

## Leaves: The inside story about how plants rule the world



### 1 Purpose and Content of Lesson:

We often refer to an industrial factory as a “plant.” This metaphor is explored to understand the key role played by green plants in Earth’s biosphere. Green plants are like industrial factories in several important and amazing ways:

- They make food from air, powered by the energy of sunlight.
- The by-product of this food making is oxygen, which supports the unique atmosphere that promotes life on Earth.
- Green plants’ cooling systems move water from the ground into the air, playing an essential role in maintaining the biosphere.

Leaves are the plant’s solar energy panels and food factory, and leaves play a key role in the global water cycle that produces rain. Plants modify their leaves to keep the factory operating efficiently. Leaves are renewable and compostable. Leaves come in three basic forms — scales, needles, and broad leaves \

#### Terms and definitions:

**biome:** a major region on Earth defined by its climate and plants; examples are tundra, taiga, deciduous forest, rainforest, savanna, desert, and more

**biosphere:** Earth’s life zone, the only place in the universe where life is known to exist

**carbon dioxide:** starting material for photosynthesis, present in air as a gas

**chlorophyll:** green pigment that captures energy from sunlight

**conifer:** trees that reproduce using cones, such as pine, spruce, fir, cedar, redwood, Sequoia

**cuticle:** waxy covering on leaves that preserves wetness in the leaf

**deciduous:** trees that shed their leaves in fall

**minerals:** nutrients that plants absorb through their roots; minerals are combined with sugar to make all the building blocks of the cell

**oxygen:** waste product of photosynthesis that is essential for life on earth; present in air as a gas

**phloem vessel:** tubes filled with dissolved sugars that distribute food where needed in the plant

**photosynthesis:** the process of making sugar from carbon dioxide and water, powered by sunlight

**pigment:** a colored chemical that responds to light

**stomata, guard cell:** The guard cells open and close the pores in the leaf, which are called stomata.

**sugar:** product of photosynthesis; starting material for all forms of food

**transpiration:** Water, taken up by roots, is transported to the leaves, and evaporates through the stomata into the air. Transpiration is a key element in the global water cycle.

**xylem vessel:** tubes that transport water from roots to leaves

### 2 Next Generation Science Standards (NGSS):

<http://www.nextgenscience.org/search-standards>

#### Disciplinary Core Ideas

##### PS3.D: Energy in Chemical Processes and Everyday Life

The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (Grade 5-PS3-1)

##### LS2.A: Interdependent Relationships in Ecosystems

The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria,

break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (Grade 5-LS2-1)

### LS1.C: Organization for Matter and Energy Flow in Organisms

Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (Middle School-LS1-6)

Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (Middle School-LS1-7)

### PS3.D: Energy in Chemical Processes and Everyday Life

The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (Middle School-LS1-6)

Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (Middle School-LS1-7)

## 3 Common Misconceptions About Leaves

Students have a hard time recognizing the wide diversity of leaf forms as being actual leaves, and they may not recognize that needles and grass are leaves. They also have a hard time believing that leaves make food, and they get confused with all that happens in photosynthesis, even though they can use the term. Elementary students do not know chemical symbols, so most lessons on photosynthesis with chemical symbols and formulas are best taught with students in grades 5 and up. Younger students learn that energy from sunlight is used to make sugar in leaves, but the complexity and the enormity of the importance of what leaves do is neither appreciated nor understood. As for **transpiration**, this process is most difficult to observe; therefore, it is difficult for young children to fully grasp. The two labs included in this lesson seek to make this process visible to students. Working with the Tower Garden can illustrate transpiration. As plants grow, and if temperatures gets warmer, more water is needed to keep the reservoir filled. *Where did all those gallons of water go?*

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## Lesson Objective:

Learners will be able to state three major contributions of leaves to life on Earth: **1)** to make food for organisms on Earth, **2)** to send oxygen into the air for organisms to breathe, and **3)** to take ground water from roots and stems and send it out of leaf stomata as vapor (transpiration) that will produce clouds, then rain, hence, recycling water on the planet (water cycle).

Learners will be able to explain, in writing, what occurs during the process of photosynthesis, transpiration, and the significance of each process to life on Earth given a list of key vocabulary terms.

Learners will conduct research from a list of questions about leaves for a science presentation.

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## Lesson Procedure— THE LEARNING CYCLE: The Five Es

### ENGAGE

#### Key questions:

*Why do plants need leaves?* List all the possibilities.

*Why do WE need leaves of plants?* List all ideas.

After exploring student ideas and uncovering and dispelling misconceptions, list correct conceptions.

Plants need leaves for food and we need leaves for food and oxygen.

