LIGHT REACTION, PHOTOSYSTEM

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Light Reaction

- **Also called Light Dependent Processes**

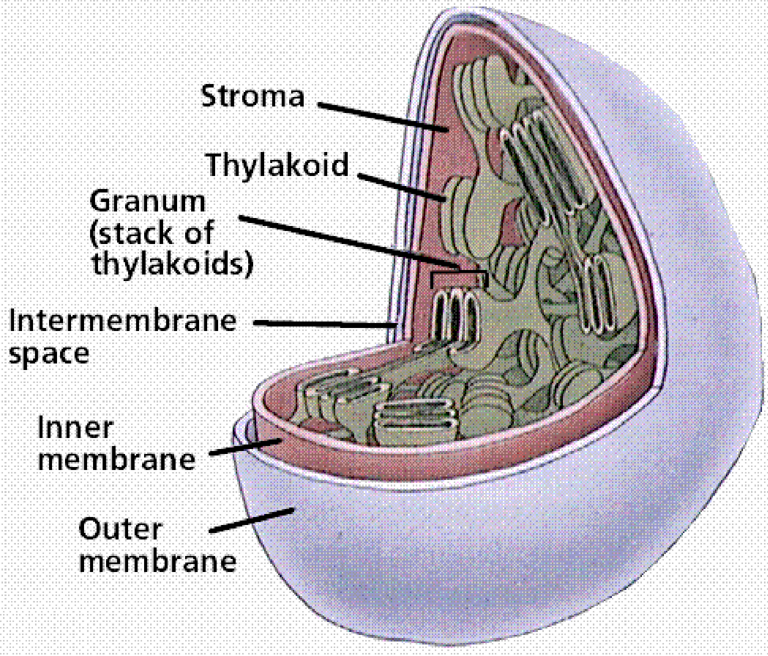
  Light strikes chlorophyll in such a way as to excite electrons to higher energy state. In a series of reaction the energy is converted (along an electron transport process) into ATP and NADPH.

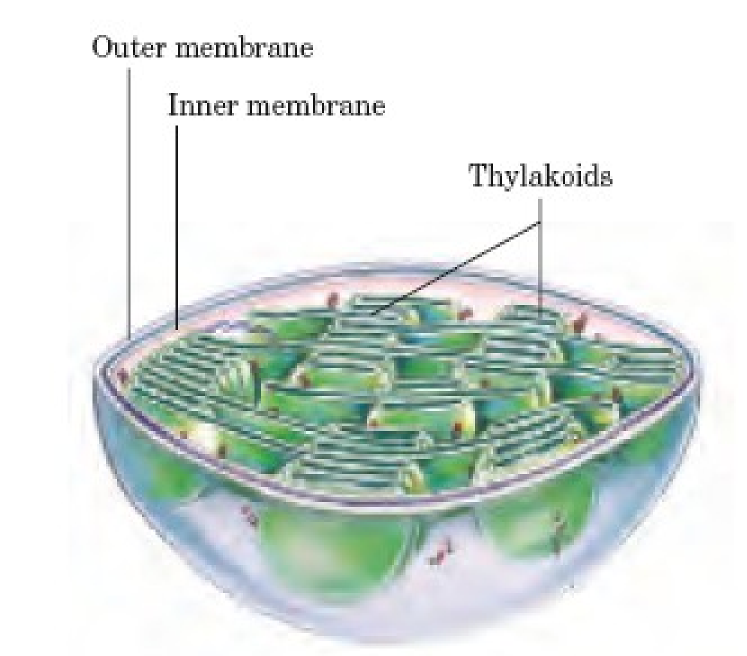
- **The ATP and NADPH are used to make C-C bonds in the Dark Reaction**

Photosystem

- The light absorbing pigments of thylakoid are arranged in functional arrays called photosystem
- Photosystems are arrangements of chlorophyll and other pigments packed into thylakoids.
- Many Prokaryotes have only one photosystem, Eukaryotes have two photosystem (photosystem II & I).

Photosystem





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Photosystem

- **Photosystem II (P680)**

  Photosystem II contains chlorophyll a, as well as up to 50% chlorophyll b.

- **It is needed to capture enough energy to do the biosynthetic reactions of the dark reaction.**
- **Its reaction center is a molecule called P680 which absorbs light maximally at 680 nm.**

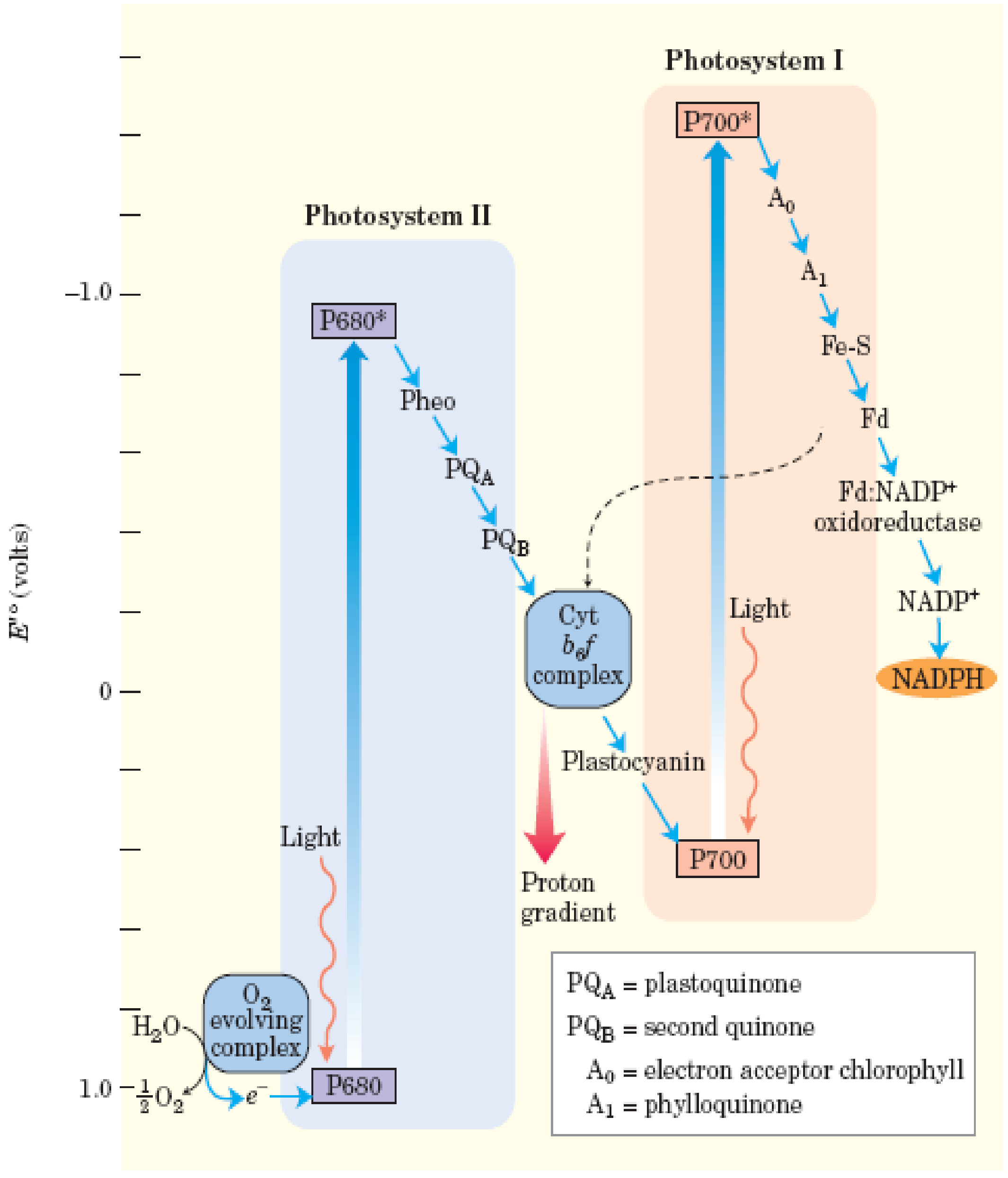
Photosystem

- **Photosystem I (P700)**

Photosystem I consists largely of chlorophyll a molecules and contains no or few chlorophyll b.

