MEDICAL EDUCATION RESOURCE

Lungs A-Z

Lungs — Introduction and Dissection

Introduction

- The **lungs** occupy the **major part of the thoracic cavity**, leaving only a small space for the heart.
- The **left lung** is slightly smaller because the **heart excavates more space** on that side, forming the **cardiac notch**.
- Together, both lungs **enclose the heart**, offering **protection** and cushioning.
- Each lung is a **spongy, elastic organ** that functions as the **primary organ of respiration**.
- The **right lung** is typically **heavier (?700 g)** and has **three lobes**, while the **left lung** is **lighter (?600 g)** and has **two lobes**.
- In the **young**, lungs are **brownish-grey**, but with age, they turn **mottled black** due to **deposition of carbon particles** from polluted air.
- Each lung is enclosed by its own **pleural sac** and separated from the other by the **mediastinum**.
- There are **ten bronchopulmonary segments** in each lung, each functioning as an independent respiratory unit

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Dissection

- **Identification of lungs:**
  - Each lung is **conical**, with:
    - A **blunt apex** projecting into the neck above the first rib.
    - A **concave base** resting on the diaphragm.
    - **Three borders** — anterior (thin), posterior (thick), and inferior.
    - **Two surfaces** — costal and medial (facing the ribs and mediastinum respectively).
  - The **right lung** has **three lobes** (upper, middle, lower), separated by **two fissures**.
  - The **left lung** has **two lobes** (upper and lower) separated by **one fissure**

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- **Right lung dissection highlights:**
  - Two bronchi at the hilum — **eparterial** (upper) and **hyparterial** (lower).
  - **Pulmonary artery** lies **between** the two bronchi.
  - **Pulmonary veins** lie **anterior** and **below** the bronchi.
  - **Impressions** on the medial surface:

        - Anterior to root ? *Superior vena cava, inferior vena cava, right atrium, right ventricle.*
        - Posterior to root ? *Azygos vein and oesophagus.*

- **Left lung dissection highlights:**
    - **Single bronchus** located posteriorly.
    - **Pulmonary artery** lies **above** the bronchus.
    - **Pulmonary veins** lie **anterior** and **below** it.
    - **Impressions**:
        - *Heart (left ventricle), ascending aorta, arch of aorta, and descending thoracic aorta.*
        - *Oesophageal groove* in the lower mediastinal part

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In summary, both lungs are **elastic, lobulated, conical organs** vital for gaseous exchange. The **right lung** is larger and divided into **three lobes**, while the **left** accommodates the **heart**, showing a **cardiac notch** and **lingula**. The **dissection** reveals distinct **bronchial, vascular, and surface impressions**, important for understanding their **anatomical relations** and **clinical correlations**.

Fissures and Lobes of the Lungs

General Overview

- Each lung is divided into **lobes** by **fissures**, which represent **deep invaginations of visceral pleura**.
- These fissures separate the lungs into **independent lobes**, each ventilated by a **secondary (lobar) bronchus**.
- The lobes function semi-independently — an important feature in localized pathology (e.g. lobar pneumonia, segmental resection).

Right Lung

- The **right lung** is **larger**, **shorter**, and **wider** than the left.
- It has **three lobes**:
    1. **Upper (Superior) lobe**
    2. **Middle lobe**
    3. **Lower (Inferior) lobe**
- These lobes are separated by **two fissures**:
    - **Oblique fissure**
    - **Horizontal fissure**

Oblique Fissure (Right Lung)

- Begins **posteriorly** about **2.5 cm lateral to the spine** at the level of the **T4 (4th thoracic vertebra)**.

- It runs **downward and forward**, crossing the **5th intercostal space** and following the **6th rib** anteriorly to end near the **6th costochondral junction**.
- Functionally, it separates the **lower lobe** from the **upper and middle lobes**.

