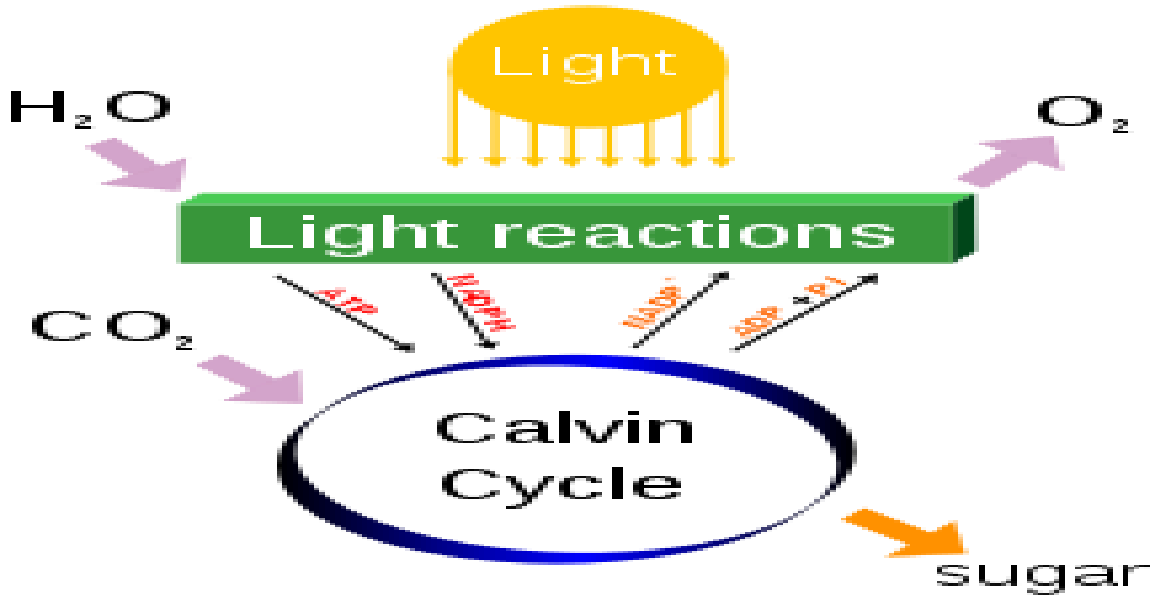
PHOTOSYNTHESIS (LIGHT REACTION)

For B.Sc. Part II (Subs) Group C (Plant Physiology)



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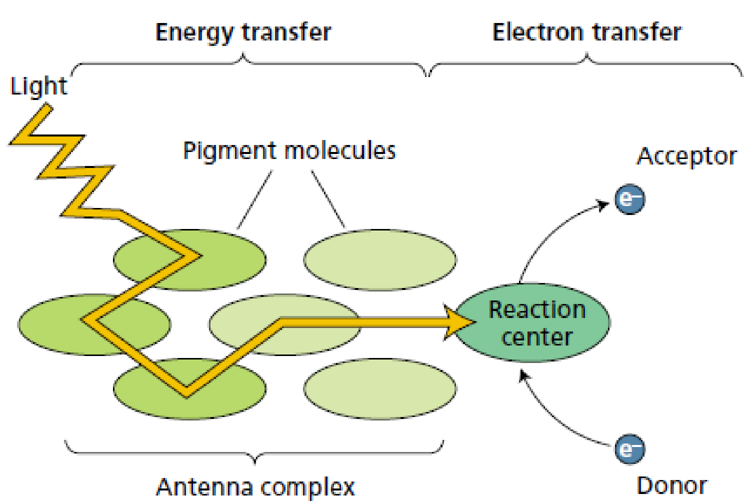
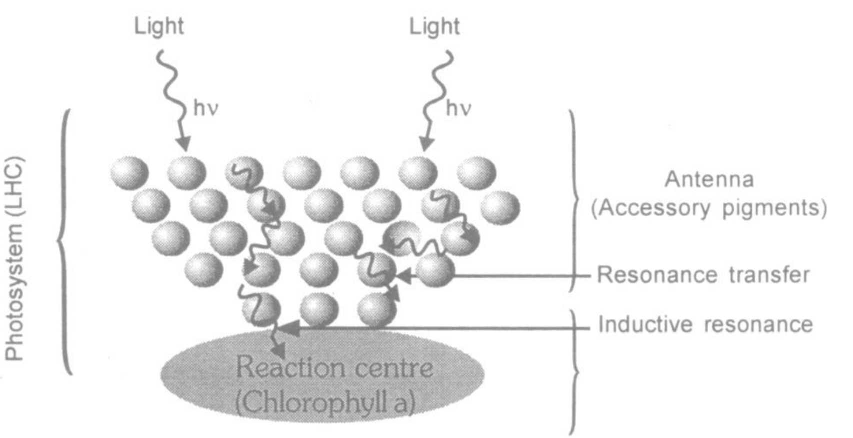
Lecture No.05

