LEAVES

The Inside Story of How Plants Rule the World

Leaves are the plant's solar energy panels and food factory.

They play a key role in the global water cycle.

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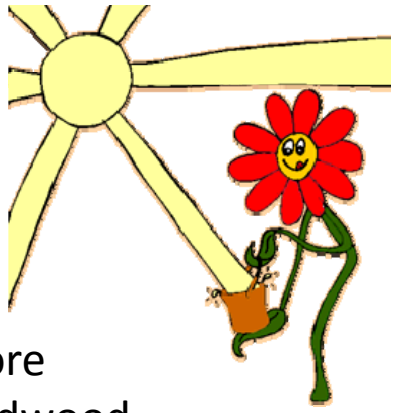
Why is a factory often called a *plant*?

Green plants are like industrial "***plants"*** in several important and amazing ways:

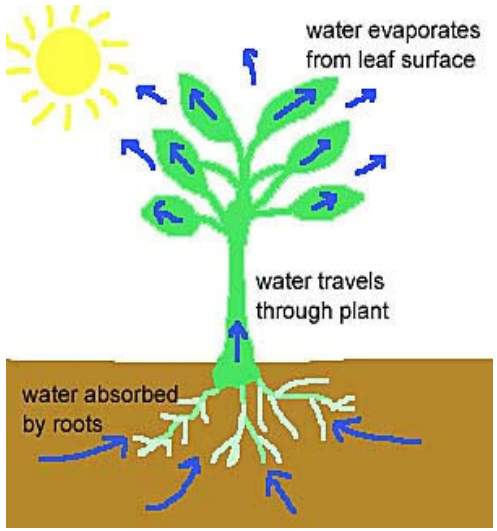
- They **make food** from air powered by the energy of sunlight.
- The by-product of this food-making is **oxygen**, which supports the unique atmosphere that promotes life on Earth.
- Green plants' cooling systems **move water** from the ground into the air, playing an essential role in maintaining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

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: tundra, taiga, deciduous forest, rainforest, 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

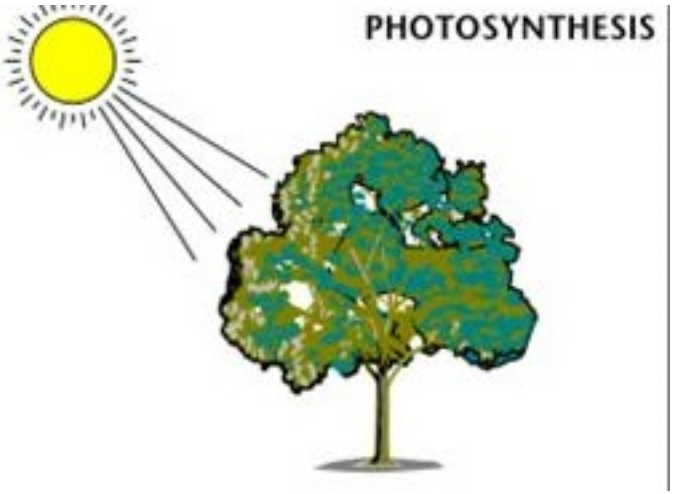
More terms and definitions



- **transpiration:** Water is taken up by roots, 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

Leaves

- Why do plants need leaves?
- Why do WE need leaves of plants?

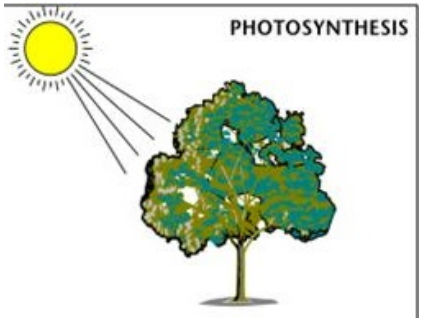


"I can live without leaves.

I'm not a rabbit."

