Respiration is the process of **transferring energy from glucose**.

- It occurs in **every living cell**.
- It is **exothermic** (energy released to the surroundings).
- Energy released is used to make **ATP** for life processes.

Aerobic and Anaerobic Respiration

Aerobic Respiration

Uses **oxygen** | Releases the **most energy** | Most reactions occur in the **mitochondria**.

Word & Symbol Equation:

Glucose + oxygen → carbon dioxide + water

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Anaerobic Respiration occurs when there is **not enough oxygen**

Releases **less energy** | **Glucose is incompletely oxidised** | last resort, e.g. intense exercise

In animals: **Glucose → lactic acid**

In plants and yeast (fermentation): **Glucose → ethanol + carbon dioxide**
Used in **bread making** and **alcohol production**.

Response to Exercise

- Muscles need more energy → respiration rate increases.
- To supply oxygen and remove CO_2
  - **Heart rate increases**
  - **Breathing rate increases**
  - **Breath volume increases**

Oxygen Debt

- During vigorous exercise, anaerobic respiration produces **lactic acid**.
- Causes **muscle fatigue** and pain.
- **Oxygen debt** = extra oxygen needed after exercise to:
  - Break down lactic acid
  - Remove it from muscles
  - Lactic acid is transported by the blood to the **liver**, where it is converted back into **glucose**.

Metabolism

Metabolism is **the sum of all chemical reactions** in the body.

- Energy from respiration drives metabolic reactions.
- All metabolic reactions are **enzyme-controlled**.

Examples of Metabolic Reactions:

Glucose → **starch, glycogen, cellulose**

Glycerol + 3 fatty acids → **lipids**

Glucose + nitrate ions → **amino acids** → **proteins**

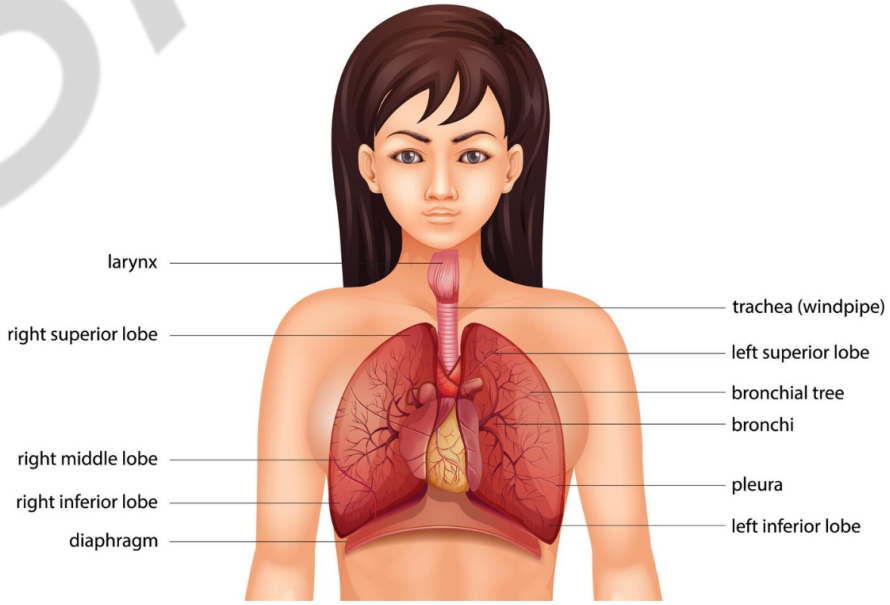
Respiration reactions

Breakdown of excess amino acids to form **urea** for excretion

The Human Gas Exchange System

Structure of the Thorax

Ribs	protect lungs
Intercostal muscles	move ribs during breathing
Diaphragm	dome-shaped muscle that **changes thorax volume**
Trachea	windpipe carrying air to lungs
Bronch	one to each lung
Bronchioles	smaller airways
Alveoli	tiny air sacs for **gas exchange**
Pleural membranes	lubricate lungs to reduce friction



