What Plants Need in Order to Survive and Grow: Water

Grades 3–6

I. Introduction

Plants, like all other living organisms have basic needs: a source of nutrition (food), water, space in which to live, air, and optimal temperatures in order to grow and reproduce. For most plants, these needs are summarized as light, air, water, and nutrients (known by the acronym LAWN).

Students will conduct an experiment to evaluate whether plants need soil in order to survive and grow.

II. Objectives

- Students will learn how to conduct an experiment and use this knowledge to gather data about plant responses to different growth regimes.
- By making observations and measurements, students will then analyze their data to draw conclusions about basic plant needs.

III. Standards Assessed

Grades 3–5

Life Sciences

Science Content Standards K–12 (2000), California State Board of Education

- Plants have structures that serve different functions in growth, survival and reproduction (3.3.a).

Investigation and Experimentation

Science Content Standards K–12 (2000), California State Board of Education

- Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept. . . . students should develop their own questions and perform investigations (3.5, 4.6, 5.6).

Grades 3–5 (cont.)

Students will:

- Use numerical data in describing and comparing objects, events, and measurements (3–5.c).
- Predict the outcome of a simple investigation and compare the results with the prediction (3–5.d).
- Collect data in an investigation and analyze those data to develop a logical conclusion (3–5.e).
- Construct and interpret graphs from measurements (4.6.e).
- Identify the dependent and controlled variables in an investigation. Construct and interpret graphs from measurements. (5–6.d).

Grades 6–8

The Living Environment

Benchmarks for Science Literacy (1993), American Association for the Advancement of Science

- In all environments—freshwater, marine, forest, desert, grassland, mountain, and others—organisms with similar needs may compete with one another for recourses, including food, space, water, air, and shelter. In any particular environment, the growth and survival of organisms depend on the physical conditions (5.D 6-8).

Investigation and Experimentation

Science Content Standards K–12 (2000), California State Board of Education

- Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept . . . students should develop their own questions and perform investigations (6.7, 7.7, 8.9).
- Recognize whether evidence is consistent with a proposed explanation (6–7.e).

IV. Background

While at the Huntington Botanical Gardens, your class will visit three different gardens: the Desert Garden, Lily Ponds, and the Jungle Garden. Each of these gardens represents a distinct plant community in which plants exhibit adaptations to the unique conditions of their local environment.

Plants meet their needs in different environments in different ways, since the quantity or quality of resources varies from one ecosystem type to another. In order to appreciate the complexity of natural communities and make comparisons between them, students need to understand the basic needs of living organisms and how these resources are obtained.

This lesson focuses on water, the "W" in LAWN. Living things are comprised largely of water (2/3 of the human body is made up of water and 9/10 of the weight

of most plants). Water serves as a medium for nutrient transfer within the body, as a medium for metabolic reactions, and provides structural support for individual cells. Water is also one of the key ingredients in the photosynthesis process. At the same time, the amount of water varies from place to place and from environment to environment. Students might have been exposed to ideas such as "cacti do not need water." This, of course, is not true.

If a potted plant is allowed to grow indefinitely and no water is added, the plant will eventually be unable to absorb enough water to meet its needs and will droop and wilt or become shriveled. If the plant is watered soon after wilting and recovers, it has reached its temporary wilting point. When wilting is extreme, the plant will not recover; it will have reached its permanent wilting point and will have died.

V. Materials Needed (for each group of 3–4 students)

- 2 identical plants with average water needs (pansies, impatiens, petunia, etc.)—use the same plant for all groups in the entire class
- sunny outdoor area for growing plants (a small table, cart, or bench that can be moved inside at night works well if no space is available) or a sunny windowsill
- labels to place on sides of pots
- marking pens
- data sheets
- measuring cups
- water
- for entire class, two small cacti in pots

VI. Procedure

Guide your students through a discussion of the needs of living things. When discussing each need, describe it as representing a natural resource. Then discuss underlying concepts related to the resource. In this case, explore water as a natural resource. Discuss the water cycle, local seasonal weather patterns, and factors affecting water quality and availability.

Explain to the students that they will be doing an experiment to see if plants really need water. Describe the two treatments and the methods for recording observations, and then ask them to formulate a hypothesis about what is going to happen in the experiment. Ask students to be specific in their predictions. Discuss scientific methods with your students and ask them to determine which variables are dependent and independent. These early steps will help them reason through the process and analyze the results in a critical and thoughtful manner.