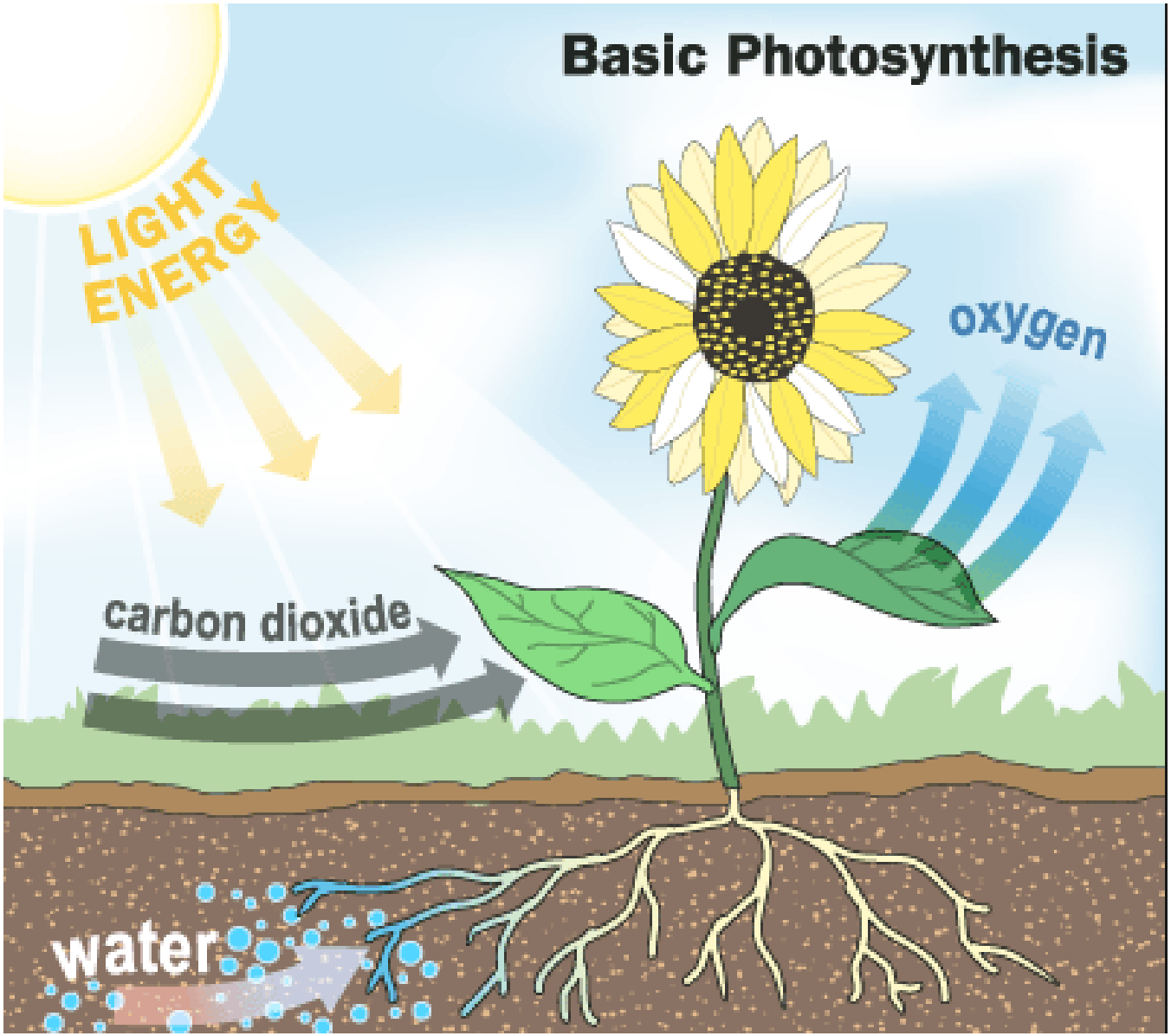
Do you agree?

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

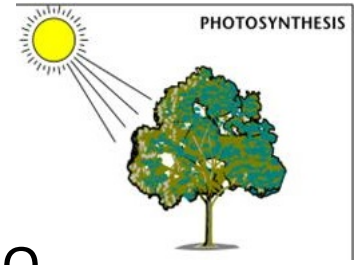


- Leaves use light energy to make sugar, the building block for all other food.
- Chlorophyll, a green pigment, captures light energy to power the food factory.
- Photosynthesis: *Photo* means light; *synthesi*s means "to combine."
- Photosynthesis combines carbon dioxide and water to make sugar.
- Oxygen, a waste product, is released into the air.

