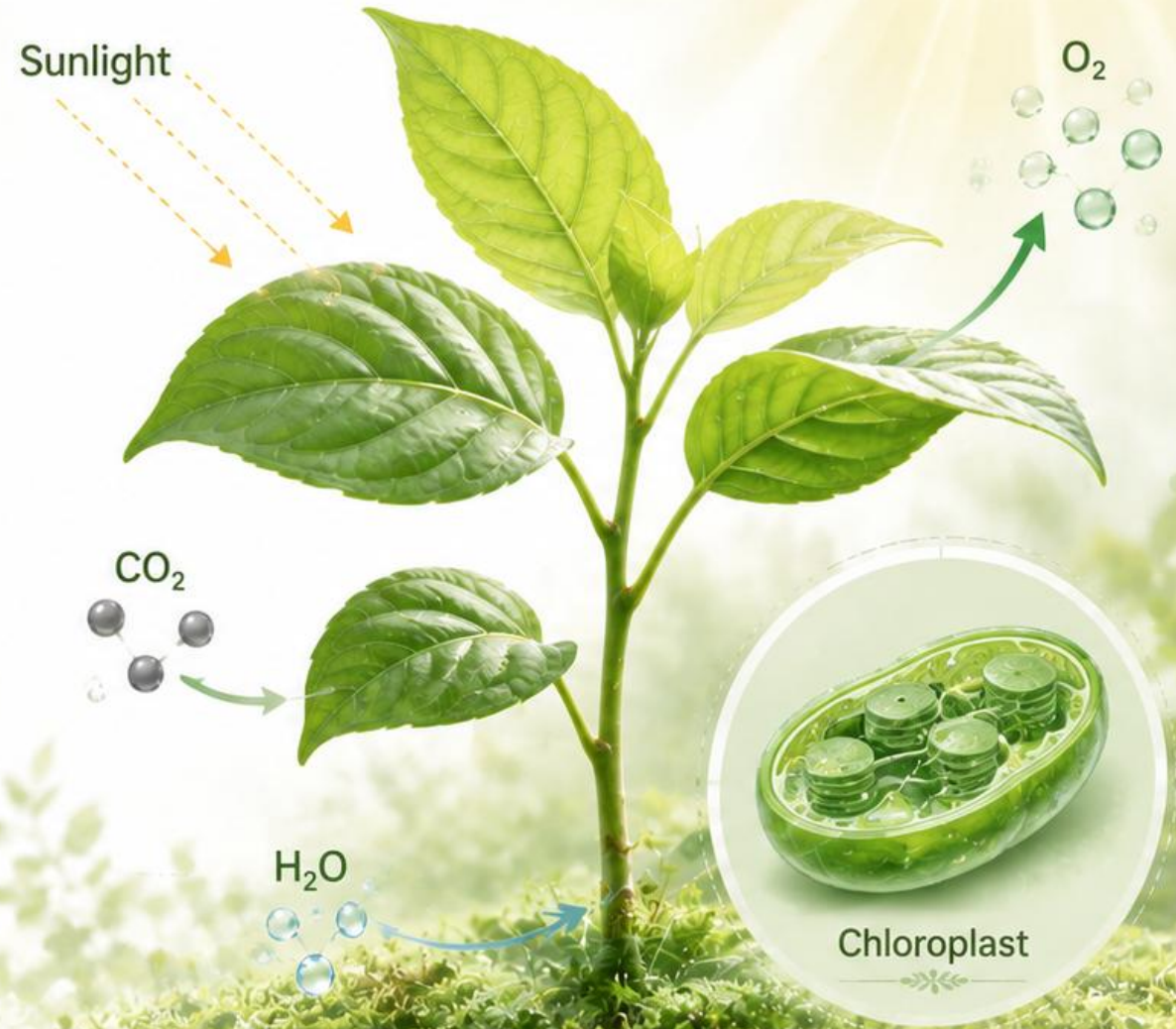


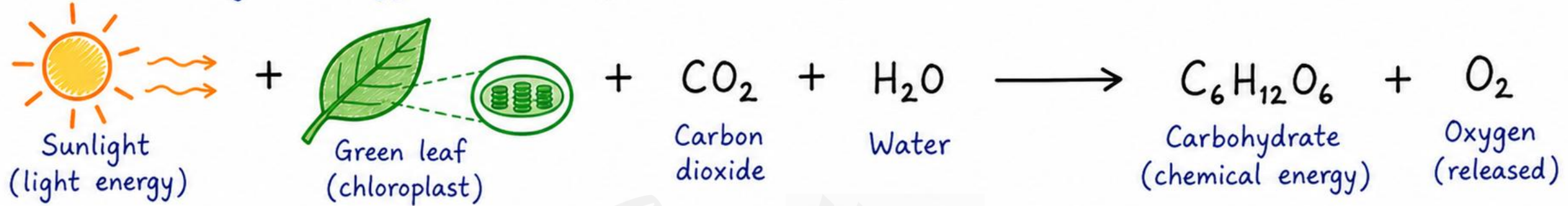
Chapter 11 : Photosynthesis in Higher Plants

Biology Notes | Class 11



PHOTOSYNTHESIS: ENERGY, MATTER & LIFE

Definition: Photosynthesis is a physicochemical process in which green plants use light energy to drive synthesis of organic compounds.



Balanced net
representation
(overall)



balanced net representation of a multistep process — not one reaction

Important: The released O₂ comes from water (H₂O), not from CO₂.

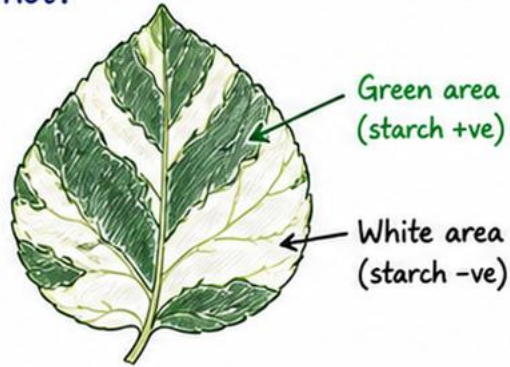
Biological significance of photosynthesis:

- Primary source of food and biomass: It synthesizes organic compounds that constitute the food and biomass of all living organisms.
- Releases oxygen (O₂) into the atmosphere: Essential for aerobic life and maintenance of the ozone layer.
