ACTIVITIES 38&39

Stomata and Transpiration (Sessions I and II)

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 4
Activities 38 & 39

SC.F.1.2.3
The student knows that living things are different but share similar structures.

SC.F.1.2.4
The student knows that similar cells form different kinds of structures.

SC.H.1.2.1
The student knows that it is important to keep accurate records and descriptions to provide information and clues on causes of discrepancies in repeated experiments.

SC.H.1.2.2
The student knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.

SC.H.1.2.3
The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

SC.H.1.2.4
The student knows that to compare and contrast observations and results is an essential skill in science.

SC.H.3.2.2
The student knows that data are collected and interpreted in order to explain an event or concept.

ACTIVITY ASSESSMENT OPPORTUNITIES

The following suggestions are intended to help identify major concepts covered in the activity that may need extra reinforcement. The goal is to provide opportunities to assess student progress without creating the need for a separate, formal assessment session (or activity) for each of the 39 hands-on activities at your grade.

1. **Session I—Activity 38:** Ask, *Is this activity a controlled experiment? Why or why not?* (Yes; we are testing only one variable while keeping all other variables the same. We are comparing our observations on the tested leaf to a control leaf.) Ask, *What are some of the variables that need to be controlled?* (Variables that need to be controlled include:

the size and kind of leaf used; the amount of sunlight to which the leaves are exposed; the kind of bag used; whether or not the bags are sealed; the amount of time the bags are left.)

2. **Session II—Activity 39:** Tell students that scientists sometimes develop phrases to describe certain events. Ask, *How would you define the phrase* transpiration pull, *based on what you learned in this activity?* Require that they use the following words in their description: stomata, stem, leaf, roots, water, air, and xylem. (Transpiration pull happens when water moves up the xylem in a plant stem to a leaf and eventually goes through the stomata into the air. This movement results in more water being pulled up from the roots at the same time it is leaving the plant by transpiration.)

3. Use the Activity Sheet(s) to assess student understanding of the major concepts in the activity.

In addition to the above assessment suggestions, the questions in bold and tasks that students perform throughout the activity provide opportunities to identify areas that may require additional review before proceeding further with the activity.

ACTIVITIES 38&39

Stomata and Transpiration

OBJECTIVES

Students observe stomata and experiment to determine their role in passing water through plants.

The students

- observe stomata on the underside of a leaf
- observe transpiration through leaves
- discover that blocking stomata inhibits transpiration
- relate the transpiration of water from leaves to the uptake of water from the soil

SCHEDULE

Session I—Activity 38 About 40 minutes

Session II—Activity 39 About 20 minutes, 1 day after Session I

VOCABULARY

guard cells
leaf
stoma
stomata
transpiration

MATERIALS

For each student

1	Activity Sheet 38
1	magnifier
1 pr	safety goggles*

For each team of four

2	bags, recloseable, 15 cm × 15 cm
1 pc	paper, scrap*

For each team of eight

1	microslide strip
1	microslide viewer

For the class

3	geranium plants*
1 roll	paper towels*
2 tubes	petroleum jelly
1 roll	tape, masking
	DSR *Plants in Our World*

*provided by the teacher

PREPARATION

Session I—Activity 38

1. Make a copy of Activity Sheet 38 for each student.
2. Preview the microslide images of the lower epidermis of a leaf with stomata (image 6) and a close-up of a stoma (image 7).
3. For each team, squeeze about one tablespoon of petroleum jelly—enough to cover both sides of one leaf completely—onto a scrap of paper.
4. Each team of four will need two pieces of masking tape, two recloseable bags, two geranium leaves, a paper towel, and some petroleum jelly on a piece of scrap paper.
5. Students will need to work in teams of eight when using the microslide viewers and strips.

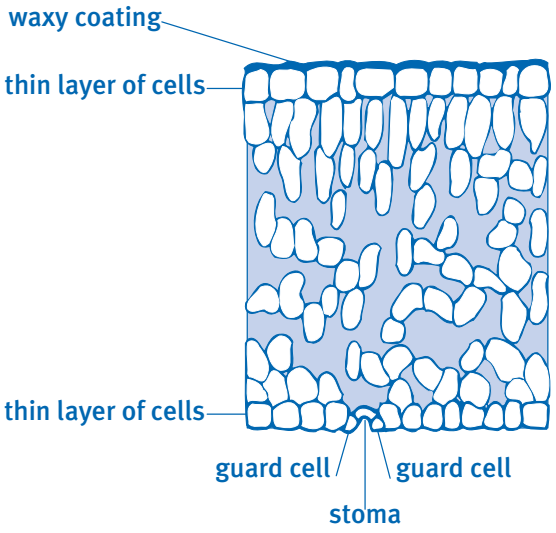
Session II—Activity 39

Each team of four will need its bags of geranium leaves from Session I.

BACKGROUND INFORMATION

Figure 38-1 is a simplified diagram of the cross-section of a leaf as it appears under a microscope. The upper and lower surfaces of a leaf are covered by a thin layer of cells that lack chlorophyll. This layer of cells is called the epidermis. In some plants, a layer of waxy substance covers the epidermis, to help prevent water loss. Scattered throughout the epidermis are ***stomata*** (s. *stoma*), tiny openings into the leaf similar to the pores in skin. The two cells on either side of a stoma, called ***guard cells***, open and close the stoma.

When the stomata are open, carbon dioxide, oxygen, and water can all pass in and out of the leaf. In general, stomata are open during the day, when photosynthesis is occurring, and are closed at night. However, when a leaf stands to lose a lot of water, such as on a very warm and sunny day, the stomata will close during the hottest part of the day. Because the underside of a leaf is not as likely to be exposed to direct sunlight, more stomata are located there. This also helps to minimize water loss.



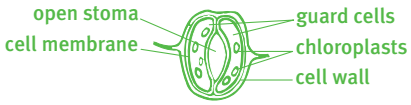
▲ ***Figure 38-1.*** *A cross-section of a leaf as it appears under a microscope.*

▼ **Activity Sheet 38**

Stomata and Transpiration

Session I—Activity 38

1. Observe microslide image 6 of the underside of a leaf. How many stomata can you find?
   Six
2. Observe microslide image 7, a close-up of a stoma. Compare the guard cells—the two cells that open and close the stoma—with the surrounding cells that cover the underside of the leaf. What differences do you notice?
   The guard cells are smaller, bean-shaped, and contain chloroplasts. The surrounding cells that cover the leaf are larger, irregularly shaped, and do not contain chloroplasts.
3. Draw the stoma and guard cells. Include and label any other cell parts that you can see.



4. Use masking tape to label one bag *Covered* and the other *Uncovered*. Write your team's name on both bags. Then cover both surfaces of one geranium leaf with petroleum jelly. Be sure to spread the jelly over the entire surface of both sides. Place each leaf into its corresponding bag.
5. Gently press each bag to let most of the air out, and then seal it. Set the bags aside overnight. What do you predict will happen in each bag?
   Answers will vary.

Session II—Activity 39

6. The next day, observe the bags. What do you see?
   The bag containing the leaf covered with petroleum jelly remained almost dry; the bag containing the uncovered leaf became filled with moisture.

   How does your prediction compare with what actually happened? How can you account for any differences?
   Students may have observed some moisture in the bag containing the covered leaf. If so, the leaf was not entirely sealed off by the petroleum jelly.

Guiding the Activity

Session I—Activity 38

Guiding the Activity	Additional Information
1 Show the students the geranium plants. Ask, **What plant parts are visible?**	*The stem and leaves, and probably flowers, are visible.*
Write the word *leaf* on the board. Explain to the students that a **leaf** is made up of several layers of cells. Draw a simple diagram on the board like the one in Figure 38-1. Next to it write the words *stomata, stoma,* and *guard cells.*	
Point out that the upper and lower surfaces of a leaf are made up of a thin layer of cells, and that in these thin layers there are openings into the leaf, called **stomata** (s. **stoma**). Explain that two cells, one on either side of the opening, act like double doors to open and close the stoma. These cells are called **guard cells**.	
2 Distribute a magnifier to each student. Have students use their magnifiers to look for stomata on the underside of the geranium leaves. Tell them that this is what they will be looking for as they observe the microslide strips. Give each student a copy of **Activity Sheet 38**.	
Divide the class into teams of eight and distribute one microslide viewer and one microslide strip to each team. Tell the students to follow the directions in Steps 1–3 on the activity sheet.	
Discuss the students' observations. Ask, **What do you think is the function of the stomata?**	*Accept reasonable answers. Students may suggest that air can pass in and out of the leaf through the stomata.*
3 Divide the class into teams of four. Distribute to each team two leaves from the geranium plants, two recloseable bags, two pieces of tape, a paper towel, and a piece of scrap paper with about a tablespoon of petroleum jelly on it. Tell the students they will discover the importance of stomata by comparing	

Guiding the Activity

	Additional Information
what happens to geranium leaves with and without petroleum jelly spread over them. Ask, **What does the petroleum jelly do when spread over a leaf?**	*The petroleum jelly coats the leaf surfaces and blocks the stomata.*
Tell the students to follow the directions in Steps 4 and 5 on the activity sheet. Instruct them to wipe off their hands with the paper towel after spreading the petroleum jelly.	
Have the students place the labeled plastic bags in light—but not in direct sunlight or bright light—and leave them overnight.	*If the bags are left where it is too warm or too sunny, both bags will become cloudy with water vapor, making it difficult to distinguish between what has happened in the two bags. If the bags are left where it is cold, water vapor in the bags may condense out and form droplets, again making it difficult to distinguish between what has happened in the two bags.*
Have the students discard the scrap paper and paper towels. Return the microslide viewers and strips, petroleum jelly, and tape to the kit.	

