Biology 1305 – Modern Concepts in Bioscience – Campbell Textbook – Week 8

Hey hey guys! I hope you all are doing well. Welcome back to another resource! Most professors are starting to split up now in terms of content, but thankfully we are still keeping up with some of the faster sections! We are now approaching exam 2 and I hope you are on your way to becoming a Biology MASTER! Hopefully this resource can help you out in your efforts.

Remember that the Tutoring Center offers free individual and group tutoring for this class. Our Group Tutoring sessions will be every Thursday from 5:00-6:00 PM CST. You can reserve a spot at https://baylor.edu/tutoring. I hope you sign up!:)

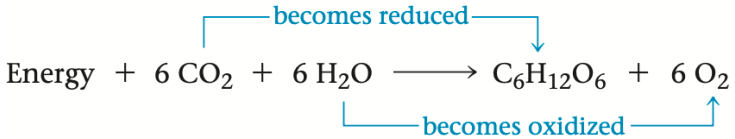
Today we will be covering chapter 10, specifically looking at light dependent reactions and the Calvin Cycle, as these are what most students will struggle with. I am including the relevant videos you should watch if you are confused on these topics below.

In this resource, we will discuss: light dependent reactions, carbon fixation, electron excitement, and redox reactions

Khan Academy Photosynthesis Library
Linear Electron Flow
Cyclic Electron Flow
Calvin Cycle

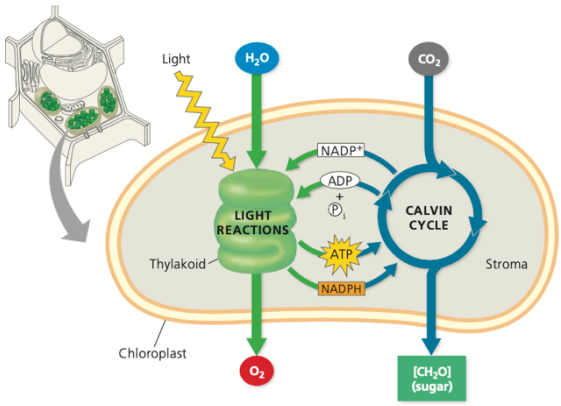
Just as a general overview for photosynthesis, let's remind ourselves of what is happening here.

Notice how this is the reverse of the chemical process we saw in chapter 9?



Water is being split, and its electrons are transferred along with protons to reduce up-taken CO2 to a sugar.

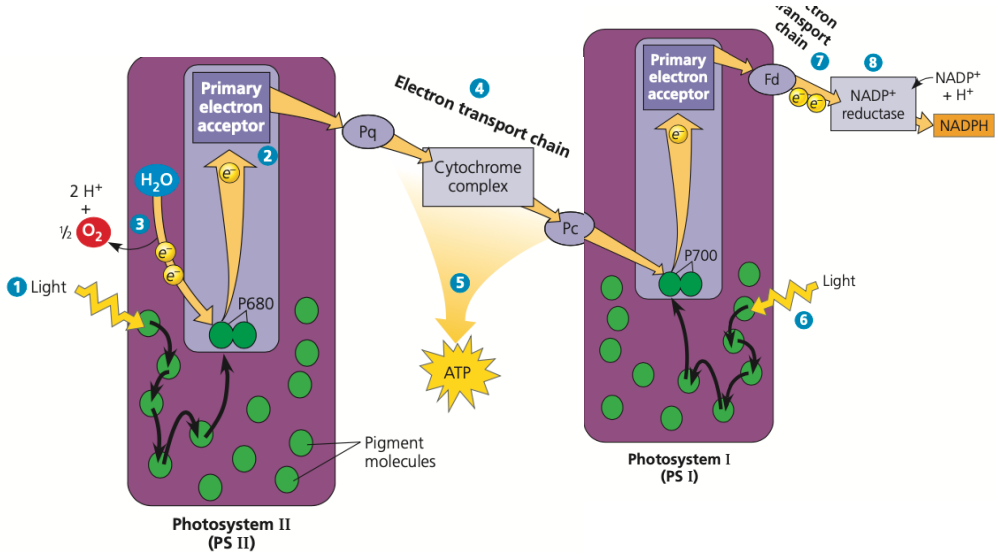
Because these electrons are increasing in energy, this process is deemed endergonic. **So what does that mean for the plant? What will it need to input to make photosynthesis occur?** If you answered energy, you'd be exactly right! Thankfully for the plant, this energy comes from light provided by the sun.