- Converts light energy to chemical energy: Traps solar energy and stores it in chemical bonds of organic compounds.
- Supports heterotrophs: Autotrophs (green plants, algae, some bacteria) produce food that supports all heterotrophic organisms directly or indirectly.

EVIDENCE FOR PHOTOSYNTHESIS REQUIREMENTS

① OBSERVATION

When a variegated leaf is illuminated and then tested for starch, only the green areas turn blue-black with iodine; the white areas do not.

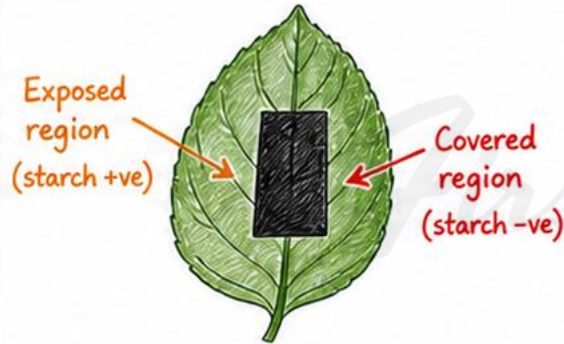


CONCLUSION

Chlorophyll-containing tissue is required for carbohydrate formation.

② OBSERVATION

When part of a leaf is covered with opaque black paper and the leaf is illuminated, only the exposed part turns blue-black with iodine; the covered part does not.

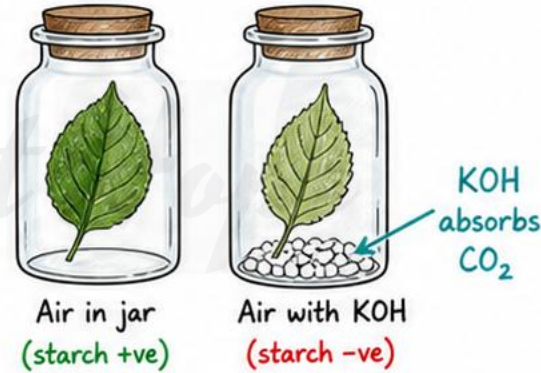


CONCLUSION

Light is required for carbohydrate formation.

③ OBSERVATION

When a leaf is enclosed in a jar with air, it forms starch on illumination; when another leaf is enclosed in a jar in which CO_2 is absorbed by KOH , it does not form starch.

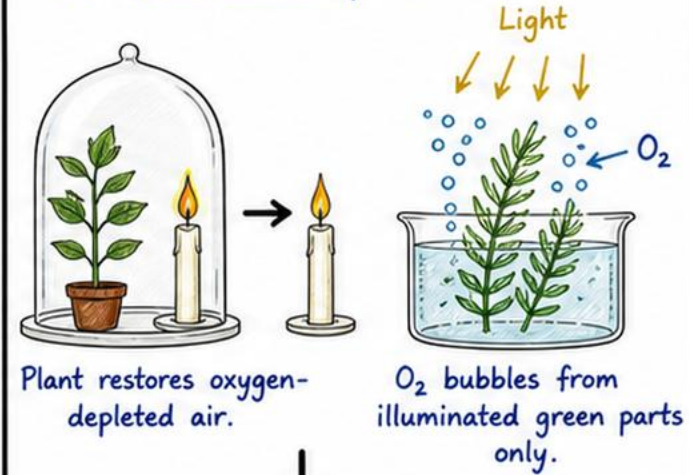


CONCLUSION

CO_2 is required for carbohydrate formation.

④ OBSERVATION

Priestley and Ingenhousz showed that a green plant restores oxygen-depleted air (a candle burns again). Oxygen bubbles are released only from illuminated green parts and not from shaded parts.



CONCLUSION

Oxygen is released by illuminated green tissue.

CONCLUSION: LIGHT + CHLOROPHYLL + CO_2 are required for carbohydrate formation; oxygen is released by illuminated green tissue.

CLASSIC EXPERIMENTS & THE ORIGIN OF OXYGEN

1

Julius von Sachs (1860s)

CONTEXT:

Leaves contain green bodies and manufacture food in light.

OBSERVATION:

The green chlorophyll-containing bodies in leaf cells, which he isolated and studied, are the sites where glucose is formed during photosynthesis.

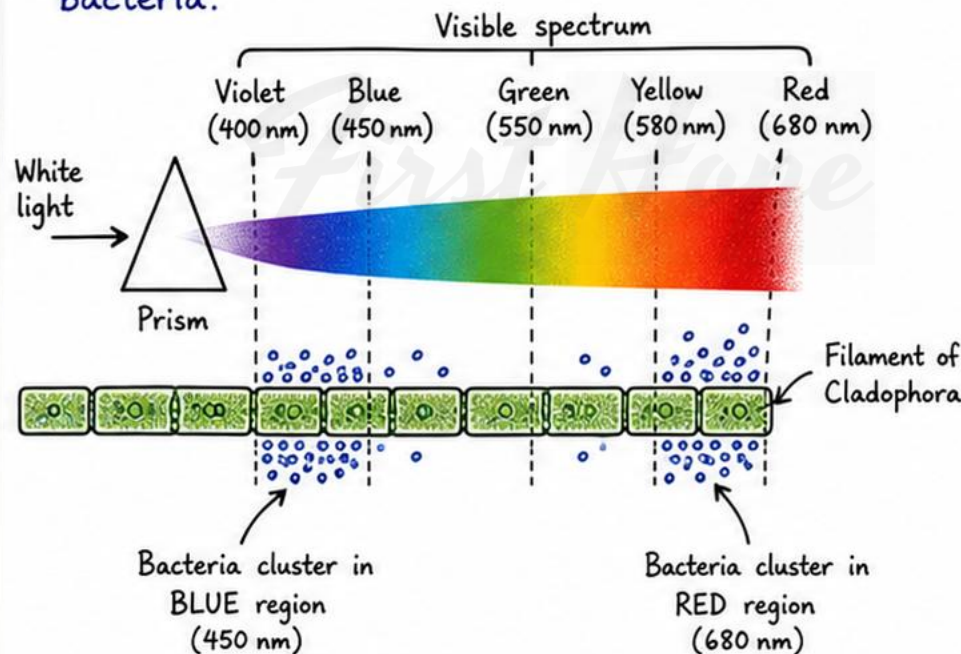
CONCLUSION:

- These bodies were later called chloroplasts.
- The glucose formed is commonly stored in the leaf as starch.

2

T. W. Engelmann (1883)

He used a prism to spread visible light across a filament of the green alga Cladophora in a suspension of aerobic bacteria.



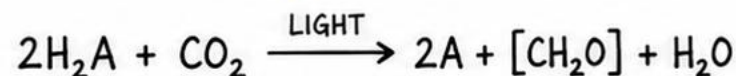
Bacteria concentrate only in the blue and red regions, where O_2 evolution is greatest.

This produced an early ACTION SPECTRUM.

3

Cornelius van Niel (1930s-1940s)

Photosynthesis requires a hydrogen/electron donor. General equation:



In oxygenic photosynthesis (green plants, algae, cyanobacteria):

- H_2O is the hydrogen/electron donor.
- Therefore, the released O_2 comes from H_2O .
- Confirmed later by isotope tracing (e.g., ^{18}O in water appears in O_2).

In anoxygenic photosynthesis (e.g., sulfur bacteria):

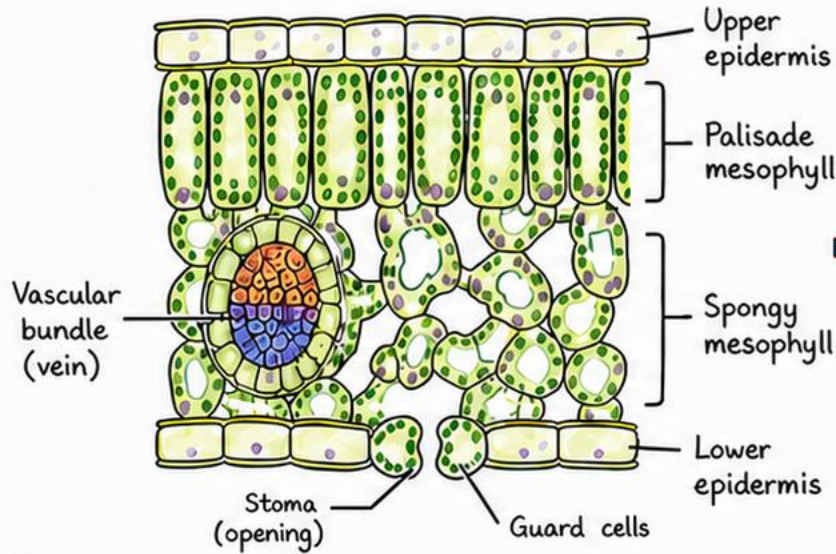
- H_2S (or other reduced compounds) may be the hydrogen/electron donor.
- These organisms do not release O_2 .

CONCLUSION:

ACTION peaks in blue/red;
oxygenic O_2 originates from water.