Photosystem

- Photosystem I probably was the 1st to develop and can exist independently of Photosystem II to create energy for a plant. However, the enzymes it is associated with when it works independently are different then those it is associated with when it works with Photosystem II.


Photosystem I
Photosystem II
P700*
A_0
A_1
Fe-S
Fd
Fd:NADP+ oxidoreductase
$NADP^+$
NADPH
Light
P680*
Pheo
PQ_A
PQ_B
Cyt b_6f complex
Plastocyanin
P700
Proton gradient
Light
O_2 evolving complex
H_2O
$\frac{1}{2}O_2$
e^-
P680
$E'°$ (volts)
−1.0
0
1.0
PQ_A = plastoquinone
PQ_B = second quinone
A_0 = electron acceptor chlorophyll
A_1 = phylloquinone

Interlationship Between Photosystem II and I

Electrons flow through a series of membrane - bound carriers including cytochromes, quinones, and iron-sulfur proteins, while protons are pumped across a membrane to create an electrochemical potential.

Photosystem II

- **Photosystem II**

  Excitation of its reaction center drives electrons through the Cytochrome b6f complex

- **P680 $\xrightarrow{\text{light}}$ P680* (donor electron)**

  the e^- is transferred into pheophytin

Photosystem II

$$P680^* + Pheo \longrightarrow \bullet P680^+ + \bullet Pheo^-$$

- $\bullet P680^+$ is an oxidizing agent

the e^- that removed from P680 is replaced with an e^- obtained from oxidation of water

$$2\ H_2O \longrightarrow 4H^+ + 4\ e^- + O_2$$

Photosystem II

- •Pheo$^-$ very rapidly passes to a protein-bound plastoquinone (PQ)

$$2\ \bullet Pheo^- + 2H^+ + PQ_B \longrightarrow 2Pheo + PQ_BH_2$$

- PQ_BH_2 dissolved in the membrane and moves through the lipid phase of the bilayer to the cytochrome complex. And then continue transferring to the plastocyanin.

Photosystem II

Overall reaction in photosystem II

$$4P680 + 4H^+ + 2PQ_B + 4\ \text{photons} \longrightarrow 4P680^+ + 2PQ_BH_2$$

Photosystem I

- **Photosystem I**

P700 $\xrightarrow{\text{light}}$ P700* (donor electron)

the e^- is transferred into an acceptor Ao (special form of chlorophyll)

$$P700^* + Ao \longrightarrow \bullet P700^+ + \bullet Ao^-$$

Photosystem I

- •$P700^+$ (an oxidizing agent)

  Acquires an e^- from plastocyanin

- •Ao^- (a reducing agent)

  e^- passes into phylloquinone (A_1) and then the electron moves to ferredoxin (Fd) that's donates its e^- to $NADP^+$ reductase.

