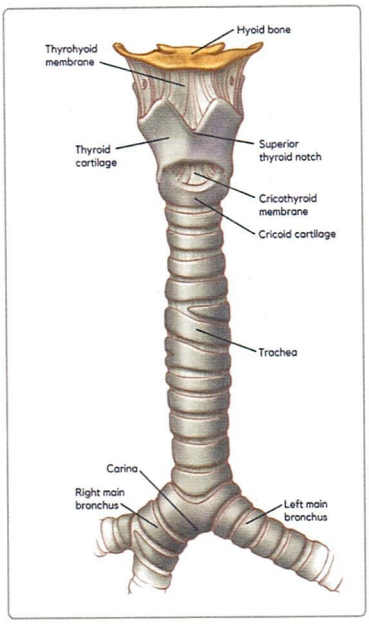
- The sternal angle is the junction where the **manubrium and the sternum meet** at the level of the second rib. This landmark serves as a critical anatomical reference for:
  - The **Carina** (the bifurcation of the trachea into the right and left main bronchus).
  - The **aortic arch** and the bifurcation of the **pulmonary trunk**.
  - The intervertebral disk located between the **T4 and T5 vertebrae**.





Tracheal Anatomy and Surgical Precautions

- The trachea is roughly **10 to 13 centimeters long** and 1.5-3 cm in width. Extends from C6-C7(lower larynx) to T4-T5 vertebral level --> bifurcation at carina. It contains approximately **20 incomplete hyaline cartilage rings**. Anterior + lateral: hyaline cartilage
- Posterior: membranous trachea made of smooth muscle
- As a general rule, there are roughly two tracheal rings for every centimeter of length.
- **The Cricoid Cartilage:** This is the **only complete cartilaginous ring** and marks the end of the larynx.

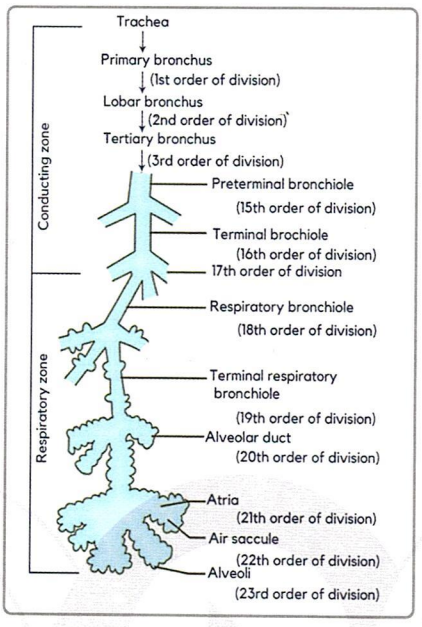


- **Blood Supply:** The trachea receives a **segmental blood supply** primarily along its **posterolateral margins** from arteries such as the inferior thyroid, internal thoracic, supreme intercostal and bronchial arteries.
- **Surgical Note:** To prevent **ischemia and necrosis,** surgeons must avoid circumferential devascularization and should not dissect the trachea more than **two centimeters**..
- Nearly 5cm of trachea can be safely resected for reconstruction.
- Squamous cell carcinoma is the most common tumour in trachea, malignant tumours being more common