Light reaction/Photochemical reaction/Hill reaction

➢ During the light reaction, the primary function of the two pigment systems/photosystems is interact with each other to trap light energy and convert in into the chemical energy (ATP). These reactions are cyclic and non cyclic types.

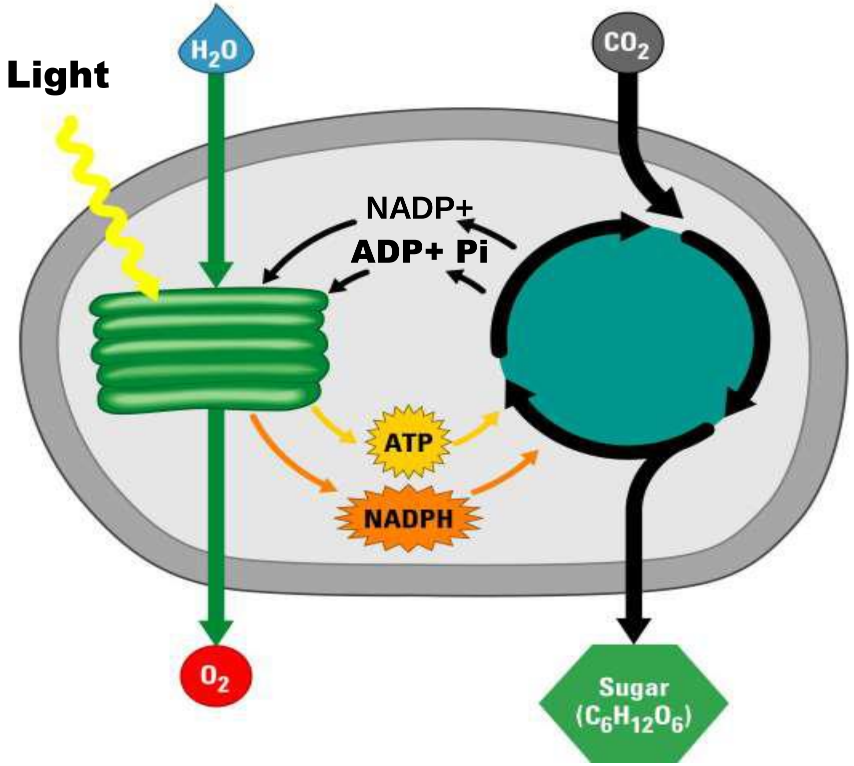
➢ Antenna or accessory pigments receive radiant energy and transfer it among themselves. This transfer of energy is known as resonance transfer. Then antenna molecules excited and transfer their energy to the chlorophyll 'a' molecules of reaction centre.





Conversion of light into electrical energy. Accessory pigment molecules absorb light and **funnel** it to the reaction centre for conversion to electrical energy and charge separation.

➢ Light-dependent reaction converts light energy into chemical energy; produces ATP and NADPH molecules to be used as fuel in light independent(dark) reaction.



➢ During the light reaction, there are two possible routes for electron flow.

