



Plants and the Water Cycle

Lesson Plan

Overview

Plants interact with their environment in many ways that we cannot see. Children often enjoy learning about these “hidden secrets” of plant life. In this lesson, children will learn about role of plants in recycling water by collecting water vapor that is emitted, or *transpired*, by green plant leaves. Students will learn that this process helps to cool plant leaves, just as perspiration helps to cool their own bodies. In addition, students learn that the water vapor transpired by leaves contributes to the formation of clouds and eventually returns to the surface in the form of rain.

Suggested Lesson Sequence	Please see the Greenlinks Module description.
Lesson Level	Extended
Science Connections	<ul style="list-style-type: none"> Students learn that while people perspire water through their skin to keep cool, plants transpire water vapor through their leaves to keep cool. Students learn that water vapor from plants helps to form clouds in the sky, and that clouds are made of water droplets that can then fall to the ground as rain. Students learn that rain water is taken up by plant roots, which feed the water through the plant stem and back to leaves once again to continue the water cycle.
Math Connections	<ul style="list-style-type: none"> Students will measure accumulations of water in milliliters.
Human Connections	<ul style="list-style-type: none"> Students learn about the important role of plants in delivering moisture to the air and sustaining the environment for humans and other living organisms. Students consider the implications of human removal on the water cycle.
Lesson Assessment	<ul style="list-style-type: none"> Assessment and Standards Table (Word) Assessment Activity Description (below) Authentic Assessment (below)

Materials

Keeping Cool interactive slide show ([Powerpoint](#))

Arrange the Water Cycle assessment slide show ([Powerpoint](#))

Transpiration Activity Sheet ([Word](#))

A pair of glasses or small mirror, preferably kept in a cool place prior to use

Access to a broadleaf tree or shrub growing outside; or a broadleaf potted plant growing inside. *Note: this activity works best on a sunny day.*

Gallon-sized plastic bags that can be sealed shut

Clothespins

Digital camera (optional)

Eye dropper and graduated cylinder with milliliter scale marked on the side (optional)

About the slideshows: these slideshows are not meant for students to read through on their own. They are intended to be viewed together, to outline and illustrate a discussion of the lesson's themes, led by the teacher. You might have a different student read the text on each slide.

Vocabulary

- **Exhale:** to breathe out. When exhaling, animals emit water vapor and other gases to the atmosphere from their mouth.
- **Gas:** a form of matter that fills the shape of a container and expands (gets larger) when heated. Many gases are invisible. The air we breathe in and out is made of different mixtures of gases.
- **Perspiration:** the process of sweating. When people perspire, they sweat through tiny pores in their skin. People keep cool by perspiring water through their skin.
- **Stomate:** a tiny, mouthlike pore in a leaf. Gases (including water vapor) pass through a leaf's many stomates.
- **Transpiration:** the process through which plants give off (emit) water vapor, largely through tiny (microscopic) pores in leaves called stomates. Plants keep cool by transpiring water through their leaves.
- **Vapor:** the gas form of a substance. Water vapor is water in the form of a gas.
- **Water cycle:** the process of water moving through various parts of the Earth. An example of a water cycle is when water is taken up from soil by plant roots, moves through the plant to its leaves, enters the outside air by transpiring through the leaves, and then forms clouds which rain out to return the water to the soil surface.

Procedure

I. Assessing Prior Knowledge

To introduce the concept of plant transpiration, ask students what they think happens when they exhale (breathe out) when they are outside on a very cold day. For students who have lived in or experienced cold climates, they should recall the interesting phenomenon of "seeing your breath." A person's exhaled breath is what releases water vapor and other gases from their lungs. Plants emit water vapor through their leaves mainly by a process called *transpiration*. Although "seeing your breath" is not an identical process to plant transpiration, it provides students with a conceptual model to help them understand what occurs when plants release (transpire) water vapor. The human body and plant leaves are both moist on the inside, and when gases from inside animals or plants are released to the outside, these gases carry water vapor with them.

II. Contextual preparation

Have students brainstorm to come up with ideas for how to test what might be in their breath that they would see on a cold day, by using a pair of glasses or a small mirror. Show students how the glass or small mirror becomes "clouded" when it is breathed upon, and reveal to the students that these "clouds" on the glass are actually made up of very small water droplets. (Hint: keeping the glasses or mirror cool prior to this demonstration will allow the water droplets to persist longer.) In cold air, this water vapor within our warm breath quickly turns to very small water droplets in mid-air, and becomes visible as a "cloud" of breath. This discussion should set the stage for students to later recognize that plants complete a similar process; when the sun heats water inside plant stems and leaves, it is released into the atmosphere as a vapor through small pores in the leaves. Furthermore, students may begin to realize that as water is warmed (either in our bodies or in plant leaves exposed to the sun), it tends to turn partly to an invisible gas (vapor) form, and that when this vapor is cooled (either by the cold air, or a cool mirror), it turns back into a visible liquid droplet form.

Using a computer, show children the [Keeping Cool Slide Show](#). In these slides, many of the concepts mentioned above will be reinforced through the use of photos and cartoons. The slide show reveals various aspects of the water cycle, including plant transpiration. Through transpiration, water vapor passes through tiny pores in the leaves of plants to enter the atmosphere. This water vapor then rises in the atmosphere, cools and forms droplets which accumulate into clouds, then rains out to moisten soils and be taken up by plant roots once again.

III. Student Activities

1. To learn about the process of transpiration, children will collect water that transpires through the tiny pores of leaves called stomates. On the playground, choose a deciduous tree or shrub with broad leaves in direct sunlight. This activity will work best outside on a warm, clear day. Depending on the climate, weather, and location in which you live, you will

experience varying degrees of success. In the case that broadleaf plants are not available outside, place a potted plant in a sunlit window inside. Repeated trials may be necessary.

2. Children should carefully slide a large, transparent plastic bag over a branch or stem of a plant containing at least 3 or 4 large healthy leaves that are dry on their surfaces. Secure the bag around the stem with a clothespin. For interesting comparison purposes, students may wish to use several different species of plants (or use different numbers of leaves) for this activity.
3. Children can observe and record findings over the course of a day on the [Transpiration Activity Sheet](#). If the leaves are green and healthy on a warm, sunny day, children should see water droplets accumulate on the interior of the plastic bag. *(Note: little or no water will collect in the bag when leaves are brown and/or absent or on needleleaf plants during cold weather.)*
4. Children may take a digital photo of the amount of water that has accumulated in the plastic bag.
5. Children may also measure the amount of water in the droplets by collecting the water in an eyedropper and measuring in a graduated cylinder with a milliliter scale marked on the side.
6. Students also may wish to crush a healthy green leaf in their hand. Many broadleaf plants will produce a moist "slime" when crushed. This moistness comes from water held within the tissues of the leaf. Water turns from this liquid form into a gas (vapor) form during the transpiration process.
7. Teachers should discuss with children the important role that plants play in the water cycle through transpiration. Plants are a vital part of all ecosystems. Without plants to recycle water back to the atmosphere, rainwater would collect in rivers, flow to the ocean, and leave behind very dry landscapes. If a landscape is dry, then there is little water to evaporate off the land or transpire through leaves to produce more clouds and, subsequently, more rain. This results in another type of cycle - a drought cycle. Many people across the globe are concerned about the role of plants in the water cycle. For example, as tropical rainforests are cut down, how will this change the water cycle in tropical areas? The plants in rainforests across the globe recycle millions of gallons of water a day. Will once-lush forests turn into deserts? Scientists all around the tropics are conducting studies to investigate this issue and many related questions. The United Nations has convened a special group of scientists to examine the possibility of increased desert formation (also known as *desertification*) around the world, and how we may take measures against desertification.

IV. Assessment

By collecting and observing water that transpires through the leaves of plants, children will learn about the role of plants in the water cycle. Some of the questions (from the [student activity sheet](#)) that may be used to assess children's understanding of the water cycle are listed below. In addition, you may show students the Arrange the Water Cycle [assessment slideshow](#) to assess their knowledge about how plants play an integral role in water cycling. In this slide show, students should be able to identify that the water is in:

- A. *Plants (water in leaves) and air (water vapor in atmosphere).*
- B. *Soil and roots.*
- C. *Clouds and air (water droplets in the form of rain).*
- D. *Clouds.*

The photo arrangement showing the sequence of movement for the water should be in the following order:

...A, D, C, B, A, D, C, B, A, D...

Questions for Class Discussion

1. Where does the water in the plastic bags come from?

Water is absorbed in the roots of the plants, travels through the trunk, stems, and branches and then transpires through tiny pores in the leaves.

2. If the bag had not been placed over the plant, where would the water that you observed have gone?

The water vapor would enter the atmosphere (air) and possibly form clouds high above the ground when it cools.

3. Is there a connection between the water that transpires from plant leaves and the water that falls to Earth from clouds (rain and snow)?

The water transpired by plants produces more clouds, and subsequently, more rain.

4. How do your results compare with your classmates (who may have collected water in other types of plants)? Be sure to think about the size of the leaves.

Results will vary, although children should find that large sunlit broad leaves will transpire more than smaller leaves, brown leaves, needle leaves, and shaded leaves.

5. Why do you think trees are important part of keeping rainforests rainy?

Refer to the explanation in section III.6 above.

Extensions for Authentic Assessment

1. How much water?

Students may be challenged to think about how much water an individual tree may have transpired throughout the course of a day. This problem holds promise for being very challenging mathematically. Students need to collect water in their bags, measure the water with an eye dropper and graduated cylinder, determine how much water is likely to be transpired from a single leaf, and then estimate the total number of leaves on the tree to calculate the total amount of water transpired. You may need to provide some scaffolding to help students complete this task. As they work on this task, students should be reminded that this kind of estimation is exactly what scientists do on a larger and slightly more technical scale.

2. Vocabulary Story

Have students write a story about the water cycle as if they were a small molecule, or fundamental particle, of water. In writing the story, have students study and use the words provided in the vocabulary list above.