



Smithsonian


All About Photosynthesis

Table of Contents


Plant Power	4
Nature’s Green Recipe	6
The Stage-by-Stage Guide	12
Curious Case Studies	22
A Miraculous Process	26
STEAM Challenge	28
Glossary.	30
Index.	31
Career Advice	32

Plant Power

Earth is a safe and comfortable home for countless living things, including humans. There are many reasons why Earth is the only known planet that can host life. For instance, the world gets an ideal amount of light and warmth from the sun. There is also enough liquid water to sustain life across the globe. And Earth is home to organisms called *autotrophs*. There are many kinds of autotrophs, but the best-known are plants with green leaves. These organisms use a process called *photosynthesis* to make their own food. This process also ensures that Earth can support life.



Whether they grow in nature or in small pots inside, all plants perform photosynthesis.



Photosynthesis allows plants to sustain themselves as they transform from sprouts into fully grown plants.



Photosynthesis roughly translates from Greek to “putting together with light.” That’s because one crucial **reactant** of this process is sunlight. This chemical reaction has many complex steps. But it only requires a few key reactants—carbon dioxide, water, and sunlight—to work.

The process of photosynthesis creates two products: oxygen and **glucose**. Both are necessary for life on Earth. Oxygen allows humans and animals to breathe, while glucose provides energy for all living things. Without photosynthesis, life on Earth would not exist. Let’s break down how this process works and consider the power of plants on Earth.



Nature's Green Recipe

Just like humans, plants need food to survive. However, unlike humans, plants can't walk into a grocery store to buy ingredients for their next meal. They also can't eat a meal at a restaurant or order food for delivery. Instead, plants have to make food themselves.

Photosynthesis is a process that changes energy from the sun into chemical energy. Three **essential** reactants, or ingredients, are needed for plants to make their meals. Let's examine the recipe and how these ingredients are gathered.



Ingredient #1: Carbon Dioxide

Every day, humans breathe in a gas called *oxygen*. Then, they breathe out a gas called *carbon dioxide*. Humans must do this to stay alive. Just like humans, plants also need these gases to survive. But plants have different **respiratory** needs than humans. Plants take in carbon dioxide and let out oxygen.



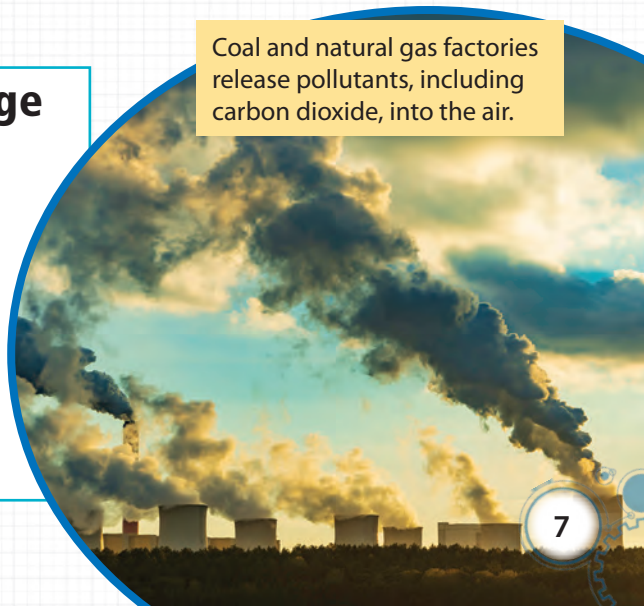
Carbon dioxide is the first ingredient in the photosynthesis recipe. It is a greenhouse gas that has quite a reputation! Most people know it as a heat-trapping gas. This gas exists in Earth's atmosphere, keeping the planet at a comfortable temperature for living things. Some natural events can lead to a release of carbon dioxide. For instance, this gas is released when a volcano erupts. But it is released when people **extract** or **burn** fossil fuels, too.

SCIENCE

Climate Change

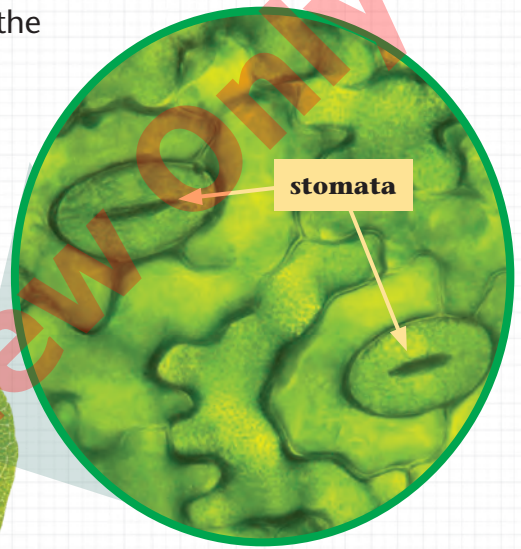
The amount of carbon dioxide in Earth's atmosphere is rapidly rising. This is leading to rising global temperatures. Higher temperatures can have negative effects on weather patterns and life on the planet.

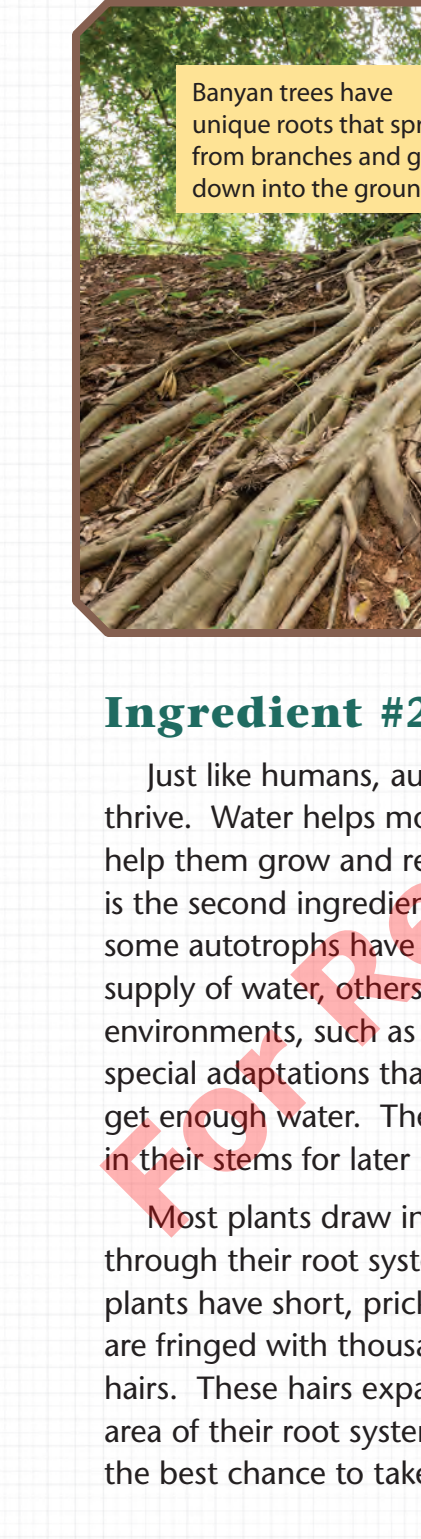
Coal and natural gas factories release pollutants, including carbon dioxide, into the air.



Autotrophs take in carbon dioxide through their stomata. Stomata are tiny pores that exist on different parts of a plant. Stomata are round and have holes in their centers, making them look like tiny bagels. Gases, including carbon dioxide, can move in or out of a plant through stomata.

Stomata are usually found on the bottom side of a plant's leaves. This location protects them from the intense glare of the sun or kicked-up dust. However, stomata can be found in other places, too. Depending on the plant, stomata can be found on the top side of leaves, flower petals, stems, or even on roots.






Banyan trees have unique roots that sprout from branches and grow down into the ground.

Ingredient #2: Water

Just like humans, autotrophs require water to survive and thrive. Water helps move **nutrients** throughout plants to help them grow and reproduce. This clear, odorless liquid is the second ingredient needed for photosynthesis. While some autotrophs have access to an endless supply of water, others do not. In certain environments, such as deserts, plants have special adaptations that allow them to get enough water. They may store it in their stems for later use.

Most plants draw in water through their root systems. Many plants have short, prickly roots that are fringed with thousands of little hairs. These hairs expand the surface area of their root systems, giving them the best chance to take in water.



Roots need adequate soil to grow.

STEAM CHALLENGE

Define the Problem

Agriculture, the science and practice of farming, is an important industry all around the world. Engineers design greenhouses so that farmers can grow different plants in controlled environments. Your task is to design and build a model greenhouse. Your greenhouse must allow sunlight to come through, include an entry point to water the plants inside, and have enough space to house three clay pots.



Constraints: You may only use the materials provided to you. You must meet the three conditions for plants to grow.



Criteria: Your model must open and close to allow for watering. It has to allow sunlight to come through the interior. Your greenhouse must fit three small clay pots inside.



CAREER ADVICE

from Smithsonian

Do you dream of working with plants?

**Here are some tips to keep in mind
for the future.**

"Get involved in local gardening clubs or start one at your school. There are many different disciplines of horticulture, such as plant propagation, greenhouse management, caring for specialized types of plants, and maintaining interior plant displays. Don't limit yourself to just one! Explore as much as you can!"

– Joe Curley, *Horticulturist, Smithsonian Gardens*

"I encourage you to learn more about one of Earth's most significant flowering plant families. For example, every orchid has a unique story that can inspire us to study its intricate relationships with other living things, from microscopic fungi to fluttery butterflies. Orchids are indicators of the health of an ecosystem. If orchids are thriving, it is a sign that our planet's ecosystems are also thriving."

– Justin Kondrat, *Horticulturist, Smithsonian Gardens*



Read and Respond

1. What is an autotroph, and how is it related to photosynthesis?
2. Why is sunlight important to photosynthesis?
3. Give one or two examples of how plants have adapted to their environments so they can complete photosynthesis.
4. How does the first stage of photosynthesis compare with the second stage?
5. What are the products of photosynthesis, and how are they used?
6. Do you agree or disagree that photosynthesis is a vital process for life on Earth? Explain why.