Photosynthesis video


Basic Photosynthesis
LIGHT ENERGY
oxygen
carbon dioxide
water

Photosynthesis with chemical symbols

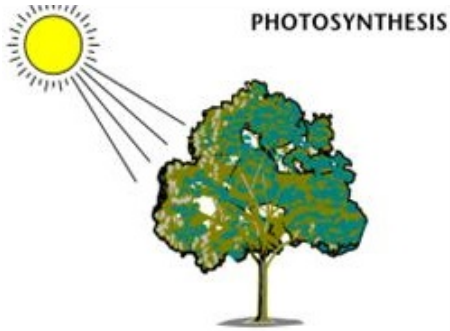


- How can you convert CO_2 to CH_2O? Add 2Hs; take away O
- Where can you get 2 Hs? From H_2O
- What's left over? O
- What does it take to break apart H_2O? Energy
- Where does energy come from? Captured from sunlight
- What captures it? Chlorophyll
- Does this make sugar? Yes, repeat it 6 times

$C_6H_{12}O_6$

- Sugar can be combined with minerals to make proteins, fat, and food!

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.

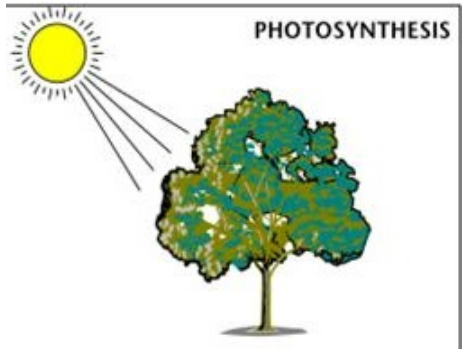
Meanwhile, Chlorophyll has captured a photon, a packet of solar energy. Chlorophyll passes the energy to Enzyme who wrangles Water, pulling it into two pieces, Oxygen and Hydrogen.

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!

For those who like chemistry…



$$6CO_2 + 6H_20 \xrightarrow{\text{photosynthesis}} C_6H_{12}O_6 + 6O_2$$

← respiration

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

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.

Where does the gas exchange happen on a leaf?

- Examine a healthy leaf from the test plant using a magnifier.
- Predict whether gases enter and leave the leaf through the upper, the lower, or both surfaces of the leaf.
- Write a hypothesis, with a reason, in your science notebook. The hypothesis is an educated guess, based on your observations.

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?

Write three predictions.

Set up the experiment on a test plant.

- Coat the tops of three or four leaves with Vaseline.
- Coat the bottom of three or four different leaves.
- Coat the tops and bottoms of three or four other leaves.

  Be careful not to get Vaseline on the uncoated surface.

Observe the leaves throughout the week and write observations in your notebook.

?

One week later…

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

What is Transpiration?