Horizontal Fissure (Right Lung)

- Extends from the **oblique fissure** along the **4th costal cartilage** to meet the **anterior border** of the lung.
- It separates the **upper lobe** from the **middle lobe**.
- The fissure corresponds to the **4th intercostal space** anteriorly.

Summary of Right Lung Divisions

- **Upper lobe:** above horizontal fissure.
- **Middle lobe:** between horizontal and oblique fissures.
- **Lower lobe:** below oblique fissure.

Left Lung

- The **left lung** is **smaller and narrower** due to the **cardiac impression** and **notch**.
- It has **two lobes**:
    1. **Upper (Superior) lobe**
    2. **Lower (Inferior) lobe**

- These are separated by a **single oblique fissure** similar to that on the right side.

Oblique Fissure (Left Lung)

- Begins **posteriorly** at the **T4 level**, about **2.5 cm lateral to the midline**.
- Runs **downward and forward**, crossing the **5th intercostal space** and ending near the **6th costal cartilage** anteriorly.
- It separates the **upper lobe** from the **lower lobe**.

Cardiac Notch and Lingula

- The **anterior border of the left lung** shows a deep **cardiac notch** below the **4th costal cartilage**, accommodating the **heart**.
- Below the notch lies a **tongue-like projection** of the upper lobe known as the **lingula**, which corresponds to the **middle lobe of the right lung** both anatomically and functionally.

Functional Significance

- Each lobe acts as a **distinct respiratory unit**, ventilated by its own **lobar bronchus** and **pulmonary artery branch**.
- The arrangement allows **segmental resection** in localized disease without impairing overall lung function.
- The fissures facilitate **lung expansion** during inspiration but may also serve as **planes of spread** for infection or effusion.

Clinical Anatomy

- **Incomplete fissures** are common, leading to **fusion between lobes**, which can alter the spread of infection.
- **Accessory fissures** may occur, such as:
    - *Superior accessory fissure* (separating superior segment of lower lobe).
    - *Inferior accessory fissure* (isolating medial basal segment).
- On **chest X-ray**, fissures appear as **thin linear shadows**; knowledge of their normal position helps identify **lobar collapse**, **effusion**, and **tumours**.

Summary Table

LUNG	LOBES	FISSURES	REMARKS
Right Lung	3 (Upper, Middle, Lower)	Oblique, Horizontal	Larger, shorter, wider
Left Lung	2 (Upper, Lower)	Oblique	Has cardiac notch and lingula

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The **fissures and lobes** are not only anatomical boundaries but also **surgical and radiological landmarks** — understanding them is essential for interpreting **lung imaging, resections, and pathology localization**.

Root of the Lung, Bronchial Tree, and Dissection

Root of the Lung

- The **root of the lung** is a short, broad pedicle connecting the **medial surface of the lung** to the **mediastinum**.
- It contains all the **structures entering or leaving the lung** at the **hilum** (the depression on the medial surface).
- It lies opposite the **bodies of the 5th to 7th thoracic vertebrae**

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Contents of the Root:

1. **Bronchus:**
   - Right side — two bronchi (*eparterial and hyparterial*)
   - Left side — one principal bronchus
2. **Pulmonary artery** — middle part of the root
3. **Two pulmonary veins** — superior and inferior, in the anterior part
4. **Bronchial arteries** — one on right, two on left
5. **Bronchial veins**
6. **Lymphatics of the lung**
7. **Bronchopulmonary lymph nodes**
8. **Anterior and posterior pulmonary nerve plexuses**

9. **Areolar tissue**

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Vertebral Level:
Roots lie opposite **T5–T7** vertebrae.