Additionally, leaves that fall from trees decompose (rot) and become part of the soil. Fallen leaves recycle their nutrients, become homes for animals, serve as ground cover for new shoots and adult plants, provide cooling shade for animals and plants, offer hiding places to keep animals safe, provide beauty in nature, and more.

#### Let's Investigate: *What is a leaf?*

Provide each group of three or four students with a tray of plant samples highlighting leaves and other plant parts that have been collected.

Ask students to classify the sampling of plant parts into two groups: Leaves and Not Leaves. Students can present their criteria for classification. Conclude with the common characteristics of leaves: thin, pigmented, attached to a stem, waxy outer covering, wet inside, mostly green, for example.

Include as many different leaves and leaf-like examples as possible, such as compound leaves (such as hickory, locust, horse chestnut, etc.), simple leaves (such as oak, maple, dogwood), leaves of grass, non-green leaves (such as from a copper beech), green bean, head of lettuce, broccoli, head of cabbage, pine needles, asparagus, celery, needles of blue spruce or Atlas cedar, scales of arbor vitae, holly leaf, cactus, green pine cone, fern, and moss.

### Other questions to explore:

**1. How are the common visible characteristics of a leaf (thin, pigmented, wet inside, waxy covering, attached to a stem or branch, mostly green) related to its role as solar panel, food factory, and cooling system?**

The thinness allows sunlight to pass through to lower leaves. The solar panel requires a pigment to capture light energy. The wetness dissolves carbon dioxide so it can leave the air and enter the factory. The wetness is also a key element in the cooling system; when water evaporates through the stomata, it keeps the leaf from getting too hot in the sun. This process is also a key step in the global water cycle: plants transport water from the soil to the atmosphere. Waxy covering prevents the leaf from drying out. The leaf would die if it got too dry. The stem or branch connects the leaf with the roots to receive water and minerals and to send food into the roots for storage and up the stem for new growth.

**2. What's going on inside the leaf that makes it like a factory?** Photosynthesis involves making food and releasing oxygen; leaves also release water into the atmosphere through transpiration.

**3. Why is this factory important to all of life?** Plants are the foundation of the food web, the source of oxygen, and provide moisture to form clouds.

**4. Why are most leaves green? (chlorophyll) Why are some leaves other colors?** Other pigments show up when there is less chlorophyll, as in autumn.

**5. What is going on when leaves turn colors and drop off plants in the winter?** Chlorophyll degrades under conditions of less light and cool temperatures. The tree absorbs most of the nutrients in the leaf, closes off the vessels to the stem, and discards the leaf, which falls to the ground. Its remaining nutrients are recycled into the soil as it decays, and roots can absorb the minerals, thus completing the cycle.

**6. How are evergreen leaves different from leaves that fall off every year?** These leaves are tougher, made to last longer, and not disposable like the thin leaves of deciduous trees.

**7. How do leaves help their plants adapt to Earth's different biomes?** Their many forms are adapted to different climates. Detailed explanations will be developed by the student groups.

## EXPLAIN

### All about Photosynthesis

*The process of photosynthesis is essential to life on Earth.*

Project the video, which has a simple yet correct explanation: [http://www.harcourtschool.com/activity/science\\_up\\_close/311/deploy/interface.swf](http://www.harcourtschool.com/activity/science_up_close/311/deploy/interface.swf)

Leaves use light energy to make sugar, the building block for all other food. This process is called **photosynthesis**—**photo** means “light” and **synthesis** means “to combine” or “to make.”

**Chlorophyll** is a green pigment that captures light energy and uses it to power the food factory.

The factory takes in **carbon dioxide** gas from air and combines it with water to make sugar, a carbo-hydrate (means carbon+water). **Oxygen** is a waste product and is released back into the air.

If students know that water is H<sub>2</sub>O and carbon dioxide is CO<sub>2</sub>, they can follow the chemistry here:

*How can you convert CO<sub>2</sub> to CH<sub>2</sub>O?* Answer, add 2Hs and remove one O

*Where can you get the Hs?* From H<sub>2</sub>O, break it apart

*What's left over?* Oxygen

*What does it take to break apart H<sub>2</sub>O?* Energy

*Where does energy come from?* Captured from sunlight

*What captures it?* Chlorophyll

*Does this make sugar?* Yes, repeat it 6 times. C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>  
Sugar can combine with minerals to make proteins, fat, and food!

### Or photosynthesis can be explained as a story:

**Carbon dioxide** is floating in the air. It wanders into a leaf when the guard cells open a stoma. The inside of the leaf is wet (feel it yourself). Carbon dioxide dissolves into the water. Meanwhile, **Chlorophyll** has captured a photon, which is a packet of light energy. Chlorophyll passes the energy to **Enzyme** who wrangles **Water**, pulling it into two pieces called **Oxygen** and **Hydrogen**. Carbon dioxide is happy to hook up with Hydrogen, which leaves Oxygen all alone. So Oxygen pops out of the wet leaf and takes off into the air. When this happens six times, it makes one **Sugar**. (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>)

### Leaves in a global context:

**Discuss this:** Both the product and the by-product from photosynthesis are essential to the continuation of life on Earth. Sugar is the basic material for building the plant body, which is the foundation for the food web. Oxygen, the waste product of photosynthesis, is essential for life as we know it.

### OPTIONAL

For learners who understand chemical formulas, summarize with the equations that unify the processes of photosynthesis and cellular respiration. C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> is the chemical formula for the sugar made by photosynthesis.



In words, this is the two-way process that has two names: photosynthesis goes to the right, and cellular respiration goes to the left.

**carbon dioxide + water** <---is converted into---> **glucose (sugar) + oxygen**

## EXPLORE

### LABS TO TEST GAS EXCHANGE IN LEAVES

#### Lab I. STOMATA<sup>1</sup>

**Key Question:** *Where does the gas exchange happen most on a leaf — the top, bottom, or throughout?*

#### Materials needed:

- Test plant that has small, sturdy leaves, such as a jade plant, begonia or geranium (basil or tatsoi growing in the Tower Garden®)
- Binocular microscope or hand lens
- Petroleum jelly such as Vaseline
- Science notebook

**Procedure:** Each student examines a healthy leaf from the test plant and predicts whether gases enter and exit the leaf through the upper, the lower, or both surfaces of the leaf. Each student writes a hypothesis and a reason in a science notebook. The hypothesis is an educated guess, based on the observations they made. Explain to students that coating a leaf surface with a thick layer of Vaseline could obstruct the passage of gases.

**Say to class:** “Predict what would happen to the leaf, according to your hypothesis, if the leaf is coated with Vaseline on the top surface, on the bottom surface, or on both sides. Write predictions in your science notebook for each instance with reasons.”

Students set up the experiment using the test plant with three or four leaves of each category (top, bottom, both), being careful not to get Vaseline on the uncoated surface. Have them observe the leaves throughout the week and write observations in notebooks.

One week later:

Based on the results, which of the hypotheses is supported? Students compile results and represent data in a chart to determine the conclusion and/or if further experimentation is needed.

*What did we learn about where most stomata are on a leaf?*

It is hoped that the results will teach the following: The underside of leaves have more stomata than the upper side because less transpiration will take place in the cooler, shady underside of the leaf, and leaves must minimize water loss, but there are stomata on both sides of the leaf.

Here is a link to a short video with good microscopy.  
<https://www.youtube.com/watch?v=cFX4JrsPaUs>

#### Lab II: TESTING FOR TRANSPIRATION

Transpiration is vital to life on Earth. It is the process of moving water from the soil into the roots, up the stem, and out of the leaf into the air.

**Key question:** *How do we know leaves transpire?*

Read the USGS website Evapotranspiration — The Water Cycle and place a plastic bag around part of a potted plant as shown in the photo. <http://water.usgs.gov/edu/watercycleevapotranspiration.html>

*If this plant is transpiring, what do you expect to see in the bag? (droplets)*

Students record observations in their science notebook each day. After a week, they discuss their observations and write up conclusions.

*What additional questions could be tested to better understand transpiration? (effects of temperature, differing amounts of water, differing amounts of light, for example.)*

<sup>1</sup>[http://www.all-science-fair-projects.com/science\\_fair\\_projects/102/875/c801868849883b66115427e6546782dc.html](http://www.all-science-fair-projects.com/science_fair_projects/102/875/c801868849883b66115427e6546782dc.html)

## EXPLAIN

For the leaf, transpiration produces a water-based cooling system, so leaves do not get overheated in the sun. When the water evaporates through the stomata of the leaf, it cools the leaf, like sweat evaporating from your skin. This keeps photosynthesis operating efficiently.

Transpiration from a lot of plants, as in a rain forest, produces enough moisture to form clouds, which release their water as rain. This system creates a local water cycle, as the same water is recycled from the air to the soil and back.

*What would happen to the water cycle if the trees in the forest were removed?*

*How might this change the region's climate?* (Possible answers: The water cycle would be disrupted so the air would be drier and clouds would be less likely to form; there would be less rain. Seeds of trees might not have enough water to regrow the forest.)