Transpiration is the process

of moving water

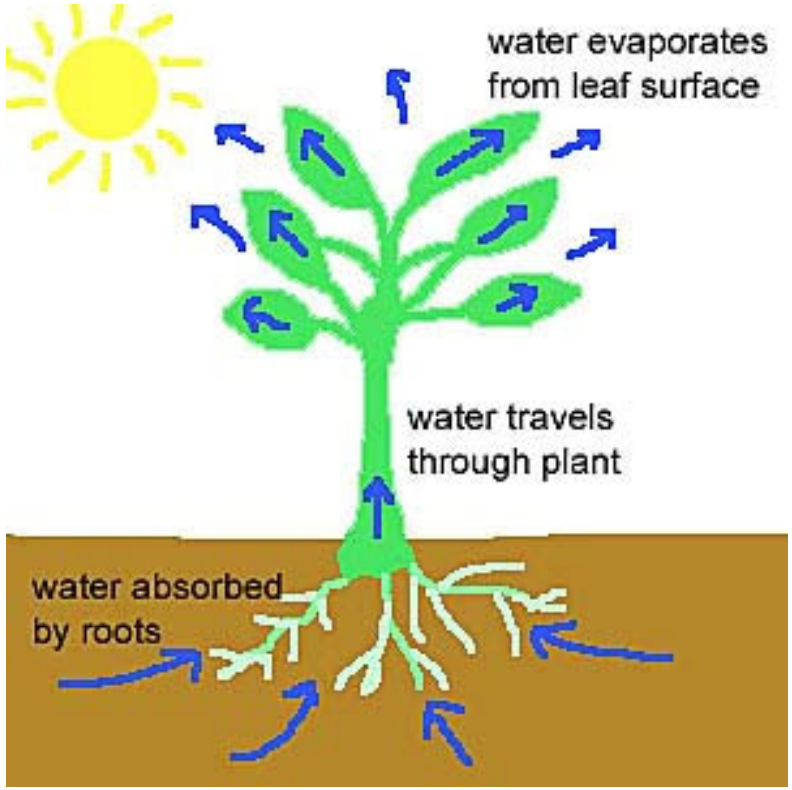
from the soil

into roots,

up the plant,

out of the leaf

into the air.



How do we know leaves transpire?

Set up an experiment to look for evidence of transpiration.

- Place a plastic bag around part of a plant as shown.

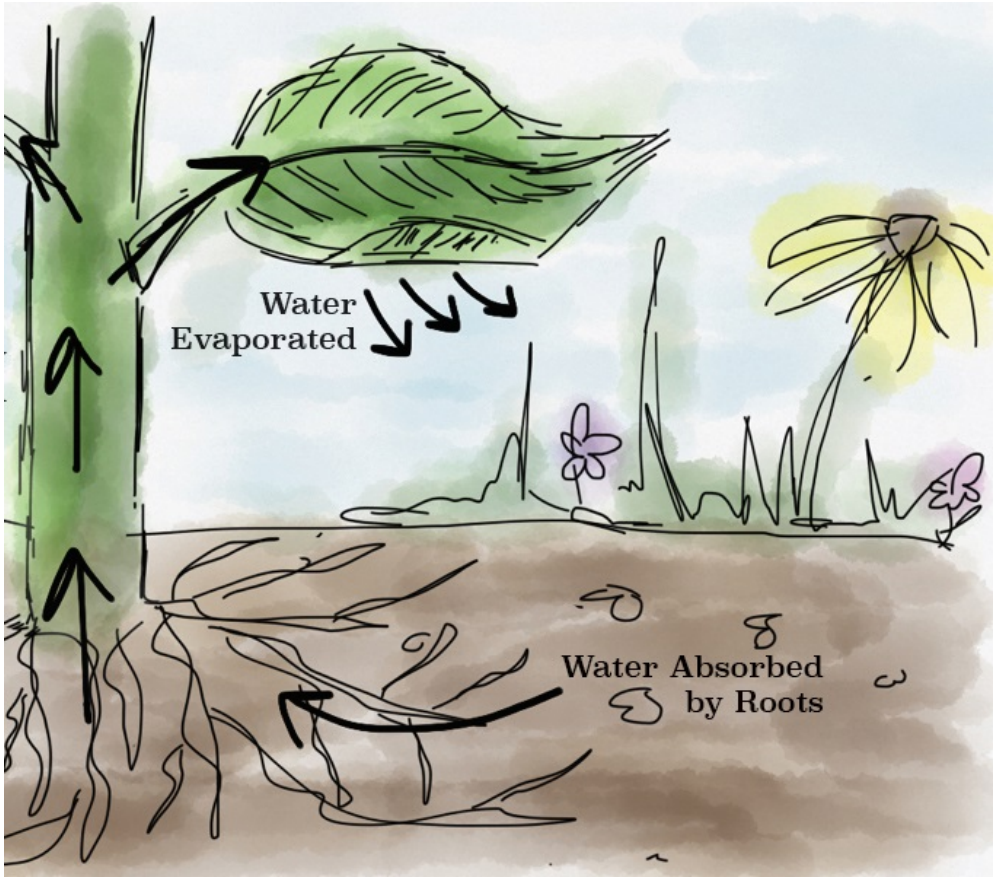
If this plant is transpiring, what do you expect to see in the bag?

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

Transpiration cools.

Transpiration produces a water-based cooling system, so leaves don't 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.



Transpiration makes clouds; 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.

