

**Course- B.Sc. (SUBSIDIARY COURSE), Part -2**  
**Subject- Botany, Paper-II (Group-B)**  
**Topic- Photosynthesis-Photophosphorylation.**

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## Photosynthesis-Photophosphorylation

Life on earth ultimately depends on energy derived from sun. Photosynthesis is the only process of biological importance that can harvest this energy.

Literally photosynthesis means 'synthesis using light'. Photosynthetic organisms use solar energy to synthesize carbon compound that cannot be formed without the input of the energy.

Photosynthesis (Photon = Light, Synthesis = Putting together) is an anabolic, endergonic process by which green plant synthesize carbohydrates (initially glucose) requiring carbon dioxide, water, pigments and sunlight. In other words, we can say that photosynthesis is transformation of solar energy/radiant energy/light energy (ultimate source of energy for all living organisms) into chemical energy.

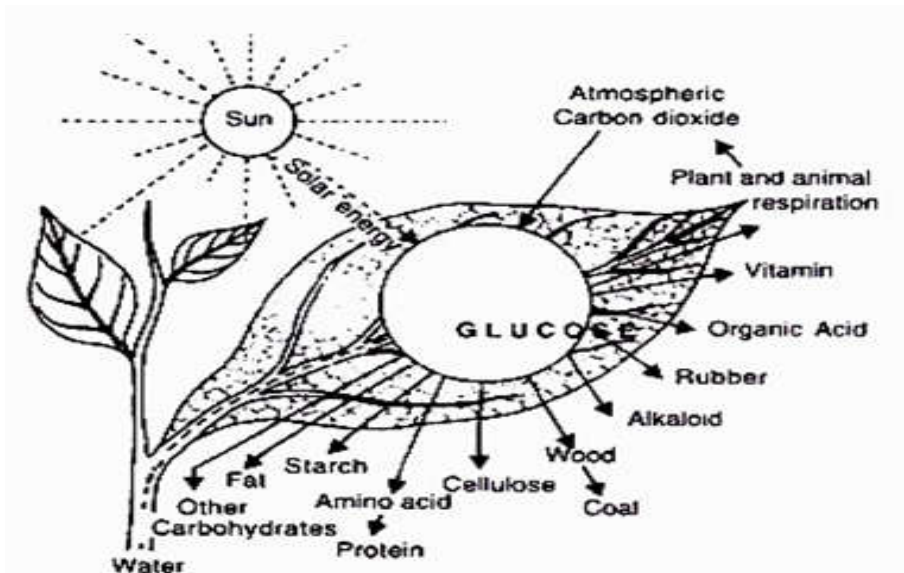
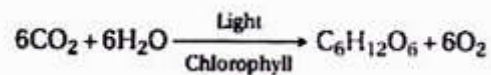


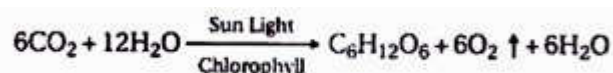
Fig. 6.1. Diagram showing the formation of different organic components from glucose which was also formed by the process of photosynthesis.

Simple general equation of photo synthesis is as follows:



According to Van Neil and Robert Hill, oxygen liberated during photosynthesis comes from water and not from carbon dioxide.

Thus, the overall correct biochemical reaction for photosynthesis can be written as:



Some photosynthetic bacteria use hydrogen donor other than water. Therefore, photosynthesis is also defined as the anabolic process of manufacture of organic compounds inside the chlorophyll containing cells from carbon dioxide and hydrogen donor with the help of radiant energy.

### **Types of Photophosphorylation:**

The following points highlight the two types of Photophosphorylation. The types are:

#### **1. Cyclic Photophosphorylation and**

#### **2. Non-Cyclic Photophosphorylation.**

##### **Type # 1. Cyclic Photophosphorylation:**

It is a process of photophosphorylation in which an electron expelled by the excited photo-centre is returned to it after passing through a series of electron carriers. It occurs under conditions of low light intensity, wavelength longer than 680 nm and when CO<sub>2</sub> fixation is inhibited.

Absence of CO<sub>2</sub> fixation results in non-requirement of electrons for formation of NADPH. Cyclic photophosphorylation is performed by photosystem I only. Its photo-centre P<sub>700</sub> extrudes an electron with a gain of 23 kcal/mole of energy after absorbing a photon of light (hv). After losing the electron the photo-centre becomes oxidized.

The expelled electron passes through a series of carriers including X or A<sub>0</sub> (a special P<sub>700</sub> chlorophyll molecule), A, (a quinone), FeS complexes (FeS<sub>x</sub>, FeS<sub>A</sub>, FeS<sub>B</sub>), ferredoxin, (Fd), plastoquinone (PQ), cytochrome b – f complex and plastocyanin before returning to photo Centre. While over the cytochrome complex, the electron energises passage of protons to create a proton gradient for synthesis of ATP from ADP and inorganic phosphate.

Halo bacteria or halophile bacteria also perform photophosphorylation but ATP thus produced is not used in synthesis of food. These bacteria possess purple pigment bacteriorhodopsin attached to plasma membrane. As light falls on the pigment, it creates a proton pump which is used in ATP synthesis.

