Class 6-7 Biology: Respiratory System

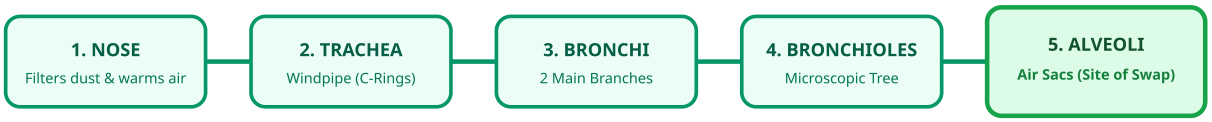
Comprehensive 5-Page Master Class • Human Anatomy, Mechanics & Lab Experiments

MODULE 2

⚡ **Cellular Respiration Formula: $C_6H_{12}O_6$ (Glucose) + $6O_2$ ➔ $6CO_2$ + $6H_2O$ + Energy (38 ATP)!**

1. Why Do We Need Respiration?

Every living organism requires energy to perform vital body functions like growth, movement, repair, and thinking. Food (Glucose) acts as fuel, but to release its stored energy, our body cells need **Oxygen**. Respiration is the biological process of taking in oxygen, burning food inside cells to release energy, and expelling waste carbon dioxide.



2. Breathing vs. Cellular Respiration

Feature	Breathing (External Respiration) 🫁	Cellular Respiration (Internal) ⚡
Nature of Process	Physical / Mechanical process	Biochemical chemical process
Site of Action	Lungs, Nasal Cavity, Trachea	Inside microscopic cells (Mitochondria)
Energy Production	No energy produced (Consumes energy)	Releases energy in the form of ATP
Enzyme Requirement	No enzymes required	Requires specific respiratory enzymes

3. Detailed Anatomical Organs & Functions

The human respiratory system consists of organs that filter, warm, transport, and exchange gases:

1. Nasal Cavity & Nostrils

Air enters through nostrils. Fine hair trap dust; sticky **mucus** moistens air and traps microbes; blood capillaries warm air to body temperature.

2. Pharynx & Larynx

Pharynx: Common passageway for food and air.
Larynx (Voice Box): Contains vocal cords that vibrate to produce sound. **Epiglottis** flap prevents food entering windpipe.

3. Trachea (Windpipe)

A 12 cm long tube supported by **C-shaped cartilaginous rings** that prevent the windpipe from collapsing even when empty of air!

4. Lungs & Alveoli

Spongy elastic organs housed in the chest cavity protected by 12 pairs of **ribs**. Contain ~300 million balloon-like **Alveoli** for gas diffusion into blood.

4. Hands-On Lab Experiment: Model Respiratory System

🫁 EXPERIMENT 1: Constructing a Plastic Bottle Lung-Diaphragm Model

Objective: To demonstrate how diaphragm movement drives lung inflation.

- **Materials:** Clear 2L plastic bottle, Y-shaped tube, 2 small balloons, 1 large rubber sheet.
- **Procedure:** Cut bottle base. Attach balloons to Y-tube arms inside neck. Stretch rubber sheet over bottom.
- **Action A:** Pull rubber sheet DOWN ➔ *Inside bottle volume increases* ➔ *Air rushes in* ➔ *Balloons inflate! (Inhalation)*
- **Action B:** Push rubber sheet UP ➔ *Inside bottle volume decreases* ➔ *Pressure rises* ➔ *Balloons deflate! (Exhalation)*

5. Mechanics of Breathing: Inhalation vs. Exhalation

INHALATION (Breathing In)

- Diaphragm contracts & moves DOWN (Flattens)
- Ribcage moves UP & OUTWARDS
- Chest volume INCREASES ➔ Air Sucked In

EXHALATION (Breathing Out)

- Diaphragm relaxes & moves UP (Dome shape)
- Ribcage moves DOWN & INWARDS
- Chest volume DECREASES ➔ Air Pushed Out

