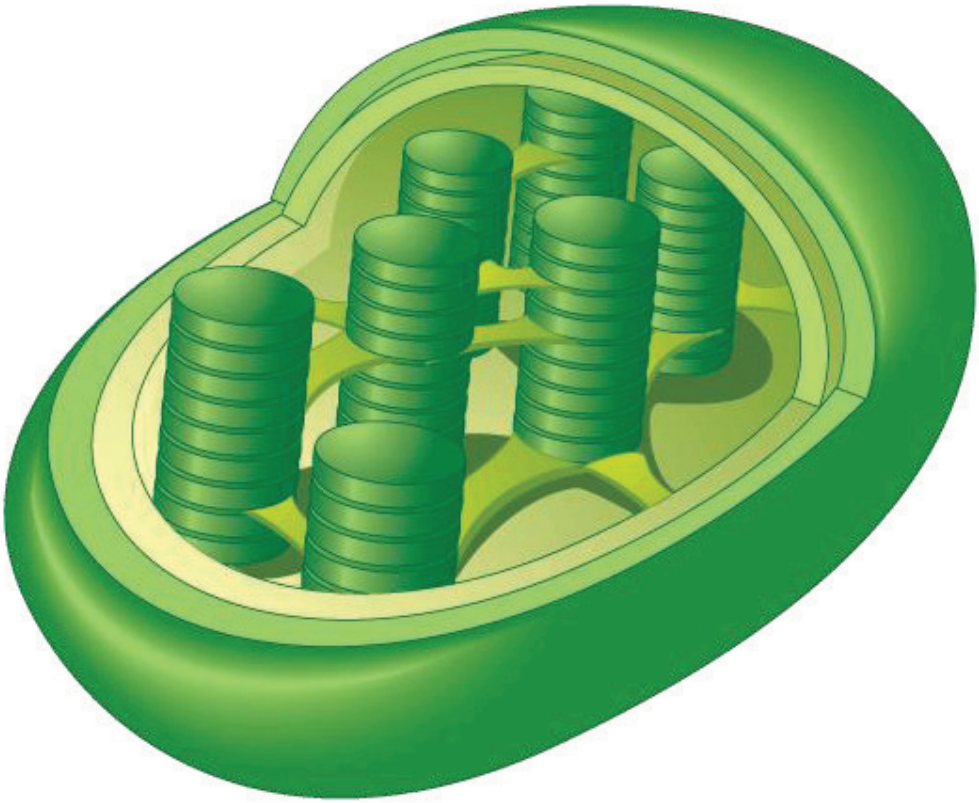
PHOTOSYNTHESIS IN HIGHER PLANTS



PHOTOSYNTHESIS IN HIGHER PLANTS

Photosynthesis

Photosynthesis is an enzyme regulated anabolic process of manufacture of organic compounds inside the chlorophyll containing cells from carbon dioxide and water with the help of sunlight as a source of energy.

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

Historical Perspective

Josheph Priestley (1770): Showed that plants have the ability to take up CO_2 from atmosphere and release O_2. (Candle with bell jar and mouse expt.)

Jan Ingenhousz (1779): Release of O_2 by plants was possible only in sunlight and only by the green parts of plants. (Expt. with aquatic plant in light & dark)

Theodore de Saussure (1804): Water is an essential requirement for photosynthesis to occur.

Julius Von Sachs (1854): Green parts in plant produce glucose which is stored as starch.

T.W. Engelmann (1888): The effect of different wavelength of light on photosynthesis and plotted the first action spectrum of photosynthesis.

C.B. Van Niel (1931): Photosynthesis is essentially a light dependent reaction in which hydrogen from an oxidizable compound reduces CO_2 to form sugar. He gave a simplified chemical equation of photosynthesis.

$$2H_2A + CO_2 \xrightarrow{\text{Sun Light}} 2A + CH_2O + H_2O$$

Hill (1937): Evolution of oxygen occurs in light reaction.