1. Divide the class into groups of 3–4 students.
2. Provide each group with two plants that are as similar as possible in height, number of leaves, etc.
3. Label one plant with group name/number and the word "water" (for instance, "Table 1— water"). Label the other plant with group name/number and the words "no water" ("Table 1—no water").
4. Use the data sheet at the end of this lesson plan to write out a hypothesis for the experiment and to make initial, baseline measurements of each plant's height, number of leaves and flowers, and their respective color. These may change during the experiment, so it is important to accurately record these measurements at this time.
5. Place all the plants that are labeled "water" in one area in a sunny location outside or on a windowsill.
6. Place all the plants that are labeled "no water" in a nearby, identical area in a sunny location outside or on a windowsill. If it is raining, place plastic over the top of these plants to prevent them from receiving any water.
7. At the same time as initiating the experiment above, label and place one cactus in the "water" location, and one in the "no water" area.
8. Establish a routine for watering the plants that are labeled "water"—check them every day, and water them when the soil begins to dry out.
9. Repeat measurements of both plants at least once a week.
10. Carry out the experiment for 4 weeks and then have students record their results on their data sheets, as well as on classroom charts and graphs that summarize the data for the whole class.
11. Discuss the results.
12. Continue monitoring the cacti for several months to see what happens as time passes.

VII. Discussion Questions

1. What happened to the plants that received regular water during this experiment?
2. What happened to the plants that did not receive any water?
3. Do you think plants need water in order to grow? Why or why not?
4. How long did it take for the plants that did not receive any water to show signs of stress? What signs of stress did you notice?
5. Is it possible to revive the unwatered plant at this point by giving it water?
6. How does the unwatered cactus compare with the first plant you studied? Does it show signs of stress? What do you notice? (We will discuss adaptations

to limited water resources in another lesson plan.) What features do cacti have that help them survive in an environment with limited water availability?

VIII. Discussion Questions Related to *Reading Plants*

After your visit to the Huntington Botanical Gardens, explore the following questions:

1. The amount of water varies considerably for each of these environments. How would you characterize water availability in a desert environment? (*Seasonally, deserts receive less than 10 inches or precipitation per year—water is limiting much of the time!*)
2. How would you characterize water availability in a rain forest environment? (*It can rain every day in the wet tropical rain forests, or be more seasonal in some places—water is usually abundant in these environments, up to 200 or 300 inches a year!*)
3. How would you characterize water availability in a pond or marsh environment? (*Water is available year round—in fact, plants without special adaptations to being partially or completely submerged can become waterlogged and rot.*)

IX. Extension Activites & Web Links

Try growing two cacti (both of same species and size) and two water-loving houseplants like *Spathyphyllum* (both of same species and size) in well-drained soil. Water one cactus and water-loving houseplant every day; water the other cactus and water-loving houseplant once a month (or less, you can play with this). What happens?

Now try the same thing with another set of 4 plants (two cacti and two water-loving houseplants), but this time plant them in clay soil that includes a lot of peat. What happens this time?

See also lesson plans What Plants Need in Order to Survive and Grow: Light and What Plants Need in Order to Survive and Grow: Air.

Educating Young People About Water (University of Wisconsin)
Search a database of water-related curricula.
< http://cf.uwex.edu/ces/erc/eypaw/search.cfm >

Water Science for Schools (United States Geological Survey)
Background, links, and online activities related to water.
< http://wwwga.usgs.gov/edu >

Water: Environmental Education Center (Environmental Protection Agency)
Curriculum, activities, and lessons from the EPA and others.
< http://www.epa.gov/teachers/curriculumwater.htm >

Water: Teacher's Guides (Sea World / Busch Gardens Adventure Parks)
Activities and lessons mostly on physical properties of water for grades 4–8.
< http://www.seaworld.org/Water/water.html >

Vocabulary

nutrient a necessary ingredient for a plant's growth and survival, such as, nitrogen or potassium

photosynthesis the process in plants by which the sun's energy (light energy) is captured by chlorophyll and converted to chemical energy that is stored in sugars, by combining carbon dioxide (CO_2) and water (H_2O) to make sugars ($C_6H_{12}O_6$) and release oxygen (O_2):

$$6CO_2 + 6H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

Do Plants Need Water?

Name:_____ Date:_____

Name of plant: _____

My hypothesis:

Procedure I used:

Water	No water
Baseline—first day of experiment Date: Height of main stem: # leaves: color of leaves: # flowers:. color of flowers:	***Baseline—first day of experiment*** Date: Height of main stem: # leaves: color of leaves: # flowers:. color of flowers:
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Results and conclusions: