

# What is photosynthesis and how it works



Photosynthesis Essay During the Light Dependent Reactions, activity occurs within the thylakoids of the chloroplast.  $\text{NADP}^+$  accepts two high energy electrons and an  $\text{H}^+$  ion and then converts into  $\text{NADPH}$ . This process ultimately traps some of the sunlight in chemical form. Then,  $\text{NADPH}$  is able to carry the energy it absorbs to the rest of the cell. The reaction produces  $\text{O}_2$  gas and converts  $\text{ADP}$  to  $\text{ATP}$  and  $\text{NADP}^+$  to  $\text{NADPH}$ . First, pigments in Photosystem II absorb light, which is then absorbed by electrons, which are then passed along the Electron Transport Chain.

Chlorophyll loses an electron, but interestingly, those missing electrons are replaced through enzymes in the thylakoid membrane, which divide  $\text{H}_2\text{O}$ . Secondly, electrons move through the Electron Transport Chain from PII to PI and an  $\text{H}^+$  ion moves from the stroma to the inner thylakoid space. Thirdly, pigments from PI use energy from light to reenergize electrons;  $\text{NADP}^+$  picks them up along with  $\text{H}^+$  ions in the outer surface of the thylakoid, making  $\text{NADPH}$ .

Next, as the electrons pass from chlorophyll to  $\text{NADP}^+$ , more  $\text{H}^+$  ions are being pumped through the membrane to the inside of the thylakoid, which accounts for the inside being positive and the outside being negative. Lastly,  $\text{ATP}$  synthase, which passes the membrane, allows the  $\text{H}^+$  ions to go through it. As they go through, the synthase spins and rotates and binds an  $\text{ADP}$  to a phosphate group, producing  $\text{ATP}$ . Specifically, the Light Reactions can either follow a noncyclic electron pathway or a cyclic electron pathway.

During the noncyclic electron pathway, PII absorbs solar energy, which is passed along pigments until it is concentrated in a particular pair of chlorophyll a molecules, called the reaction center. Here, the electrons

become very energized that they escape and go to electron acceptor molecules. The electron acceptor sends electrons down the ETC and ATP production occurs when they flow their gradient in ATP synthase. PI absorbs solar energy, but the electrons are captured by different electron acceptors, which pass electrons to NADP+.

Each one accepts two electrons and an H<sup>+</sup> to become NADPH. The cyclic electron pathway is the same as the noncyclic pathway, where ATP production occurs; however instead of electrons moving to NADP+, they return to PSI, which how it receives replacement electrons. This is why it is called a cyclic pathway; ATP production occurs but not NADPH production. The Light Independent Reactions, also known as the Calvin Cycle and or the "dark cycle", ATP and NADPH produce high energy sugars.

To begin the cycle, six CO<sub>2</sub> molecules enter from the atmosphere and combine with six 5-carbon molecules to form twelve 3-carbon molecules. Next, these are converted into higher energy forms using ATP and high energy electrons from NADPH. Lastly, two of the twelve 3-carbon molecules are removed from the cycle, used by the plant for metabolism and growth; the remaining ten are converted back into six 5-carbon molecules, which ultimately begin the next cycle.

The Calvin Cycle has three in depth parts: CO<sub>2</sub> fixation, CO<sub>2</sub> reduction, and RuBP regeneration. During CO<sub>2</sub> fixation, CO<sub>2</sub> from the atmosphere is attached to RuBP, which is a 5 carbon molecule, which splits into two 3 carbon molecules. RuBP carboxylase is the enzyme that speeds up this reaction. Secondly, both of the 3PG molecules formed undergoes reduction

to G3P: ATP and NADPH are used as energy to fuel this reduction where carbon dioxide reduces to a carbohydrate (R-CO<sub>2</sub> to R-CH<sub>2</sub>O).

Lastly, the Calvin Cycle has to cycle three times for one G3P to exit. This occurs because five molecules of G3P are used to reform three RuBP molecules. Glyceraldehyde -3-phosphate, G3P, produced from this cycle is an ultimate carbohydrate used for nutrition for most living things on Earth. Glucose phosphate is an organic molecule that results from G3P metabolism. Glucose is essential to plants and animals to be able to produce ATP for energy purposes. Glucose phosphate is also the starting point for the synthesis of starch and cellulose.