

## Chapter 3 - Respiratory System

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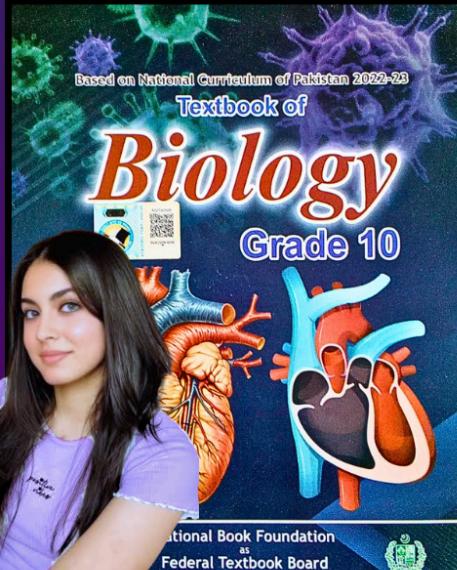
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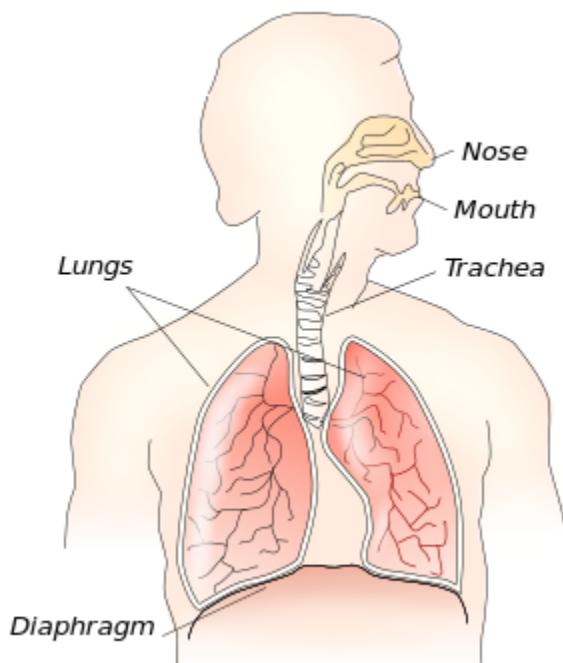
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### What is Respiration?

- **Respiration** is the process by which cells obtain energy from glucose using oxygen.
- It involves a chemical reaction inside the cell, releasing energy needed for growth and other activities.
- **Aerobic respiration:** In the presence of oxygen, glucose is broken down into carbon dioxide and water, releasing energy.
- **Cellular respiration:** A series of chemical reactions inside the cell.



## Breathing vs Respiration

- **Breathing:** Physical movement of air into and out of the lungs.
- **Respiration:** Chemical reaction inside cells.