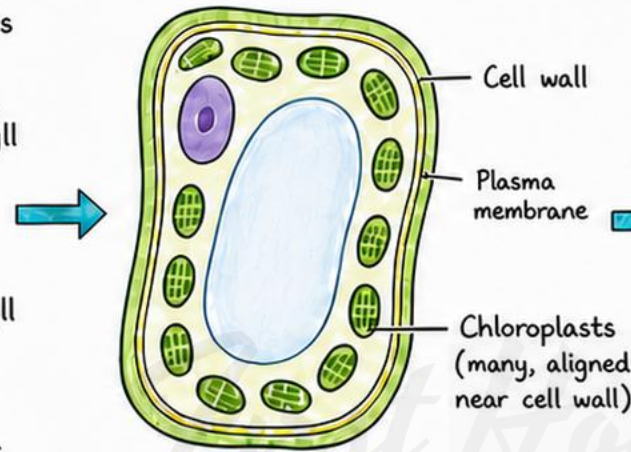
WHERE PHOTOSYNTHESIS OCCURS

① Leaf (Transverse Section)

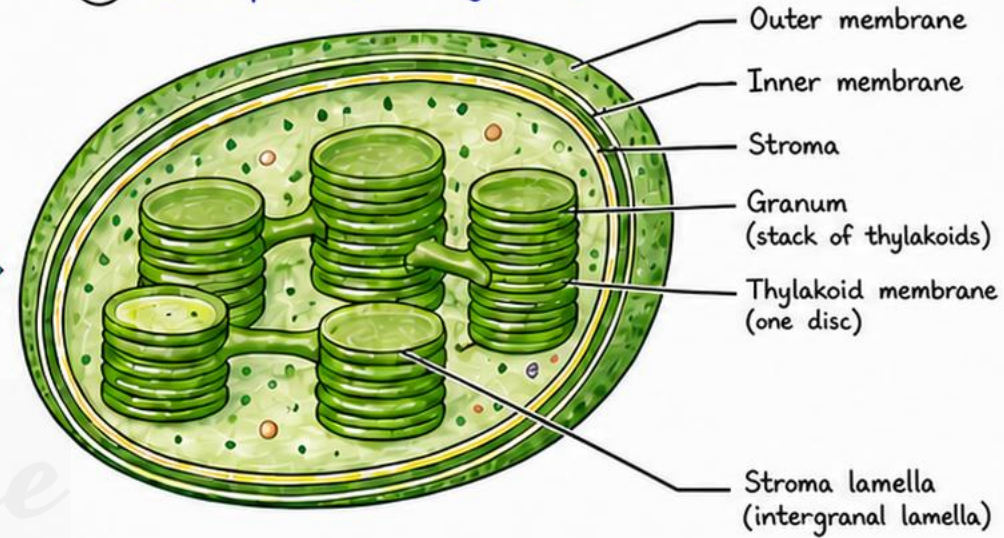


Mesophyll (palisade and spongy) cells contain many chloroplasts.

② One Mesophyll Cell



③ Chloroplast (Cutaway View)



DIVISION OF LABOUR

THYLAKOID MEMBRANES

- Capture light (by chlorophyll and other pigments)
- Electron transport (photosynthetic electron transport chain)
- Make ATP (photophosphorylation) and NADPH

STROMA

- Enzymatic CO_2 fixation (Calvin-Benson cycle)
- Formation of triose phosphate, sugars (e.g., sucrose) and starch

- * Light reactions occur on the thylakoid membranes. They are **directly photochemical**—light energy is absorbed and converted to chemical energy (ATP and NADPH).
- * Stromal (carbon) reactions occur in the stroma. They use ATP and NADPH to fix CO_2 and synthesise triose phosphate, sugars and starch.
- * These reactions do **NOT** inherently require darkness. They are not directly photochemical. They may continue briefly after light is removed, but normally depend on light-generated ATP/NADPH and light-regulated enzymes.
- * Therefore, the term "**dark reaction**" is a misleading name.

INSIDE VS SURROUNDING

-  **Thylakoid lumen** (inside thylakoid)
Aqueous space inside the thylakoid disc; site of proton (H^+) accumulation.
-  **Stroma** (outside thylakoids)
Fluid matrix surrounding thylakoids; site of CO_2 fixation (Calvin cycle) and synthesis of sugars and starch.

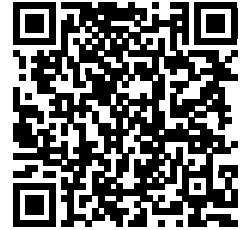


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