4.3 Photosynthesis in Detail

**The first stage of photosynthesis captures and transfers energy.**

During the light-dependent reactions, energy is captured from the sun and moved along the thylakoid membrane. This process involves 2 groups of molecules called **photosystems.** The 2 photosystems are called photosystem I and photosystem II. They both absorb energy from the sun.

**Photosystem II and Electron Transport**

There are several things that happen in photosystem II:

-Chlorophyll and other light-absorbing molecules absorb (take in) energy from the sun.

-The energy is transferred to electrons (e-) that leave the chlorophyll.

-These high-energy electrons enter the **electron transport chain,** which is made of proteins in the thylakoid membrane.

-Water molecules are split apart into oxygen, hydrogen ions, and electrons.

-Oxygen is released.

-The electrons from water take the place of electrons that left the chlorophyll.

-Electrons in the electron transport chain move from protein to protein, pumping hydrogen ions (H+) across the thylakoid membrane, from outside the thylakoid to inside so that there is a higher concentration of H+ ions inside of the thylakoid than on the outside of the thylakoid membrane.

**Photosystem I and Energy—Carrying Molecules**

There are several things that happen in Photosystem I:

-The electrons from photosystem II move on to photosystem I.

-Chlorophyll absorbs energy from sunlight, which results in even more high-energy electrons.

-The electrons are added to NADP+, a molecule that is kind of like ADP.

-This makes NADPH, a molecule that acts a lot like ATP.

-The concentration gradient in the thylakoid from photosystem I provides energy to make ATP.

-The H+ ions diffuse back out of the thylakoid through a channel in the membrane- **ATP Synthase.**

-Phosphate groups are added to ADP to make ATP.

-The energy from both ATP and NADPH is used late to make sugar.

**Summary of Light-Dependent Reactions:**

1. **Energy is absorbed from sunlight.**
2. **Water molecules are broken down.**
3. **Hydrogen ions are transported across the thylakoid membrane.**
4. **Energy is absorbed from sunlight.**
5. **NADPH is produced when electrons are added to NADP+.**
6. **Hydrogen ions diffuse through a protein channel.**
7. **ADP is changed into ATP when hydrogen ions flow through ATP synthase.**

**The second stage of photosynthesis uses energy from the first stage to make sugars.**

The second stage of photosynthesis is the light-independent reactions. This also happens in the chloroplast—in the stroma. This stage is light-independent because it does not need light. The reactions in this stage use energy from ATP and NADPH to run the chemical reactions that make up the Calvin Cycle. The Calvin Cycle uses carbon dioxide and energy from ATP and NADPH to make sugars.

**Steps of the Calvin Cycle:**

1. **Carbon dioxide (CO2) molecules enter the cycle and are added to five-carbon molecules. Six-carbon molecules are formed.**
2. **Energy is added. The six-carbon molecules split to form three-carbon molecules. More energy is added and the molecules are rearranged into higher-energy molecules.**
3. **A high-energy three-carbon molecule exits for every 3 CO2 molecules that enter. After 2 three-carbon molecules have exited, they bond to form 1 six-carbon sugar.**
4. **Three-carbon molecules are changed back to five-carbon molecules by energy from ATP.**

Photosynthesis is important for many reasons. Plants make food for themselves and other organisms. They use the sugars from photosynthesis to build carbohydrates necessary for growth and development. Photosynthesis also removes carbon dioxide from the Earth’s atmosphere and produces the oxygen that you breathe.

