LIGHT REACTION IN PHOTOSYNTHESIS

Q. Give a brief account of the recent works for the process of light reaction in Photosynthesis?

Photosynthesis is the manufacture of simple carbohydrates from CO_2 and H_2O in presence of sunlight inside the chlorophyll containing cells.

$$6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6CO_2 + 6H_2O$$

It consists of two reactions :—

1. Light reaction.
2. Dark reaction.

The role of light reaction is to synthesis ATP and $NADPH_2$ which are utilized in dark reaction for the production of carbohydrates.

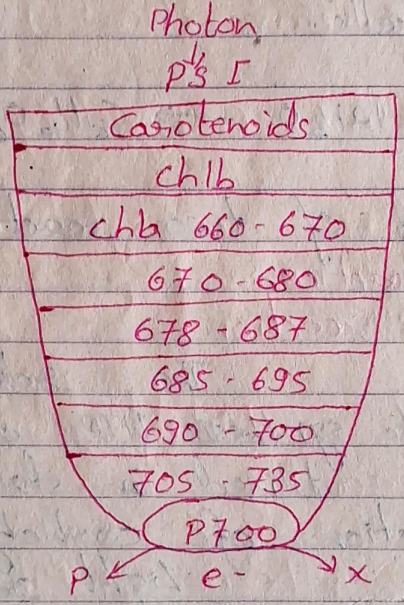
Light reaction is also known as photochemical reaction. Hill and others (1937) have proved that O_2 which is released in photosynthesis comes from H_2O, not from CO_2.

Amon proved that NADP is reduced by hydrogen which is released by splitting of H_2O. He later on showed that ATP is formed in light. Entire light reaction occurs in grana of the chloroplast.

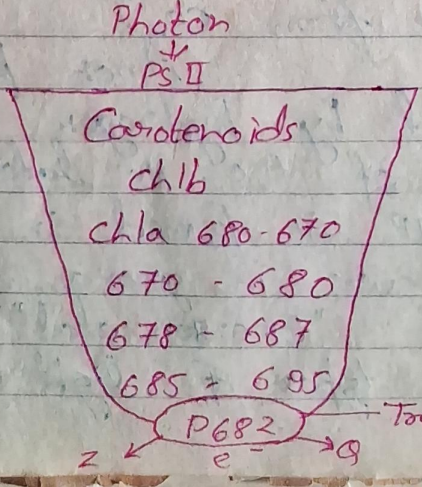
"Emerson etal" (1957) discovered that two types of light wave length i.e

682 & 700nm are utilized in light reactio of photosynthesis. These two types of wave lengths are collected by two types of pigment system which are known as PS PS II.

PS I collects light energy by carotenoids, chlb, chla 670, chla 680, chla 687, chla 695 and chla 700.



PS II collects light of shorter wave leng by carotenoids, chlb, chla 670, chla 680, chla 687, chla 695.



PS I is active in NADP reduction and cyclic photophosphorylation. PS II is responsible for photosynthesis of water, evolution of O_2 and non-cyclic photophosphorylation.

Quantosome or photosynthetic unit

Each PS system consists of many molecules. These molecules constitute photosynthetic unit or quantosome. A photosynthetic unit is the smallest group of pigment molecules which takes part in a photochemical reactions. They have a molecular weight of 2 millions and a diameter of about 20 nm. Each quantosome contains about 230 chlorophyll molecules.

Each quantosome consists of a trap centre or a reaction centre which is fed by 230 molecules known as harvesting molecules. The trap centre is made up of special type of chla which absorbs light energy at larger wave length. The harvesting molecules absorb light energy of shorter wave length.

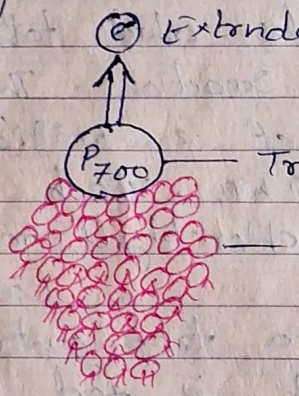
Harvesting molecules form a centre core complex and peripheral antenna system.

The molecules of antenna system absorb radiation of various wave length. They get exited. They are then trafer this energy to the trap centre

and care complex.

The natural path quanton flow from highes energy to lowes energy i.e from shortes wave length to larger wave lengths.

In PS I P_{700} and in PS II P_{682} forms the reaction centre of photochemical reaction. When they absorb light energy of suitable wave length - they becomes excited and extrude electrons for chemical reaction.



Light energy → starting from the discovery of release of oxygen from water by unit reduction of NADP in to $NADPH_2$ and formation of ATP by "Arnon". discovery of two types of Ps units in light reaction of photosynthesis by "Emerson & others" we now conclude that light reaction has to play the following roles in photosynthesis

① Photosynthesis of waters.
② Evolution of O_2.
③ Photophosphorylation.

④ Formation of $NADPH_2$.

① Photosynthesis of water & evolution of O_2 → According to "Hill & Berdall (1960)" "Robinowitch & Govindji (1965)" the two phases of light reaction occurs in regulas series. The produd of one is utilized by other. The first reaction is light ie photolysis of water. Or it water breaks in to H^+ & OH^-. For photolysis, light energy is not utilized directly. Photolysis occurs in presence of enzyme. The enzyme is activated by light. Mn^{++} is also essential for photolysis. By OH^- ion, O_2 and e^- are evolved during light period. Reaction occurs as below —

$$4H_2O \rightleftharpoons 4H^+ + 4OH^-$$
$$4OH^- \rightleftharpoons 2O_2 + 4e^-$$

③ Photophosphorylation → When a quantum of short wave length of light is received by PS II at about $E_0 = +.1V$, it loses an electron. The loss of electron of PS II is soon compensated by electron released during Photosynthesis of water. The electron extruded by PS II is picked up by quinone. The electron then travels down & falls back to $E_0 = +0.4$ volt through a series of carrier to PS I. The carrier are plastoqui-

-none (E_0 = 0.096 v), cyt b_{539} (E_0 = 0.055 v), cyt f (E_0 = 0.036 v) and plastocyanin (E_0 = ...). Energy released in the transfer electron from cyt b_{559} to cyt f utilized to convert ADP is called non-cyclic photophosphorylation.

When PS I absorb light energy of larger wave length, it extracts an electron. This electron is transferred to ferradoxin reducing substance at E_0 = −0.6 volt, Fd is then reduced E_0 = −0.43 volt.

In ordinary process it transfers this electron to NADP for the formation of $NADPH_2$. But when NADP is not available Fd transfers this electron to cytochrome. At this stage $NADPH_2$ is not formed photolysis of water stops & assimilation of CO_2 is retarded. This phenomenon is called RED - DROP.

The electron of Fd enters first into cyt b_{559} at E_0 = −0.6 ... The electron is ultimately cycled back to P_{700} via cyt f and plastocynin. During the course of travel, electron losses energy. This energy is utilised in the formation of ATP. The production of ATP by PS I alone in which electron circulates through the system is called cyclic photophosphorylation. Thus at the end of light reaction ATP & $NADPH_2$ are formed which are utilized by the

dark reaction of photosynthesis.