Honors Biology

*Step by step: How does the Light Dependent stage of Photosynthesis happen?*

Parts of the Thylakoid that you should be familiar with:

* Phospholipids
* Photosystem II
* Electron Carriers
* Lumen
* Protein Pumps for H+
* ATP Synthase
* Photosystem I

Molecules that you should be familiar with:

* Chlorophyll
* Photon (not actually a molecule, but a bundle of energy)
* Water (H20)
* Carbon dioxide (CO2)
* Adenosine Triphosphate (ATP)
* NADPH
* Phosphate (P)
* Adenosine Diphosphate (ADP)

Equation: Photons + 6CO2 + 6H20 yields C6H12O6 + 6O2

Stageone goal: To convert the energy found in the photons from the sun into ATP and NADPH molecules.

1. Photons, which are energy, from the sun come through the atmosphere and hit a leaf. The photon moves through the cells and the membrane of the chloroplasts, until the hit the photosystem II complex in the thylakoid membrane.
2. The photons are absorbed by the chlorophyll and this causes an electron in the chlorophyll molecule to become excited (it moves it to a higher energy state).
3. The electron jumps off of the chlorophyll molecule and on to an electron carrier protein in the thylakoid membrane.
4. This electron carrier protein can and does actually move through the phospholipids until the electron jumps onto a protein pump.
5. The electron jumps onto another electron carrier protein, but loses some energy as it moves through the protein pump. The pump uses this energy to pump hydrogen ions (H+) against a concentration gradient from the stroma to the lumen of the thylakoid.
6. Our electron is on the electron carrier and moves through the phospholipids until it hits another protein pump and step 5 repeats: The electron jumps onto another electron carrier protein, but loses some energy as it moves through the protein pump. The pump uses this energy to pump hydrogen ions (H+) against a concentration gradient from the stroma to the lumen of the thylakoid.
7. This process continues down the membrane building up a high concentration of H+. The H+ begin to diffuse through a specialized protein channel. Attached to this channel is an additional protein complex that takes some of the kinetic energy from the H+ as they move through the channel and spins a wheel or motor. This motor takes lone phosphate molecules and ADP and bonds them together making ATP molecules. This is the first product that is required by the Calvin Cycle of Photosynthesis.
8. Eventually our electron reaches the photosystem I and replenishes lost electrons to the chlorophyll there.
9. Photons hit photosystem I and excite an electron just as in photosystem II, the electron jumps off of the chlorophyll and continue the process described in steps 3 through 7.
10. Eventually the electron loses most of the energy it gained from the photons. At this point the electron jumps off of the membrane and onto a H+ in the stroma. This makes the hydrogen ion a hydrogen atom. The hydrogen atom accepts one more electron, which turns the hydrogen atom into a negatively charged hydrogen ion. The new H- ion is attracted to the positively charged NADP+ and the two bond together making NADPH, which is the second molecule required for the Calvin Cycle of Photosynthesis.
11. The one remaining point is to answer this question. If photons hit the chlorophyll and make electrons leave, doesn’t the chlorophyll run out of electrons? The answer is yes. But there is a mechanism to replace the electrons.
12. This is where the water in the equation comes in, The water is split into two hydrogen atoms and one oxygen atom. And electrons are stripped from the hydrogen atoms and given to replenish the chlorophyll. The Hydrogen ions (H+) are added to the lumen to help build up the concentration gradient. The oxygen combines with another oxygen (from another water molecule) to become an oxygen molecule. This is the oxygen in the other side of the equation and the oxygen that we breathe. This process is called Hydrolysis.

**Directions:** On the following page diagram each step of the light dependent reaction of photosynthesis, using the template of the thylakoid membrane provided.

Thylakoid Membrane

Phospholipid Bi-layer

Lumen

Electron Carrier

Protein Pump

Photosystem I

ATP Synthase

Protein Pump

Electron Carrier

Protein Pump

Electron Carrier

Photosystem II

Stroma

Name: