How It Works: Photosynthesis

Ever wonder why vegetables, fruits and grains are so nutritious and filled with energy? It all starts with an amazing process called photosynthesis.

PRACTICAL SCIENCE WITH PHIL FREDA

Welcome to my semi-regular series "How It Works," where we tackle some of the complex processes of our natural world.

This first column explores the integral mechanism that's key, not only to plant life, but all life on Earth.

Did you ever ask yourself, "Why are plants green?"

It seems like a stupid question, but if you really think about, it is a perfectly valid one.

Before we answer that question, let's look at the process of photosynthesis and what it really is.

What is photosynthesis?

According to the University of Cincinnati - Clermont College's Biology website, photosynthesis is the process in which plants, bacteria and some protists convert light energy into chemical energy.

This chemical energy is stored in carbon-based molecules called sugar.

For the purposes of this article, we are going to look at the photosynthetic system found in most plants because it is the most relevant to us humans.

If you remember one of my previous articles on prokaryotes, all life on this planet is split into two major groups:

- Prokaryotes
- Eukaryotes

Plants, like us, are eukaryotic organisms, meaning that their cells are made up of a central nucleus and many other important parts called organelles.

Just as a human body has important parts called organs, a single cell also has important parts that are called organelles (little organs).

Plants have a very special organelle that animals and fungi do not called a chloroplast.

Chloroplasts house the structures, and a very special molecule, that makes photosynthesis possible.

This special molecule is called chlorophyll.

Chlorophyll is the reason why plant leaves are green. As light enters the chloroplast, chlorophyll absorbs blue and red light while reflecting green light. The light is reflected and enters our eyes, making leaves look green to us.

The chlorophyll molecule uses the red and blue light, however, as a energy source to ultimately make energy rich sugar; let's take a closer look!

How does photosynthesis work?

A chemical equation that has been drilled into my head for the past three years of biology shows the overall process of photosynthesis:

- **$6CO_2 + 6H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$**

I know it may seem like gibberish, but let's explore what is really going on here.

Six molecules of carbon dioxide (CO_2) are used as a carbon source from the atmosphere. Six molecules of water are the source the plant uses for electrons. These electrons are important because they are the carriers of the light energy provided by the sun or artificial light provided by lights in your home.

The first parts of photosynthesis are called the **light-dependent reactions** in that they require the presence of light.

In the chloroplast, the electrons that were stripped from the water molecules are excited by the light energy absorbed from the sun. The electrons, and the energy they are now storing, are used to form a very important molecule called ATP.

We briefly discussed ATP in my article on why we sleep. ATP molecules are like little batteries that help make reactions in the cell go forward.

Another very important molecule called NADPH is also formed as a source of electrons (reducing power).

After adequate amounts of ATP and NADPH are made from the light reactions, they can now be put into the **light-independent reactions** along with carbon dioxide in a process called the **Calvin Cycle**.

The light-independent reactions do not require the presence of light.

The six molecules of carbon dioxide, along with 18 molecules of ATP and 12 molecules of NADPH, flow through the reactions of the Calvin Cycle yielded one sugar molecule ($C_6H_{12}O_{6)}$ and six molecules of atmospheric oxygen (O_2).

What's in it for us?

This process is extremely important to us humans for two reasons.

The first is that we use the manufactured sugar molecules as a food source.

Fruits, vegetables and grains are all sources of sugar energy that we use to keep ourselves going.

Fruits are loaded with sugar, as you probably know. Fruits are sweet because they attract animals that are looking for a meal.

Through evolutionary processes, plants have achieved a way to maximize seed dispersal through animals.

If an animal eats a fruit containing the seeds of the next generation of plants, it is a good change that the seed will wind up somewhere far away from the parent plant, ensuring that the new offspring will not compete with the parent for resources and light.

In return, we get a nutritious, energy-rich meal.

Most vegetables are sugar sources used by the plant during the winter to get them through the harsh months. Potatoes and carrots are modified tubers and roots that are used to store carbohydrates (sugar).

The second important outcome of photosynthesis of us is the release of atmospheric oxygen as a byproduct.

Plants, algae and bacteria produce the oxygen that we breathe.

We can thank our oxygen-rich atmosphere to the photosynthetic systems of these living things.

This is why things like deforestation are bad.

Beside the habitat destruction that deforestation does, we are actually limiting the amount of oxygen that is available to us by cutting down trees.

Next time you look at a green plant, you now know why they are green and the amazing process that is going on inside their leaves!

Think about it.

Think about it yet? Tell us in the comments.