*Explain how transpiration works in the Tower Garden®.* (Water from the reservoir enters the roots and is released through the leaves.)

*Is there a local water cycle?* (No, the water from the reservoir has to be replenished by us!)

## EXPAND

**Project-Based Learning.** Form groups consisting of three or four students. Each group selects a topic for research to present in a poster presentation or PowerPoint slideshow, a Glogster.com poster, a digital story, or movie at a Science Family Night or an in-school science event. Students will be able to teach others about the importance of plants, and, more specifically, leaves.

### List of topics for research

1. *How does water rise up a tall tree against the pull of gravity?* Explain how transpiration works (examining forces of cohesion, adhesion, capillary action, and more) and why transpiration is part of the water cycle.
2. *What causes leaves of deciduous trees to change color and fall off each year?* Explain the process.
3. **Evergreen trees are the dominant trees in the taiga region of Earth. Describe the climate of the taiga and explain how the leaves of evergreen trees are adapted for this climate.**
4. **Transpiration is a hazard in dry climates like the desert. Some cactuses have no leaves. Explain how plants without leaves undergo photosynthesis and how they avoid drying up. Does cactus have a stem with xylem vessels? How is water transported in a cactus?**
5. *What is the climate of the tundra biome? How are the plant parts (including leaves) and growing cycles adapted to cope with this climate?*
6. **Grass plants are plentiful all over the planet. How are they able to survive in the savanna, the Great Plains, and a front lawn in spite of heat, drought, flooding, mowing, predation, and disease? What are some of their adaptations to various climate zones and extremes?**

### Project process:

- 1) Each student researches the complete topic and submits a written report with citations and images. The group meets to discuss individual findings.
- 2) The group chooses images and text from the four reports for the poster.
- 3) The group prepares a trifold poster (or other selected mode of visual representation) to showcase at a science event. All must participate equally.

<sup>2</sup><http://water.usgs.gov/edu/watercycleevapotranspiration.html>

## EVALUATE

**Put needed vocabulary on the board without any definitions.**

1. **Ask the students to write the process of photosynthesis using at least five of the vocabulary words.**
2. **Ask the students to write the process of transpiration using at least three of the vocabulary words.**
3. **Explain how the process of photosynthesis is essential to the continuation of life on Earth in two important ways.** (Foundation of the food web, source of oxygen.)
4. **Explain how the process of transpiration is essential to the continuation of life on Earth in two important ways.** (Allows plants to control leaf temperature, creates moisture in the air to form clouds.)

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### Web Resources

**Web Resources for research:**

- <http://water.usgs.gov/edu/watercycletranspiration.html>
- <http://www.eschooltoday.com/water-cycle/what-is-transpiration-and-evapotranspiration.html>
- <http://www.na.fs.fed.us/fhp/pubs/leaves/leaves.shtm>
- <http://www.mbgnet.net/bioplants/adapt.html>
- <http://www.cotf.edu/ete/modules/mse/earthsystflr/biomes.html>
- <http://photosynthesiseducation.com/photosynthesis-for-kids/>

Video: [http://www.harcourtschool.com/activity/science\\_up\\_close/311/deploy/interface.swf](http://www.harcourtschool.com/activity/science_up_close/311/deploy/interface.swf)

## 7

### Additional Applications

(Homework? Classwork? Group work? Further research and reading)

<http://inhabitat.com/scientists-discover-methods-of-harvesting-electricity-from-plants/>

<http://inhabitat.com/mit-scientists-create-artificial-solar-leaf-that-can-power-homes/>

## 8

### Appendices

(Powerpoint Slides)

# Leaves

## The Inside Story of How Plants Rule the World



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# The Function of Leaves

Leaves are the plant's solar energy panels and food factory. They play a key role in the global water cycle.



## Why is a **factory** often called a “**plant**?”

Green plants are like industrial “plants” in several important and amazing ways:

- They **make food** from air powered by the energy of sunlight.
- The by-product of this food-making is **oxygen**, which supports the unique atmosphere that promotes life on Earth.
- Green plants' cooling system **moves water** from the ground into the air, playing an essential role in maintaining the biosphere.