6. Quantitative Air Composition Comparison

Gas Component	Inhaled Air (Atmospheric)	Exhaled Air (Expelled)	Reason for Difference
Oxygen (O_2)	**21%**	**16.4%**	Absorbed into blood by alveoli for cellular respiration
Carbon Dioxide (CO_2)	**0.04%**	**4.4%**	Produced as waste product by cells and dumped into lungs
Nitrogen (N_2)	78%	78%	Not used or absorbed by the respiratory system
Water Vapour	Variable (Low)	Saturated (High)	Evaporates from moist lung linings during breathing

7. Lab Experiment: Testing Exhaled Carbon Dioxide

🧪 EXPERIMENT 2: Lime Water Test for Exhaled CO_2

Procedure: Take two test tubes (A and B) filled with fresh clear Lime Water [$Ca(OH)_2$]. Use a syringe to pump air into Test Tube A. Use a straw to blow exhaled breath into Test Tube B.

Observation: Tube A stays clear for a long time. Tube B turns **Milky White** in seconds due to formation of insoluble Calcium Carbonate [$CaCO_3$]!

8. Microscopic Site of Exchange: The Alveolus



9. Types of Respiration: Aerobic vs. Anaerobic

Cellular respiration occurs in two distinct pathways depending on oxygen availability:

1. Aerobic Respiration

- Occurs in the **presence of Oxygen**.
- Complete breakdown of glucose into CO_2 and H_2O.
- Releases maximum energy (**38 ATP molecules** per glucose).
- Occurs in humans, animals, plants, and most organisms.

2. Anaerobic Respiration

- Occurs in the **absence of Oxygen**.
- Partial breakdown of food into Alcohol (Yeast) or Lactic Acid (Muscles).
- Releases very low energy (**2 ATP molecules**).
- Causes muscle cramps during heavy sprinting due to lactic acid build-up!

10. Respiration in Other Living Organisms

- **Insects (e.g., Cockroach):** Breathe through tiny side pores called **Spiracles** connected to air tubes called *Tracheae*.
- **Earthworms:** Breathe directly through their moist, slimy **Skin** by simple diffusion.
- **Fish:** Extract dissolved oxygen from water using feathery, blood-rich **Gills**.
- **Plants:** Exchange gases through microscopic pores on leaves called **Stomata** and woody stem pores called *Lenticels*.

11. End-of-Chapter Master Practice Worksheet

SECTION A: Fill in the Blanks

1. The muscular floor sheet of the chest cavity is called the _____.
2. Trachea is supported by C-shaped rings made of tough, flexible tissue called _____.
3. The gas exchange in lungs occurs inside millions of microscopic air sacs called _____.
4. Accumulation of _____ acid in muscle cells causes cramps during rapid heavy exercise.

SECTION B: Give Scientific Reasons

1. **Why should we always breathe through our nose and not our mouth?**
   Answer: The nasal cavity contains fine hair and sticky mucus that filter dust particles, bacteria, and warm/moisten incoming air.
2. **Why do aquatic animals (fish) breathe much faster than terrestrial animals (land mammals)?**
   Answer: The amount of dissolved oxygen in water is very low compared to oxygen present in atmospheric air.
3. **Why does lime water turn milky when we blow air into it?**
   Answer: Exhaled air contains ~4.4% CO_2 which reacts with calcium hydroxide to form insoluble calcium carbonate chalk.

SECTION C: Match Column A with Column B

Organism	Respiratory Structure	Correct Match
(a) Earthworm	(i) Gills	(a) ➔ (iii) Moist Skin
(b) Fish	(ii) Spiracles	(b) ➔ (i) Gills
(c) Cockroach	(iii) Moist Skin	(c) ➔ (ii) Spiracles
(d) Plant Leaf	(iv) Stomata	(d) ➔ (iv) Stomata

🏆 **Chapter Summary:** Respiration releases ATP energy from food. Pathway: Nose ➔ Trachea ➔ Bronchi ➔ Bronchioles ➔ Alveoli ➔ Capillaries. Inhalation drops diaphragm down; exhalation pushes it up!