Relations at the Hilum:

- **Right lung:** impressions of *SVC, IVC, right atrium, azygos vein, oesophagus*
- **Left lung:** impressions of *left ventricle, arch of aorta, descending thoracic aorta, thoracic duct, oesophagus*

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Vascular Supply:

- **Right lung:** one bronchial artery (from 3rd posterior intercostal artery).
- **Left lung:** two bronchial arteries (from descending thoracic aorta).
- **Deoxygenated blood** enters via pulmonary arteries; **oxygenated blood** exits via pulmonary veins

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- **Bronchial and pulmonary arteries** anastomose precapillarily; the anastomosis enlarges in disease states

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Bronchial Tree

- The **trachea** divides at the lower border of the **T4 vertebra** into **two primary (principal) bronchi**.
- **Right principal bronchus:**
  - 2.5 cm long, **shorter, wider**, and more vertical (angle 25°).
  - Hence, foreign bodies tend to lodge here.
- **Left principal bronchus:**
  - 5 cm long, **narrower**, more oblique (angle 45°)

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Branching Pattern:

- Each principal bronchus ? **Lobar bronchi (secondary)** ? one for each lobe.
  - Right lung ? 3 lobar bronchi.
  - Left lung ? 2 lobar bronchi.
- Lobar bronchi ? **Segmental bronchi (tertiary)** ? one for each **bronchopulmonary segment** (10 on each side).
- Segmental bronchi ? **Terminal bronchioles** ? **Respiratory bronchioles** ? **Alveolar ducts ? Atria ? Air saccules ? Alveoli**

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Functional Unit:
Each respiratory bronchiole aerates a **pulmonary unit**, the smallest functional area for

gaseous exchange.

Dissection Notes

- Identify lungs by **thin anterior border**, **thick posterior border**, **apex**, and **concave base**.
- **Right lung** ? 3 lobes (upper, middle, lower).
- **Left lung** ? 2 lobes (upper, lower).
- **At the hilum** of the right lung:
    - Two bronchi — *eparterial (upper)* and *hyparterial (lower)*.
    - Pulmonary artery — between bronchi.
    - Pulmonary veins — anterior and inferior.
- **At the hilum** of the left lung:
    - One bronchus (posterior).
    - Pulmonary artery — above bronchus.
    - Pulmonary veins — anterior and inferior

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Impressions on Medial Surface:

- **Right lung:** SVC, IVC, right atrium, azygos vein, oesophagus.

- **Left lung:** Left ventricle, aortic arch, descending aorta, thoracic duct, oesophagus

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Summary Table

STRUCTURE	RIGHT LUNG	LEFT LUNG
Bronchus	Two (eparterial & hyparterial)	One principal
Pulmonary Artery	Between bronchi	Above bronchus
Pulmonary Veins	Anterior & below bronchi	Anterior & below bronchus
Bronchial Arteries	One (from 3rd right posterior intercostal)	Two (from thoracic aorta)
Impressions	SVC, azygos, right atrium	Aortic arch, left ventricle
Vertebral Level	T5–T7	T5–T7

Together, the **root of the lung**, **bronchial tree**, and **hilum anatomy** form the basis for understanding **bronchopulmonary segments**, **pulmonary surgeries**, and **radiological orientation**.

Development of the Respiratory System

Embryological Development

- The **respiratory system** begins to develop in the **3rd week of intrauterine life** as an **outgrowth (respiratory diverticulum)** from the **ventral wall of the foregut** (primitive pharynx caudal to the hypobranchial eminence).

- The **epithelium of the larynx, trachea, bronchi, and alveoli** is derived from the **endoderm of the foregut**, while the **cartilage, muscle, and connective tissue** arise from **splanchnic mesoderm** surrounding the foregut

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- The **respiratory diverticulum** separates from the foregut by the **tracheo-oesophageal septum**, except at the opening of the larynx.

Sequence of Lung Development:

1. The respiratory diverticulum grows **caudally** to form the **trachea**, which bifurcates into **two lateral lung buds**.

2. During the **5th week**, the proximal parts of each lung bud form the **principal bronchi**.

3. The bronchi invaginate into the **pericardioperitoneal canals** (primitive pleural cavities).

4. The **right bronchus** divides into **three secondary bronchi** and the **left** into **two** — corresponding to the lobes of each lung.