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

Tower Garden considerations

1. Explain how transpiration works in the Tower Garden.

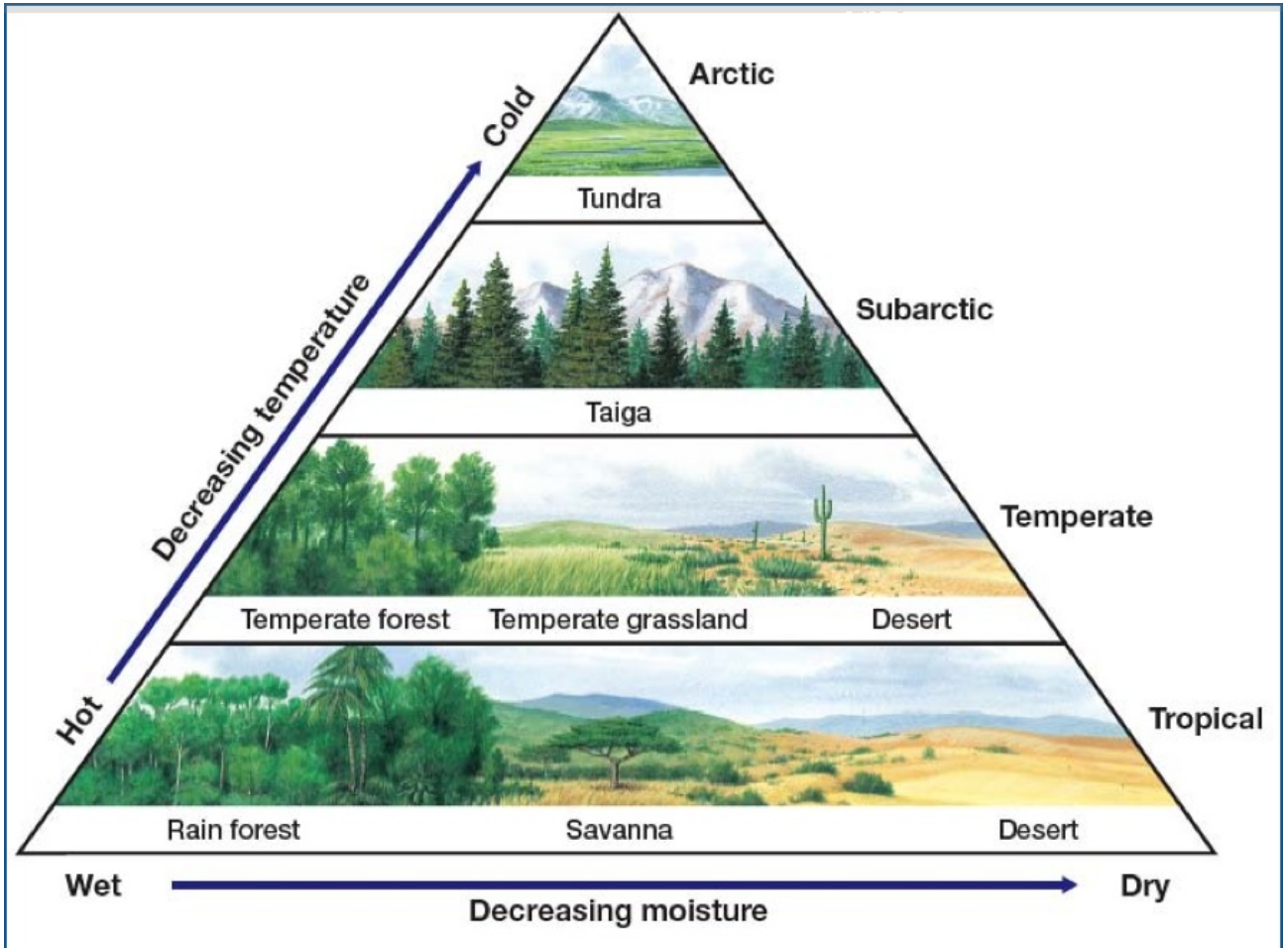
2. Is there a local water cycle? Explain.

3. Look carefully at this photo of wilted plants. What might have happened to cause this phenomenon?

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.



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 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 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?

Web Resources for Research

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

Project Process

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

Evaluating what you 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.