# Leaves: Terms and Definitions

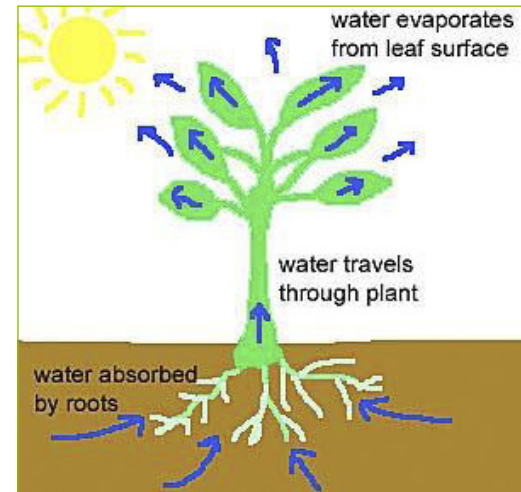
- **biosphere** – Earth’s life zone, the only place in the universe where life is known to exist
- **biome** – a major region on Earth defined by its climate and plants; examples are: tundra, taiga, deciduous forest, rain forest, savanna, desert, and more...
- **conifer** – trees that reproduce using cones, such as pine, spruce, fir, cedar, redwood
- **deciduous** – trees that shed their leaves in fall
- **photosynthesis** – the process of making sugar from carbon dioxide and water powered by sunlight
- **stomata, guard cell** – The guard cells open and close the pores in the leaf which are called stomata.
- **carbon dioxide** – starting material for photosynthesis; present in air as a gas
- **oxygen** – waste product of photosynthesis that is essential for life on earth; present in air as a gas
- **sugar** – product of photosynthesis; starting material for all forms of food
- **chlorophyll** – green pigment that captures energy from sunlight
- **pigment** – a colored chemical that responds to light





# Leaves: Terms and Definitions

- **transpiration** – Water is taken up by roots, is transported to the leaves, and evaporates through the stomata into the air. Transpiration is vital to the global water cycle.
- **cuticle** – waxy covering on leaves that preserves moisture in the leaf
- **xylem vessel**– tubes that transport water from roots to leaves
- **phloem vessel** – tubes filled with dissolved sugars that distribute food where needed in the plant
- **minerals** – nutrients that plants absorb through their roots Minerals, dissolved in water, are combined with sugar, made in leaves, to make all the building blocks of the cell.





# The Function of Leaves

**Why do plants need leaves?**

**Why do we need leaves?**

“I can live without leaves.  
I’m not a rabbit.”

**Do you agree?**





# The Function of Leaves

## What's going on inside a leaf that makes it like a factory?

- Leaves use light energy to make sugar, the building block for all other food.
- Chlorophyll, a green pigment, captures light energy to power the food factory.
- Photosynthesis combines carbon dioxide and water to make sugar.

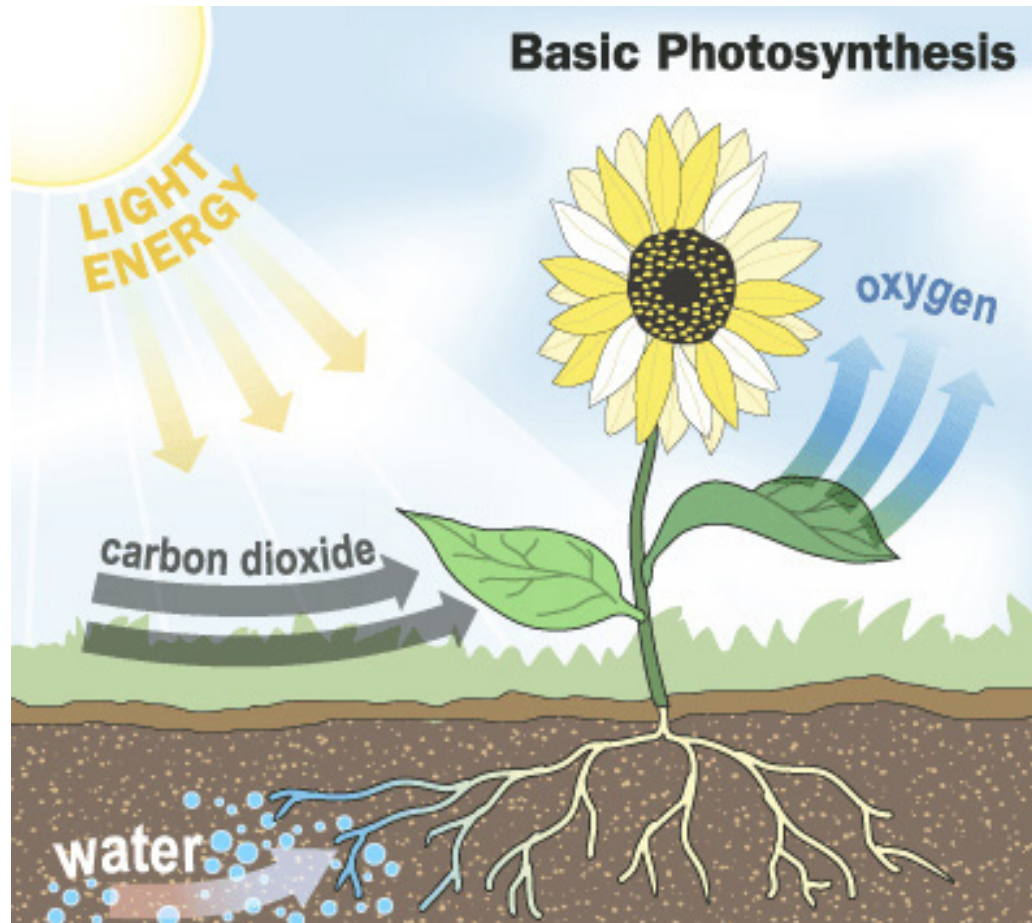
(Photosynthesis: *Photo-* means light; *synthesis* means “to combine.”)