1. Cyclic Electron Flow

2. Noncyclic Electron Flow

- Two types of photosystems cooperate in the light reactions.
- Photosystem I preferentially absorbs far-red light of wavelengths greater than 680 nm; photosystem II preferentially absorbs red light of 680 nm and is driven very poorly by far-red light. This wavelength dependence explains the enhancement effect and the red drop effect. Another difference between the photosystems is that

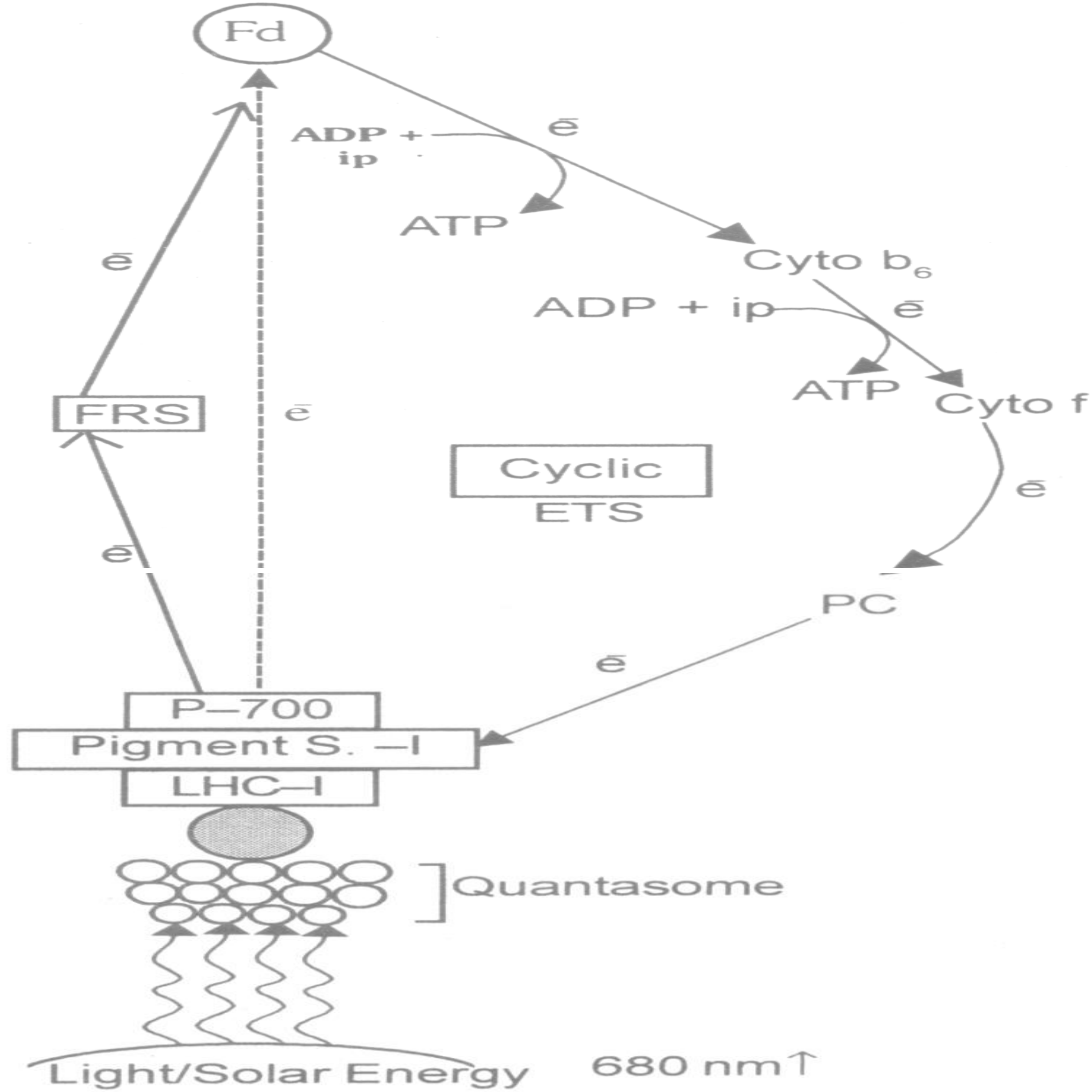
✓ Photosystem I produces a strong reductant, capable of reducing NADP+, and a weak oxidant.

✓ Photosystem II produces a very strong oxidant, capable of oxidizing water, and a weaker reductant than the one produced by photosystem I.

1. Cyclic Electron Flow

✓ In cyclic ETS, only PS-I works

✓ In Cyclic ETS PS-I is activated by wavelength of light greater than 680 nm.



