

# Lungs A-Z

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## Lungs — Introduction and Dissection

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### 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

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### 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).
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## 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**
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## 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**.
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### 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.
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### Summary of Right Lung Divisions

- **Upper lobe:** above horizontal fissure.
  - **Middle lobe:** between horizontal and oblique fissures.
  - **Lower lobe:** below oblique fissure.
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### 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**
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- These are separated by a **single oblique fissure** similar to that on the right side.
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### 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**.
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### 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.
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### 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.
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## 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**.

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### 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

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#### 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.

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## 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                   |
|---------------------------|--------------------------------------------|-----------------------------|
| <b>Bronchus</b>           | Two (eparterial & hyparterial)             | One principal               |
| <b>Pulmonary Artery</b>   | Between bronchi                            | Above bronchus              |
| <b>Pulmonary Veins</b>    | Anterior & below bronchi                   | Anterior & below bronchus   |
| <b>Bronchial Arteries</b> | One (from 3rd right posterior intercostal) | Two (from thoracic aorta)   |
| <b>Impressions</b>        | SVC, azygos, right atrium                  | Aortic arch, left ventricle |
| <b>Vertebral Level</b>    | 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<br><br>bd-chaurasias-human-anatomy-vol... |

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### 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**.
- **Agensis of lung:** Failure of lung bud development