



Transpiration

Lesson Concept Living things contribute to the water cycle; plants release water into the atmosphere through the process of transpiration.

Link In the previous lesson students learned that water moves through a cycle of accumulation, evaporation, condensation and precipitation. In this lesson, students learn that water from living things contribute to the water cycle. They investigate transpiration as an example. In the next lesson, students will learn how water accumulates in water sheds.

Time Day 1: 30 minutes
Day 2: 40 minutes
(Note: Day 2 should be taught with at least 1 full day between Day 1 and Day 2)

Materials Whole class
Water cycle diagram
Picture of Stomata
Small electric fan
Leaf in baggie
Per Group of 4 students
Quart-size plastic bag
Twist Tie
Potted plant with leafs (see advance preparation).
Individual
Science Notebook
Resource
R1 Teacher Background

Advance preparation

1. Decide whether to purchase plants for each group or use the school's plants. If each group has a plant, they can experiment with the effect of different conditions on transpiration because

they can place the plant in a variety of locations (OPTION A IN THE PROCEDURE SECTION). If this is not possible, student groups can simply use outside plants for their investigation (OPTION B IN THE PROCEDURE SECTION).

2. If plants are purchased, buy multiples of the same kind that have lots of leaves. If you are not buying plants, locate an area in the school with the same plants. If you can locate some in the sun and some in the shade, that would allow for some “experimentation.”
3. For OPTION A: The variables for the potted plants are: sunny location, windy location (with fan) and dark location (e.g., closet). In each location, one plant should be somewhat dry; another should have just been watered. Decide how to divide students into these 6 groups (it is ok to have multiples of the 6 groups).
4. For OPTION A AND B: use the bag to cover a small portion of the leaves and then seal with the twist-tie.
5. Review teacher background (R1)

Procedure:

Day One

Engage (10 minutes) Living things contribute to the water cycle

1. Display the water cycle diagram. Ask students to label the “white boxes” with the phases of the water cycle they remember. Correct if necessary.
2. Ask partners to think about: what else might contribute to the water cycle? What other things contain water. Ask several partners to share their thinking.
3. Use their ideas to introduce the idea that living things contribute to the water cycle. Have students breathe into their hands—what do they notice? What other ways to their release water? (sweat/perspiration, urine). If animals contribute water, what do you think plants do?
4. Explain that today they will explore how plants release water into the atmosphere.

Explore (15 minutes) Plants contribute water to the atmosphere through a process called transpiration.

5. Hold up a plant and ask students what they know about the transport of water in a plant. Most students should know that plants take in water from the roots, it moves up the stem to the leaves.
6. Ask students to discuss what they think happens to the water once it is in the leaves.

Teacher Note: If students have experienced the life science unit, they should recall that leaves have stomata that allow water to be released to the atmosphere. If they have not had the life science unit, record their ideas and introduce stomata at the end of the exploration.

OPTION A (groups with potted plants that can be placed in various locations)

7. Divide the students into 6 groups. Give each group 1 potted plant (1/2 of the groups should get plants with somewhat dry soil; the other 1/2 should get plants that have just been watered); 1 plastic baggie; 1 twist tie.
8. Ask each group to approximate how many leaves are on their plants so that they determine how many leaves to put in the baggie. Help students determine a number because it is best if approximately the same amount of leaf area is sealed in the baggie.
9. Demonstrate how to place the baggie over the number of leaves and seal with the twist tie. Be careful not to remove the leaves from the plant.



Credit: Ming kei College, Hong Kong

Teacher Note: it is not necessary to cover as many leaves as shown in this picture. What is most important is that students cover approximately the same number of leaves of each plant in their experiment.

10. Ask table groups to use the baggie and twist ties to seal the agreed-on number of leaves on their plant. Ask students to draw a picture of the setup in their science notebook.
11. Assign each group a location: sunny window, closet, by a fan on a desk. Note there should be two plants at each location (one semi dry and one watered).
12. Ask students to predict what they will observe tomorrow when viewing their plant. Have them write their prediction in their notebook. Ask the table groups to share their predictions.
13. Display the baggie with the single leaf. Ask students what they predict they will observe tomorrow when they view this bag. Ask them to write their prediction in their notebook.

OPTION B (using plants outdoors on the school ground)

14. Divide the class into small groups—half of which will use plants in the sun and the other half of which will use plants in the shade.

- Take the class outside (have students bring their science notebooks) and follow steps 8-10; 12-13.

Day 2

Explore /Explain (30 minutes) Plants release water vapor through the stomata to the atmosphere through a process called transpiration.

- Have groups observe their plants and record their observations in their notebooks. Then ask them to carefully remove the plastic bag (keeping any moisture/water in the bag), and seal the bag with the twist tie. Ask students to estimate the amount of water that was formed.
- Create a class chart of the data from each group like the one below:

OPTION A CLASS CHART

Plant Type/location	Observation	Amount of water
Dry in Sun		
Watered in Sun		
Dry in Closet		
Watered in Closet		
Dry in Wind (Fan)		
Watered in Wind (Fan)		