- Oxygen, a waste product, is released into the air.
- (Photosynthesis video)





# The Function of Leaves





# The Function of Leaves

## Photosynthesis with chemical symbols:

- How can you convert  $\text{CO}_2$  to  $\text{CH}_2\text{O}$ ? .....► Add two Hs; take away one O
- Where can you get two Hs? .....► From  $\text{H}_2\text{O}$ .
- What's left over? .....► O
- What does it take to break apart  $\text{H}_2\text{O}$ ? .....► Energy
- Where does energy come from? .....► Captured from sunlight
- What captures it? .....► Chlorophyll
- Does this make sugar? Yes (repeat six times)•►  $\text{C}_6\text{H}_{12}\text{O}_6$
- Sugar can be combined with minerals to make proteins, fat, and food!



# The Function of Leaves

## Photosynthesis explained as a story:

**Carbon Dioxide** is floating in the air.

It wanders into a leaf when the guard cells open a stoma. The inside of the leaf is wet, and **Carbon Dioxide** dissolves into the water.

Meanwhile, **Chlorophyll** has captured a photon, a packet of solar energy. **Chlorophyll** passes the energy to **Enzyme** who wrangles **Water**, pulling it into two pieces, **Oxygen** and **Hydrogen**.

**Carbon Dioxide** is happy to hook up with **Hydrogen**, which leaves **Oxygen** all alone. So **Oxygen** pops out of the wet leaf and takes off into the air.

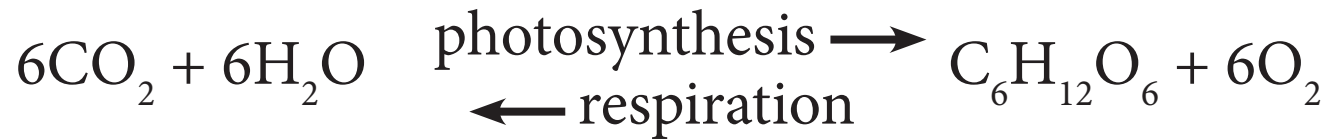
When this happens six times, you get **Sugar**.

SWEET!



# The Function of Leaves

**For those who like chemistry:**



carbon dioxide + water <-----> sugar + oxygen



# The Function of Leaves

## A very important concept:

Both the sugar and the oxygen from photosynthesis are essential to the continuation of life on Earth.

Explain why this is so.



“Mmm!  
A yummy looking  
package of stored energy  
from the sun.”

“The glucose this plant  
made from sunlight, carbon  
dioxide and water will sure  
come in handy.”







# The Function of Leaves

## Where does the gas exchange happen on a leaf?

Examine a healthy leaf from the test plant using a magnifier.

- 1 Predict whether gases enter and leave the leaf through the upper, the lower, or both surfaces of the leaf.
- 2 Write a hypothesis, with a reason, in your science notebook. The hypothesis is an educated guess, based on your observations.
- 3 What would happen to the leaf if it were to be coated with Vaseline?
  - on the top surface?
  - on the bottom surface?
  - on both sides?
- 4 Write 3 predictions.



# The Function of Leaves

## Set up the experiment on a test plant.

- 1 Coat the tops of 3 or 4 leaves with Vaseline.
- 2 Coat the bottom of 3 or 4 different leaves.
- 3 Coat the tops and bottoms of 3 or 4 other leaves.
- 4 *Be careful not to get Vaseline on the uncoated surface.*
- 5 Observe the leaves throughout the week and write observations in your notebook.