BRONCHIAL DIVISIONS

00:11:25

- 23 generations from trachea to terminal **alveoli.**

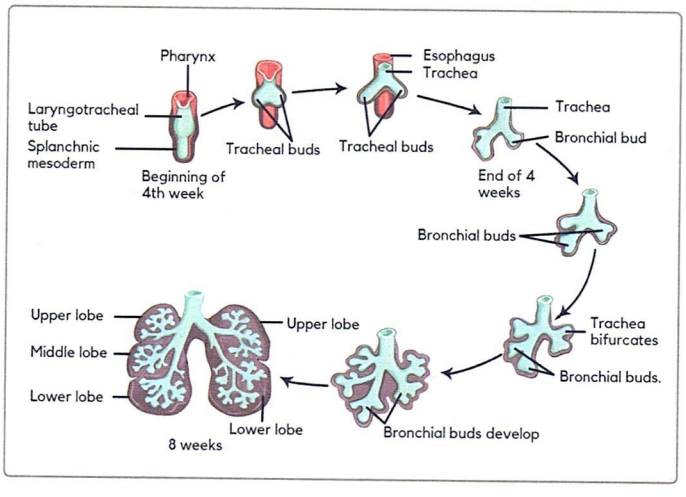


LUNGS

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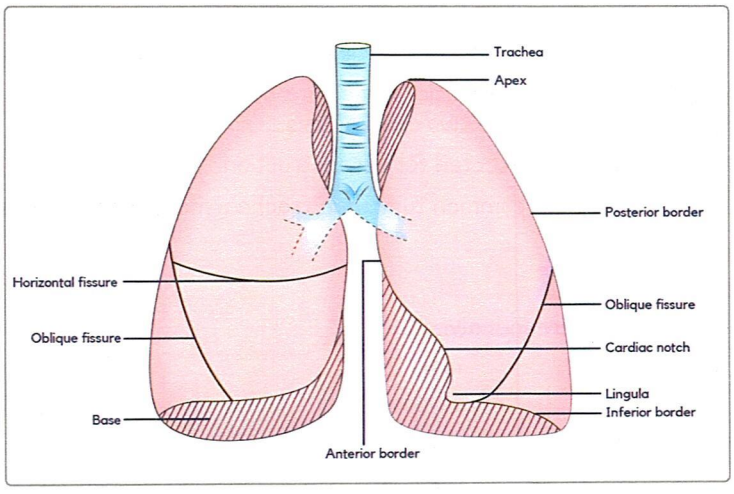
Development of lungs

- The lungs are derived from an outpouching of the primitive foregut during the 4th week of intrauterine life. This bud becomes a two-lobed structure, the ends of which ultimately become the lungs.



Alveoli and Bronchi

- There are approximately **20 million alveoli at birth,** which increase to approximately **300 million by age 10 years,** with no more increase after that time.
- There are 23 generations of bronchi between the trachea and terminal alveoli.
- **300 million alveoli in each lungs.**



Right Lung

- **3 lobes:** Upper, Middle, Lower
- **2 fissures:**
- Major (Oblique) fissure → separates Lower lobe from Upper + Middle
- Minor (Horizontal) fissure → separates Upper from Middle
- Middle lobe unique to right lung

Left Lung

- **2 lobes:** Upper and Lower

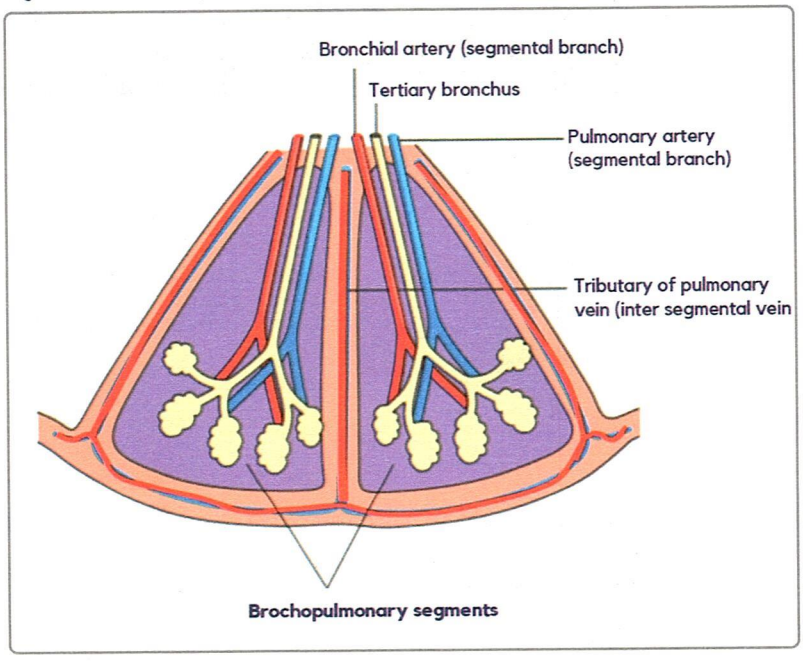
Lingula:

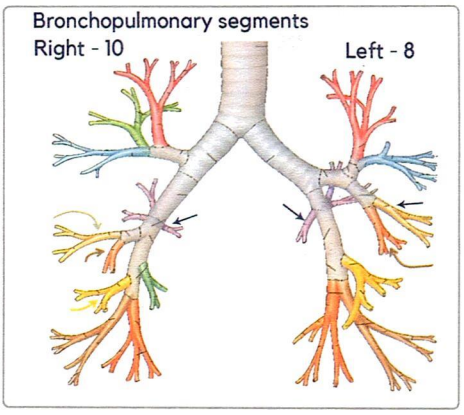
- Part of upper lobe
- Embryologic + anatomic equivalent of right middle lobe
- I fissure:
  - Oblique fissure → separates Upper from Lower lobe

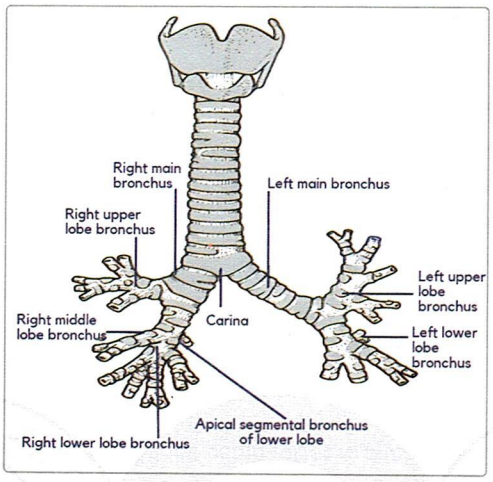
Bronchopulmonary Segments

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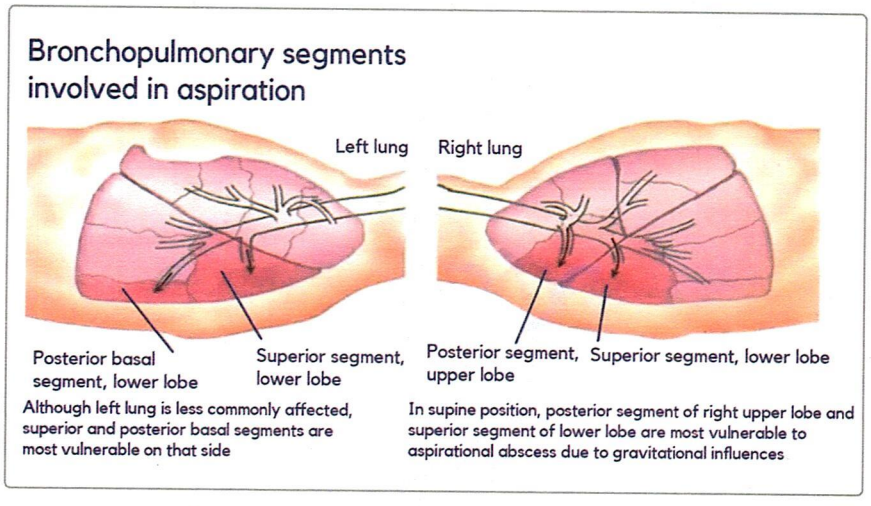
- The Bronchopulmonary segments are the **anatomic structural and functional unit of lung parenchyma**, each ventilated by a segmental/tertiary bronchus







- **Right main bronchus (2.5 cm) is shorter,** wider and nearly vertical (25 degree with trachea).
- **Left main bronchus (5 cm) is longer,** narrower and more oblique (45 degree with trachea).
- "Since the right main bronchus is shorter, wider and nearly vertical, aspiration and lung abscess are common on right side"
- **Distribution of lung abscess:**
  - Right lower lobe - 33%
  - Left lower lobe - 20%.
  - Right upper lobe - 25%
  - Right middle lobe - 10%
  - Left upper lobe - 12%



- Lung abscesses are common due to aspiration.
- Most common organisms causing lung abscess are anaerobes like Peptostreptococcus, prevotella, bacreroides (not b. fragilis) and fusobacterium.

