

Photosynthesis in Higher Plants

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Introduction

- All animals, including humans, depend on plants for food.
- But how do **plants obtain their food**?
- Green plants do not consume food like animals; instead, they synthesize their own food through a process called **photosynthesis**.
- Hence, green plants are called **autotrophs** (auto = self, troph = nourishment).

Autotrophs and Heterotrophs

A. Autotrophs

- Green plants are called **autotrophs**.
- They can synthesize their own food using natural resources like:
 - Sunlight
 - Carbon dioxide (CO₂)
 - Water (H₂O)
- This mode of nutrition is known as **autotrophic nutrition**.
- It is found only in green plants (and some photosynthetic bacteria).

B. Heterotrophs

- All other organisms, including humans and animals, are known as **heterotrophs**.
- They cannot synthesize their own food.
- They depend on plants directly (herbivores) or indirectly (carnivores, omnivores) for their nutritional needs.
- This mode of nutrition is called **heterotrophic nutrition**.

What is Photosynthesis?

- **Photosynthesis** is the process by which green plants prepare their own food.
- It is a physico-chemical process that occurs in **plant cells**.
- During this process, plants use **light energy from the sun** to convert:
 - Carbon dioxide (CO₂) from the air
 - Water (H₂O) from the soil
 - into organic compounds such as glucose (C₆H₁₂O₆).

- The process takes place primarily in the **chloroplasts** of plant cells.
- **Chloroplasts** contain a green pigment called **chlorophyll**, which:
 - Captures sunlight
 - Drives the conversion of CO_2 and H_2O into glucose
- **Oxygen (O_2)** is released as a **byproduct** of photosynthesis.

Significance of Photosynthesis

Photosynthesis is essential for life on Earth due to the following **two major reasons**:

1. Primary Source of Food

- Photosynthesis is the foundation of all food chains.
- Green plants **produce food** using sunlight, and all other organisms **depend on plants** either directly or indirectly for their nutrition.
- Without photosynthesis:
 - Food would not be produced
 - Life would not be sustained for any organism

2. Release of Oxygen

- **Oxygen (O_2)** is released as a **byproduct** of photosynthesis.
- This oxygen is essential for the survival of most living organisms, including humans and animals.
- Without photosynthesis, the oxygen supply would be depleted, making **aerobic respiration** (breathing) impossible.

Photosynthesis and Life on Earth

- **Sunlight** is the ultimate source of energy for all living organisms.
- Organisms depend on sunlight in **two** ways:
 - Directly – Green plants use sunlight to prepare food through photosynthesis.
 - Indirectly – Animals and humans obtain energy by consuming plants or plant-eating organisms.
- **Photosynthesis** captures solar energy and converts it into **chemical energy** (in the form of glucose).
- This stored chemical energy:
 - Powers metabolic activities in all organisms.
 - Sustains the entire biosphere

What Do We Know About Photosynthesis?

- Before we explore photosynthesis in detail, let us recall some important concepts we have already learned through simple experiments in earlier classes.
- These experiments help us understand the **basic requirements for photosynthesis**.

Essential Requirements for Photosynthesis

- From past experiments, we know that the following **three components** are necessary for photosynthesis to occur:
 - **Chlorophyll** – the green pigment in leaves
 - **Sunlight** – as the source of energy
 - **Carbon dioxide (CO₂)** – as a raw material

Experiment 1: Role of Chlorophyll and Light

- You may have performed an experiment using:
 - A variegated leaf (having both green and non-green areas), or
 - A leaf partially covered with black paper and then exposed to sunlight.
- After some time in sunlight, the leaf is tested for the presence of **starch** using an iodine solution.

Observation:

- Only the **green areas** of the leaf test **positive for starch**.
- The non-green or covered areas do **not** show starch presence.

Conclusion:

- **Chlorophyll** is required for photosynthesis.
- Photosynthesis occurs only in the green parts of the leaf and only in the presence of light.

Experiment 2: Role of Carbon Dioxide (CO₂)

- In another experiment, part of a leaf is enclosed in a test tube containing **potassium hydroxide (KOH)** soaked cotton, while the other part is left exposed to normal air.
 - **KOH absorbs carbon dioxide** from the air inside the tube.
 - The setup is then placed in sunlight for a few hours.
- After exposure, the leaf is tested for starch formation.

Observation:

- The part of the leaf exposed to air tests **positive for starch**.

- The part enclosed in the tube with KOH tests **negative**.

Conclusion:

- Carbon dioxide is essential for photosynthesis.
- In the absence of CO₂, starch is not formed, indicating that **photosynthesis does not occur**.

Early Experiments in Understanding Photosynthesis

- Understanding **photosynthesis** developed gradually through a series of simple but significant **experiments** conducted by scientists over several centuries.

Joseph Priestley's Experiments (1733–1804)

Year of Experiment:

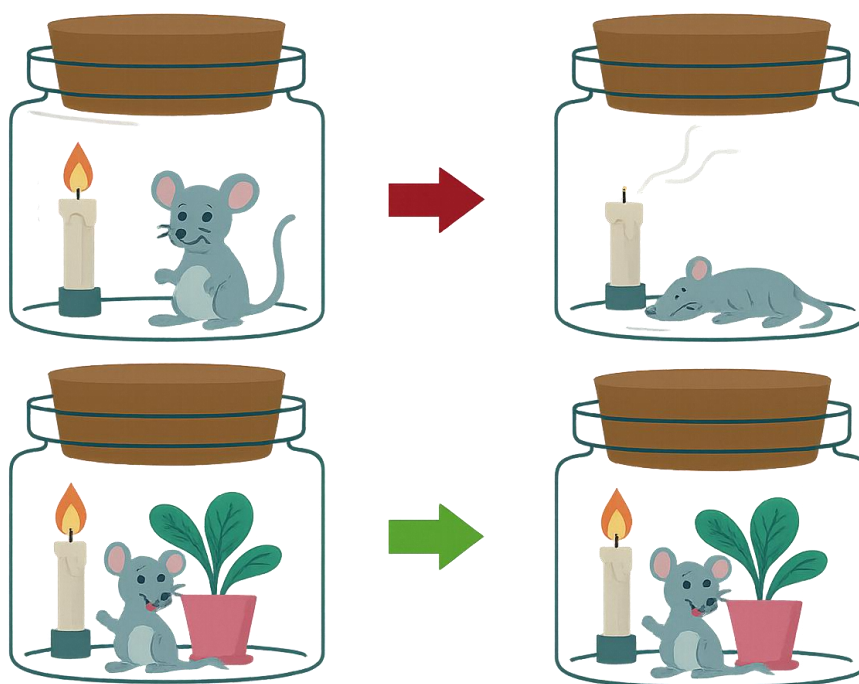
- 1770

Discovery:

- Revealed the essential role of air in plant growth.

Observations:

- A candle placed in a **closed bell jar** extinguished after a short time.
- A mouse placed in a closed bell jar **suffocated**.
- A **mint plant**, when placed in the same jar, restored the air, allowing the mouse to survive and the candle to burn again.



Priestley's experiment

Conclusion:

- “Plants restore to the air whatever breathing animals and burning candles remove.”
 - Priestley also **discovered oxygen** in 1774.

Think About It

- How might **Priestley** have tested the candle's ability to **burn again** without disturbing the sealed setup? How could the candle be rekindled inside the bell jar?

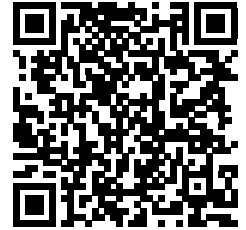


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