TENDER HEART SCHOOL, SEC 33B, CHD

CLASS-10
Subject - Biology

Date - 8.04.2024
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CHAPTER - 6 PHOTOSYNTHESIS

Photosynthesis is the process by which living plant cells (containing Chlorophyll) produce food substance (glucose) from carbondioxide and water using light energy.

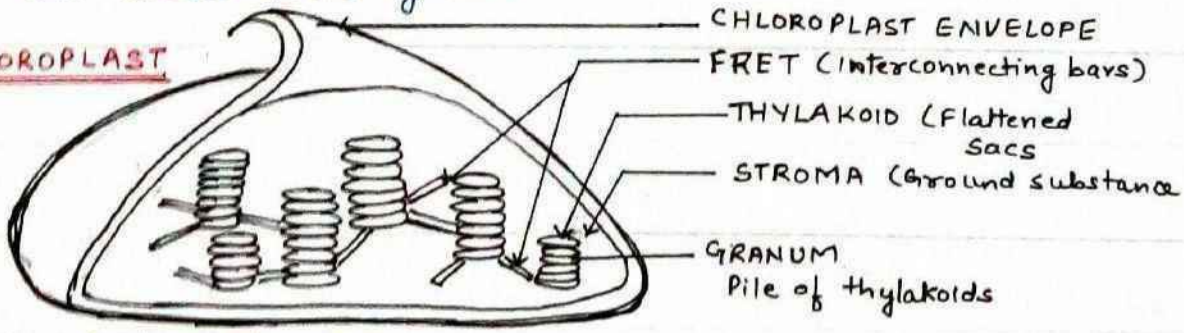
Importance - Photosynthesis produces food for all living things on earth. It provides oxygen for respiration to all living beings

CHLOROPHYLL - a green pigment found in chloroplasts in Plant Cells. **Structure of Chloroplast** - Chloroplast are small oval shaped bodies (organelle) bounded by double membrane, and inside them they contain closely packed flattened sacs (thylakoid) arranged in piles (grana). There is a colourless fluid (ground substance) present inside the chloroplasts called Stroma. Chlorophyll is present inside the thylakoids It is contained in the walls of thylakoid. Chlorophyll contains carbon, hydrogen, oxygen, nitrogen and magnesium

Location of Chloroplast - in the mesopyll cells located between the upper epidermis and the lower epidermis of leaves. These are also found in guard cells and outer layers of green stems

Chlorophyll is sensitive to light. Too much light destroys chlorophyll. Also formation of chlorophyll depends on exposure of the plant to light. This is the reason why a grass growing in the shade turns yellow.

CHLOROPLAST



Regulation of stomatal opening

Main purpose of stomatal opening/closing is diffusion of gases for photosynthesis. But when the stomata opens water is also lost as vapours (transpiration) through the stomata. Thus, transpiration is the price which the plant pays for photosynthesis Stomata open/close on account of inward (turgidity) and outward (flaccidity) movement of water in the guard cells.

Theories on opening and closing of stomata -

① **K^+ ion Theory** - During daytime, chloroplasts in guard cells photosynthesis which leads to production of ATP. ATP is used to actively pump the potassium ions of the adjacent cells into the guard cells. Increased K^+ ions in guard cells make the condition inside them hypertonic, hence they start drawing in water from adjacent cells. Thus guard

cells become more turgid and they move outward to open the stomatal pore. Guard cells have thick inner wall and thin outer wall. Hence when turgid they become 'C' shaped opening the stomatal pore. At night reverse happens, K^+ ions leak out, thus reducing the turgor of guard cells and stomatal pore closes.

(2) Sugar Concentration Theory - During day guard cells perform photosynthesis leading to formation of glucose. This glucose increases the concentration in guard cells making them hyper tonic. This increases the osmotic pressure which draws in more water from adjoining cells due to endosmosis. Guard cells thus become turgid and bulge outwards due to their thin walls (outer) and stomata opens.

Loss of water from guard cells due to exosmosis makes them flaccid. As a result, their inner walls straighten to close the stomata.

Raw materials for photosynthesis

(i) Carbondioxide - taken from the atmosphere by diffusion.

(ii) Water - taken from soil by roots

Balanced chemical equation for photosynthesis

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} C_6H_{12}O_6 + 6H_2O + 6O\uparrow$$

$6H_2O$ in product are being reformed in the process and are not the original ones.

Process of Photosynthesis - Two main Phases

[A] Light Dependent Phase - Photochemical Phase

A series of chemical reactions occur in very quick succession initiated by light. Therefore this phase is called the Photo-chemical phase. Site of light Phase is Thylakoid.

Main Steps of Light phase

(i) Activation of Chlorophyll - During daytime when sunlight falls over the leaf, light energy is trapped by chlorophyll. Chlorophyll on exposure to light energy becomes activated by absorbing photons.

(ii) Splitting of water - The absorbed light energy splits the water molecules into its two components (Hydrogen and oxygen) releasing electrons

$$2H_2O \xrightarrow[4 \text{ photons}]{\text{energy of}} 4H^+ + 4e^- + O_2$$

This reaction is called photolysis.

Photolysis is the process of splitting of water molecules into hydrogen ions and oxygen in the presence of Light and grana.

End result of the products of photolysis

(i) Hydrogen ions (H^+) are picked up by the compound NADP

NADP - Nicotinamide adenine dinucleotide phosphate

(ii) $NADP^+ + e^- + H^+ \xrightarrow{enzyme} NADP$

The Oxygen - is given out in the atmosphere as molecular oxygen O_2 (used for respiration process).

$2O \rightarrow O_2$

(iii) The electrons - are used to convert ADP (Adenosine diphosphate) to ATP (Adenosine triphosphate) by adding one phosphate group Pi (inorganic phosphate) in presence of light.

ADP + Phosphate (inorganic) $\longrightarrow$ ATP

This process is called phosphorylation (addition of Phosphate)

Photophosphorylation - is the process of conversion of ADP to ATP by adding (inorganic) phosphate using electrons in presence of light. It occurs during light phase of Photosynthesis.

[B] Light - independent (Dark phase) - Biosynthetic phase

Dark phase doesnot mean it occurs in the dark, but it means it is independent of light.

Site of Light independent phase is Stroma in Chloroplast.

In the dark phase CO_2 taken from atmosphere combines with various products of light phase; undergoes many chemical reactions in quick succession (using energy from ATP and $NADPH^+$ molecules produced in light phase) and is finally converted into glucose. (product of photosynthesis).

Conversion of glucose into Starch as soon as it is formed during photosynthesis by the process of polymerisation.

Polymerisation is the process by which several glucose molecules are transformed to produce one molecule of starch (for storage purpose). In some plants glucose is converted into sucrose, or oils etc.

ADAPTATIONS IN LEAF TO PERFORM PHOTOSYNTHESIS

(1) Large surface area of leaf helps to absorb maximum sunlight More the area, more the sunlight received, more the trapping of sunlight to perform photosynthesis

(2) Leaf arrangement. Leaves should be at right right angles to the falling sun rays to obtain maximum light.

(3) Cuticle and upper epidermis are transparent to allow light to enter freely without any obstacle.

(4) Numerous stomata - More the number of stomata easy and rapid exchange of gases (O_2 & CO_2) will occur. Rate of photosynthesis will be more

(5) Thinness of leaves - If the leaves are thin then it reduces the distance between cells. Thus transportation of substances (gases, food etc) will be faster, helping to increases rate of photosynthesis

(6) The Chloroplasts - are concentrated on the upper side of the leaf. Pallisade and spongy mesophyll cells are towards the upper side of leaf which receives more sunlight Hence it helps to obtain more light energy quickly.

(7) Extensive vein system in the leaves helps in rapid transport of substances to and from the mesophyll cells of the leaf.

End Products of photosynthesis

(i) Glucose - is the main energy source by the plant, provides immediate source of energy to plant cells. It may be stored in the plant cells as starch, may be converted to sucrose or used in synthesis of fats, proteins etc.

(ii) Water - produced in photosynthesis may be reutilized in the continuance of photosynthesis

(iii) Oxygen - some of the oxygen is used by plant itself for its own respiration. Rest of it is given out in the atmosphere used by other organisms for doing respiration.

NOTE FOR STUDENTS

After reading these notes please also go through the topics as given in Ch-6 of your text book carefully.
Give multiple readings to grasp the topic completely

HOME ASSIGNMENT

(1) Draw the diagrams of
   a) Chloroplast (b) stomatal apparatus
   (c) Structure of Leaf (Vertical section)
   in your notebooks

(2) Answer the Question No 1 'Progress Check' Pg No 70 in the book itself
   Progress Check given after the topic 6.4 'Regulation of opening of stomata for Letting in Carbondioxide'

(3) Answer the Questions Q No 1, 2, 3, 4, 5, 6, 7 'Progress Check' (given after the topic Two main phases of Photosynthesis) Q.No 2, 3 can be done in the book itself. Write the answers to Q.No. 1, 4, 5, 6, 7 in the notebook.