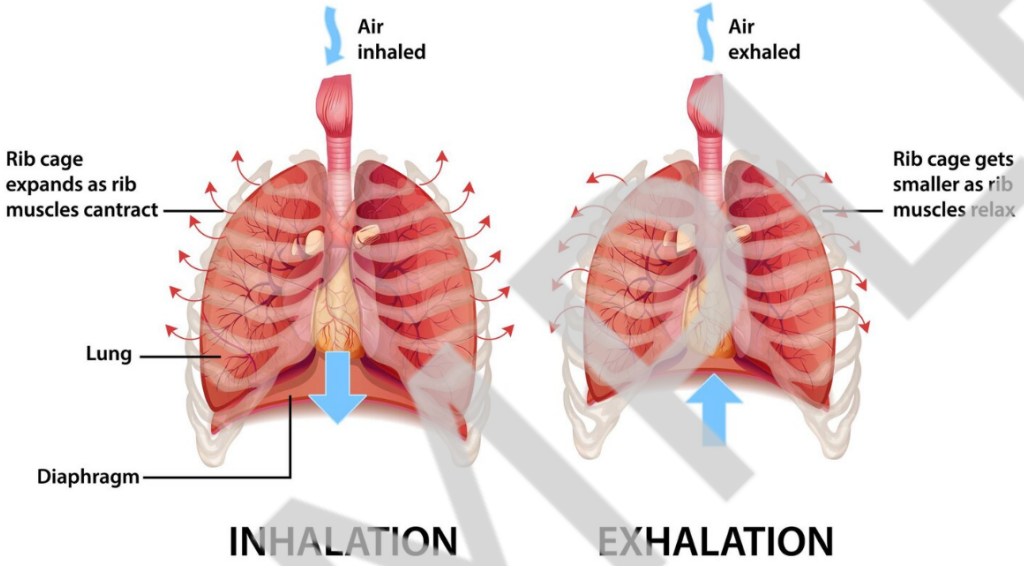
Ventilation (Breathing Mechanism)

Inhalation

Intercostal muscles **contract**
Ribcage moves **up and out**
Diaphragm **contracts and flattens**
Thorax volume **increases**
Pressure **decreases**
Air **moves in**

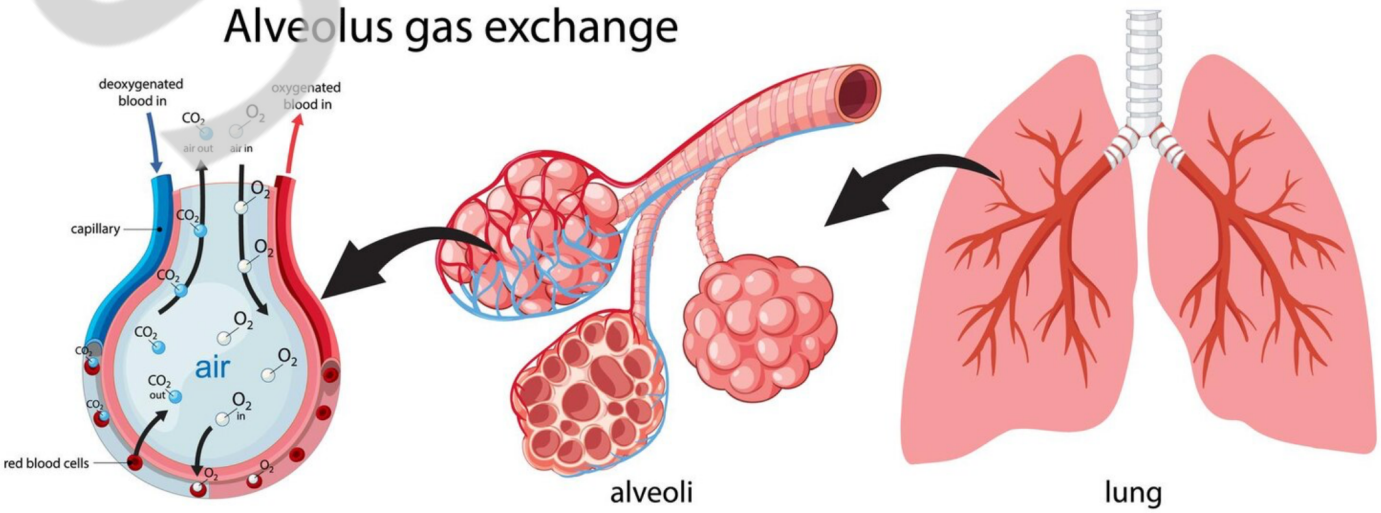
Exhalation

Intercostal muscles **relax**
Ribcage moves **down and in**
Diaphragm **relaxes and domes**
Thorax volume **decreases**
Pressure **increases**
Air **moves out**
Air moves from **high pressure to low pressure**



Alveoli Adaptations for Gas Exchange

- **One cell thick walls** → short diffusion distance
- **Folded structure** → large surface area
- **Dense capillary network:**
  - Maintains steep concentration gradients
  - Oxygen diffuses into blood
  - Carbon dioxide diffuses out



Gas Exchange in Plants

Plants need **carbon dioxide** for **photosynthesis** and **oxygen** for **respiration**

