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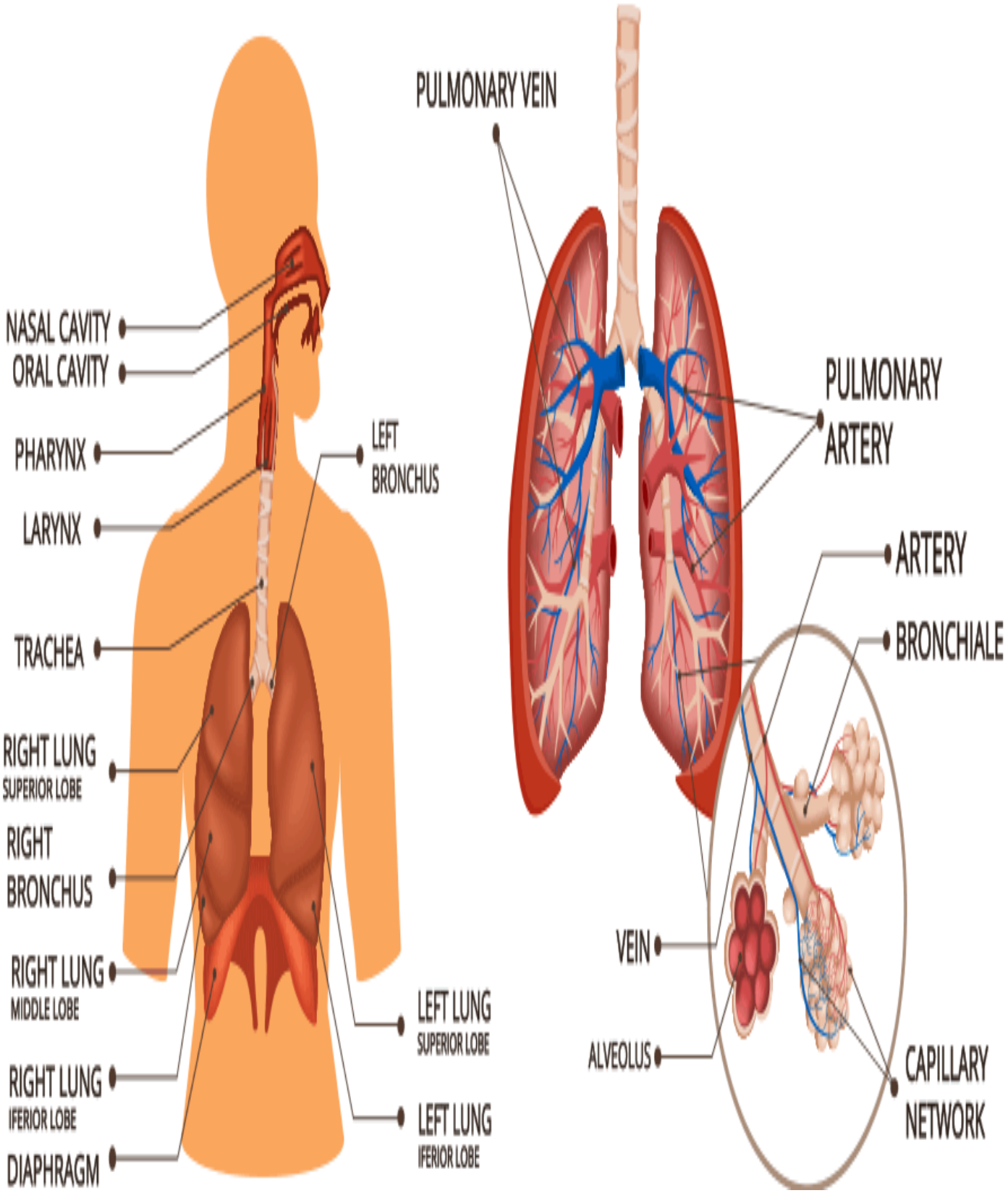
Anatomy of the Respiratory System



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The respiratory system is responsible for **bringing oxygen (O_2) into the body** and **removing carbon dioxide (CO_2)**. Air enters through the nostrils and passes sequentially through the **Nasal cavity → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveoli** in the lungs.

The respiratory tract is lined with **ciliated pseudostratified columnar epithelium** containing numerous mucus-secreting cells to trap dust and microorganisms.

I. Anatomical Classification of Respiratory System:

A. Upper Respiratory System

Structures located **outside the thoracic cavity** that conduct air to the lungs. That consist from:

1. Nose (external nose & nasal cavity)
2. Paranasal sinuses
   - ✓ Frontal
   - ✓ Maxillary
   - ✓ Ethmoid
   - ✓ Sphenoid
3. Pharynx
   - ✓ Nasopharynx
   - ✓ Oropharynx
   - ✓ Laryngopharynx

B. Lower Respiratory System

Structures located **within the thoracic cavity** responsible for air conduction and gas exchange. That consist from:

1. Larynx
2. Trachea
3. Bronchial tree
    - ✓ Primary bronchi
    - ✓ Secondary bronchi
    - ✓ Tertiary bronchi
    - ✓ Bronchioles
    - ✓ Terminal bronchioles
4. Lungs
5. Alveoli

A. Upper Respiratory System

I. External Nose

The external nose is the **visible portion** of the respiratory system that projects from the face and surrounds the external nares (**Nostrils**).

Structure

- **Framework:**
    - ✓ **Upper part:** Nasal bones
    - ✓ **Lower part:** Hyaline cartilage (flexible)
- **External nares:** Two openings that allow air to enter the nasal cavity
- **Vestibule:** Dilated anterior part of nasal cavity inside the nostrils

Special Features

- **Vibrissae (nasal hairs):** Trap large dust particles and insects
- **Sebaceous and sweat glands:** Keep nostrils moist and sticky to trap debris

Functions of External Nose

1. Entry of air into the respiratory tract
2. Filtration of large airborne particles
3. Support and protection of nasal cavity structures

II. Nasal Cavity

The nasal cavity is a **large, air-filled chamber** located posterior to the external nose, divided into **right and left cavities** by the nasal septum.

A. Boundaries of the Nasal Cavity

1. Medial Wall (Nasal Septum)

- Divides nasal cavity into two halves
- **Components:**
  - ✓ Anterior part: Septal cartilage
  - ✓ Posterior part: Vomer and perpendicular plate of ethmoid bone

2. Lateral Wall

- Contains three curved bony projections called **nasal conchae (turbinates):**
  - ✓ Superior concha
  - ✓ Middle concha
  - ✓ Inferior concha
- These form **air passages (meatuses):**
  - ✓ Superior meatus

- ✓ Middle meatus
- ✓ Inferior meatus

- □ Increase surface area and create air turbulence

3. Roof

- ✓ Formed by nasal bone, ethmoid bone, and sphenoid bone
- ✓ Contains **olfactory bulb** and nerves

4. Floor

- ✓ Formed by hard palate (maxilla and palatine bones)
- ✓ Separates nasal cavity from oral cavity

B. Lining Epithelium

Area	Type of Epithelium	Function
Most of nasal cavity	Ciliated pseudostratified columnar epithelium	Filtration, humidification
Superior concha & roof	Olfactory epithelium	Sense of smell

C. Openings into the Nasal Cavity

- □ Nasolacrimal duct (tears)
- □ Paranasal sinuses:
  - ✓ Frontal
  - ✓ Maxillary
  - ✓ Ethmoid
  - ✓ Sphenoid
- □ Pharyngotympanic (Eustachian) tube opens into nasopharynx

Functions of the Nasal Cavity

1. **Air filtration:** Mucus traps dust and microbes
2. **Warming:** Rich blood supply warms inhaled air
3. **Humidification:** Moistens air
4. **Olfaction:** Detects smell
5. **Voice resonance:** Acts as resonating chamber

III. Clinical Correlation (Important for Exams)

- ☞ **Deviated nasal septum:** Causes nasal obstruction
- ☞ **Rhinitis:** Inflammation of nasal mucosa
- ☞ **Epistaxis:** Nosebleed due to rich blood supply
- ☞ **Sinusitis:** Infection of paranasal sinuses

III. Paranasal Sinuses

The paranasal sinuses are **air-filled cavities** located within the bones of the skull surrounding the nasal cavity. They are lined by **respiratory epithelium** and communicate with the nasal cavity through small openings.

Types of Paranasal Sinuses

There are four paired paranasal sinuses:

Sinus	Location	Drainage
Frontal sinus	Frontal bone (forehead)	Middle nasal meatus
Maxillary sinus	Maxilla (cheek)	Middle nasal meatus
Ethmoid sinuses	Ethmoid bone (between eyes)	Superior & middle meatus
Sphenoid sinus	Sphenoid bone (posterior to nasal cavity)	Sphenoethmoidal recess

Lining of Paranasal Sinuses

- ✓ Lined by **ciliated pseudostratified columnar epithelium**
- ✓ Contains **goblet cells** that secrete mucus
- ✓ Cilia move mucus toward the nasal cavity for drainage

Functions of Paranasal Sinuses

1. Humidify inhaled air
2. Warm inhaled air
3. Filter and clean air
4. Enhance voice resonance
5. Reduce weight of the skull
6. Provide insulation to sensitive structures

Clinical Correlation

- ☞ **Sinusitis:** Inflammation due to infection or obstruction
- ☞ **Maxillary sinusitis:** Common due to poor drainage
- ☞ **Frontal sinusitis:** Causes forehead pain
- ☞ **Ethmoid sinusitis:** Can spread to orbit
- ☞ **Sphenoid sinusitis:** Rare but serious (near vital structures)

IV. Pharynx

The pharynx is a muscular, funnel-shaped tube extending from the base of the skull to the level of the sixth cervical vertebra (C6). It forms a common passageway for both air and food, connecting the nasal cavity to the larynx and the oral cavity to the esophagus.

Anatomical Divisions of the Pharynx : The pharynx is divided into **three regions**:

1. Nasopharynx (Passage of air)

- **Location:** Posterior to the nasal cavity and above the soft palate
- **Lining epithelium:** Ciliated pseudostratified columnar epithelium (respiratory epithelium)
- **Important structures:**
  - ✓ Pharyngeal tonsil (adenoids)
  - ✓ Opening of the pharyngotympanic (Eustachian) tube

2. Oropharynx (Passage of air and food)

- **Location:** Posterior to the oral cavity, between soft palate and epiglottis
- **Lining epithelium:** Stratified squamous epithelium (protection against abrasion)
- **Important structures:**
  - ✓ Palatine tonsils
  - ✓ Lingual tonsils

3. Laryngopharynx

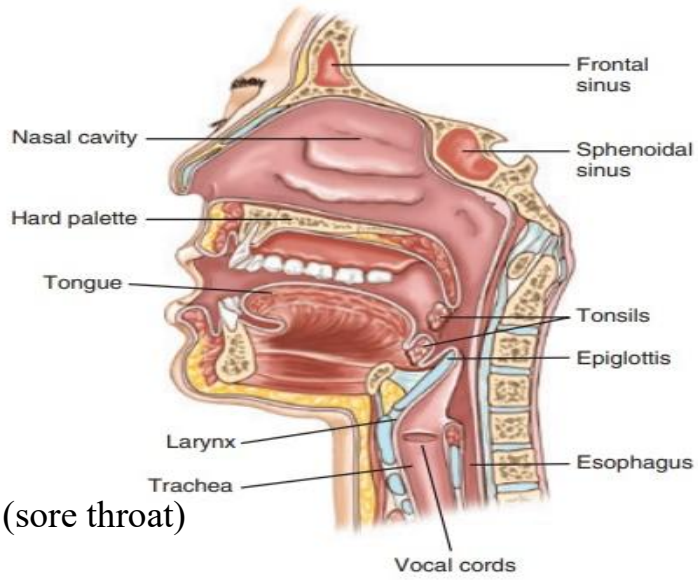
- **Location:** Posterior to the larynx, extends from epiglottis to esophagus
- **Lining epithelium:** Stratified squamous epithelium
- **Function:**
- Passage of air to the larynx
- Passage of food to the esophagus

Muscular Structure of the Pharynx

- Composed of **skeletal muscles**
- Arranged in **circular (constrictor) and longitudinal muscles**
- Coordinated muscle contractions aid in **swallowing (deglutition)**

Functions of the Pharynx

1. Serves as a common air and food passage
2. Assists in swallowing
3. Participates in voice resonance
4. Provides immune defense through tonsils



Clinical Correlation

- **Pharyngitis:** Inflammation of the pharynx (sore throat)
- **Tonsillitis:** Infection of tonsils
- **Adenoid hypertrophy:** Enlargement of pharyngeal tonsil causing nasal obstruction
- **Dysphagia:** Difficulty swallowing due to pharyngeal disorders

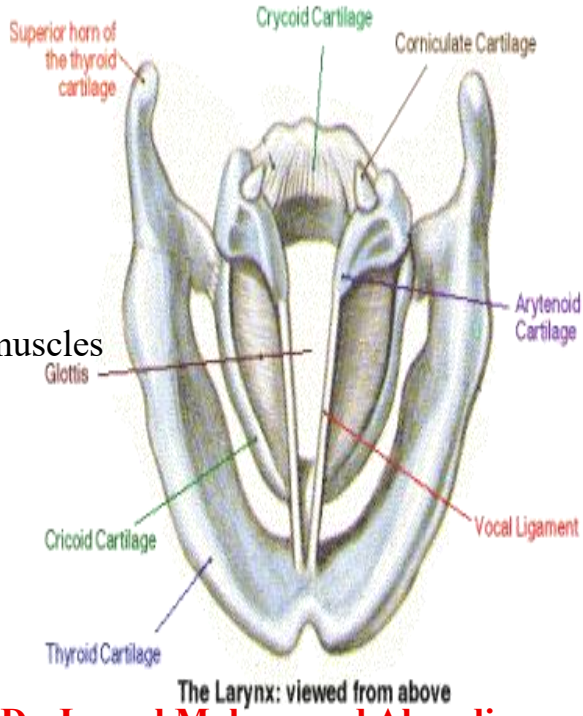
B. Lower Respiratory System

1. Larynx (Voice Box)

The **larynx** is a short tubular structure that connects the **pharynx to the trachea**. It acts as an **air passage**, **protective valve**, and **organ of voice production**.

Location

- Situated in the neck between **C3–C6 vertebrae**
- Anterior to the laryngopharynx
- Composed of **9 cartilages**, ligaments, and skeletal muscles



The Larynx: viewed from above

Unpaired cartilages:

1. Thyroid cartilage
2. Cricoid cartilage

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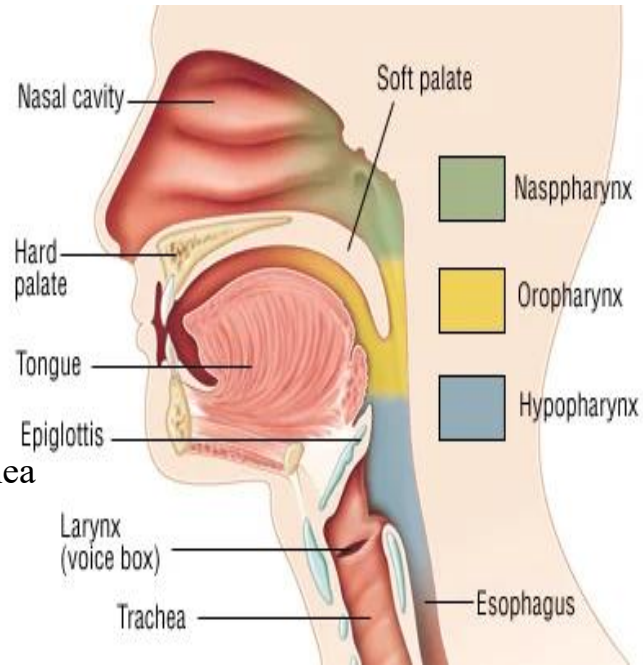
3. Epiglottis

Paired cartilages:

4. Arytenoid
5. Corniculate
6. Cuneiform



Functions

1. Maintains open airway
2. Prevents food and liquids from entering the trachea
3. Produces sound (phonation)

2. Trachea (Windpipe)

The **trachea** is a flexible tube that conducts air from the **larynx to the bronchi**.