$$2Fd_{red} + 2H^+ + NADP^+ \longrightarrow 2Fd_{ox} + NADPH + H^+$$

Water Is Split by Oxygen-Evolving Complex

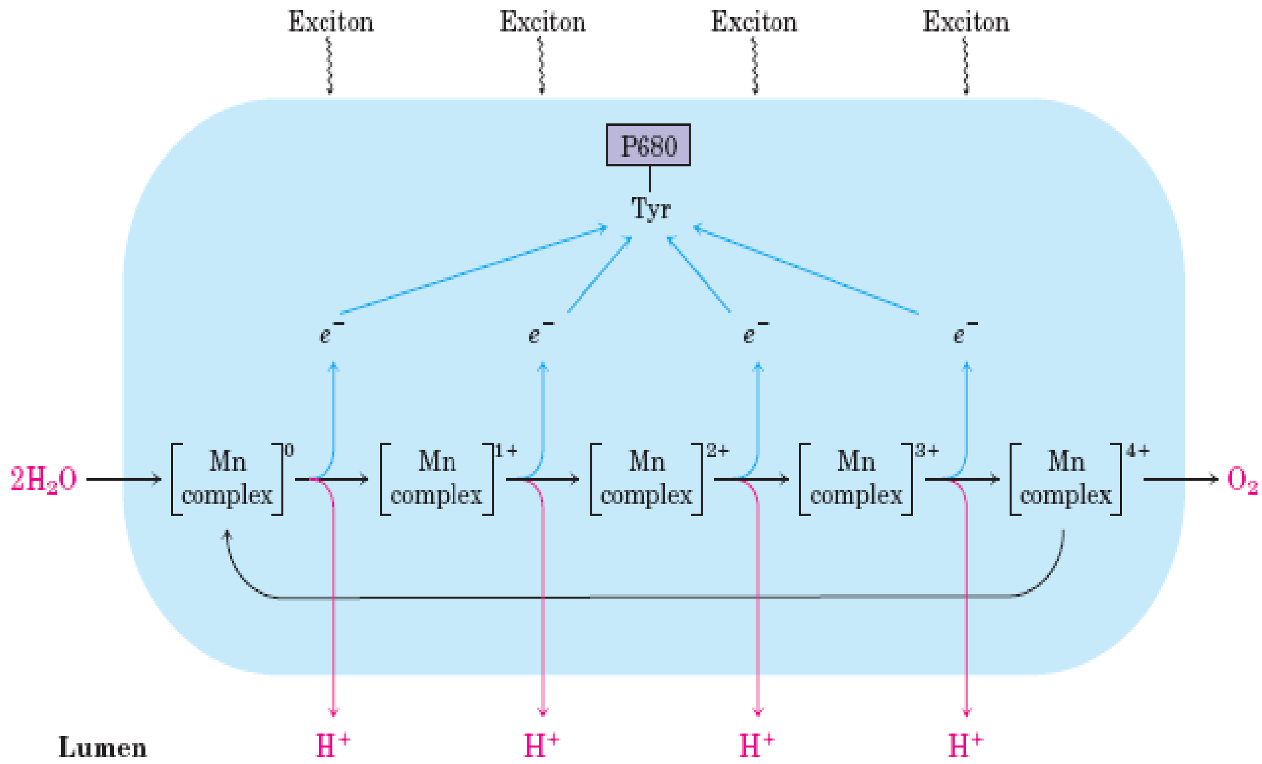


FIGURE 19–56 **Water-splitting activity of the oxygen-evolving complex.** Shown here is the process that produces a four-electron oxidizing agent—believed to be a multinuclear center with several Mn ions—in the water-splitting complex of PSII. The sequential absorption of four photons (excitons), each absorption causing the loss of one electron from the Mn center, produces an oxidizing agent that can remove four electrons from two molecules of water, producing O_2. The electrons lost from the Mn center pass one at a time to an oxidized Tyr residue in a PSII protein, then to $P680^+$.

