Photosynthesis: Provider of food for all.

Photosynthesis is a physiological process by which plant cells containing chlorophyll produce food in the form of carbohydrate by using carbon dioxide, water and light energy. Oxygen is released as a byproduct.

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2\uparrow + 6H_2O$$

—x

Diagrammatic representation of a electron micrograph of chloroplast

Stomata - Stomata are the structures mainly responsible for the gaseous enchange in the process of photosynthesis, respiration and transpiration.

Stomata open in light when guard cell are turgid and close when they are flaccid.

These turgor changes lead to the opening and closing of stomata. There are two theories for the opening and closing of stomata.

1. Sugar concentration theory : According to this theory during daytime, as guard cells photosynthesise and produce sugar, the cells become turgid. This causes the stomata to open. If exosmosis happen then the guard cells become flaccid and stomata is closed.

2. Potassium ion exchange theory : According to malate K^+ ions pump hypothesis, the turgor changes that open and close the stomata are due to the reversible absorption and loss of potassium ions (K^+).

(4) The stomata open when guard cells absorb K^+ ions from surrounding epidermal cells.

(B) The intake of K^+ ions by guard cells take place through H^+ and K^+ ion exchange.

(C) The H^+ ions appear in the guard cell due to dissociation of malic acid.

(D) The malic acid dissociates into malate anions and H^+ ions in the guard cells.

(E) During night, the K^+ ion concentration decreases in the guard cells. This lowers the osmotic pressure of the guard cells which results in the closing of stomata due to exosmosis

Mechanism of Photosynthesis.

Photosynthesis consists of two stages - the light phase and the dark phase.

Light Reaction	Dark Reaction.
It take place only in the presence of light.	It can take place in the pre-sence or absence of sunlight.
It is a photochemical phase.	It is a biochemical phase.
It takes place in the grana of the chloroplast.	It takes place in the stroma of the chloroplast.

• NADP utilizes H^+ ions to form NADPH.	• The hydrogen of NADPH combines with CO_2.
• The end products are ATP and NADPH.	• Glucose is the end product-ATP and NADPH help in the formation of glucose.
• The water molecules split into hydrogen ions and oxygen.	• Glucose is produced CO_2 is utilized in the dark reaction.

Different experiment on photosynthesis.

1. Test for photosynthesis : Leaf is killed in boiling water (5-10 min), dried, decolourised in warm spirit, moistened and dipped in iodine solution. Blue black colour indicates starch.

2. CO_2 is necessary for photosynthesis / Moll's half leaf experiment: One half of the destarched leaf is inserted in an air-tight wide mouthed bottle having a small quantity of KOH (for absorption of CO_2) and illuminated. Starch test after one hour indicates absence of CO_2 in the inserted half and presence in the outer half (where CO_2 is available).

3. Light is necessary for photosynthesis : Intact leaf of a destarched plant is fitted in Ganong's light screen with a designed cut in its lid. The same is exposed to light for sometime and then tested for starch. Only the design through which light falls on the leaf becomes blue coloured.

4. Chlorophyll is essential for photosynthesis : Illuminated variegated leaf of the Coleus plant is tested for starch. Only those areas turn blue which had chlorophyll.

Factors affecting photosynthesis

1. External factors

(A) Light : Photosynthesis is successfully accomplished in the visible light (380-760 nm wave-length) of the spectrum. The rate of photosynthesis is maximum in red light, average in blue light and minimum in green light. A moderate light intensity is favourable for high rate of photosynthesis.

B) Carbon dioxide : 0.03% CO_2 is present in the atmosphere. Increase in CO_2 concentration upto 0.9% increases the rate of photosynthesis but concentration above 0.9% is harmful and decrease the rate of photosynthesis.

(C) Temperature: Generally, the photosynthesis increases with an increases in temperature in the range of 10-35°C. Beyond the 35°C, the rate of photosynthesis decrease.

(D) Water: About 1% total water absorbed is used in photosynthesis. Water deficiency reduces the rate of photosynthesis.

2. Internal factors

(A) Chlorophyll: It is essential for photosynthesis to occur. The rate of photosynthesis per unit of chlorophyll decreases with the age of the leaf.

(B) Accumulation of end product of photosynthesis: The rate of photosynthesis falls with the accumulation of food synthesised by photosynthesis.

(C) Anatomy of leaf: Photosynthesis rate is greatly influenced by the internal structure of the leaf, thickness of the cuticle and epidermis number, structure and distribution of stomata.

Adaptation of a leaf for photosynthesis.

1. Large surface area to manimise light harvesting.
2. Thinning of leaves to reduce distance for CO_2 to diffuse through the leaf and to ensure that light penetrates into middle of the leaf.

3. Arrangement of chloroplast on the upper surface of leaves so as to receive maximum amount of light.

4. The presence of more stomata to allow rapid enchange of gases (CO_2 and O_2).

5. Loosely packed spongy mesophyll cells help to trap carbon dioxide gas, allowing some photosynthesis even when the stomata are closed.