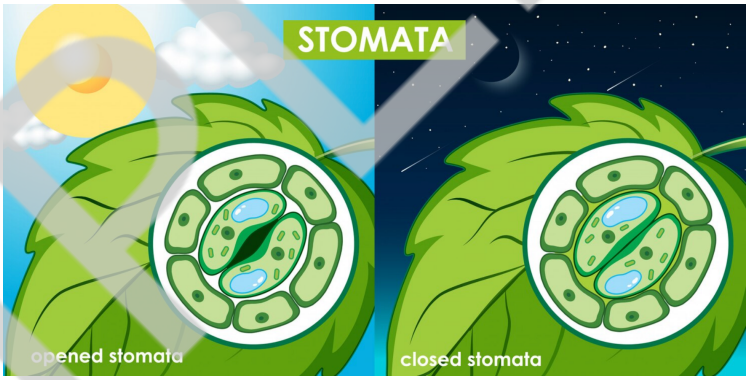
Gas exchange occurs by **diffusion**

Photosynthesis reminder:

carbon dioxide + water → glucose + oxygen (light)

Adaptations of Leaves for Gas Exchange

- **Thin leaves** → short diffusion distance.
- **Large surface area** (flattened shape).
- **Spongy mesophyll**:
  - Large **air spaces** for rapid diffusion.
- **Stomata**:
  - Gaps in lower epidermis.
  - Allow **CO_2 in, O_2 out**.
  - Also allow **water loss by evaporation**.
- **Guard cells**:
  - **Kidney-shaped**
  - Open/close stomata by gaining or losing water



Remember:

Respiration occurs **day and night**

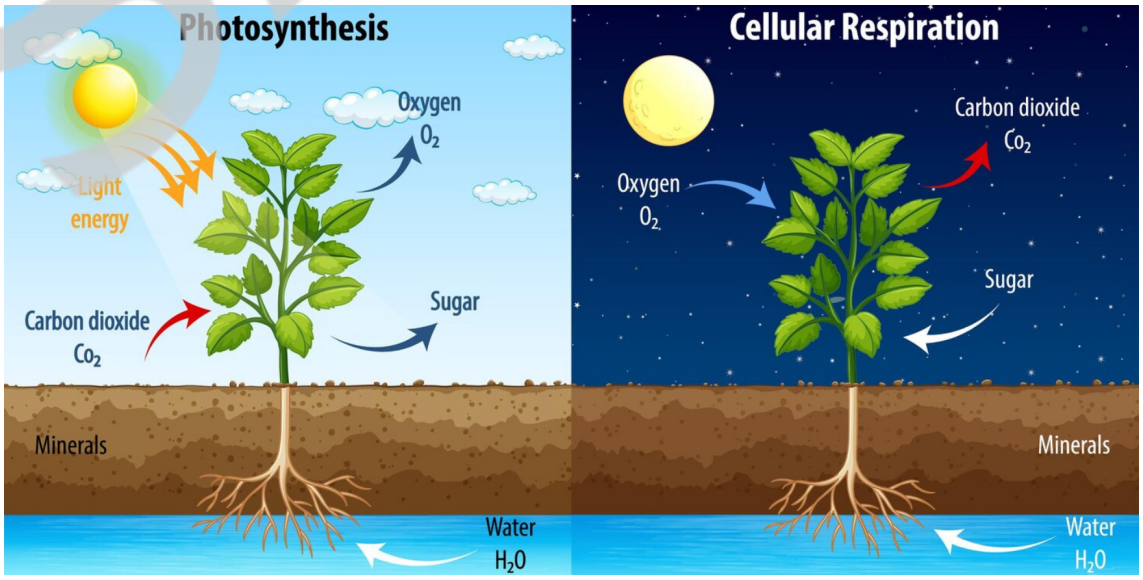
Photosynthesis only occurs **in light**

Daytime:

- Photosynthesis > respiration.
- Net **CO_2 in, O_2 out**.

Night-time:

- No photosynthesis.
- Respiration only.
- Net **O_2 in, CO_2 out**.



