

MP3 Tutor Topic: **Photosynthesis** Estimate Time: 6:50 Vocabulary: chloroplast, enzyme, thylakoid

Hey there and welcome to another MP3 Tutor session. This is Eric Simon and I'll guide you through today's topic of photosynthesis. In your text and in other MP3 sessions, we've tried to emphasize the importance of energy to living things. Life requires a constant input of energy. For almost all of the planet's multi-celled organisms, the ultimate source of that energy is sunlight. Photosynthesis is the process by which solar energy is captured and converted into chemical energy. It is green plants that carry out most of this work. Thus, you depend on green plants for the food energy that powers your life.

In this MP3 Tutor session, we will explore the two separate reaction pathways that take place in the cells of green plants. These two sets of reactions ultimately convert light energy into food energy. Let's refer to these two pathways using the phrases in the overall name: photo and synthesis.

First, let's explore how the "photo" part of photosynthesis captures light energy. These first steps are called the light reactions. Plant cells involved in photosynthesis are packed with organelles called **chloroplasts**. Within these chloroplasts are flattened membrane sacks stacked up like coins—the **thylakoids**. Groups of proteins and pigment molecules are embedded within the thylakoid membranes. The structure and arrangement of these molecules creates a system of interacting components that work together to capture the energy from light and convert it into chemical energy. These collections of molecules are called photosystems and they come in two types called photosystem I and photosystem II. The two photosystems lie in close proximity to each other. In fact, they are wired together with an electron transport chain.

Trying to keep track of the details of the various photosynthetic reactions is a bit much. Refer to the light reaction illustrations in your text and please explore the animations on your CD-ROM. The animations present a clear picture of the how the photosystems work. Here, let's focus on an overview of the light reactions with an emphasis on the inputs and outputs.

Remember there are two photosystems; each collects light photons. When a photosystem absorbs a photon, an electron is bumped to a higher energy level. The high-energy electrons from photosystem II are used to produce ATP, while the high-energy electrons from photosystem I are used to produce NADPH, a shuttle molecule that carries high-energy electrons to other reactions. The products of the light reaction then are two high-energy molecules, ATP and NADPH. These two molecules power the synthesis reactions of photosynthesis.

One final point about the light reactions: Since electrons are exported out of the photosystems, they have to be replaced. The source of these replacement electrons is water. Inside the chloroplast, a water molecule is split into the electrons and protons which will take part in the photosynthesis reactions and oxygen atoms which are released as a waste product.

Let's recap the light reactions:

1. Energy is captured by two photosystems.
2. The outputs are ATP and NADPH. These products will drive the synthesis in photosynthesis.
3. Water is split and oxygen released.

Let's move on to the sugar-producing or synthesis reactions.

A plant produces energy-rich ATP and NADPH during the light reactions. You might think then, that all a plant needs is the light reactions—not so. A number of environmental conditions can limit

the output of the light reactions—darkness is an obvious one. The second part of photosynthesis—the synthesis part—uses the energy captured in the light reactions to build sugar molecules. These molecules can store energy to be used at later times or in other parts of the plant.

The synthesis part of photosynthesis is called the Calvin cycle. The **enzymes** that make up the Calvin cycle are located within the chloroplasts. The carbon source used to build sugars is carbon dioxide drawn from the air.

The Calvin cycle is fairly complex, and I'm not going to try to account for each and every atom in this audio file. You'll surely get lost; I know I would. But there are some important points that we can emphasize.

First, a carbon dioxide is attached to a five-carbon molecule, producing a six-carbon compound. This step is called carbon fixation. The six-carbon molecule is immediately split in half into two three-carbon molecules. Each of these three-carbon molecules is then pumped up with one ATP and one NADPH to produce a high-energy sugar molecule called glyceraldehyde-three-phosphate, or G3P. Later the plant will use G3P to make other sugars such as glucose.

So let's see—for one carbon dioxide, the Calvin cycle has produced two molecules of G3P. This actually happens three times, with a total of three carbon dioxides used to produce a total of six molecules of G3P. The thing is, only one of the six is available for energy. The other five G3Ps go back into the Calvin cycle to be recycled. Check out this process in the Calvin cycle diagrams in your text and the animations on your CD-ROM. I've found, over the years, that some students don't spend enough time on these diagrams. Remember: a picture is worth a thousand words, and I bet they'll help you, too.

Let's wrap this up with a summary of the “synthesis” part of photosynthesis:

- The inputs are NADPH and ATP from the light capturing reactions and three CO₂ molecules from the atmosphere.
- The output is one molecule of G3P, a three-carbon sugar that can later be used to build other carbohydrates such as glucose.

So there you have it. We've gone over the light reactions and now the sugar-producing reactions. I hope this summary helped. It wouldn't surprise me if you need to rewind this MP3 and listen to it a few times to get the whole thing. And I'm sure it would help to read it while looking at the figures in your book. That's it for now. Hang in there and good luck with your studies!