

Transpiration Investigation

Grades (correlated to California Science Standards): 4th -5th

Objective: To engage students in investigating transpiration through a plant's leaves.

Materials: tree, plastic bags, rubber bands, pipettes, scientific inquiry page

Summary: Students will conduct a simple investigation to observe if a tree's transpiration is affected by environmental conditions.

Background Information: Transpiration is the evaporation of water from small pores on the leaf called the stomata. The stomata open and close in order to absorb carbon dioxide gas from the air and release oxygen from the plant, both processes that are associated with photosynthesis. (For information on photosynthesis, see the *Background Information* in "Reach for the Sun"). The stomata on a redwood leaf are found within the white stripes on the underside of the needle.

The atmosphere surrounding the leaf directly influences the opening of the stomata and therefore the amount of transpiration. Transpiration depends on a variety of factors including size of leaf, light intensity, temperature, humidity, amount of water in soil and wind exposure. Following is an explanation of how each of these variables might affect transpiration:

- Size of leaf—more surface area means more transpiration. Leaves that are broader or longer will transpire more than leaves that are skinnier and shorter. This is why leaves found in the higher, exposed part of the tree are smaller and narrower, reducing their surface area and therefore also reducing their water loss.
- Light intensity—plants transpire more in the light than in the shade or dark. Light stimulates photosynthesis and in effect increases the opening of the stomata.
- Temperature—Cold temperatures decrease plant metabolism and photosynthesis, therefore decreasing transpiration. Extremely hot temperatures increase transpiration, as water is sucked out of the leaf by the dry air. The plant also transpires as a method of cooling itself in extremely hot temperatures.
- Humidity— when the atmospheric humidity is low, water is sucked out of the leaf. A higher humidity environment decreases transpiration.
- Amount of water in soil— a plant cannot continue to transpire if the water it loses is not replaced, otherwise it will lose turgor pressure, close its stomata and wilt. On the other hand, if a plant is over watered, it will transpire at a great rate.
- Wind exposure— when there is not wind the air around a leaf becomes more humid, therefore reducing the rate of transpiration. When wind is present, humidity is dispersed, the air becomes drier and transpiration increases.

Water loss through transpiration is significant. It has been estimated over a growing season, one acre of corn plants may transpire 400,000 gallons of water, which is the equivalent of a one acre lake that is 15 inches deep. Large redwoods transpire approximately 500 gallons of water into the atmosphere each day, contributing to coastal fog. In addition, during the summer, transpiration causes the redwood stems to shrink and expand with the cycles of night and day. (Kocher, S. D, University of Ca, Division of Ag and Nat Resources, Working in the Woods, 1990)

Method:

1. Review the water cycle. Explain how water evaporation not only occurs from bodies of water, but also occurs from plants.
2. Review photosynthesis, as transpiration is a result of gas exchange during photosynthesis.
3. Discuss the variables that may affect the amount of transpiration that occurs.
4. Students will design a question relative to transpiration and environmental conditions that they can answer through an experiment on a single tree (i.e. size, light, wind vs. amount of transpiration).
5. Working in teams of four, students will pick four areas of the same tree that are each affected by different environmental conditions (i.e. light, wind) and enclose approximately the same amount of leaf tips within a plastic bag that is sealed securely with a rubber band.
6. The students will make an educated guess about the outcome of their experiment. Will one branch transpire more than another and why? Will one transpire less than another and why?
7. The students return to their tree two days later to examine their results. Students measure and document the amount of water accumulated in each plastic bag using a pipette and fill out the rest of the scientific inquiry page.
8. Repeat the experiment. Check back in another 2 days and compare results.

Variations:

1. Repeat the experiment on the same tree and branches at different times of the year and compare the results.
2. Have the student groups work on trees that are exposed to a variety of environmental conditions and compare their results of each group to one another.

CALIFORNIA SCIENCE CONTENT STANDARDS

Grade Four

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- b. Measure and estimate the weight, length, or volume of objects.
- c. Formulate and justify predictions based on cause-and-effect relationships.
- d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.
- e. Construct and interpret graphs from measurements.

Grade Five

Life Sciences

1. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

- a. Students know many multicellular organisms have specialized structures to support the transport of materials.
- e. Students know how sugar, water, and minerals are transported in a vascular plant.

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- b. Develop a testable question.
- c. Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.
- f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.
- g. Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.
- h. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.
- i. Write a report of an investigation that includes conducting tests, collecting data or examining evidence, and drawing conclusions.

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SCIENTIFIC INQUIRY

What is the question you are asking?

What is your hypothesis of the outcome? A hypothesis is an educated guess.

How will you conduct your investigation? Be specific and give details.

What are the results of your study?

What can you conclude from your study?

Can this experiment be repeated? Why or why not? How might the outcomes in the next study be different?

FOREST ED-VENTURES EVALUATION

How did you use this curriculum? Please be specific regarding age group, number of students and where you conducted the activities.

Were the activities age and/or subject appropriate? If not, please explain:

Overall did you find this curriculum useful? Why or why not?

Do you have any suggestions for how we can improve this resource?

Please submit this evaluation to:
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