MOISTURE MAKERS

BIO KEY

Plant Investigation
Bio-Technique
Transpiration

OVERVIEW

The youngsters use moisture-sensitive cobalt chloride paper to compare the amounts of moisture released from different kinds of leaves.

BACKGROUND

Transpiration is the evaporation of water from plant surfaces—primarily leaves—into the air. Most plants in temperate climates transpire about 99 percent of the water taken in by their roots. The other 1% is incorporated into the plant's structure. All but 5 to 10% of the total water vapor lost from plants escapes through small openings called ***stomates***.

On most plants, the greatest number of stomates is located on the undersides of leaves, i.e. the side of the leaf that is usually turned away from the sun.

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Apple, oak, and orange plants, for instance, have *no* stomates on the upper leaf surface, but have between 100,000 and 150,000 stomates per square centimeter of leaf surface on the undersides of their leaves. Other plants, such as beans, pumpkins, and sunflowers, have between two and ten times more stomates on the undersides of their leaves.

Fluctuations in transpiration rates occur seasonally and even daily, depending on environmental factors such as wind, light, humidity, and temperature. In the summer, for example, a maple tree may transpire up to 200 liters per day; but in winter, when the tree's leaves have dropped, transpiration is negligible.

Plants in dry climates must retain a greater percentage of water than plants in wetter climates. Adaptations in the location, shape, size, and number of stomates help reduce transpiration.

CHALLENGE: COMPARE THE MOISTURE RELEASED FROM DIFFERENT KINDS OF LEAVES AND FROM DIFFERENT PARTS OF THE SAME LEAF BY OBSERVING THE COLOR CHANGE OF COBALT CHLORIDE PAPER.

MATERIALS

For each team of two:
4 cobalt chloride paper*† test strips (1 cm × 5 cm) (See the "Preparation" section.)
1 plastic container* or lid (See the "Preparation" section.)
2 different Action Cards
index card* and pencil

For the group:
1 watch
1 roll of transparent tape*
1 sheet of Action Cards*

Optional:
hand lenses*

* Available from Delta Education.
† You may purchase ready-made cobalt chloride paper or make your own from cobalt chloride crystals (available from Delta). See the "Preparation" section.

PREPARATION

Group Size. This activity is suitable for any size group.

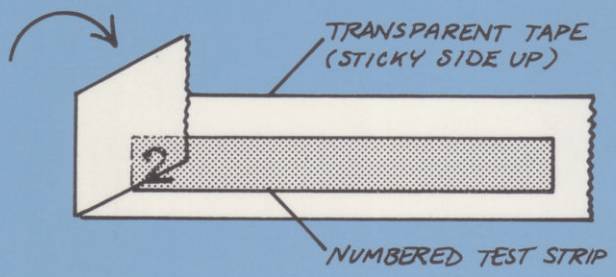
Time. Plan on forty to fifty minutes for this activity. Choose a dry day when the humidity is low. If you try this activity on a humid day, the moisture in the air alone may turn the cobalt chloride paper from blue to pink.

Site. Choose a site with a variety of plants, free from dew or moisture. If necessary, obtain permission to pick leaf samples.

Making Cobalt Chloride Paper. Mix two teaspoons of cobalt chloride crystals, one teaspoon of table salt, and four teaspoons of water in a bowl until all the crystals dissolve. If you let the mixture sit overnight, the crystals will dissolve without having to grind them. Soak several sheets of white typing paper in the pink solution. Dry the paper by hanging it from a line. The cobalt chloride paper will turn blue when it is dry. Cut the paper into strips 1 cm × 5 cm. Store the paper in ziplock bags or some other airtight container.

Preparing the Cobalt Chloride Paper Test Strips. For each team, number four strips of cobalt chloride paper consecutively (1 through 4) with a pencil and press the strips onto the sticky side of

a 7- or 8-cm long piece of transparent tape as shown.



Fold the excess tape back over about one-fourth of the strip, and press the folded tape together.

Prepare all four strips this way, and stick them onto a plastic lid or container (plastic cottage cheese, yogurt, or sour cream containers work fine) for each team.

How to Use the Test Strips. Moisture turns cobalt chloride paper from blue to pink. The paper strips *must* be blue to start with. The test strips should be handled by their double taped ends to keep moisture from the fingers or hands from reacting with the paper.

To use a test strip, simply press the sticky side of a strip against a leaf surface or other plant surface and time how long it takes the paper to turn pink (usually 5 to 15 minutes). The double-taped end of the test strip will remain blue (a control) after the rest of the strip turns pink from exposure to moisture. A temporary record of the pink color can be made by removing a test strip after it has changed color and quickly sealing the uncovered side of the test strip with another piece of tape. Practice using the strips on the undersides of plant leaves so you can demonstrate the procedure to your group. Choose a plant whose leaves produce a fairly rapid color change (5 minutes or less) for the demonstration.

ACTION

1. Ask the group if they think plants release water into the air (in the form of water vapor). Tell them you have some test paper that turns from blue to pink when it comes into contact with water.

2. Demonstrate the procedure for using the cobalt chloride paper test strips. Stick a paper strip to the underside of a leaf on the demonstration plant, and time how long it takes for the color to change. Emphasize that the leaves must remain on the plant while they are being tested.

3. While waiting for the test strip to turn pink, describe how you prepared the test paper strips. Divide the group into teams of two and point out limits for the activity site.

4. When the test strip changes color, record the elapsed time on an index card. Tell the group that the pink color indicates that water is being released by the leaf. Keeping the test strip in place, pick the leaf you tested and pass it around. Point out that the end of the test strip is still blue because it is taped on both sides. Explain that plants lose most of the water taken in by their roots through a process called *transpiration*. (See the "Background" section.)

5. Give each team two Action Cards, an index card, a pencil, and four test strips. Point out that the strips are numbered for recording purposes. Challenge the teams to compare the moisture released from different kinds of leaves and from different parts of the same leaf by observing the color change of cobalt chloride paper.

6. Each team can time its own experiments by recording what time it is when they put their two test strips in place and then when the strips change color. Since they have two Action Cards, each team will conduct two experiments. For record-keeping purposes, the teams

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can pick the leaves they tested (after the strips change color), and put them into their plastic containers with the test strips still attached to the leaves.

WHAT DO YOU THINK?

1. Describe some of your Action-Card comparisons and what you discovered.

2. Which leaves released the most moisture, that is, made the test strips change color the fastest? What characteristics do these leaves have in common?

3. Which leaves released the least moisture? How do they differ in size, shape, color, and so forth from the leaves that released the most moisture?

4. Which side of your leaves released more water: top side or bottom side?

BRANCHING OUT

1. Investigate the effects of excessive watering on transpiration. Choose two plants of the same type and approximately the same size. Label the plants "A" and "B." Water plant A the day before and just before measuring the rate of transpiration. Do not water plant B. Measure the rate of transpiration and compare the results.

2. Check the transpiration of one type of plant at different times of the day or during different weather conditions, and compare the results.

3. Investigate the transpiration of a potted plant by conducting the following experiment:

a. Obtain several potted plants in metal, plastic, or styrofoam containers that have no drainage holes in the bottom.
b. Water the plants only once.
c. Cover the soil surface with foil, plastic food wrap, or paraffin to prevent evaporation of water from the soil.
d. Weigh the entire setup.
e. Set up an identical pot as a control. Add soil and water, but replace the plant with a wooden stick. Cover the soil surfaces as before and weigh the entire setup.
f. Continue to weigh the plants and control setup every other day. The difference in weight loss between the control and experimental pots is the water lost through transpiration.

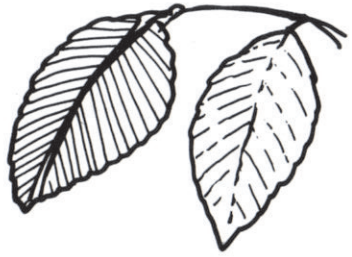
4. Compare the transpiration of plants that are adapted to live in deserts, e.g. cacti and other succulents. What leaf and stem features keep their transpiration rates low?

Moisture Makers
Action Card

Compare transpiration of a small leaf with that of a large leaf on the same plant. Place the test strips on the *underside* of each leaf.

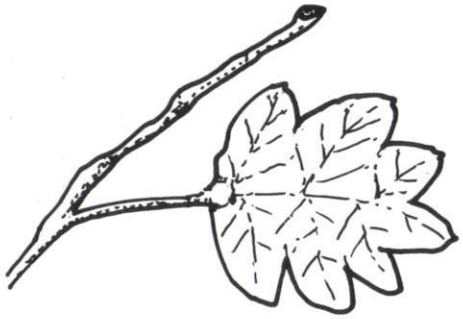
Moisture Makers
Action Card

Compare the upper and lower sides of the same leaf for transpiration. Try to position the two strips so they are directly opposite each other.



Moisture Makers
Action Card

Compare transpiration of a stem with that of a leaf on the same plant.



Moisture Makers
Action Card

Compare transpiration of a clump of pine needles with that of a broad leaf.

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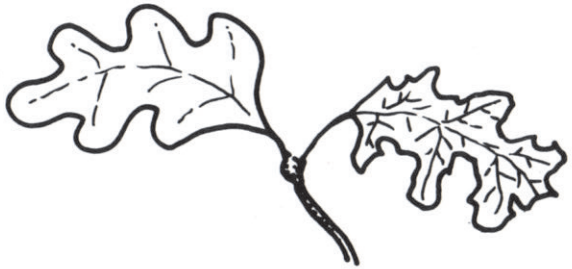
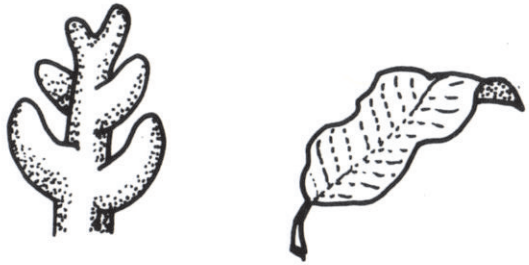
Moisture Makers
Action Card

Compare transpiration of a dead leaf with that of that of a live leaf attached to the same tree.



Moisture Makers
Action Card

Compare transpiration of a thick juicy leaf (succulent) with that of a thin, flat leaf.



Moisture Makers
Action Card

Compare transpiration of a hairy-surfaced leaf with that of a smooth-surfaced leaf.

Moisture Makers
Action Card

Compare transpiration of a leaf in the shade with that of a leaf of the same size and shape in the sun.

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