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# The Function of Leaves

## One week later:

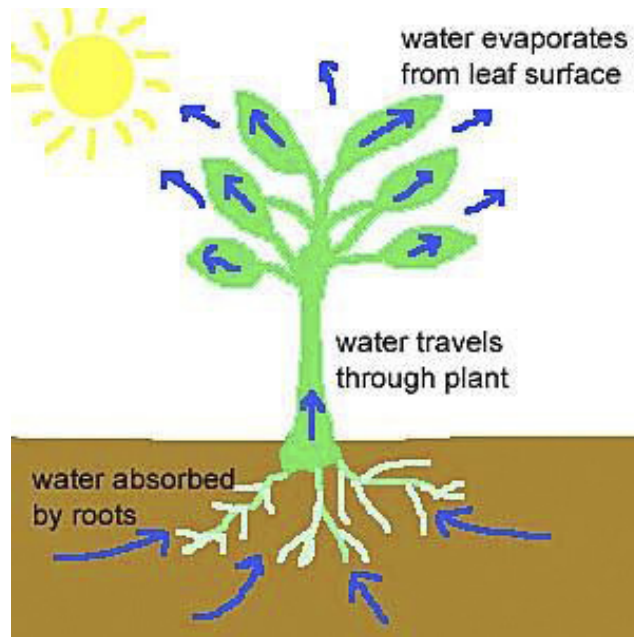
- 1 Based on the results which of the hypotheses is supported?
- 2 Compile the results and represent data in a chart to determine the conclusion, or if more experimentation is needed.
- 3 What did we learn about where most stomata are on a leaf?
- 4 Here is a link to a short video with good microscopy. (VIDEO)



# The Function of Leaves

## What is transpiration?

Transpiration is the process of moving water  
from the soil  
into roots,  
up the plant,  
out of the leaf  
into the air.





# The Function of Leaves

## How do we know leaves transpire?

- 1 Set up an experiment to look for evidence of transpiration.
- 2 Place a plastic bag around part of a plant as shown.

**If this plant is transpiring, what do you expect to see in the bag?**

- 3 Record observations in your notebook each day.
- 4 After a week, discuss your observations and write up conclusions.
- 5 What additional questions could be tested to better understand transpiration?

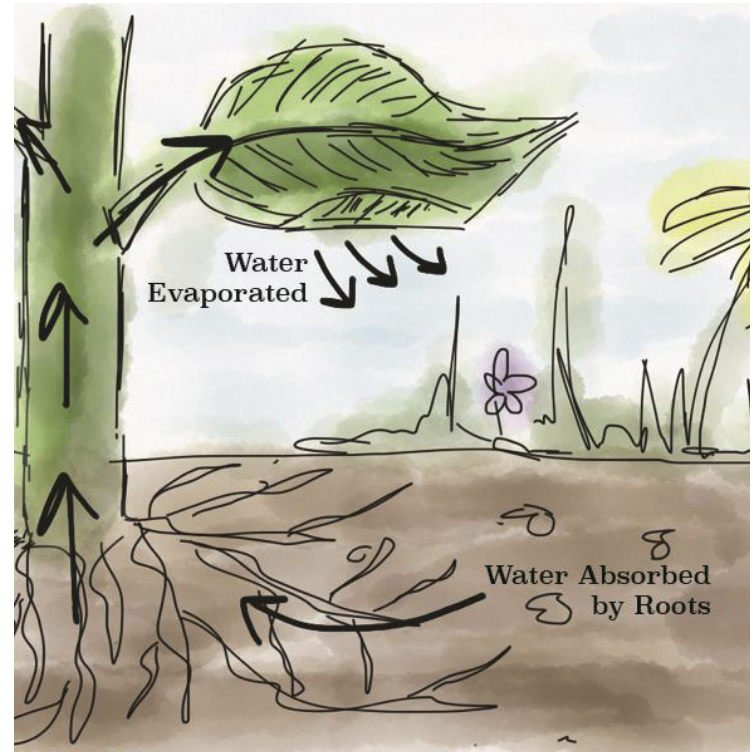




# The Function of Leaves

## Transpiration cools.

- 1 Transpiration produces a water-based cooling system, so leaves don't get overheated in the sun.
- 2 When the water evaporates through the stomata of the leaf, it cools the leaf, like sweat evaporating from your skin.





# The Function of Leaves

## Transpiration makes clouds and clouds make rain.

Transpiration from rainforest leaves produces enough moisture to form clouds, which release their water as rain.



This creates a local water cycle as water is recycled from the air to the soil and back.

- 1 What would happen to the local water cycle if the trees in the forest were removed?
- 2 How might this change the region's climate?



# The Function of Leaves

## Tower Garden considerations:

Explain how transpiration works in the Tower Garden.