CYCLIC PHOTOPHOSPHORYLATION

- ✓ During Cyclic ETS the electron ejected from reaction centre of PS-I, returns back to its reaction cetnre.
- ✓ In cyclic ETS, no oxygen evolution occurs, because photolysis of water is absent.
- ✓ Phosphoryltion takes place at two places, thus two ATP generate in each cyclic ETS.
- ✓ NADPH2 (reducing power) is not formed in cyclic process.
- ✓According to modern researches, first e- acceptor is FRS (Feredoxin Reducing Substance), which is a Fe-S containing Protein. Earlier fd (Ferredoxin) was considered as first e- acceptor.

Noncyclic Electron Flow/Z scheme

- ✓ Both PS-I and PS-II involved in non cyclic ETS.
- ✓ *Z (for zigzag) scheme, has become the basis for* understanding O2-evolving(oxygenic) photosynthetic organisms. It accounts for the operation of two physically and chemically distinct photosystems (I and II), each with its own antenna pigments and photochemical reaction center.

- ✓ The two photosystems are linked by an electron transport chain.
- ✓ The e- ejected from PS-II never back to chl-a-680 (Reaction centre) & finally gained by NADP.
- ✓The gap of e- in PS-II is filled by photolysis of water as a result, oxygen evolution occurs in Z scheme.

- ✓ Photons excite the specialized chlorophyll of the reaction centers (P680 for PSII, and P700 for PSI), and an electron is ejected.
- ✓ The electron then passes through a series of electron carriers and eventually reduces P700 (for electrons from PSII) or NADP+ (for electrons from PSI).
- ✓ Almost all the chemical processes that make up the light reactions of photosynthesis are carried out by four major protein complexes: photosystem II, the cytochrome *b6 f complex*, photosystem I, and the ATP synthase.
- ✓These four integral membrane complexes are vectorially oriented in the thylakoid membrane.

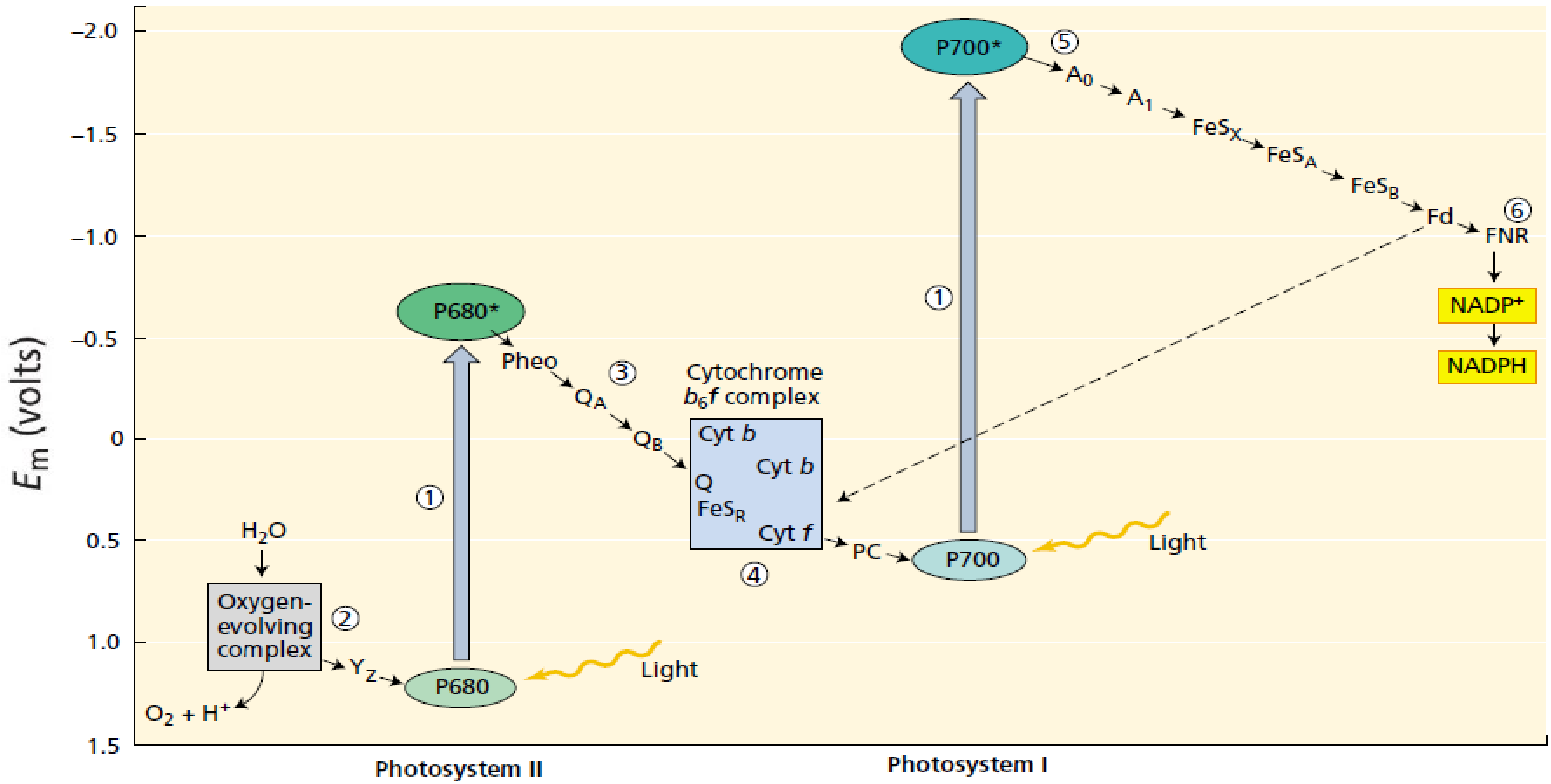


Figure: Detailed Z scheme for O2-evolving photosynthetic organisms.

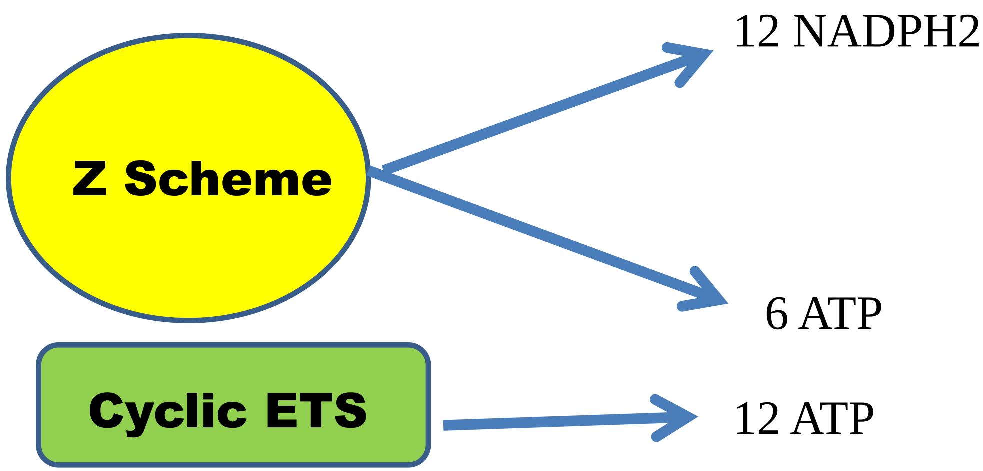
✓ Photosystem II oxidizes water to O2 in the thylakoid lumen and in the process releases protons into the lumen.

✓ Cytochrome *b6 f receives electrons from PSII and* delivers them to PSI. It also transports additional protons into the lumen from the stroma.

✓ Photosystem I reduces NADP+ to NADPH in the stroma by the action of ferredoxin (Fd) and the flavoprotein ferredoxin–NADP reductase (FNR).

✓ATP synthase produces ATP as protons diffuse back through it from the lumen into the stroma.

✓ Each turn of non cyclic ETS produces **1 ATP and 2 $NADPH_2$** (4 mol. of water is photolysed and 1 O_2 released.



➢ 12 NADPH2 + 18 ATP are required as assimilatory power to produce one molecule of Glucose in dark reaction.

- ✓ Thus 6 turns of Z-scheme are necessary for the production of one glucose molecule by calvin cycle.
- ✓ Additional 12 ATP come from 6 turn of cyclic ETS.

Dark reaction/ Calvin cycle will be discussed in next lecture

Thank You !!