

Breathing and Exchange of Gases

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Introduction

- All living organisms require energy to perform various life activities. This energy is derived through the breakdown of simple organic molecules such as:
 - Glucose
 - Amino acids
 - Fatty acids
- This breakdown occurs in the presence of **oxygen (O₂)** and results in the release of **carbon dioxide (CO₂)** as a waste product.

Role of Oxygen and Carbon Dioxide

- Oxygen (O₂) is essential for the catabolic reactions that release energy.
- Carbon dioxide (CO₂) is a harmful by-product that must be eliminated from the body.
- Thus, for efficient cellular functioning:
 - O₂ must be continuously supplied to the body cells.
 - CO₂ must be continuously removed from the body.

Definition of Breathing

- The process by which:
 - O₂ from the atmosphere is taken in, and
 - CO₂ produced by cells is released,
- is known as **breathing**.
- Breathing is commonly referred to as external respiration.

Experience Breathing

- Place your hands on your chest — you can feel the **up and down movement**.
- This movement is due to the inhalation and exhalation of air, i.e., breathing.

What Comes Next

- In the following sections of this chapter, you will learn about:
 - The respiratory organs in humans and other animals.
 - The mechanism of breathing, including inhalation and exhalation.
 - The regulation and control of the respiratory process.

Respiratory Organs

Variation in Breathing Mechanisms

- The **mechanism of breathing** varies widely across different groups of animals. This variation depends primarily on:
 - The habitat (aquatic or terrestrial),
 - And the **level of body organization** of the organism.

Respiration in Lower Invertebrates

- In simple organisms such as:
 - Sponges
 - Coelenterates
 - FlatwormsExchange of gases (**O₂** and **CO₂**) occurs by **simple diffusion** across the entire body surface.

Respiration in Annelids and Arthropods

- **Earthworms** (Annelids) respire through their **moist cuticle**.
- **Insects** (Arthropods) have a highly branched network of **tracheal tubes** that directly transport atmospheric air within their body.

Respiration in Aquatic Animals

- Most aquatic arthropods and molluscs possess specialized vascularised structures called gills for gas exchange.
- This form of respiration is termed **branchial respiration**.

Respiration in Terrestrial Animals

- Terrestrial animals typically use vascularised internal sacs called lungs for breathing.
- This is known as **pulmonary respiration**.

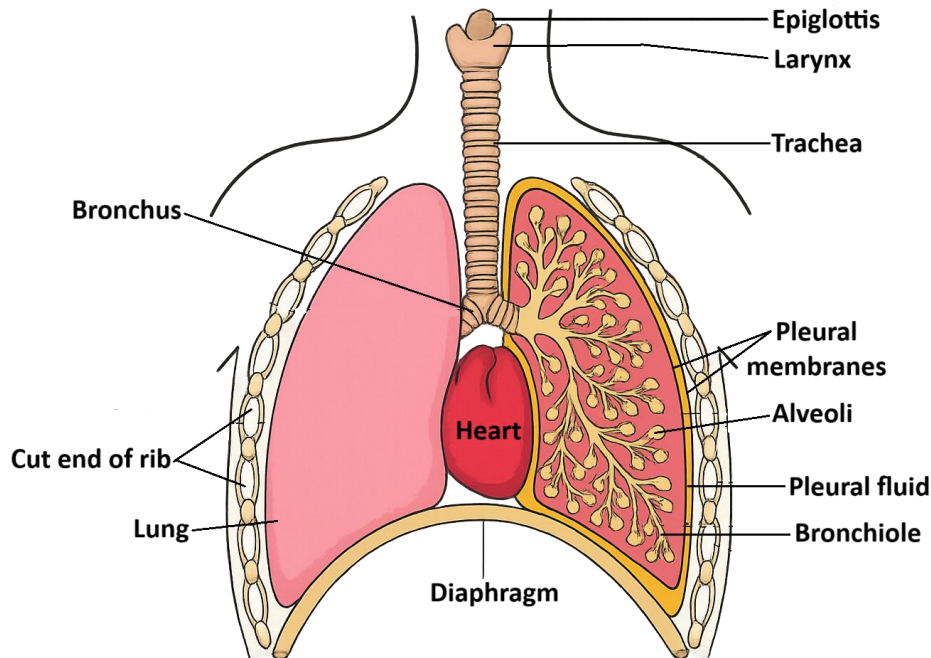
Respiration in Vertebrates

- **Fishes:** Use **gills** for respiration.
- Amphibians, reptiles, birds, and mammals: Rely on lungs for gas exchange.
- Amphibians (e.g., frogs): Can also respire through their moist skin, a process known as **cutaneous respiration**.

Human Respiratory System

- The human respiratory system is responsible for the **exchange of gases (O_2 and CO_2)** necessary for sustaining life.
- It includes a series of structures involved in the intake of air, its conditioning, and gas exchange with blood.

Structure of the Respiratory System



Diagrammatic view of human respiratory system (sectional view of the left lung is also shown)

A. External and Conducting Structures

1. External Nostrils

- A pair of nostrils located above the upper lip.
- Open into the **nasal chamber** via the **nasal passage**.

2. Nasal Chamber

- Filters, humidifies, and warms the incoming air.
- Opens into the **pharynx**.

3. Pharynx

- A common passage for both air and food.
- Opens into the **larynx**.

4. Larynx (Voice Box)

- A cartilaginous structure responsible for **sound production**.
- During swallowing, a cartilaginous flap called the **epiglottis** covers the **glottis** (opening of the larynx) to prevent food from entering the airway.

5. Trachea (Windpipe)

- A straight tube supported by incomplete cartilaginous rings.

- Extends to the mid-thoracic cavity and divides at the level of the **5th thoracic vertebra** into the right and left primary bronchi.

6. Bronchial Tree

- Primary bronchi divide into **secondary** and **tertiary bronchi**, which further branch into bronchioles and end in terminal bronchioles.
- All these structures are part of the **conducting zone**, responsible for air transport and conditioning.

B. Respiratory or Exchange Structures

1. Alveoli

- Tiny, thin-walled, vascularized sacs located at the end of terminal bronchioles.
- Site of **gas exchange** between atmospheric air and blood.

2. Lungs

- Two spongy organs made up of bronchi, bronchioles, and alveoli.
- Enclosed in a **double-layered pleural membrane**:
 - Outer pleura is attached to the thoracic wall.
 - Inner pleura is attached to the lung surface.
 - Pleural fluid between the layers reduces friction during breathing.

Thoracic Cavity and Lung Placement

- The lungs are situated in the thoracic chamber, an air-tight space formed by:
 - Dorsally – Vertebral column
 - Ventrally – Sternum
 - Laterally – Ribs
 - Inferiorly – Dome-shaped **diaphragm**
- This anatomical setup ensures that any change in thoracic volume leads to a corresponding change in pulmonary (lung) volume, which is crucial for breathing.

Functional Division of the Respiratory System

A. Conducting Part

- Includes: Nostrils → Nasal passage → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Terminal bronchioles
- Functions:
 - Transport air to **Alveoli**
 - Filter, humidify, and warm the incoming air

B. Respiratory or Exchange Part

- Includes: Alveoli and their ducts
- Function:
 - Actual **exchange of O_2 and CO_2** between air and blood

Steps Involved in Respiration

Respiration is a complex process involving multiple steps:

1. Pulmonary Ventilation (Breathing)

- Inhalation of atmospheric air and exhalation of CO_2 -rich air.

2. Exchange of Gases Across Alveolar Membrane

- **Diffusion of O_2** from alveoli to blood and **CO_2** from blood to alveoli.

3. Transport of Gases by Blood

- O_2 is carried to tissues; CO_2 is brought back to the lungs.

4. Exchange of Gases Between Blood and Tissues

- O_2 diffuses into cells; CO_2 diffuses into blood.

5. Cellular Respiration

- Utilization of O_2 by cells for **catabolic reactions**, producing **CO_2** as a by-product (detailed in Chapter 12).



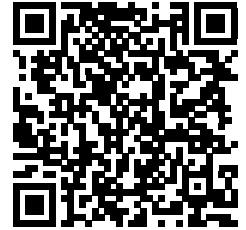


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