Transpiration Demonstration

Movement of Water Through a Plant

Introduction

How much water should be put on a plant when it is watered? Does it matter where the plant is kept? What environmental factors influence the amount of water passing through a plant?

Concepts

- Transpiration
- Evaporation

Background

Imagine a plant sealed under a bell jar and sitting under a bright light. Further, imagine that the top surface of the soil is sealed with foil around the plant. In an hour or so, moisture would accumulate on the inside of the bell jar. Because of the foil barrier, the water could not have come directly from the soil—it had to come through the plant. More than 90% of the water entering a plant passes through the plant and evaporates—primarily through the leaf stoma and into the atmosphere. This process of water vapor loss (by evaporation) from a plant (mostly through the leaves) is called *transpiration*.

The amount of water transpired from a plant is greater than many realize. For example, a corn plant can transpire about four gallons of water per week and, therefore, an acre of corn may transpire 350,000 gallons or more in one growing season. In contrast, animals recycle much of their water because they have a circulatory system. If humans, for example, had requirements for water similar to plants and didn't recycle it, we would probably have to drink 10 gallons of water per day!

In this demonstration, the amount of transpiration through celery stalks is measured under different conditions. The surface area for transpiration is reduced by eliminating the leaves from the celery stalks. Only straight line transpiration up and out of the vascular bundles is measured. Even without the evaporative surface area of the leaves, the water loss through a short section of celery stalk is impressive and can be influenced by surrounding environmental factors.

Materials

Celery stalks, 3
Food coloring, red, 6 drops
Water, distilled
Cotton balls
Electric fan, small
Erlenmeyer flasks, 125-mL, 3
Graduated cylinder
Incandescent lamp with reflector
Razor blade or sharp scalpel

Safety Precautions

Use care when cutting with a razor blade or other sharp cutting device. Follow all other normal laboratory safety procedures. Wash hands thoroughly with soap and water before leaving the laboratory.

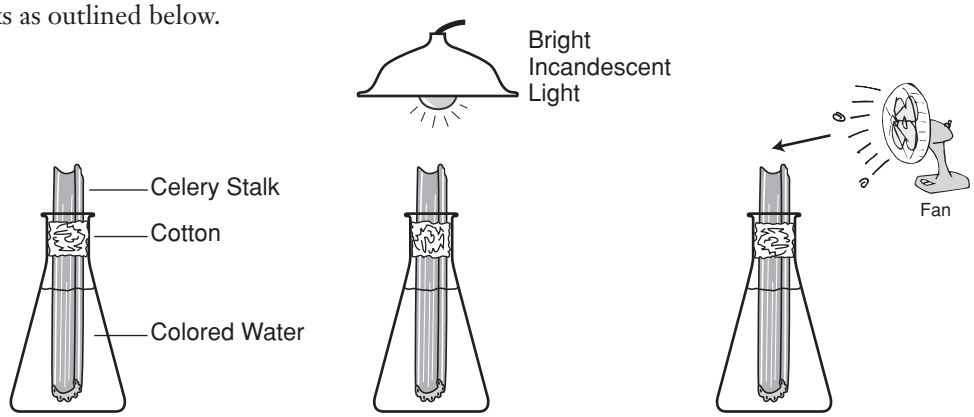
Procedure

1. Using a graduated cylinder, carefully measure 125 mL of distilled water into each of three Erlenmeyer flasks. Add two drops of red food coloring to each flask and swirl to mix evenly.
2. Select three celery stalks of equal diameter that will fit into the top of a 125-mL flask. With a razor blade cut three similar 6″ lengths from the three stalks. Both ends of the stalk must be freshly cut.
3. Put one celery stalk into each flask so that one end of the stalk nearly rests on the bottom of the flask, while the other end sticks out of the neck of the flask.
4. Stuff cotton around the stalk in the neck of the flask to hold it in place and to cut down evaporation of water through the top of the flask. Do not allow the cotton to come in contact with the water. Try to make all flasks as identical as

Publication No. 10153
121217

possible in terms of surface area of the stalk (on the ends), position in the flask, and amount of cotton stuffed in the neck of the flask.

5. Position the flasks as outlined below.



6. After several hours, use a graduated cylinder to measure the amount of water remaining in each of the flasks. Record the results and discuss how transpiration was observed and the factors that influenced the transpiration rate through the celery stalks.
7. Note the movement of the red color through the vascular bundles of the celery stalks.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Materials may be disposed of according to Flinn Suggested Disposal Methods #26a and #26b.

Tips

- This experiment probably works best as a demonstration but can also be done as a laboratory exercise. The exercise can be modified to demonstrate other concepts of transpiration. If equally-sized, leaf-bearing stalks can be obtained, the exer cise can be done with celery stalks containing leaves.
- It may be necessary to periodically add a few drops of water to the cut end of the celery stalks or scrape the ends of the stalks to prevent the ends from "healing," which can stop transpiration.
- The stalk under the hot lightbulb will likely transpire the most and show the greatest water loss followed closely by the fanned stalk. The control stalk will likely lose very little, if any, water.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-LS1 From Molecules to Organisms: Structures and Processes
LS1.A: Structure and Function

Disciplinary Core Ideas: High School
HS-LS1 From Molecules to Organisms: Structures and Processes
LS1.A: Structure and Function

Science and Engineering Practices
Asking questions and defining problems
Developing and using models
Planning and carrying out investigations
Constructing explanations and designing solutions

Crosscutting Concepts
Scale, proportion, and quantity
Systems and system models
Structure and function

Reference

McCallum, M.; *The American Biology Teacher.* Reston, VA, 2001, Vol. 63, No. 6, 420–21

Materials for *Transpiration Demonstration* are available from Flinn Scientific, Inc.

Catalog No.	Description
FB0680	Cotton Balls
GP9135	Erlenmeyer Flask, Economy Choice, 125-mL
AB1043	Razor Blades, Single Edge
V0006	Red Food Dye
AP2297	Graduated Cylinder, PMP, 100-mL

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.