Transporting Substances in Plants

Phloem

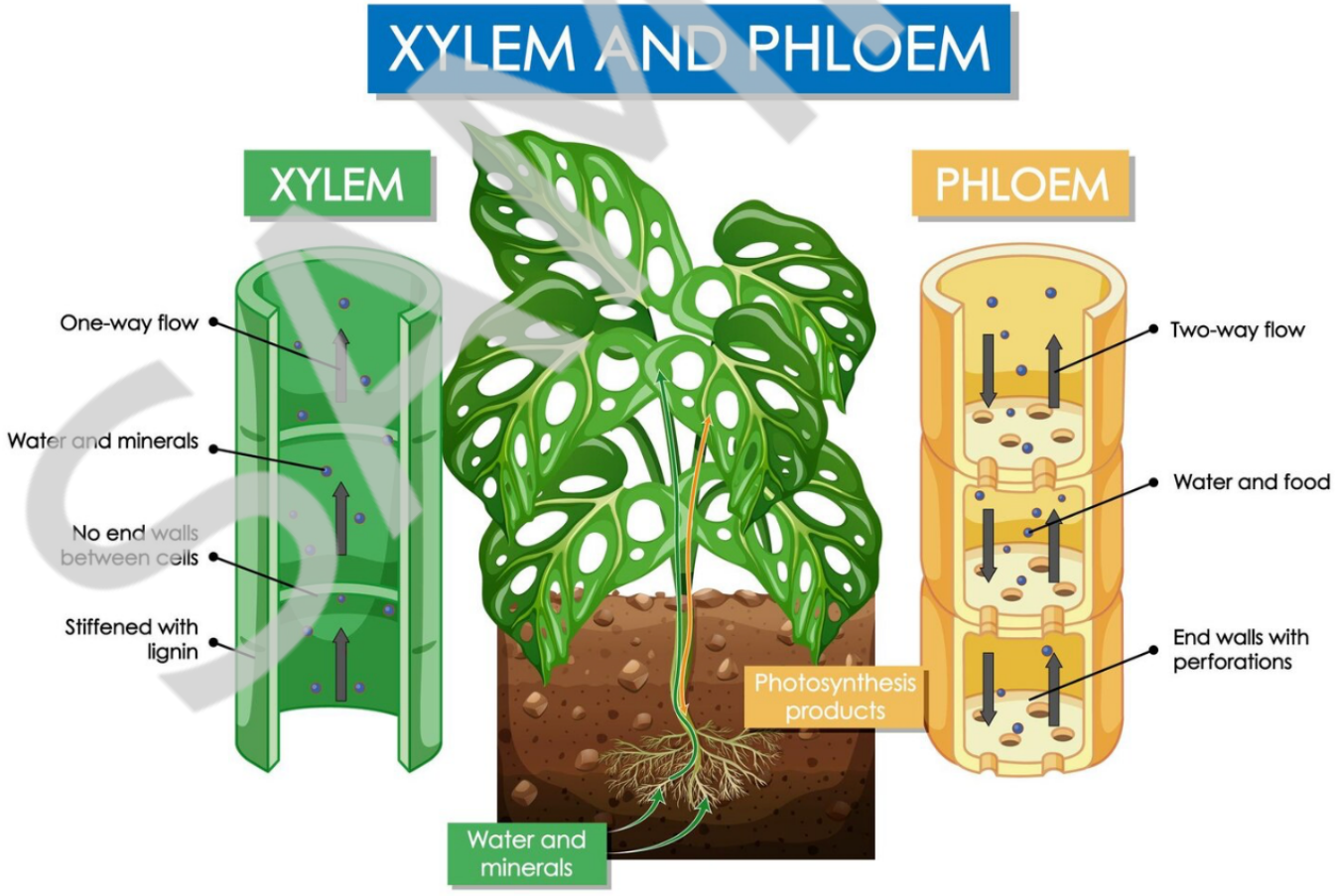
transports **sucrose** and **amino acids** (**translocation**).

- Found in roots, stems and leaves.
- **Sieve tubes** with perforated end walls (**sieve plates**).
- Few organelles → easier flow of sap.
- **Companion cells** contain many **mitochondria** to supply energy.
- **Transport occurs both directions**.

Xylem

transports **water and mineral ions** from roots to leaves.

- Cells are dead and hollow.
- Walls strengthened with **lignin**.
- Cells join end-to-end to form continuous tubes.
- **Hydrogen bonding** keeps water as a continuous column.
- **Bordered pits** allow sideways movement.
- Lignin provides **structural support**.



Transpiration

Transpiration is evaporation of water from plant leaves

Occurs through **open stomata**.

Loss of water pulls more water up the xylem → **transpiration stream**.

Increased transpiration → increased **water uptake by roots** (osmosis in root hair cells).

Factors Affecting Transpiration

Factor	Effect				
Increased light intensity:	More stomata open	→			↑ transpiration
Increased temperature:	Faster evaporation	+	more stomata open	→	↑ transpiration
Increased wind:	Removes water vapour	→	steeper gradient	→	↑ transpiration
Increased humidity:	Reduced gradient	→			↓ transpiration