Management of lung abscess

- Empiric antibiotic therapy
- Broncoscopy to assist drainage of pus
- ICD - if abscess ruptured into pleural cavity

Surgery :

- Persistent thick walled cavity of > 2 cm in size
- Failure to clear sepsis after 8 weeks of medical therapy
- Haemoptysis

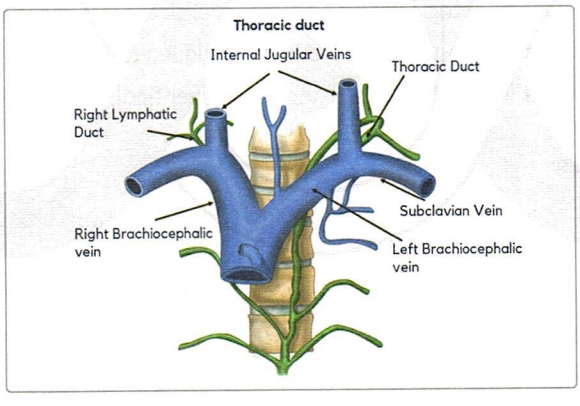
THORACIC DUCT

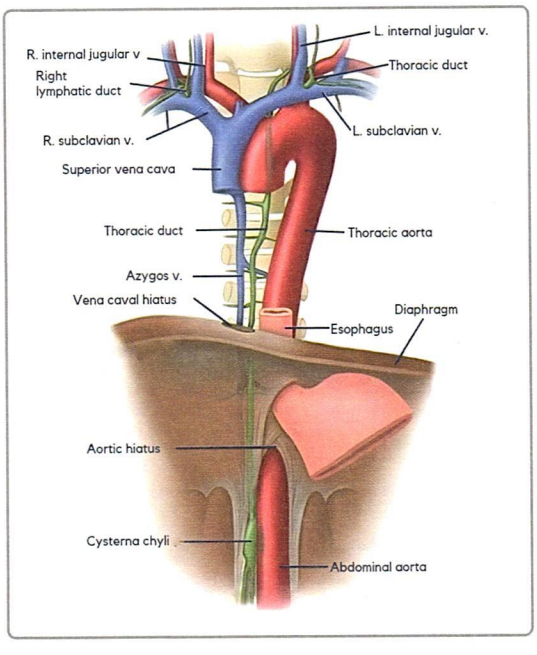
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- **Main lymphatic drainage channel of mediastinum**
- **Origin:** Cisterna chyli in abdomen
- Entry to thorax: Through aortic hiatus of diaphragm
- **Course in thorax:**
  - Runs superiorly along right of midline
  - Lies anterolateral to vertebral column
  - Crosses from right -> left at the level of T5
  - Termination:
    - Drains into **junction of left internal jugular vein + left subclavian vein**

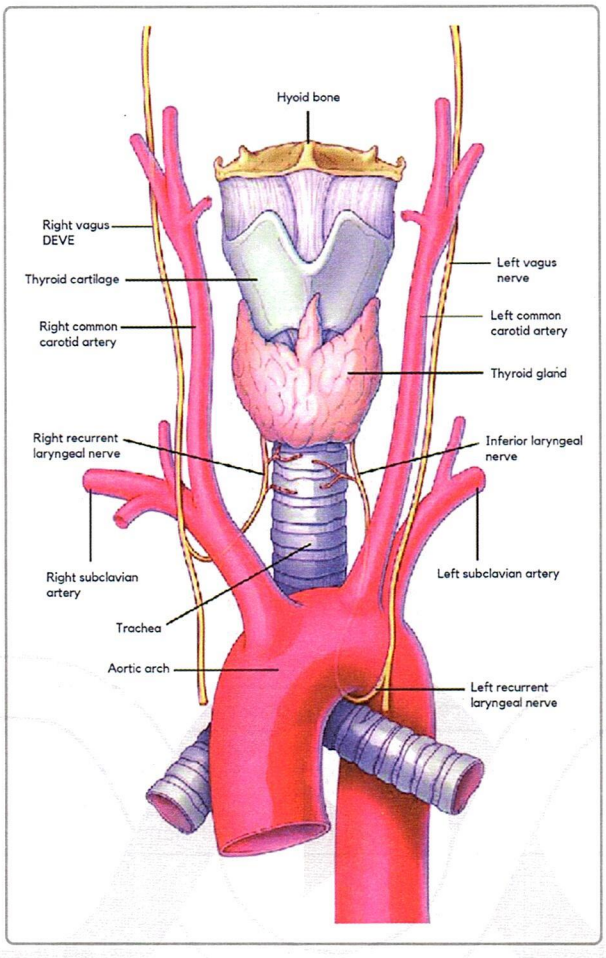
Blood supply

- The **trachea and bronchi have a systemic arterial blood supply delivered by the bronchial arteries,** which arise directly from the nearby thoracic aorta