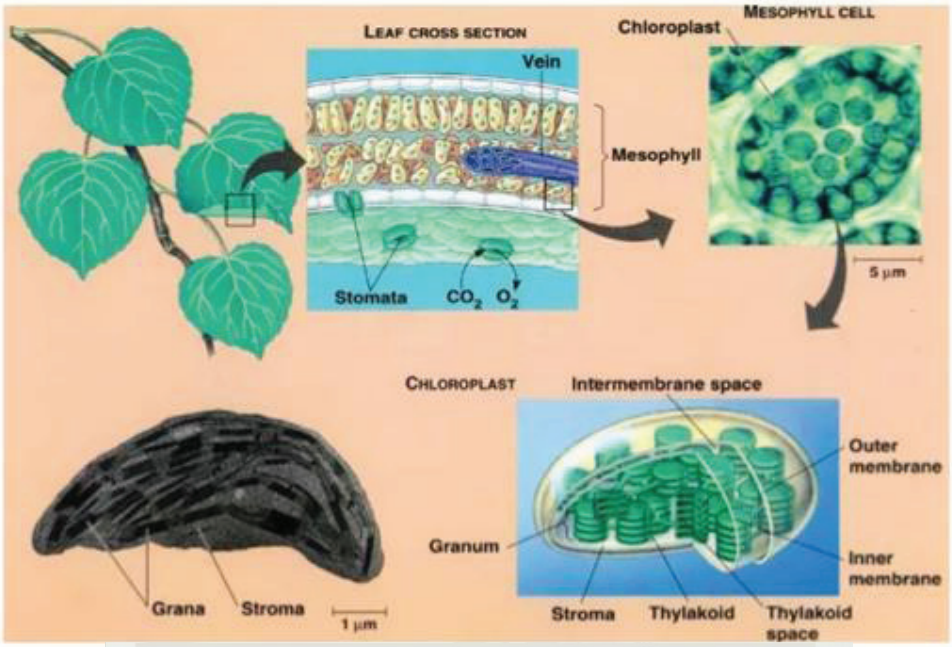
Calvin (1954-55): Traced the pathway of carbon fixation.

Site for photosynthesis

Photosynthesis takes place only in green parts of the plant, mostly in leaves. Within a leaf, photosynthesis occurs in mesophyll cells which contain the chloroplasts. Chloroplasts are the actual sites for photosynthesis. The thylakoids in chloroplast contain most of pigments required for capturing solar.

Energy to initiate photosynthesis: The membrane system (grana) is responsible for trapping the light energy and for the synthesis of ATP and NADPH. Biosynthetic phase (dark reaction) is carried in stroma.

Site of Photosynthesis



Importance of Photosynthesis

- Synthesis of organic compounds.
- Change of radiant energy into chemical energy.
- Useful products are obtained from plants gums, oils timber fire wood, resins rubber, fibers and drugs, etc.
- Balance the percentage of O_2 and CO_2 in atmosphere.
- Fossil fuels like coal, natural gas and petroleum have been formed inside the earth indirectly as a product of photosynthesis.

Pigments involved in photosynthesis

Chlorophyll a: (Bright or blue green in chromatograph). Major pigment, act as reaction center, involved in trapping and converting light into chemical energy. It is called universal photo-synthetic pigment.

Chlorophyll b: (Yellow green)

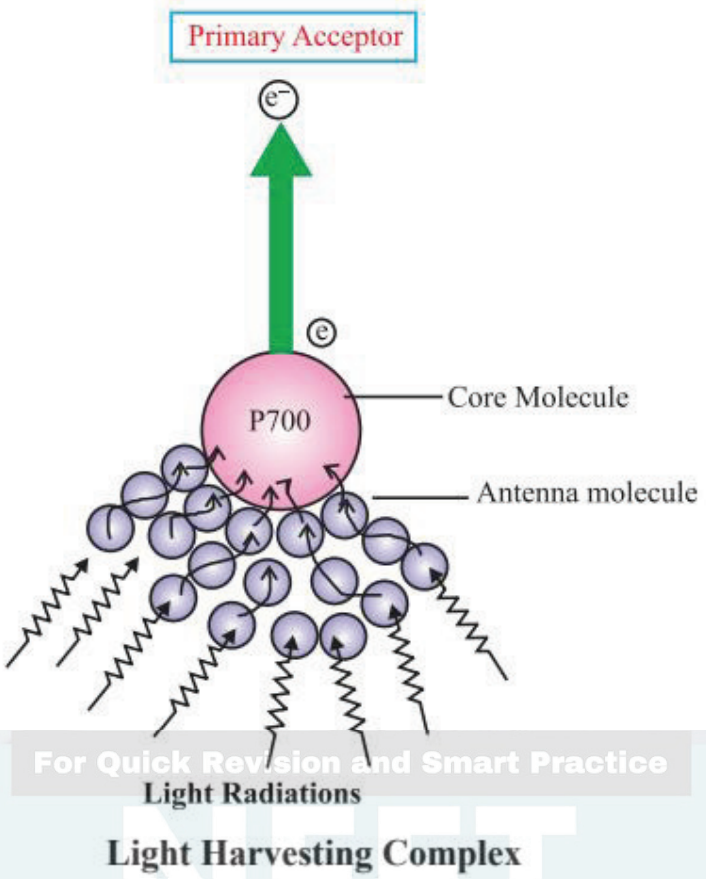
Xanthophyll's: (Yellow)

Carotenoids: (Yellow to yellow-orange)

In the blue and red regions of spectrum shows higher rate of photosynthesis.

Light Harvesting Complexes (LHC)

The light harvesting complexes are made up of hundreds of pigment molecules bound to protein within the photosystem I (PS-I) and photosystem II (PS-II). Each photosystem has all the pigments except one molecule of chlorophyll 'a' forming a light harvesting system (antennae). The reaction center (chlorophyll a) is different in both the photosystems.



Photosystem I (PS-I): Chlorophyll 'a' has an absorption peak at 700 nm (P700).

Photosystem II (PS-II): Chlorophyll 'a' has absorption peak at 680 nm (P680),

Process of photosynthesis

It includes two phases-Photochemical phase and biosynthetic phase. (Formerly known as Light reaction and dark reaction)

Photochemical phase (Light reaction): This phase includes-light absorption, splitting of water, oxygen release and formation of ATP and NADPH. It occurs in grana region of chloroplast.

Biosynthetic phase (Dark reaction): It is light independent phase, synthesis of food material (sugars). (Calvin cycle). It occurs in stroma region of chloroplast.

Photophosphorylation

The process of formation of high-energy chemicals (ATP and NADPH) in presence of light.

Non-Cyclic photophosphorylation

Two photosystems work in series First PSII and then PSI. These two photosystems are connected through an electron transport chain (Z. Scheme). Both ATP and NADPH + H+ are synthesized by this process. PSI and PSII are found in lamellae of grana, hence this process is carried here.

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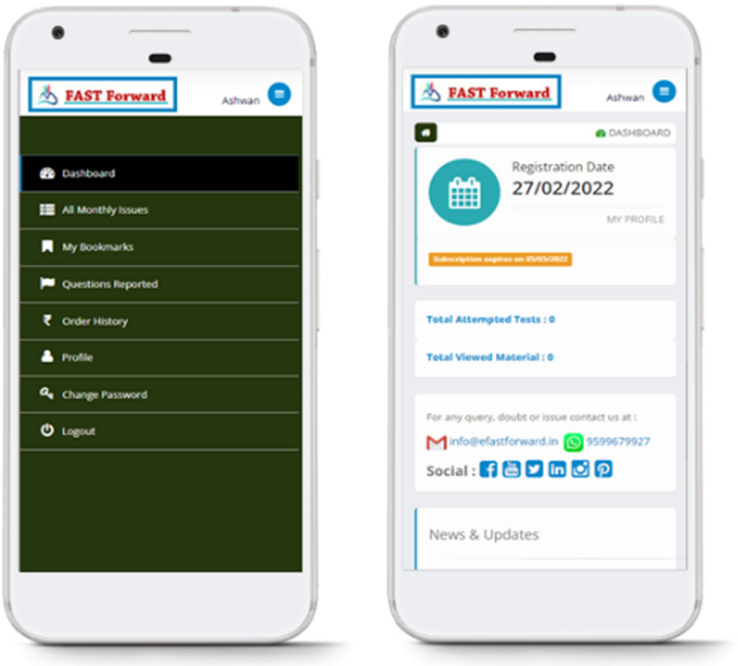

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