A Proton Gradien

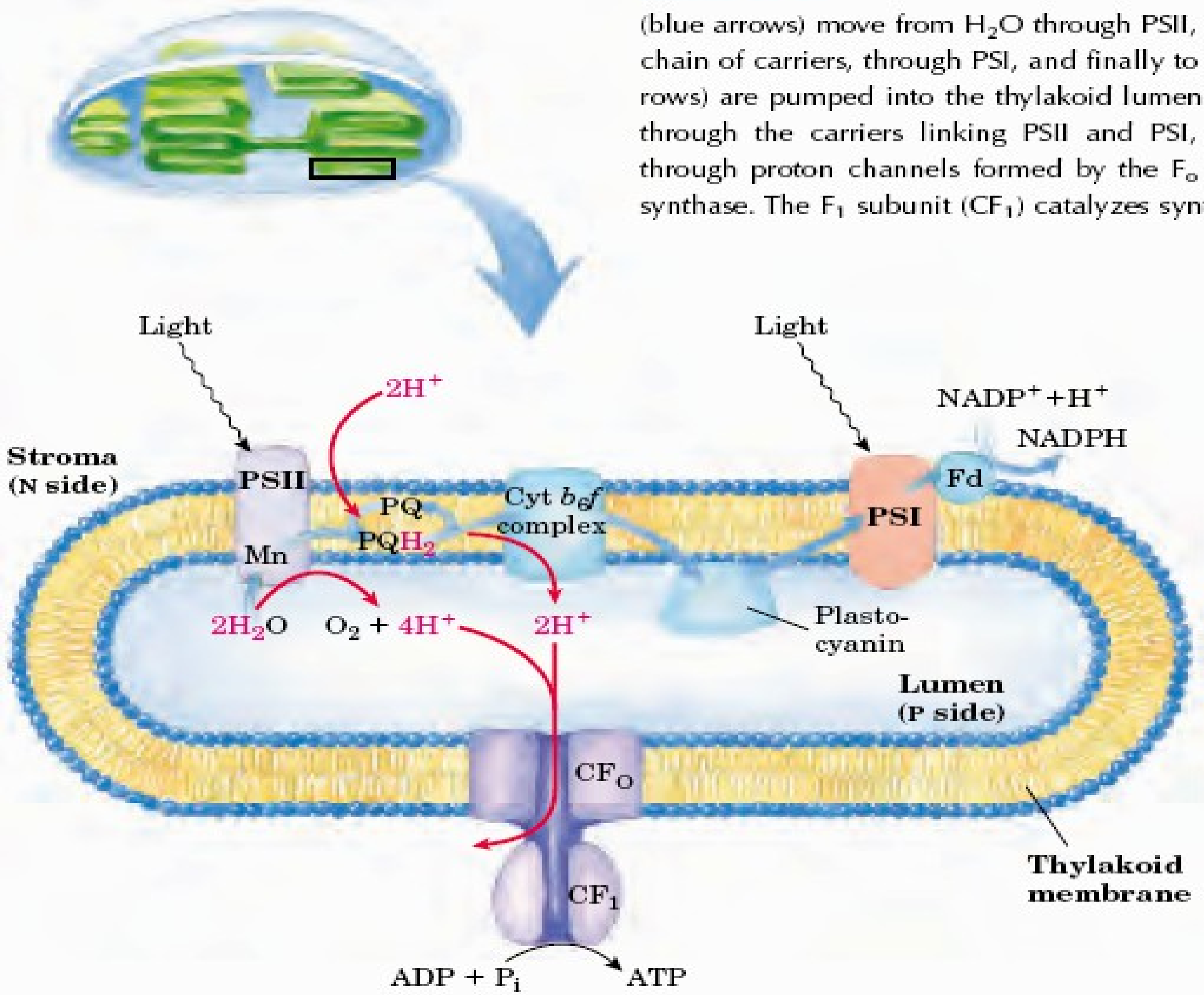
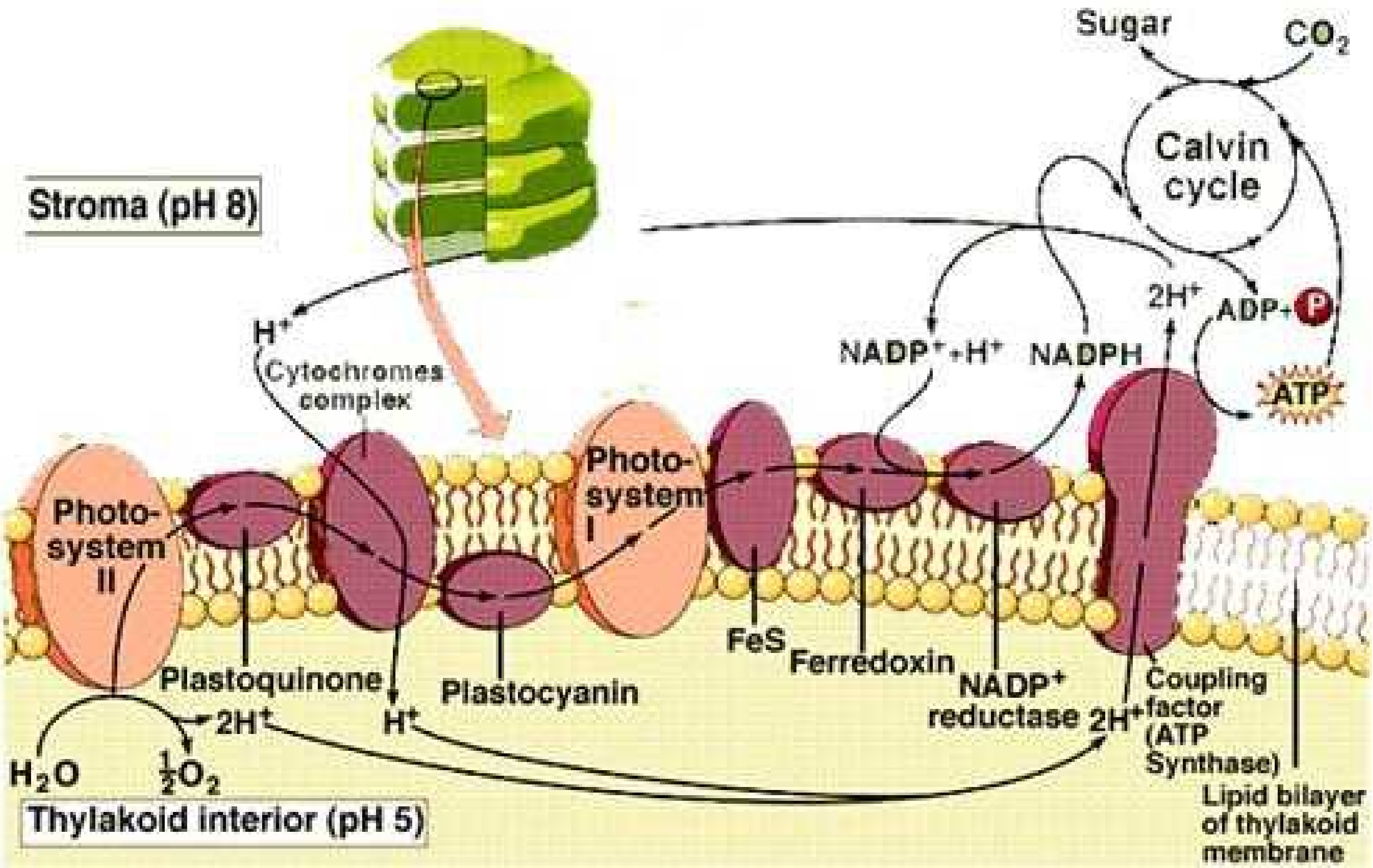


FIGURE 19–57 Proton and electron circuits in thylakoids. Electrons (blue arrows) move from H_2O through PSII, through the intermediate chain of carriers, through PSI, and finally to $NADP^+$. Protons (red arrows) are pumped into the thylakoid lumen by the flow of electrons through the carriers linking PSII and PSI, and reenter the stroma through proton channels formed by the F_o (designated CF_o) of ATP synthase. The F_1 subunit (CF_1) catalyzes synthesis of ATP.

A Proton Gradien

- **Electron flow through the cytocrome complex drives protons across the plasma membrane, creating a proton-motive force that provides the energy for ATP synthesis by an ATP synthase**
- **At least eight photons must be absorbed to drive four electrons from H_2O to NADPH. The energy in eight photons is more than enough for the synthesis of three molecules of ATP.**



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A Proton Gradien

- **The overall equation for noncyclic photophosphorylation :**

$$2H_2O + 8\text{photons} + 2NADP^+ + \sim 3ADP + \sim 3Pi \longrightarrow O_2 + \sim 3ATP + 2NADPH$$

Refference

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