To the left we can see a general overview of photosynthesis. It is important here for you to be up-to-speed on your terminology and structures. Photosynthesis is made up of 2 stages: **light reactions and the Calvin Cycle.**

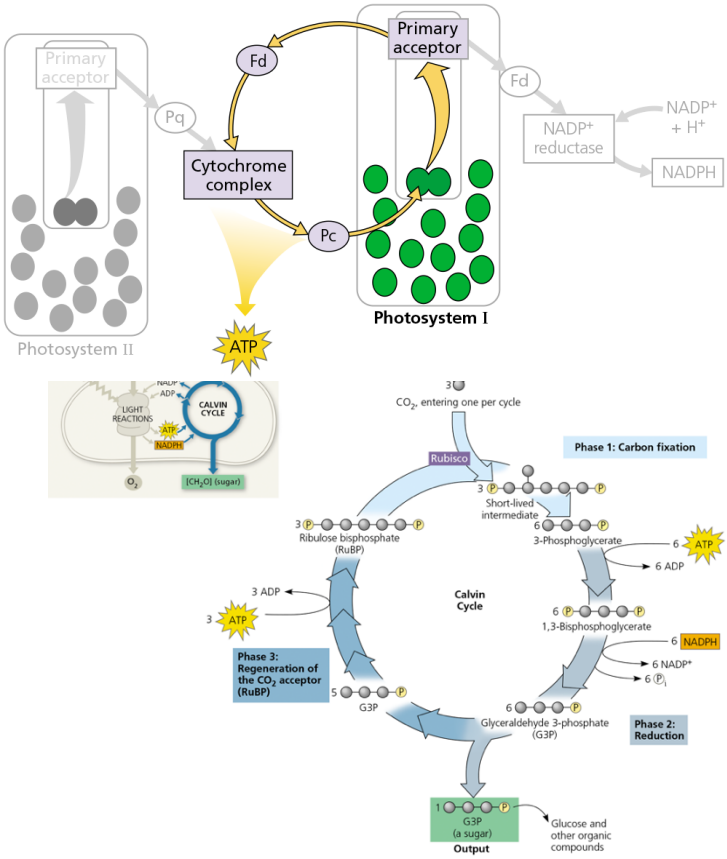
The light reactions convert **solar energy** to **chemical energy**. Water is split here, giving off O_2 , electrons, and protons. NADP+ (very similar to something seen in cellular respiration) is going to be reduced via solar energy to NADPH, and ATP is going to be produced as well in a manner very similar to the ETC in animal cells. These reactions take place within the thylakoid of a chloroplast.

In the Calvin Cycle, uptaken carbon dioxide is incorporated into organic molecules present in the chloroplast in a process called **carbon fixation**. CO2 is reduced via the electrons provided by NADPH, and is converted to a carbohydrate via an endergonic reaction. These reactions take place within the stroma, outside of the thylakoid.



Above you will see a diagram illustrating light-dependent reactions in the thylakoid. This process is extremely lengthy, so I recommend you watch the video I will link below to explain light-dependent reactions. Take note on what is occurring, what products are being formed, and how they play into photosynthesis as a whole.

Light Dependent Reaction Actors
Overview of Light Dependent Reactions



The figure on the left depicts the Calvin cycle, where chemical energy in the form of ATP and NADPH are used to reduce CO2 to sugar.

Note how this process, in a general sense, operates in **the manner opposite to the Krebbs Cycle!**

Here we are taking the most oxidized form of carbon in carbon dioxide and reducing it to a 3 carbon sugar.

We can split the Calvin cycle into 3 phases:

Phase I: Carbon Fixation
CO2 molecules, one at a time, are fixed to a 5 carbon sugar named ribulose bisphosphate (RuBP) via an enzyme named rubisco. The product of this is so unstable it immediately splits into two molecules of **3-phosphoglycerate** (for each CO2)

Phase II: Reduction
Each molecule of 3-phosphoglycerate gets an additional phosphate from the ATP produced in light-dependent reactions, and then are reduced by NADPH being oxidized to form **glyceraldehyde 3-phosphate (G3P)**. Take note that for every 3 CO2 entered, there are 6 molecules of G3P formed. This is the important part though, **only ONE G3P molecule will exit the cycle to be made into a sugar, the other 5 will go onto phase 3.**

Phase III: Regeneration of Ribulose Bisphosphate
The remaining 5 G3P molecules will undergo a series of reactions to be combined into 3 RuBP molecules with 3 ATP from light-dependent reactions. This allows the Calvin cycle to be a cycle and continue with more carbon dioxide.