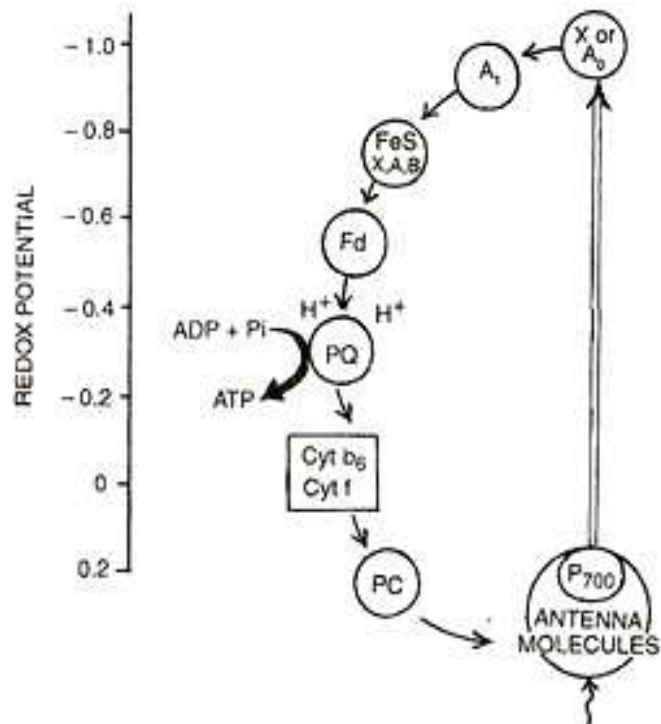


Fig. 13.17. Cyclic photophosphorylation.

### Type # 2. Non-Cyclic Photophosphorylation:

It is the normal process of photophosphorylation in which the electron expelled by the excited photo-centre does not return to it. Non-cyclic photophosphorylation is carried out in collaboration of both photosystems I and II. Electron released during photolysis of water is picked up by photo-centre of PS II called P<sub>680</sub>. The same is extruded out when the photo Centre absorbs light energy (hv).

The extruded electron has an energy equivalent to 23 kcal/mole. It passes through a series of electron carriers—phaeophytin, PQ, cytochrome b – f complex and plastocyanin. While passing over cytochrome complex, the electron loses sufficient energy for the synthesis of ATP. The electron is handed over to photo Centre P<sub>700</sub> of PS I by plastocyanin. P<sub>700</sub> extrudes the electron after absorbing light energy. The extruded electron passes through special chlorophyll X, Fe-S, ferredoxin, to finally reach NADP<sup>+</sup>. The latter then combines with H<sup>+</sup> (released during photolysis) with the help of NADP-reductase to form NADPH. This is called Z scheme due to its characteristic zig-zag shape based on redox potential of different electron carriers (Fig. 13.18).

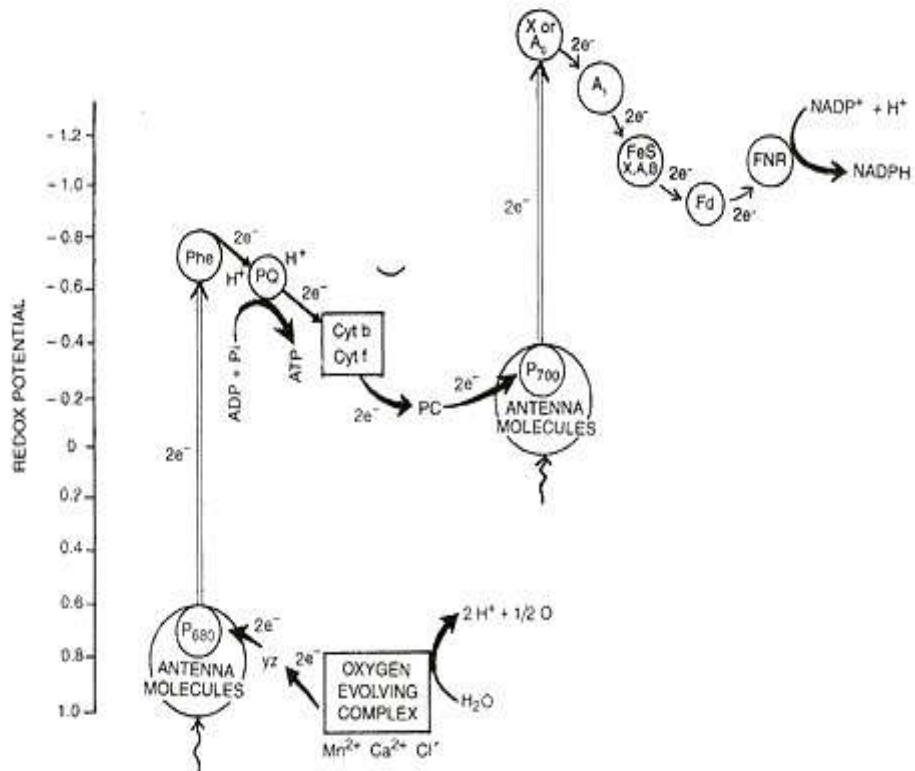


Fig. 13.18. Non-cyclic photophosphorylation and electron transport during photochemical phase.

### Related Articles:

1. [Oxidative Phosphorylation and Photophosphorylation | Plants](#)
2. [Photochemical and Biosynthetic Phase of Photosynthesis](#)