OPTION B CLASS CHART

Location	Observation	Amount of water
Sun		
Shade		

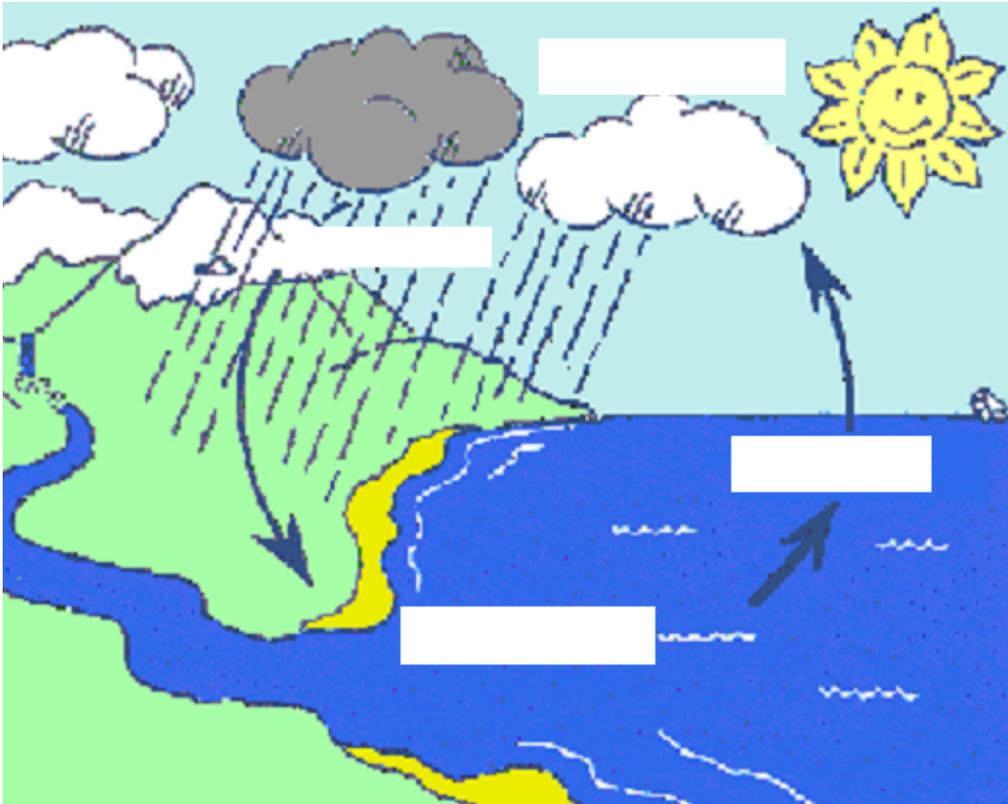
- Conduct a discussion based on the information in the class chart. For both OPTION A and B: What was similar? What was different? Why were there differences? How did the amount of light affect the amount of water in the baggie?
For OPTION A: How did the amount of moisture in the soil affect the amount of water in the baggie? How did the wind affect the amount of water in the baggie?
Compare the bags of water. Which condition had the most? Why
- Ask students to compare their observations/discussion to their predictions. What did they notice? Discuss.

20. Label the process students have been observing as transpiration.
 - a. Write the word on the board and create a class definition.
 - b. Introduce or re-introduce the word stomata and remind students that these are openings in the leaves in which water vapor is released.
 - c. Refine the definition to include the stomata (e.g., transpiration is the process whereby plants release water vapor into the atmosphere through the stomata).

Extend/Evaluate (10 minutes) Living Things Contribute Water/Water Vapor to the atmosphere

21. Display the single leaf in the baggie. Ask students what they notice (nothing). Ask students the following questions and have them write their answers in their science notebooks:
 - a. -why is this leaf not transpiring?
 - b. -why is transpiration important to the water cycle?
 - c. -how do animals contribute to the water cycle?
22. Re-display the water cycle diagram. What would you add to this diagram to make it complete? (plants and animals).
23. Ask students, "What is something you are wondering about in terms of the water cycle?"

Water Cycle Diagram



Teacher Background Information

Transpiration is the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere. Transpiration is essentially evaporation of water from plant leaves. Studies have revealed that about 10 percent of the moisture found in the atmosphere is released by plants through transpiration.

Plant transpiration is pretty much an invisible process, since the water is evaporating from the leaf surfaces, you don't just go out and see the leaves "sweating." Just because you can't see the water doesn't mean it is not being put into the air, though. During a growing season, a leaf will transpire many times more water than its own weight. An acre of corn gives off about 3,000-4,000 gallons (11,400-15,100 liters) of water each day, and a large oak tree can transpire 40,000 gallons (151,000 liters) per year.

The amount of water that plants transpire varies greatly geographically and over time. There are a number of factors that determine transpiration rates:

- **Temperature:** Transpiration rates go up as the temperature goes up, especially during the growing season, when the air is warmer due to stronger sunlight and warmer air masses. Higher temperatures cause the plant cells, which control the openings (stoma) where water is released to the atmosphere to open, whereas colder temperatures cause the openings to close.
- **Relative humidity:** As the relative humidity of the air surrounding the plant rises, the transpiration rate falls. It is easier for water to evaporate into dryer air than into more saturated air.
- **Wind and air movement:** Increased movement of the air around a plant will result in a higher transpiration rate. This is somewhat related to the relative humidity of the air, in that as water transpires from a leaf, the water saturates the air surrounding the leaf. If there is no wind, the air around the leaf may not move very much, raising the humidity of the air around the leaf. Wind will move the air around, with the result that the more saturated air close to the leaf is replaced by drier air.
- **Soil-moisture availability:** When moisture is lacking, plants can begin to senesce (premature ageing, which can result in leaf loss) and transpire less water.
- **Type of plant:** Plants transpire water at different rates. Some plants, which grow in arid regions, such as cacti and succulents, conserve precious water by transpiring less water than other plants.