- Right RLN → loops around innominate (brachiocephalic) artery
- Left RLN → loops under ligamentum arteriosum & aortic arch
- Both ascend in tracheoesophageal groove
- They innervate the respective vocal cords



- Smoking abstinence 4 to 8 weeks before surgery is necessary to reduce complication rates following surgery

Pulmonary function Tests(PFT)

00:24:00

- Assess :
  - Functional capacity,
  - Severity of lung disease, and Surgical fitness

Category	Tests Included	Purpose
Screening Spirometry	Spirometry, FEV1, FEV1/FVC, PEFR	Detect obstructive/restrictive disease and basic operability
Gas Exchange Assessment	DLCO	Assesses parenchymal functional reserve
Post-Surgical Fitness Prediction	Ppo-FEV1, V/Q lung scan	Predicts lung function after resection to decide extent of surgery

Spirometry

- Measures lung volumes + mechanical properties of lung:
  - Elasticity
  - Recoil
  - Compliance
  - Provides FEV1, FVC, flow-volume loops.

Forced Expiratory Volume in 1 second (FEV1)

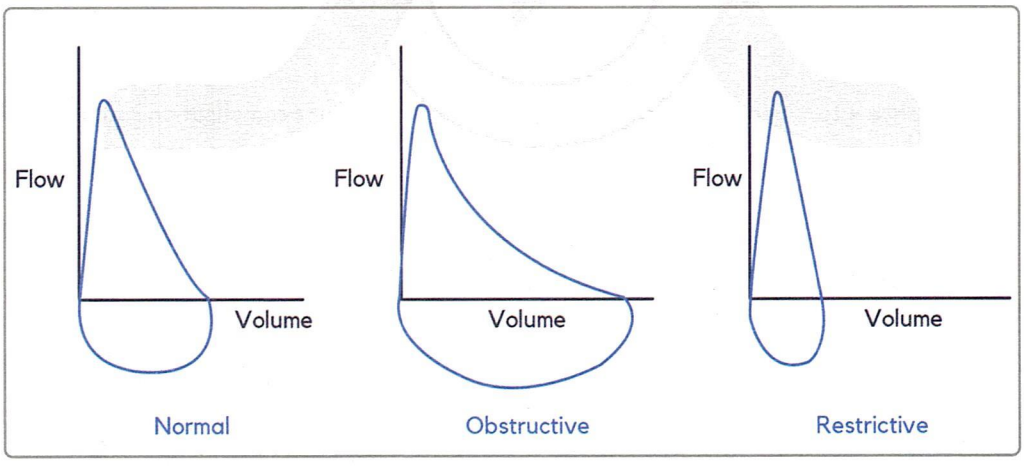
- Most common indicator of pre-operative pulmonary reserve

- FEV1 > 60% predicted → safe for lobectomy, no further PFT required
- If FEV1 < 60% predicted → perform quantitative radionuclide perfusion scan

Parameter	Definition	Clinical Significance
PEFR	Max airflow velocity in forced expiration	↓ in obstruction; effort dependent
FEV1	Volume exhaled in 1 sec	↓ in obstructive disease
FVC	Total forced volume exhaled after max inspiration	↓ in restrictive diseases
FEV1/FVC ratio	Distinguishes obstruction vs restriction	↓ <70% obstruction; Normal/high → restriction

Parameter	Definition	Clinical Significance
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Restrictive lung disease	Obstructive lung disease
Pulmonary fibrosis	Chronic obstructive pulmonary disease (COPD)
Neuromuscular disorders	Asthma
Congestive cardiac failure	Bronchiectasis/cystic fibrosis
Sarcoidosis	Cystic fibrosis
Obesity	Bronchiolitis
	α1 - antitrypsin deficiency



