Biology Bits

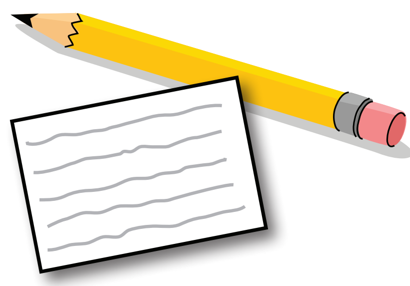
Bite-size Science

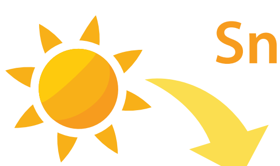
Trying new things can be hard. When you play a new sport, you have to learn and remember a whole new set of rules. When you try new food, you may end up not liking it (and you may even wish you could spit it out). The same goes for school. Learning information can be really hard and sometimes scary.

With food, what's the best way to start with something new? Trying a very small piece. You can take a tiny bite…taste it, feel the texture of it, and decide if you want more. Just like with new food, new information can also be easier to learn if you start off with really tiny bites.

Biology Bits stories are a great way for you to learn about biology a little bit at a time. We've broken down information into pieces that are very tiny—bite-sized, we call them. You can try just reading the Biology Bits at first. Cutting out the cards will let you organize them however you want, or use them as flashcards while you read.

Then, when you're ready to move on, use the empty cards to write out what you learned. You can copy what was already written, or try to write it in your own words if you are up for a challenge. Just remember, don't bite off too much at once!





Snacking on Sunlight

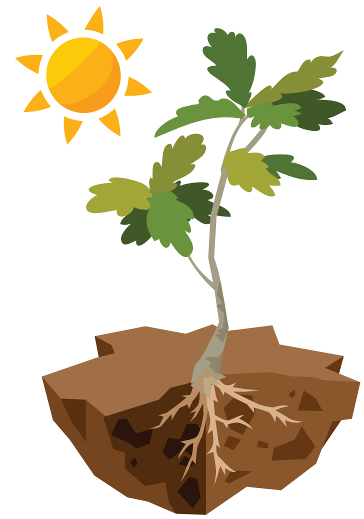
Written by Drew Peltier

For more information on photosynthesis, visit:
http://askabiologist.asu.edu/explore/snacking-sunlight

This set of bits will teach you about the process plants use to make their own food: **photosynthesis.**

Hungry for more bits? Visit:
http://askabiologist.asu.edu/activities/biology-bits

Plants make the food we eat and the oxygen we breathe. Other animals (even the ones some people eat) get their food from plants too. Just like us, plants need energy to grow. But unlike us, they can make their own energy. Plants use a process called photosynthesis to make food (energy) from sunlight, water, and the air. Because photosynthesis supports most of the life on Earth, it's important to understand how it works.



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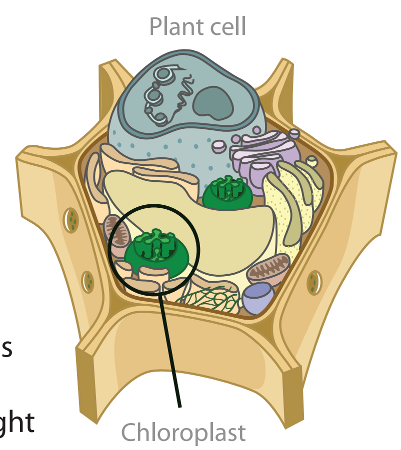
In the first step of photosynthesis, energy from sunlight is used to create a form of chemical energy called ATP. How do plants do this? The key is chloroplasts - small green organelles (“little organs”) in plant cells. Chloroplasts hold chlorophyll, which captures the sun's energy. Chlorophyll only absorbs red and blue light. Green light is not used for photosynthesis. The green light bounces off of or goes through the chlorophyll. This is why most plants look green.



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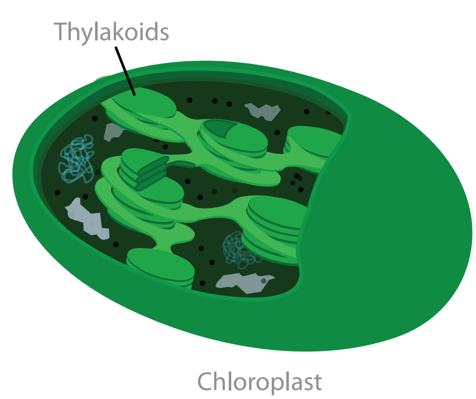
Inside chloroplasts are stacks of flat disks, called thylakoids. Their shape helps them absorb lots of sunlight. Chlorophyll is in the outer layer of the thylakoids. The chlorophyll is also arranged in flat circles, to help absorb sun. Chlorophyll uses sunlight to split water apart. This separates oxygen and hydrogen atoms so they can be used to make energy.



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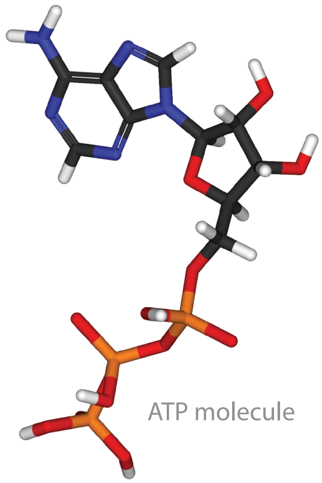
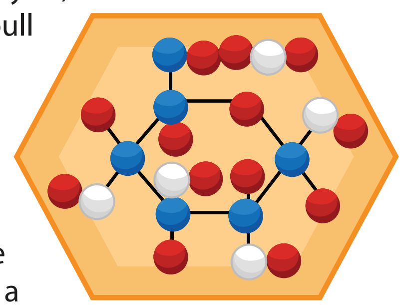
The oxygen that plants separate from water is released into the air. This is the oxygen we breathe. The electron that came from water is "excited," meaning it contains extra energy. The extra energy came from the sunlight. The electron then moves through a chain of many different molecules (called an 'Electron Transport Chain'). It jumps from one molecule to another and makes ATP along the way. ATP, or adenosine triphosphate, is a form of chemical energy used by many plants and animals.



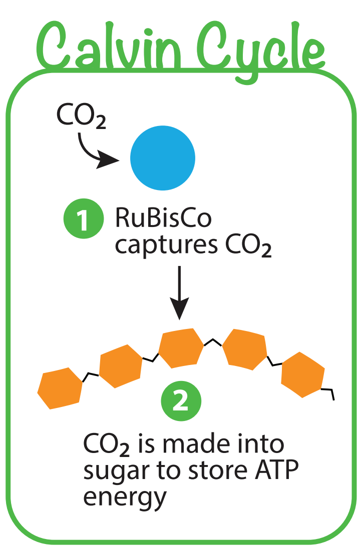
ATP molecule

Up until this point, we've been covering the light-dependent reactions of photosynthesis. But there is an entirely different part of photosynthesis that is just as important. In the second step of photosynthesis, called the Calvin Cycle, chemical energy (ATP) is used to pull carbon dioxide out of the air. Eventually, this carbon is turned into sugar (glucose), which the plant can store to use later. A single stored glucose molecule can later be converted into a huge amount of ATP (~30 molecules) in a process called cellular respiration.

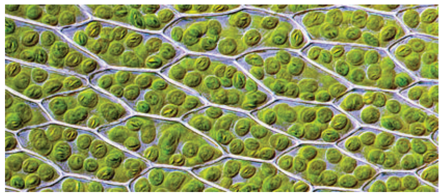


Plants convert carbon dioxide from the air into glucose molecules.

Let's take a closer look at the Calvin Cycle. Chlorophyll used energy from sunlight to split water and make ATP. But ATP is not very easy to store and holds little energy for the plant. In the Calvin Cycle, carbon dioxide is captured from the air by an enzyme called RuBisCo. The carbon dioxide is made into glucose, which holds a lot of energy. The process of changing carbon dioxide into glucose is called the Calvin Cycle. How is ATP used in this process?



RuBisCo is the most common enzyme on Earth, which should tell you it's pretty important. In the Calvin Cycle, RuBisCo combines carbon dioxide (CO_2) with other molecules in the chloroplast. This creates sugars. The problem is that the other molecules get used up in the process. Using the leftover pieces, along with ATP from the light reactions, a series of chemical reactions makes new molecules to combine with CO_2. This is why it's called the Calvin Cycle; molecules are made using ATP and then destroyed over and over again each time CO_2 is made into a sugar.



Close-up view of plant cells showing chloroplasts in bright green. The Calvin Cycle takes place in the chloroplasts.

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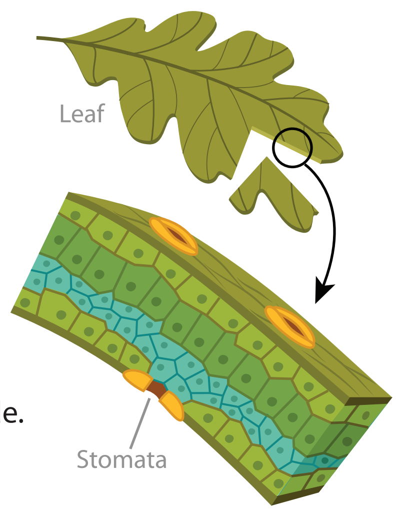
Almost all plants have leaves. Most of these leaves are filled with cells containing chloroplasts. Leaves are wide and flat so they can capture lots of sunlight. They are also covered with tiny holes, called stomata, that can only be seen with a microscope. These holes lead into the inside of the leaf. This is how the CO_2 used in the Calvin Cycle enters the leaves so sugar can be made. Unfortunately, water can also be lost through these pores.



Close up leaf cross-section

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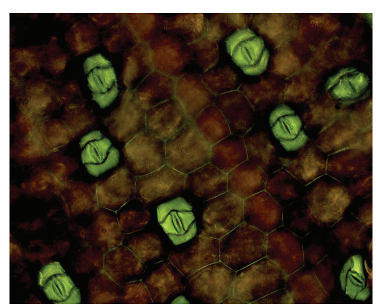
If you've left a glass of water out for a few days, you know it eventually evaporates. Inside leaves, water also turns to gas and escapes. If too much water is lost, leaf cells dry out and die. So plants have evolved stomata, which can close to prevent water loss. Most plants close stomata at night. Because there is no sunlight overnight, the plants don't need CO_2. Stomata each have two "guard cells," which are filled or emptied of water (like a balloon) to open or close the stomatal hole.



Close up view of a plant showing bright green stomata surrounded by dark plant cells.

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Grasses use a kind photosynthesis that differs from what most other plants use.

The photosynthesis we've talked about so far is called C3. But plants have evolved other kinds of photosynthesis to help conserve water. One is called C4 and is used by grasses. In C4 photosynthesis, there is one extra step. Carbon dioxide is captured first by an enzyme (PEP carboxylase), which moves the CO_2 inside of the leaf cells. The CO_2 is then used in the normal Calvin Cycle. Because this process of getting carbon is more efficient, it reduces water loss.

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The hot and dry desert is a challenging place for plants to survive. Many desert plants use a special kind of photosynthesis, called CAM, that helps save water. All cacti use CAM. In CAM, plants only open their stomata at night. During the night, they get carbon dioxide from the air and store it in chemical compounds. During the day when it is very hot and dry, the plants close their stomata, so water can't be lost. They use the stored CO_2 compounds to make sugar in the normal Calvin Cycle.

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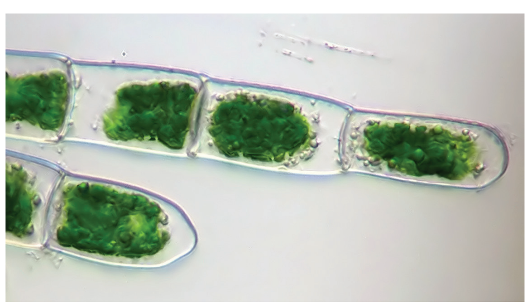
Plants are pros at making their own food using sunlight. But they aren't the only organisms able to do this. Both cyanobacteria and algae use photosynthesis to make their own energy. Cyanobacteria are single-celled, blue-green bacteria that are found in most habitats, both on land and in water. Algae are also found in many habitats, but can be either single-celled (like bacteria) or multi-cellular.



Microscopic view of green algae.

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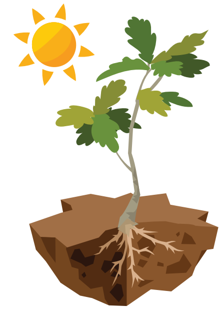

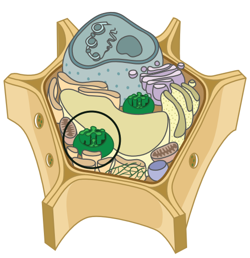

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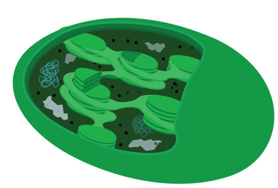

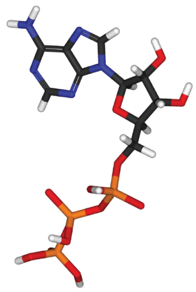

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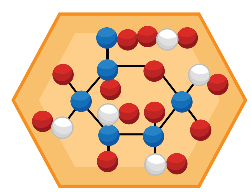

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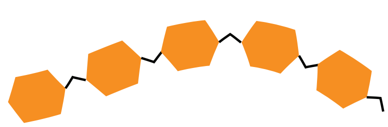

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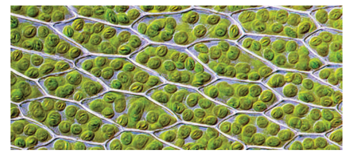

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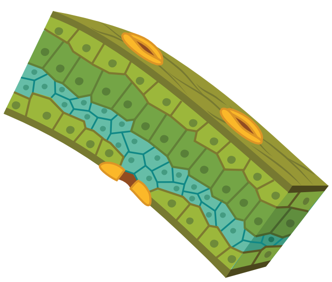

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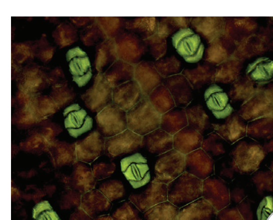

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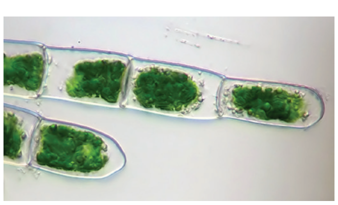

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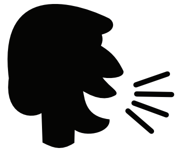

How do you say?

Photosynthesis – [fo-toe-**sin**-thuh-sis]
Capture – [**cap**-cher]
Carboxylase – [car-**box**-uh-layz]
Chloroplast – [**clore**-uh-plast]
Chlorophyll – [**clore**-uh-fill]
Enzyme – [**en**-zahym]
Evaporate – [ee-**vap**-oh-rate]
RuBisCo – [rew-**bis**-co]
Stomata – [**stow**-mah-tuh]
Thylakoids – [**thigh**-lah-coyds]

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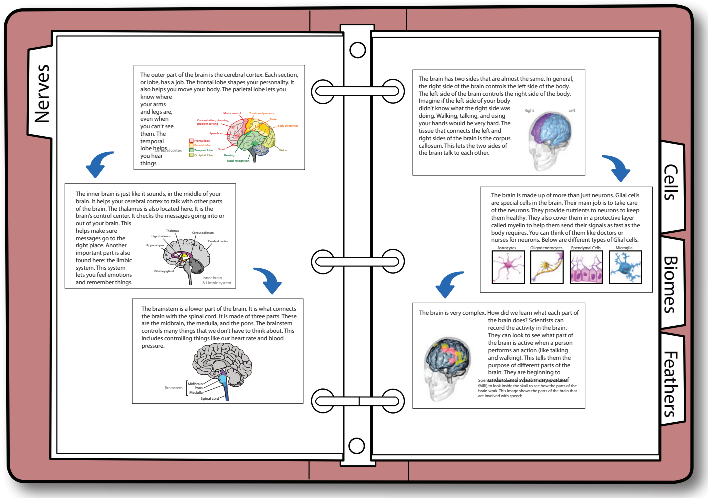
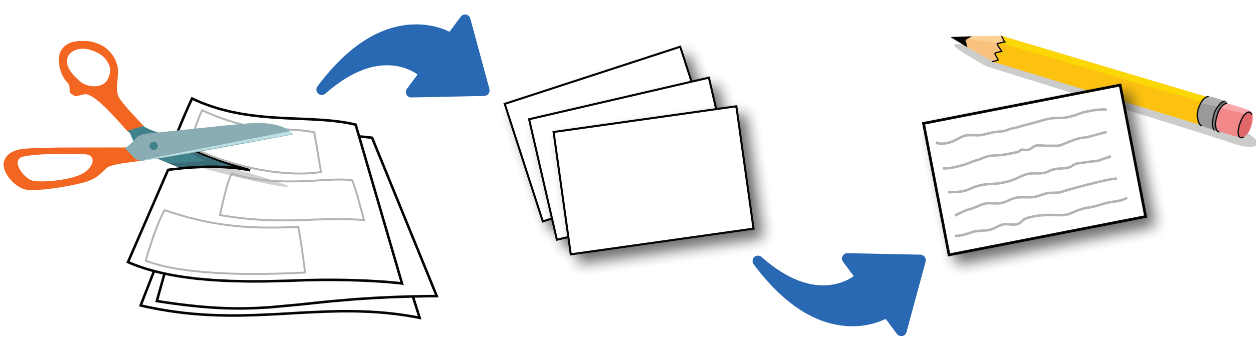


Instructions

Ready to begin? You can use these bits in many ways. You can print the pages and place them in a notebook for review. You can also cut each card out to re-organize them any way you want.

The empty cards can be used to write out what you learned in your own words, or to copy what's already written. Also included is a pronunciation guide, to help you learn how to say the more complicated words.



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