- ✓ Length: ~10–12 cm
- ✓ Composed of **16–20 C-shaped hyaline cartilage rings**
- ✓ Lined by **ciliated pseudostratified columnar epithelium**

Wall Layers

1. Mucosa
2. Submucosa (with mucus glands)
3. Trachealis muscle
4. Hyaline cartilage
5. Adventitia

Function

- ✓ Conducts air
- ✓ Keeps airway open

3. Bronchial Tree

The bronchial tree is a **branching airway system** inside the lungs.

A. Primary (Main) Bronchi

- ✓ Right and left bronchi
- ✓ Right bronchus is **shorter, wider, and more vertical**
- ✓ Conduct air into lungs

B. Secondary (Lobar) Bronchi

- ✓ Supply lung lobes
- ✓ Right lung: **3 lobar bronchi**
- ✓ Left lung: **2 lobar bronchi**

C. Tertiary (Segmental) Bronchi

- ✓ Supply **bronchopulmonary segments**
- ✓ Allow surgical removal of lung segments

D. Bronchioles

- ✓ Smaller airways without cartilage
- ✓ Walls contain **smooth muscle**
- ✓ Lined by simple columnar to cuboidal epithelium

Function:

- ✓ Regulate airflow via bronchoconstriction and bronchodilation

E. Terminal Bronchioles

- ✓ Smallest airways of the **conducting zone**
- ✓ No cartilage or glands
- ✓ Lead to respiratory bronchioles

4. Lungs

The lungs are a pair of spongy, elastic, cone-shaped organs located in the thoracic cavity on either side of the mediastinum. They are the principal organs of respiration, responsible for gas exchange between air and blood.

Location & Shape

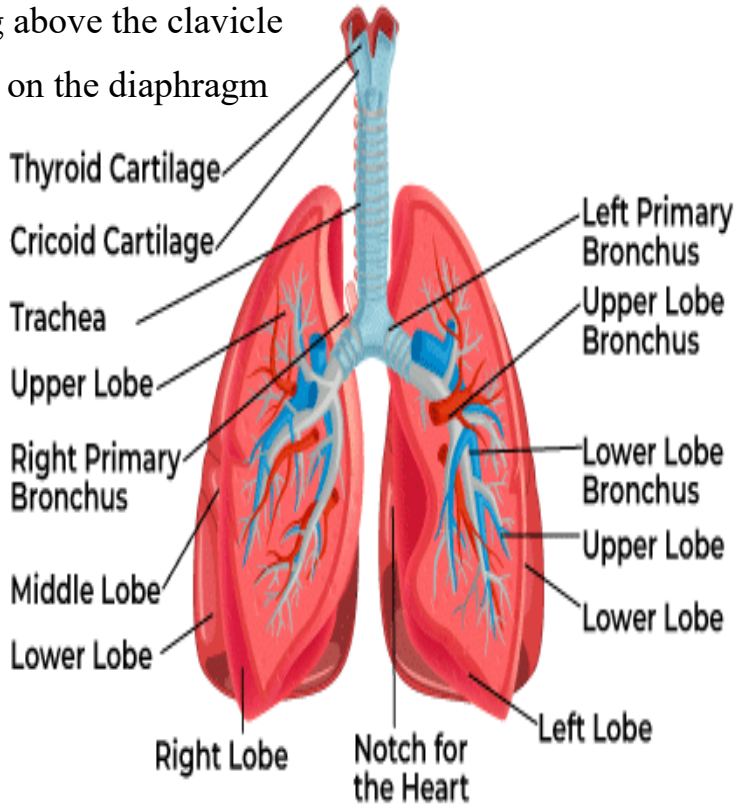
- ✓ Situated within the **thoracic cavity**
- ✓ Extend from the **clavicles** superiorly to the **diaphragm** inferiorly
- ✓ Covered by pleural membranes
- ✓ Each lung has:
  - ☐ **Apex:** Upper pointed part extending above the clavicle
  - ☐ **Base:** Broad inferior surface resting on the diaphragm