5. These bronchi branch repeatedly to form **tertiary bronchi**, each with surrounding mesenchyme forming a **bronchopulmonary segment**.

6. By the **24th week**, there are around **17 generations of branches**, and the **parenchyma** develops through **four overlapping stages**

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Four Stages of Lung Development

1. **Pseudoglandular Stage (5–17 weeks):**
    - Lung resembles a gland; formation of bronchi and terminal bronchioles.
2. **Canalicular Stage (16–25 weeks):**
    - Enlargement of bronchi and bronchioles; vascularization increases.
3. **Terminal Sac Stage (24 weeks to birth):**
    - Terminal sacs (primitive alveoli) form; capillaries approach epithelium for gas exchange.
4. **Alveolar Stage (late fetal period to ~8 years postnatal):**
    - Alveoli mature and multiply; alveolocapillary membrane allows efficient gas exchange.
    - **Cranial segments** mature earlier than **caudal ones**.

By 28–32 weeks, **type II alveolar epithelial cells** begin secreting **pulmonary surfactant**, which **reduces surface tension** and maintains alveolar patency

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Molecular Regulation

1. **TBX4 transcription factor** (in the endoderm of the gut tube) initiates **lung bud formation** and regulates **growth and differentiation** of the lungs.

2. **FGF10 (Fibroblast Growth Factor 10)** from the splanchnic mesenchyme induces **outgrowth of the tracheal bud**.

3. **Sonic Hedgehog (SHH-Gli) signaling** coordinates **epithelial-mesenchymal interactions**, controlling **branching and proliferation** of the tracheobronchial tree

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Histology of Lung

- The lung is a **lacework of alveoli** separated by **thin-walled septa**, traversed by bronchi, bronchioles, and alveolar ducts.
- The **visceral pleura** may be seen as a **mesothelial covering**.

1. Intrapulmonary Bronchus:

- **Epithelium:** Pseudostratified ciliated columnar with goblet cells.
- **Lamina propria:** Reticular and elastic fibers.
- **Submucosa:** Contains serous and mucous glands.
- **Smooth muscle layer:** Circular; responsible for mucosal infoldings.
- **Cartilage:** Irregular plates of hyaline cartilage.

2. Terminal Bronchiole:

- Diameter <1 mm.

- **Epithelium:** Simple columnar.
- **Lamina propria:** Elastic and smooth muscle fibers.
- **No glands or cartilage** present

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3. Alveoli:

- Lined by **Type I pneumocytes** (flat, squamous) and **Type II pneumocytes** (large, secretory).
- **Type II cells** produce **surfactant**, preventing alveolar collapse.
- The **interalveolar septum** contains capillaries lined by **non-fenestrated endothelial cells**, facilitating gas exchange

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Summary Table — Developmental Origins of Respiratory Components

STRUCTURE	DEVELOPED FROM
Epithelium of larynx, trachea, bronchi, alveoli	Endoderm of foregut
Muscles of larynx	Mesoderm of 4th and 6th pharyngeal arches
Cartilages of larynx	4th & 6th arch cartilages

STRUCTURE	DEVELOPED FROM
Epiglottis	Dorsal part of hypobranchial eminence
Glands of respiratory tract	Endoderm
Connective tissue, smooth muscle, cartilage of trachea & bronchi	Splanchnic mesoderm bd-chaurasias-human-anatomy-vol…

Key Clinical Correlations

- **Tracheo-oesophageal fistula:** Failure of septum formation between trachea and oesophagus.
- **Tracheal stenosis:** Abnormal narrowing of the trachea.
- **Azygos lobe:** Accessory lobe formed by an aberrant azygos vein.
- **Hyaline membrane disease (neonatal respiratory distress):** Caused by **deficiency of surfactant**.
- **Agenesis of lung:** Failure of lung bud development