Tests to Measure Diaphragm Function

- **Fluoroscopy - Sniff Test**
- Ultrasonography - radiation-free and bedside feasible

Diffusing Capacity (DLCO)

- Measures gas transfer across alveolar-capillary membrane (measurement of the lung's ability to transfer gases and is often referred to as the 'transfer factor')
- Decreased in
  - Emphysema (loss of surface area)
  - Fibrosis (thickened membrane)
- Crucial for pre-operative assessment prior to lung resection

FEVI / FVC :

- Obstructive disease: Reduced
- Restrictive disease : Normal

	Obstructive pattern	Restrictive pattern
PEFR	↓↓	Normal or↓
FEV_1	↓↓	Normal or↓
FVC	Normal or↓	↓↓
FEV_1/FVC	<70	>80

PNEUMOTHORAX

00:29:30

Type	Key Features
Primary Spontaneous Pneumothorax (PSP)	Young, tall, thin males (mid-teens to 20s). Blebs at apex.
Secondary Spontaneous Pneumothorax (SSP)	Older pts with underlying lung disease (COPD, TB, necrotic tumor). Less tolerated.
Traumatic/Iatrogenic	Central lines, ventilation, rib fractures
Tension Pneumothorax	↑ intrathoracic pressure → total collapse, mediastinal shift! → ↓venous return → emergency

Management of Pneumothorax

- ICD insertion
- Surgical :
  - VATS
- Open Thoracotomy
- Recurrence Risk of pneumothorax
  - Ist episode → 33% recurrence
  - After 2 episodes → 50% chance of 3rd
  - After 3 → frequent recurrences

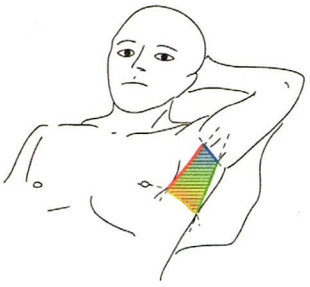
Indications for surgical intervention for pneumothorax include:
• Second ipsilateral pneumothorax • First contralateral pneumothorax • Bilateral spontaneous pneumothorax • Pneumothorax fails to settle despite chest drainage • Spontaneous haemothorax: professions at risk (e.g. pilots, divers) • Pregnancy

Pleural adhesion is achieved in one of three ways:	
1	pleurectomy: systematically stripping the parietal pleura from the chest wall
2	pleural abrasion: a scourer is used to scrape of the slick surface of the parietal pleura
3	chemical pleurodesis: usually talc is used and is insufflated into the chest cavity.

Do NOT give N2O if

- Pneumothorax is suspected or present
- Rapid worsening & tension pneumothorax risk

Preferred site for ICD insertion



Anterior:
lateral edge of pectoralis major.

Lateral:
lateral edge of latissimus dorsi.

Inferior:
fifth intercostal space.

Superior:
base of the axilla.

• A drain for pleural effusion or empyema should be nearer the base.
• The drain should pass over the upper edge of the rib to avoid the neurovascular bundle that lies beneath the rib.

- Primary pneumothorax - Leaks from small blebs or bullae
- Secondary pneumothorax - Leaks as a part of underlying lung disease.

Indications for surgical intervention for pneumothorax include:
• Second ipsilateral pneumothorax
• First contralateral pneumothorax
• Bilateral spontaneous pneumothorax
• Pneumothorax fails to settle despite chest drainage
• Spontaneous haemothorax: professions at risk (e.g. pilots, divers)
• Pregnancy

PLEURAL EFFUSION

00:35:10

- Exudate (Protein content > 30 g/L)
- Transudate- CCF, RF, LF and protein loss

Chylothorax:

- Fluid triglycerides > 110mg/dl

Empyema:

i. Exudative
ii. Fibrinopurulent
iii. Organizing
   - "Once the fluid becomes fibrinopurulent or loculated, VATS surgical debridement is required."

Treatment:

- Exudative - ICD
- Fibrinopurulent - VATS debridement
- Organizing - VATS / Open Decortication