Right Lung

- ✓ Larger and heavier than the left lung
- ✓ Divided into **three lobes** by **two fissures**

Lobes

1. Superior lobe
2. Middle lobe
3. Inferior lobe



Fissures

- ✓ **Horizontal fissure**
- ✓ **Oblique fissure**

Left Lung

- ✓ Smaller due to the position of the heart
- ✓ Divided into **two lobes** by **one fissure**

Lobes

1. Superior lobe
2. Inferior lobe

Special Features

- **Cardiac notch:** Indentation for the heart
- **Lingula:** Tongue-like projection of superior lobe

5. Pleural Membrane

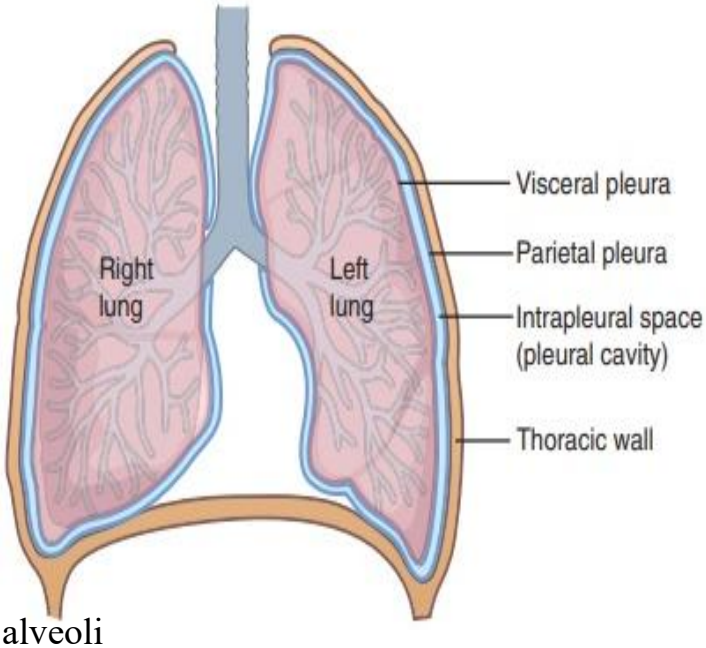
Serous membrane associated with the lung consists from:

- ✓ **Visceral pleura:** cover the outer surface of the lungs.
- ✓ **Parietal pleura:** lines the inner surface of the thoracic cavity.

Pleural Cavity

The thin space between parietal pleura and visceral pleura called pleural cavity. Both pleura secrete a small amount of pleural fluid .Pleural fluid gives a moist, slippery coating that provides lubrication, thereby reducing friction between the parietal and visceral surfaces as you breathe.

Functions of the Lungs



1. Exchange of oxygen and carbon dioxide
2. Regulation of blood pH
3. Voice resonance
4. Defense against pathogens (macrophages)
5. Acts as blood reservoir

Clinical Correlation

- **Pneumonia:** Infection of lung tissue
- **Pulmonary edema:** Fluid accumulation in alveoli
- **Atelectasis:** Lung collapse
- **Pneumothorax:** Air in pleural cavity
- **Tuberculosis:** Chronic lung infection

6. Alveoli

Alveoli are microscopic air sacs at the end of the bronchial tree and are the functional units of respiration.

Structure

1. **Type I alveolar cells:** thin, squamous → gas exchange
2. **Type II alveolar cells:** secrete surfactant
3. **Alveolar macrophages:** remove dust and microbes
4. Elastic fibers and capillaries

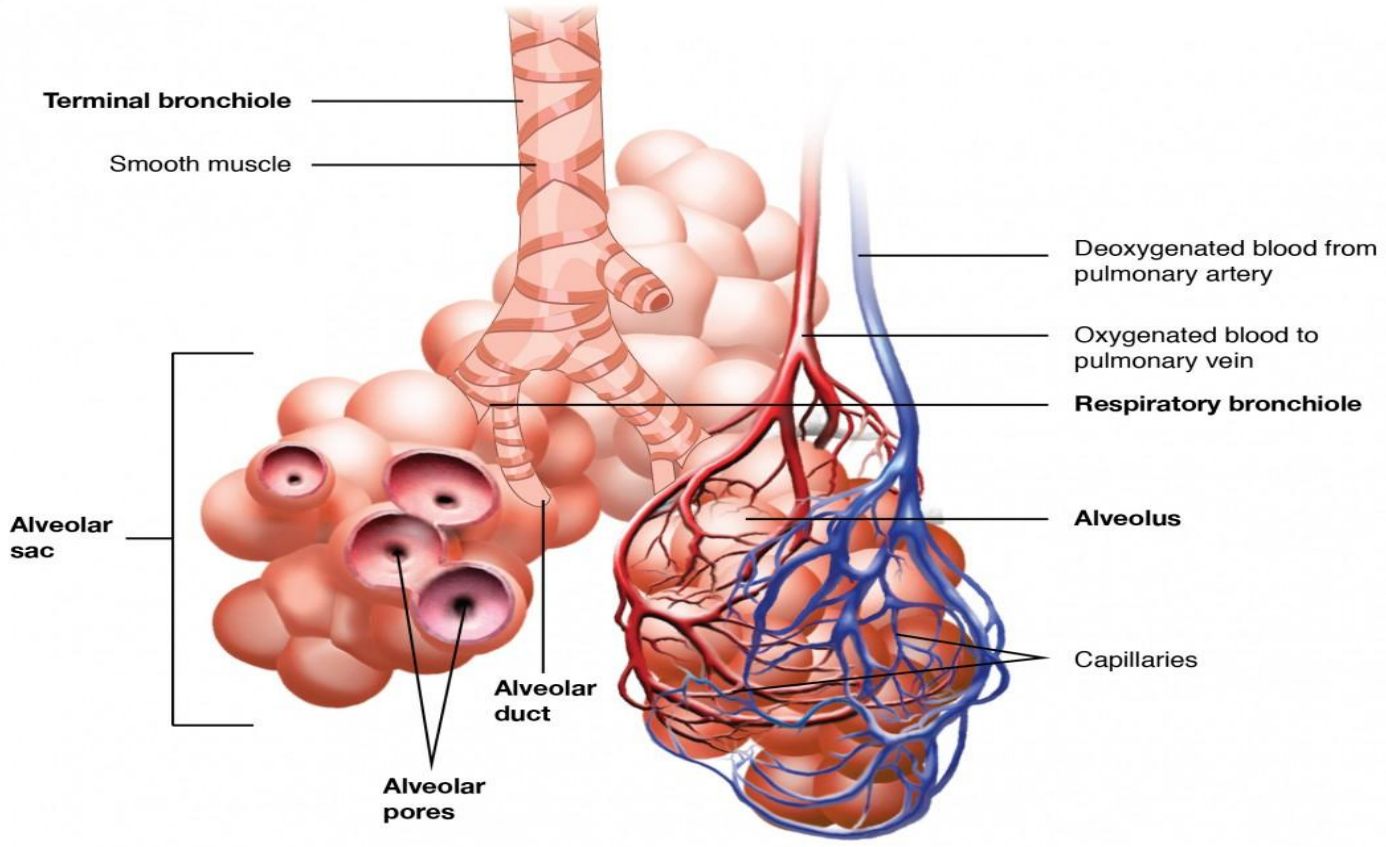
Respiratory Membrane

- ✓ Type I alveolar cell membrane

- ✓ Capillary endothelium
- ✓ Fused basement membrane

Function

- Exchange of O_2 and CO_2
- Each lung contains ~**150 million alveoli**



Structure	Main Function
Larynx	Air conduction, voice, protection
Trachea	Air passage
Bronchi	Air distribution
Bronchioles	Airflow regulation
Lungs	Gas exchange
Alveoli	Gas diffusion