- 1 Is there a local water cycle? Explain.
- 2 Look carefully at this photo of wilted plants. What might have happened to cause this phenomenon?





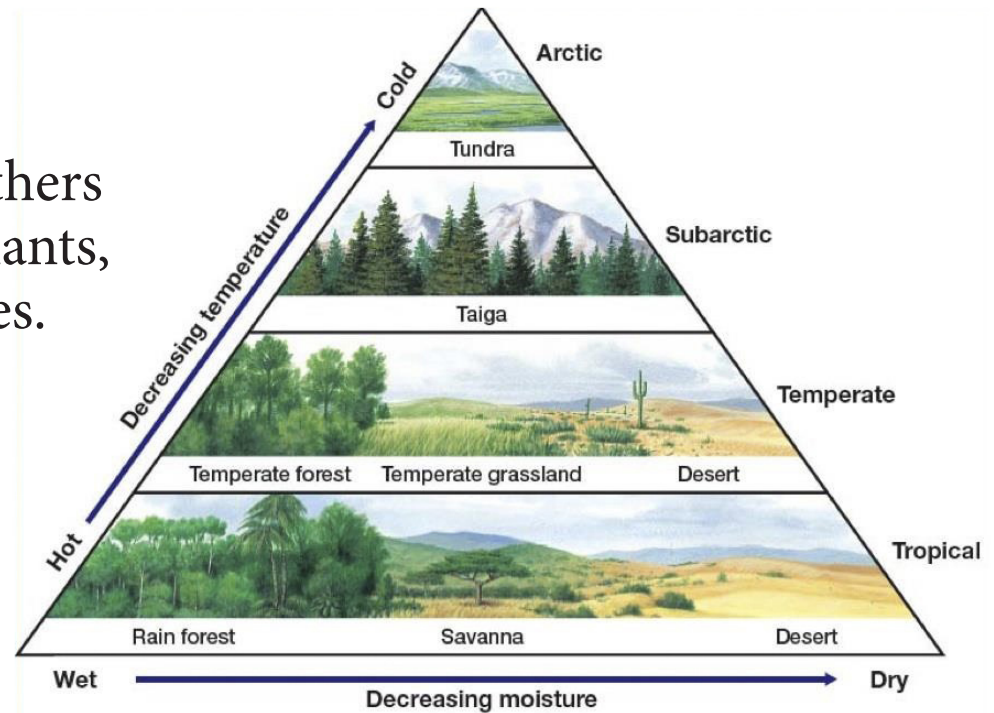


# The Function of Leaves

## How does climate affect leaves?

Work in groups to select a topic for research.

You will be able to teach others about the importance of plants, and more specifically, leaves.





# Leaves: Topics for Research

- 1** How does water rise up a tall tree against the pull of gravity? Explain how transpiration works (examining forces of cohesion, adhesion, capillary action and more), and why transpiration is part of the water cycle.
- 2** What causes leaves of deciduous trees to change color and fall off each year? Explain the process.
- 3** Evergreen trees are the dominant trees in the Taiga region of Earth. Describe the climate of the Taiga, and explain how the leaves of evergreen trees are adapted for this climate.
- 4** Transpiration is a hazard in dry climates like the desert. Some cactus have no leaves. Explain how plants without leaves do photosynthesis, and how they avoid drying up. Does cactus have a stem with xylem vessels? How is water transported in a cactus?
- 5** What is the climate in the tundra biome? How are the plant parts (including leaves) and growing cycles adapted to cope with this climate?
- 6** Grass plants are plentiful all over the planet. How are they able to survive in the Savanna, the Great Plains, and a front lawn in spite of heat, drought, flooding, mowing, predation, and disease? What are some of their adaptations to various climate zones and extremes?



# Leaves: Web Resources for Research

- transpiration
- transpiration and evapotranspiration
- leaves
- adaptations
- biomes



# Leaves: Project Process

- 1 Each student researches the complete topic and submits a written report with citations and images. The group meets to discuss individual findings.
- 2 The group chooses images and text from the individual reports for the presentation.
- 3 Together, group members prepare a trifold poster (or other selected mode of visual representation) to showcase at a science event.
- 4 Make sure everyone in the group is an equal participant.





# Leaves: Project Completion

## Evaluating what you've learned about leaves:

Use science terms written on the board to explain what you know about each question below.

- 1 Write the process of **photosynthesis** using at least five of the vocabulary words.
- 2 Write the process of **transpiration** using at least three of the vocabulary words.
- 3 Explain how the process of **photosynthesis** is essential to the continuation of life on Earth in two important ways.
- 4 Explain how the process of **transpiration** is essential to the continuation of life on Earth in two important ways.