Session II—Activity 39

4 Have the students retrieve their plastic bags and complete Step 6 on the activity sheet. Discuss the students' answers to the questions in Steps 5 and 6. Ask, **Where did the water in the bag containing the uncovered leaf come from?**	*It came from inside the leaf.*
Ask, **How did the water get out of the leaf?**	*It escaped as water vapor through the stomata of the leaf.*
Ask, **What happens to a leaf when it is covered with petroleum jelly?**	*The petroleum jelly blocks the stomata, so that water cannot escape from the leaf. Students may have observed some moisture in the bag containing the covered leaf. If so, the leaf was not entirely sealed off by the petroleum jelly.*
Ask, **What can you conclude from this experiment?**	*Students should be able to conclude that leaves contain water and that water escapes from the leaves through tiny openings, called stomata.*

Guiding the Activity

	Additional Information
5 Write the word *transpiration* on the board. Explain that the process they just observed—the escape of water through the stomata—is called **transpiration**. Continue by telling students that as the water escapes through the stomata in the leaves, more is pulled from the soil through the continuous set of tubes that runs all the way down the plant to the roots. Thus, even as water is leaving the plant, more is being drawn into it. As appropriate, read or review page 5 from the Delta Science Reader *Plants in Our World*.	
Ask, **What kind of cells make up the tubes that carry water up a plant during transpiration?**	*This process can be compared to sipping a beverage through a straw. As liquid leaves the top of the straw, more is drawn in through the bottom.* *Xylem cells*
Ask the students, **How can you summarize the function of stomata?**	*Students may answer that the function of stomata is to allow water to pass out of a plant through the leaves.*
6 Tell the students that the microslide images they viewed in Session I are from the underside of a leaf. Tell them that this is because there are many more stomata on the underside of a leaf than there are on the upper side. Ask, **Based on what you know about stomata, how can you explain this?**	*Students may be able to suggest that the stomata on the underside of plant leaves are in the shade. As a result, less water is lost from these stomata than from those on the upper surface of leaves. This helps prevent excess water loss from the plant.*

Reinforcement

The transpiration of water from a plant can also be demonstrated using an entire plant. Water a geranium or other land plant and then cover the entire plant with a clear plastic bag. Close the bag around the bottom of the stem, near the soil. Let the plant sit for several hours or overnight until water droplets form on the inside of the bag. The condensation that occurs inside the bag is due to transpiration.

Cleanup

Have the students discard the geranium leaves and the plastic bags.

Connections

Science Challenge

Have students repeat the activity sheet investigation using four identical potted plants instead of just leaves and treating the leaves on each plant as follows: plant 1, coat only the upper surfaces with petroleum jelly; 2, coat only the lower surfaces; 3, coat both surfaces; and 4, leave both surfaces uncoated. Tell students to put a labeled plastic bag over each plant and tape it closed around the stem just above the soil level. The plants should be watered well and placed in a sunny location. After two or three days, ask students to examine each bag carefully and sequence the plants from most to least water vapor released. (4, 1, 2, 3) Encourage students to devise a method for measuring the amount of water collected in each bag—for example, by weighing each bag with a sensitive balance scale and subtracting the weight of a dry bag.

Science Extension

Make sure students understand that during transpiration, plant leaves release water vapor, not liquid water, and that the water droplets they observed in the bags used in the activity sheet and Science Challenge investigations did not come directly from the plant leaves but condensed from the water vapor they released. To demonstrate this, have students seal a small, shallow dish filled with water in a plastic bag and place it and an identical water-filled but uncovered dish in direct sunlight for several hours. Water will evaporate from both dishes. With the enclosed dish, water vapor condenses again to form liquid water droplets on the inside of the bag. With the uncovered dish, the water vapor simply dissipates into the surrounding air—just as it does with transpiration from plant leaves.

Science and the Arts

Encourage students to research the parts of a typical leaf—the petiole, the midrib, the large and small veins, the margin, and the apex—and then draw a leaf and label the parts. Tell students they may copy drawings in books or create their own drawings based on leaves they have collected.

Science and Language Arts

Have students look up the derivation of the term *transpiration* and add it to the class vocabulary list. (from the Latin *trans,* "across or through," and *spirare,* "to breathe") Also ask students to list as many other words as they can think of that begin with the prefix *trans-* and define each one in their own words.

Science and Math

Give each team a small twig with several leaves on it. Tell them to trace around one average-size leaf on a sheet of graph paper and then count the number of squares inside the outline. Have them multiply this count by 2 to determine the total area of the leaf's upper and lower surfaces. Then have them multiply that result by the number of leaves on the twig to find the total leaf area. Next, have each team fill a graduated cylinder with water to the 150-mL mark, add a thin layer of cooking oil on top of the water (to prevent evaporation), put the twig in the cylinder, and leave the set-up in a sunny location for one or two days or for as long as it takes for the water level to decrease noticeably. Have students note the new water level and calculate the amount of water lost through transpiration. Then have them divide this amount by the total surface area to determine the water loss per unit of leaf area.