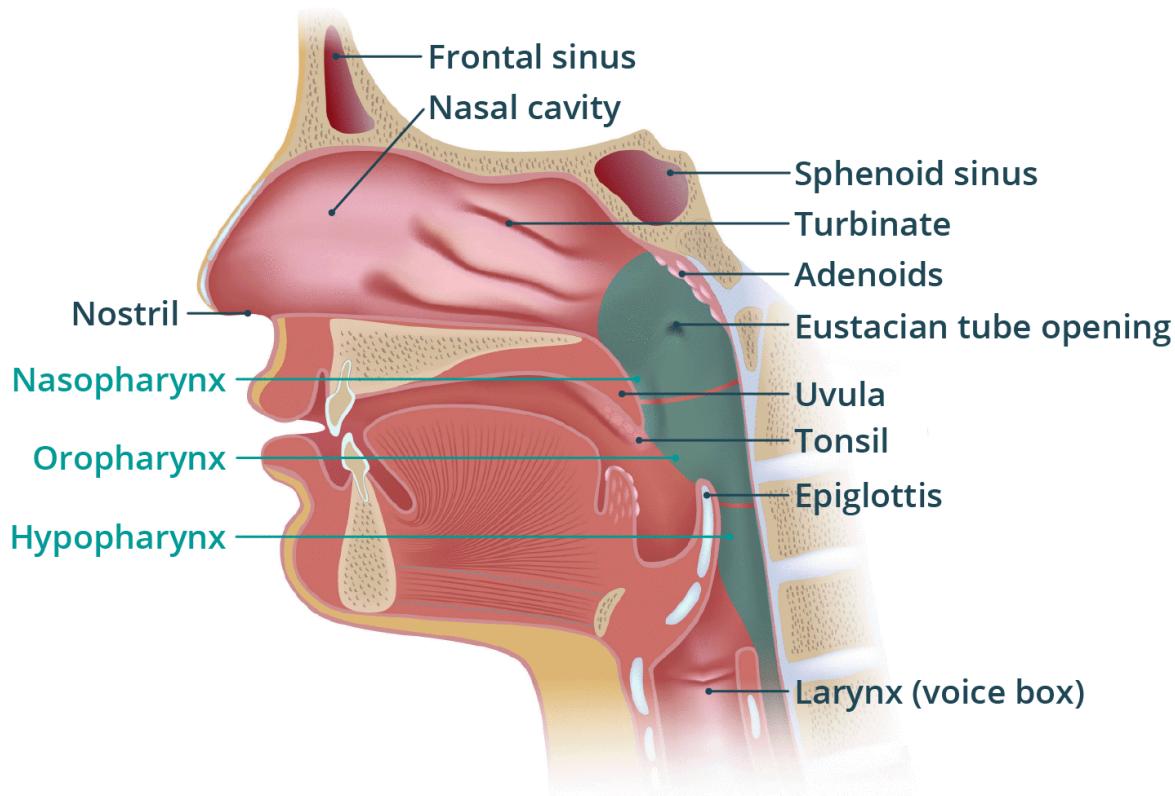
## Function of the Respiratory System

- Moves oxygen from the environment into the body.
- Removes carbon dioxide from the body.

### 3.1. Air Passage Way

#### Gas Exchange in Humans

- The main organs are the **lungs** and **air passages**.
- Air passages allow air to reach the lungs for gas exchange (oxygen intake and carbon dioxide release).
- Humans must have **moist, thin respiratory surfaces** for gas exchange.
- This exchange is called **gas exchange**.



### 3.1.1. Air Passageway and Lungs

#### 1. Nasal Cavity

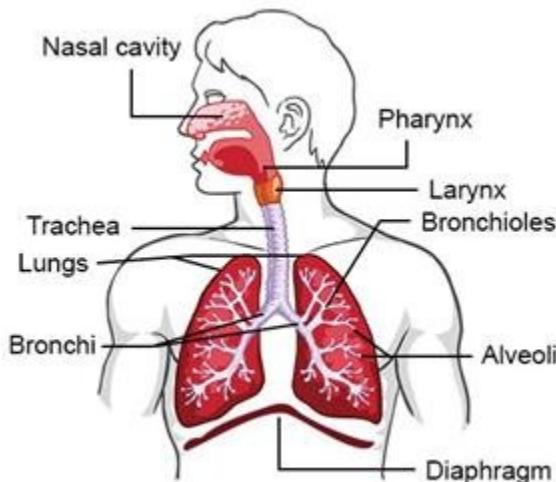
- Filters, warms, and moistens the air.
- Lined with **cilia** and **mucus** to trap dust and microbes.
- Cilia move mucus toward the throat.

#### 2. Pharynx

- Common passage for air and food.
- Located at the back of the mouth.

#### 3. Larynx (Voice Box)

- Cartilaginous structure.
- Produces sound.
- The opening is called the **glottis**, covered by the **epiglottis** during swallowing.



#### 4. Trachea (Windpipe)

- Extends from the larynx to the lungs.
- Has **C-shaped cartilage rings** to keep it open.
- Divides into two **bronchi**.

#### 5. Bronchi and Bronchioles

- Each bronchus enters a lung and divides into smaller **bronchioles**.
- Bronchioles end in small air sacs called **alveoli**.

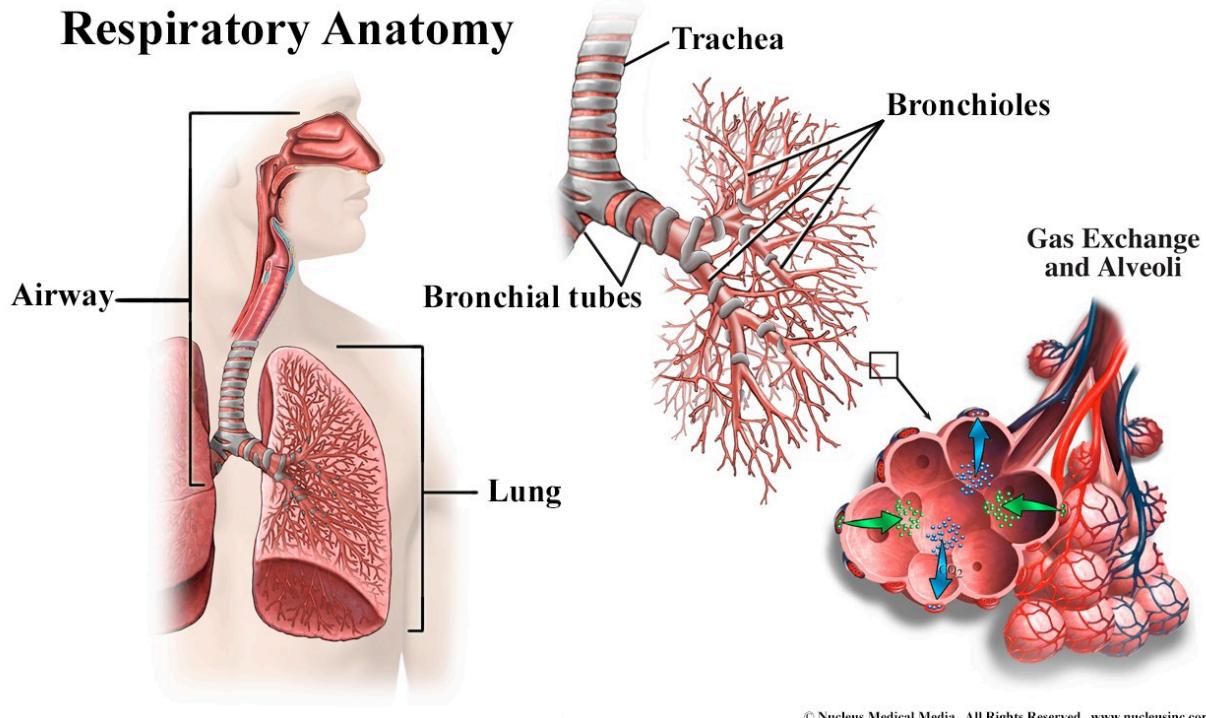
#### 6. Lungs

- Located in the thoracic cavity, protected by ribs and intercostal muscles.
- Each lung is covered by **pleura** (a double membrane).
- **Alveoli** provide a large surface area for gas exchange.

## Structure and Function of Alveoli

- **Alveoli:** Tiny balloon-like structures; grouped like grapes.
- Surrounded by **capillaries**.
- Moist inner surface helps in gas diffusion.

## Respiratory Anatomy

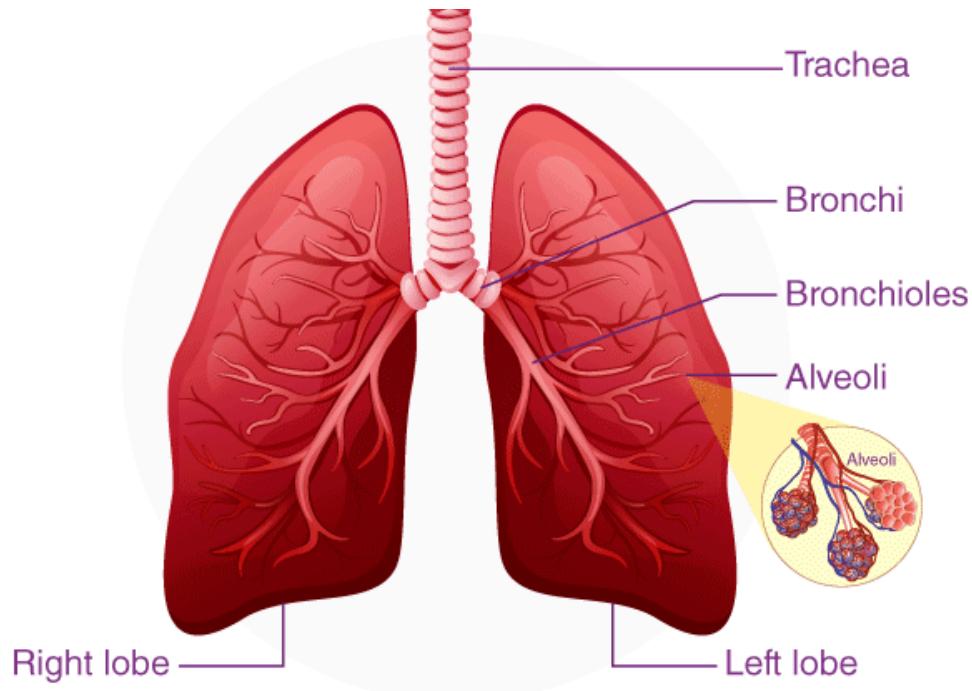


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## Gas Exchange Process

- Oxygen in alveoli diffuses into blood capillaries.
- Carbon dioxide in the blood diffuses into the alveoli.
- **Diffusion:** Movement of gases across thin membranes due to concentration differences.

## Structure and Function of Lungs



- **Location and Protection:**

- Humans have two lungs, located in the **thoracic cavity** (on either side of the heart).
- Protected by ribs and intercostal muscles.
- Each lung is enclosed in a **double membrane** called the **pleura**.
  - **Pleura:** A thin fluid-filled space between two membranes that allows smooth gliding during breathing.

- **Alveoli – The Functional Units:**

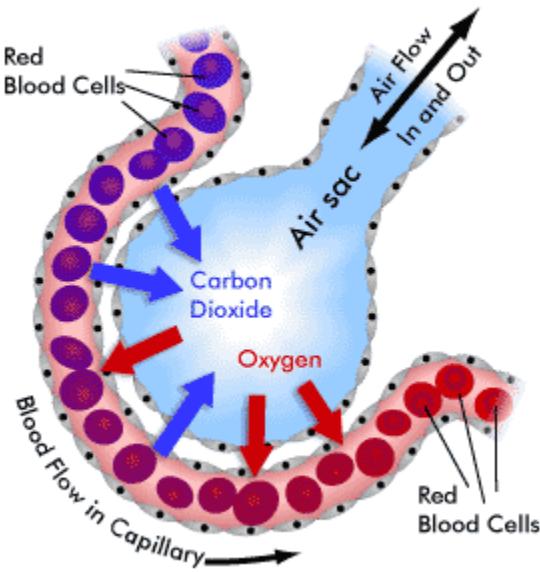
- Lungs have a **spongy texture** due to millions of **alveoli** (tiny air sacs).
- Alveoli resemble **grape-like clusters** and increase the **surface area** for gas exchange.
- Each alveolus is:
  - Surrounded by a network of **capillaries**.
  - Lined with **moisture** to help dissolve gases.

### **Gas Exchange in Alveoli**

- **Oxygen Movement:**

- Oxygen dissolves in alveolar moisture.

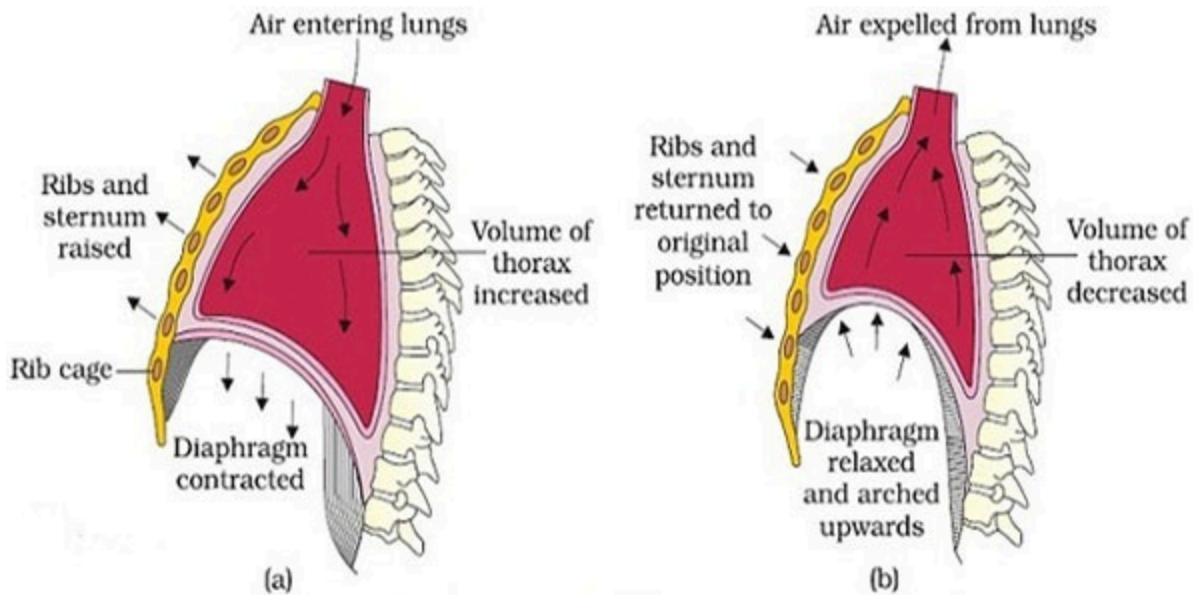
- It then **diffuses across thin alveolar walls** into the surrounding **capillaries** and enters the **red blood cells**.



- **Carbon Dioxide Movement:**
  - CO<sub>2</sub> moves in the **opposite direction**: from blood to alveoli.
  - It **diffuses across the membrane** of the capillary into the alveolus and is **exhaled**.
- **Mechanism:**
  - **Gas exchange** occurs via **diffusion** across the **thin membranes** of alveoli and capillaries.

### 3.2. Mechanism of Breathing

- Breathing is a **mechanical process** involving the movement of air in and out of the lungs.
- Lungs cannot move on their own – **muscles** (mainly the **diaphragm**) help.



### Mechanism of Breathing

- Inspiration
- Expiration

### Steps in Breathing

#### 1. Inhalation

- The diaphragm contracts and moves down.
- Chest cavity enlarges → air is drawn into the lungs.

#### 2. Exhalation

- The diaphragm relaxes and moves up.
- Chest cavity becomes smaller → air is pushed out of lungs.

### Inhalation (Breathing In)

#### Step-by-Step Process:

##### 1. Diaphragm Contracts

- The diaphragm muscle **contracts** and moves **downwards**.
- It changes from a **dome-shaped** to a **flattened** shape.

##### 2. Intercostal Muscles Contract

- The **external intercostal muscles** (located between the ribs) **contract**.

- This pulls the **rib cage upwards and outwards**, expanding the chest cavity.

### 3. Lung Expansion

- As the thoracic cavity expands, the **lungs expand** too.
- The **volume of the lungs increases**, which causes the **pressure inside the lungs to decrease** (below atmospheric pressure).

### 4. Air Intake

- Due to the low pressure inside the lungs, **air rushes in from the nose or mouth** into the lungs.

#### **Result of Inhalation:**

- Lung Volume Increases
- Air is drawn into the lungs
- The diaphragm becomes flat

#### **Exhalation (Breathing Out)**

#### **Step-by-Step Process:**

##### 1. Diaphragm Relaxes

- The **diaphragm muscles relax**.
- It returns to its **normal dome-shaped** position, reducing the chest cavity volume.

##### 2. Intercostal Muscles Relax

- The **external intercostal muscles relax**.
- The **ribs move downward and inward**, further reducing the chest cavity volume.

##### 3. Lung Compression

- As the volume in the lungs decreases, the **pressure increases** (higher than atmospheric pressure).

##### 4. Air Expulsion

- The higher pressure in the lungs causes **air to be forced out** into the surrounding environment.

#### **Result of Exhalation:**

- Lung Volume Decreases

- Air is pushed out of the lungs
- The diaphragm becomes dome-shaped

### 3.3. Composition of Inspired and Expired Air

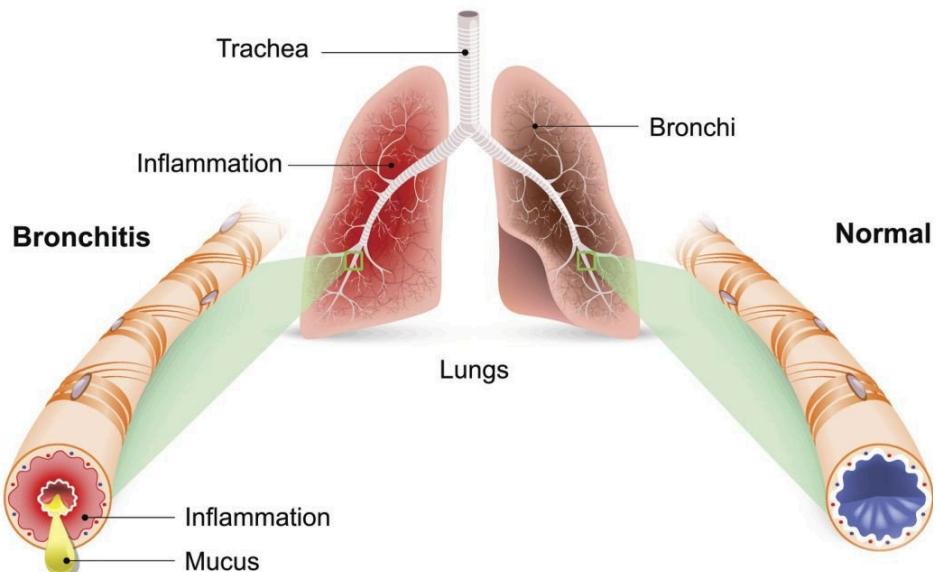
Gas	Inspired air (%)	Expired air (%)	Explanation
Nitrogen	79	79	- not used/produced by body processes
Oxygen	21	16	- used up in respiration
CO <sub>2</sub>	0.04	4	- produced in respiration
Water vapour	Variable	Saturated	- produced by respiration - moisture evaporates from surface of alveoli

### 3.4. Diseases Related to the Respiratory System

#### 1) Bronchitis

Bronchitis is the **inflammation of the lining** of the air passages, like the **trachea, bronchi, and bronchioles**.

## BRONCHITIS



### **Symptoms:**

- Excess mucus secretion from goblet cells
- Persistent cough with mucus
- Shortness of breath
- Breathing difficulties worsen as the disease progresses

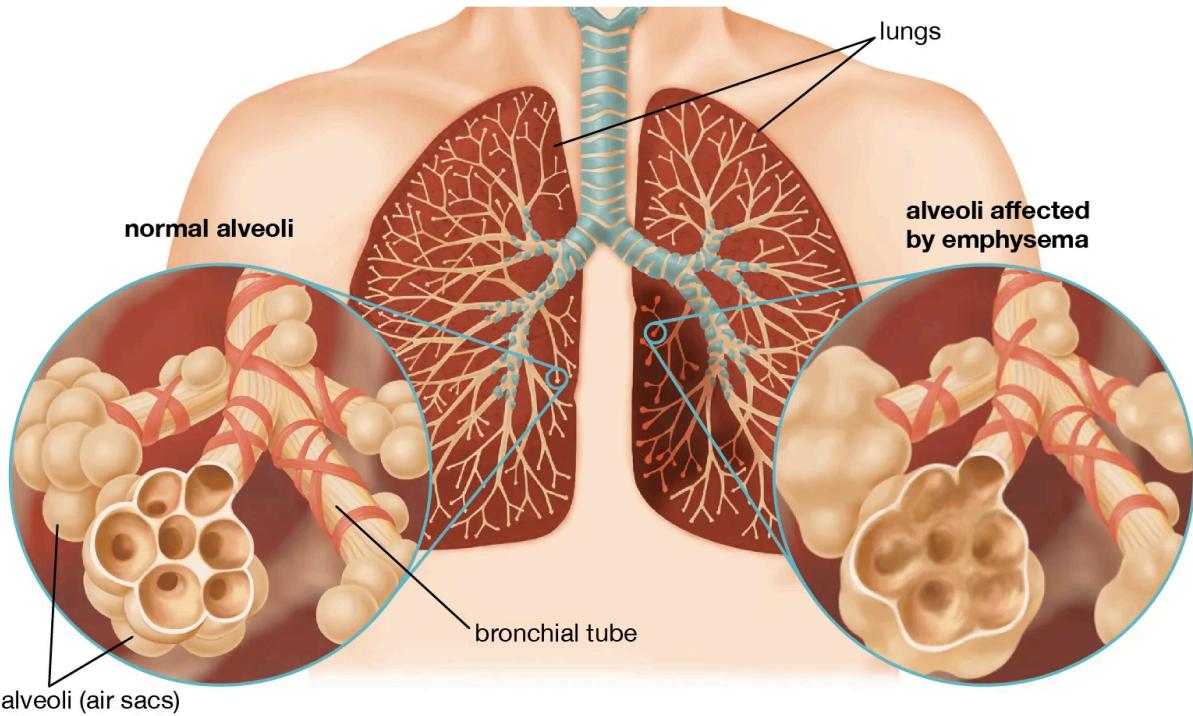
### **Types:**

- **Acute Bronchitis:**  
Short-term inflammation due to infections (like the flu). Usually lasts a few days.  
(Cause: viral infections like the flu)
- **Chronic Bronchitis:**  
Long-term conditions are mostly caused by smoking, air pollution, and industrial fumes. (Cause: smoking, air pollution, long-term exposure to irritants)

### **Treatment:**

- Usually clears up in a week
- **Relief Tips:**
  1. Avoid smoking
  2. Drink plenty of fluids
  3. Take rest
  4. Take medicine if needed
- **Doctor consultation** is important if symptoms worsen

**2) Emphysema:** A chronic respiratory disease where **alveoli** are **over-inflated and damaged**, losing elasticity.



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### Symptoms:

- Shortness of breath
- Fatigue
- Difficulty in exhalation due to loss of elasticity

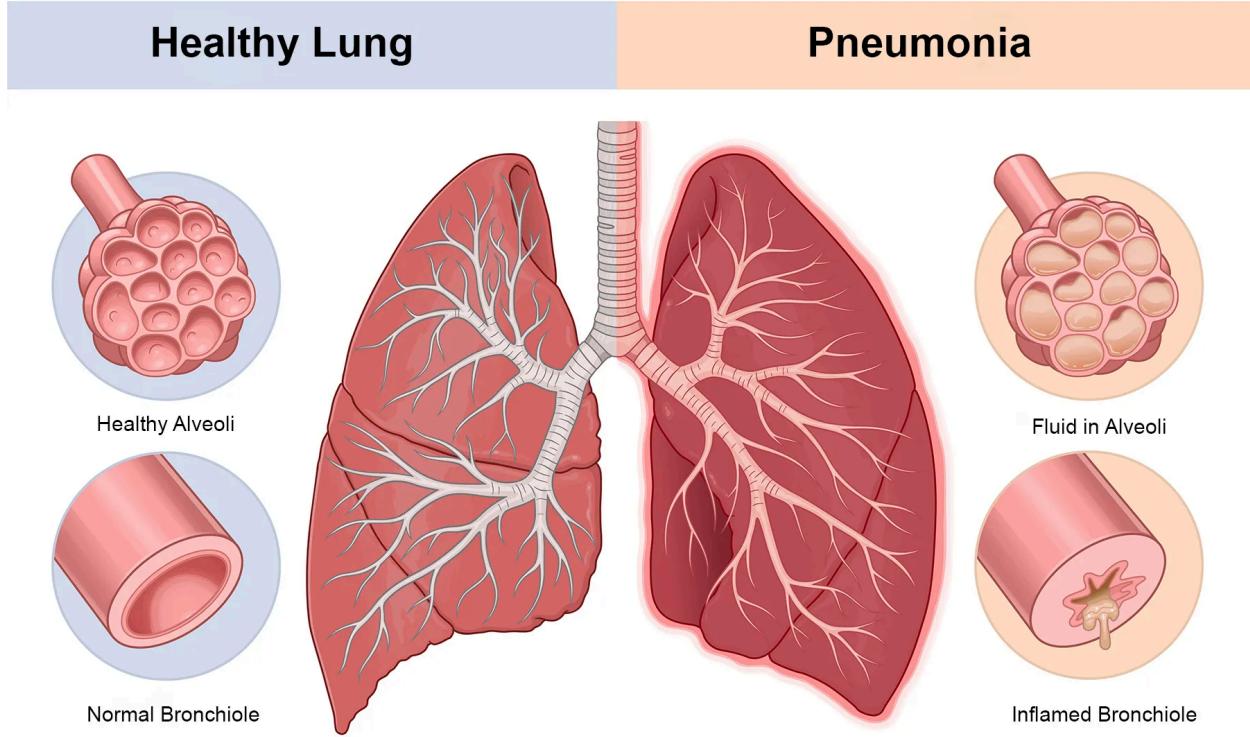
### Cause:

- Gradual breakdown of alveolar walls
- Usually due to **long-term smoking**
- Air pollution and industrial irritants may contribute

### Effect on Lungs:

- Reduced surface area for gas exchange
- Less oxygen absorption
- Air becomes trapped in the lungs

**3) Pneumonia:** Inflammation of the alveoli caused by **acute infection** leads to fluid accumulation in the alveoli.



### Symptoms:

- Fever
- Shaking chills
- Chest pain
- Cough
- Headache
- Sore throat
- Nausea
- Diarrhea

### Types:

- **Double Pneumonia:** Both lungs are infected

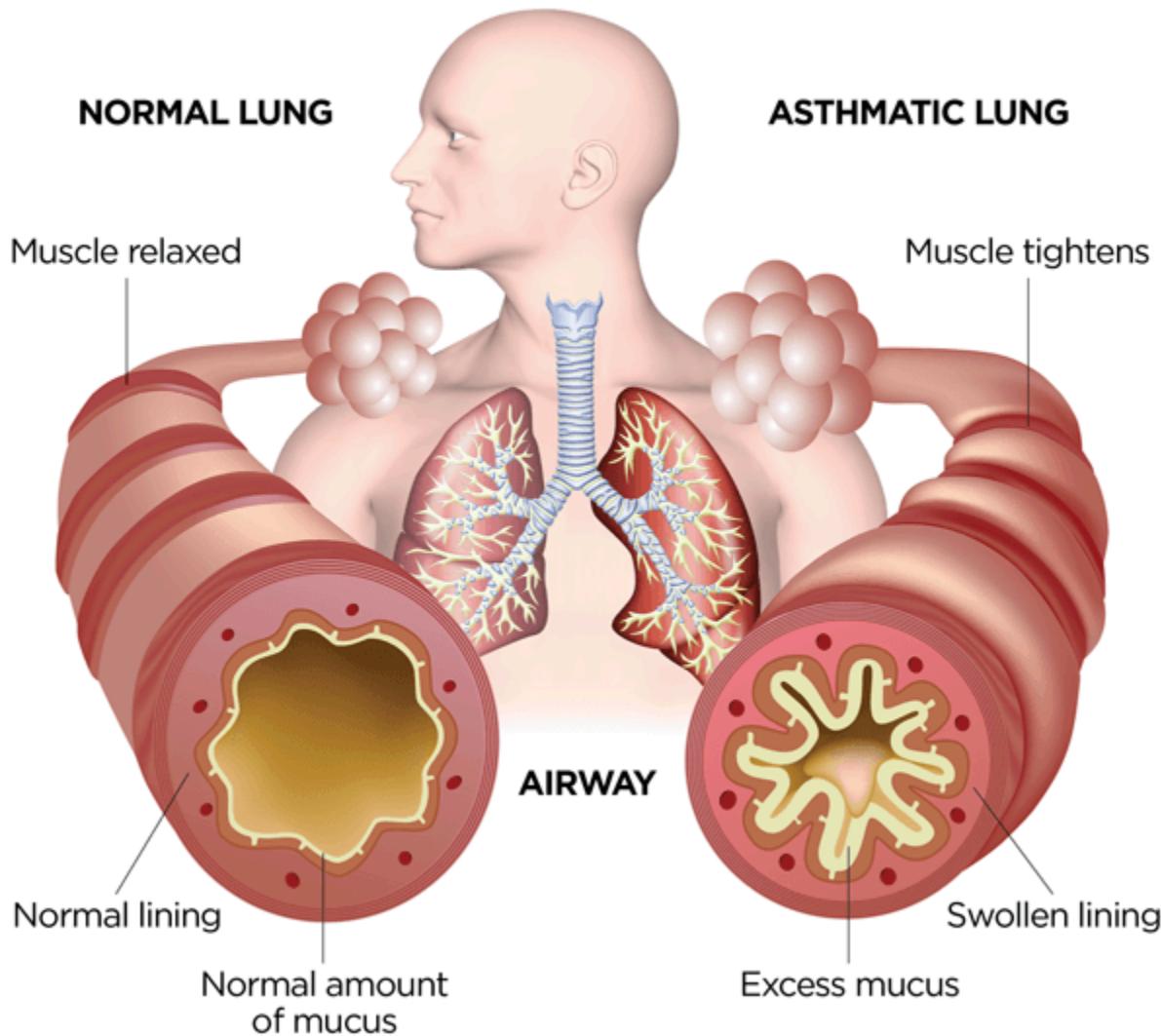
### Cause:

- Bacterial infection (commonly *Streptococcus pneumoniae*)

### Treatment:

- Antibiotics for bacterial pneumonia

**4) Asthma:** A chronic inflammatory disease of the airways triggered by allergens or irritants.



#### Symptoms:

- Wheezing (whistling sound)
- Difficulty in breathing
- Mucus secretion
- Swelling in the respiratory pathway

#### Causes/Triggers:

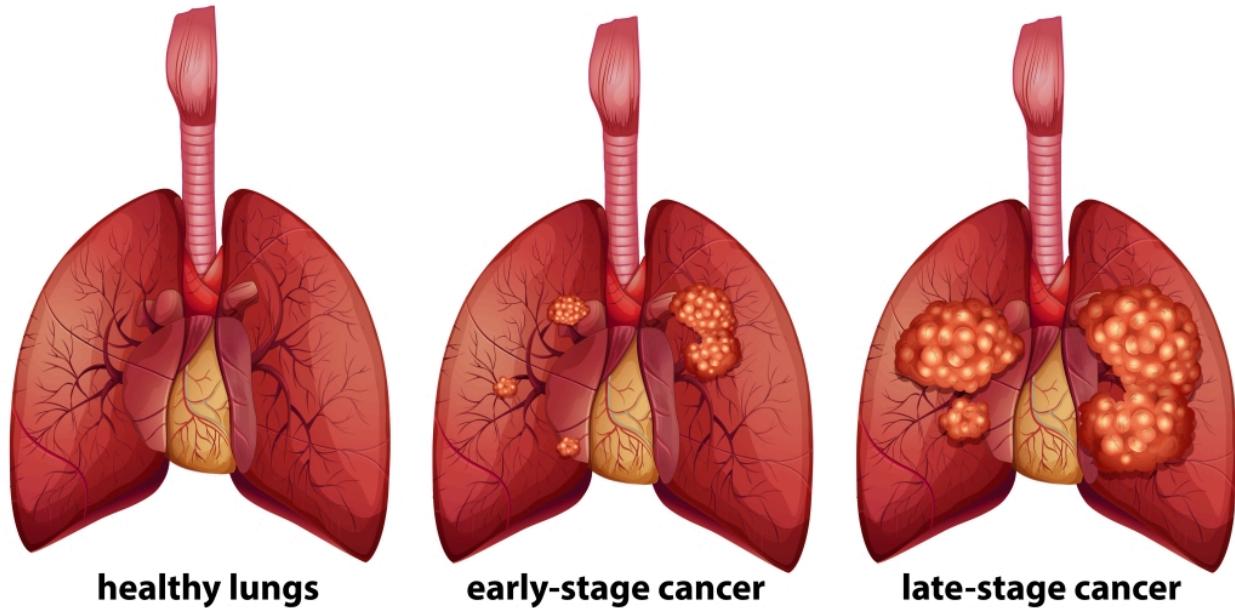
- Allergens: pollen, household dust, feathers, food
- Cold air
- Exercise
- Emotional stress
- Smoke

**Treatment:**

- **Mild asthma:** Inhalers with bronchodilators
- **Long-term asthma:** Treated with long-term control + quick-relief medicines
- Inhalers help dilate bronchioles and improve airflow

**5) Lung Cancer:** Uncontrolled cell division in the lungs forms **tumours**. Starts in the **bronchiolar epithelium** and spreads.

## Lung Cancer Stages



**Symptoms:**

1. Thickening and callusing of bronchial cells
2. Loss of cilia – dust accumulation
3. Tumour formation with cancerous cells
4. Metastasis – cancer spreads to other areas
5. The tumour blocks the bronchus, cutting off the air supply

**Cause:**

- Mainly due to **smoking**
- Long-term exposure to pollutants or carcinogens

**Impact:**

- Tumours reduce lung function
- Spread through the lungs and possibly to other body parts



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