What Plants Need in Order to Survive and Grow: Soil

Grades 3–6

I. Introduction

Plants, like all 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

- In any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all (4–3.b).

Earth and Space

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

- Soil is made partially from weathered rock and partially from organic materials and that soils differ in their color, texture, capacity to retain water, ability to support plant growth (2–3.c).

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).

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).
- Identify the dependent and controlled variables in an investigation. Construct and interpret graphs from measurements. (5–6.d).

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

- ♦ In any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all (5.D. 3–5).

Grades 6–8

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

- ♦ The number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition (6–5.e).

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).

  - Students will 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 because the quantity or quality of resources varies from one ecosystem type to another. 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 soil nutrients, the "N" in LAWN. Although plants make sugar (glucose) through the process of photosynthesis, they must still take up other essential nutrients (nitrogen, phosphorus, potassium, calcium, magnesium, etc.) from the soil to create the complex molecules that enable them to grow.

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

- 2 scarlet runner bean seeds per student (available in nurseries and garden centers)
- 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
- soil
- small pots (4" pots are good, plastic pots work fine)
- paper towels
- labels to place on sides of pots
- marking pens
- data sheets (see below)
- measuring cups
- water

VI. Preparation

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 soil as a natural resource. Soil types are related to underlying geological strata (rock layers) as well as to local topography. There are many obvious connections with studies in earth science as well as conservation.

Explain to the students that they will be doing an experiment to see if plants really need soil in which to grow. Ask them to describe how they think soil benefits plants (structural support for anchorage, source of water, and source of many nutrients). 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. Provide each student with two identical scarlet runner bean seeds.
2. Students should label two pots with their name.
3. Fill one pot with soil.
4. One seed should be planted about one inch deep in the pot filled with soil.
5. The other seed should be placed in a folded paper towel and placed in the empty pot.
6. Use the data sheet at the end of this lesson plan to write out a hypothesis for the experiment and to make initial, baseline observations of the seeds.
7. Place all student pots in a sunny location. Each student should keep his/her pots next to one another, side by side.
8. Establish a routine for watering the pots and be sure that both pots receive regular moisture (the measuring cups can be used to quantify this). The independent variable in this experiment is the quantity of soil, not water, so it is important that both pots receive adequate and regular water (the paper towel is used to hold the seed in place and to retain moisture).
9. Make measurements of seed germination and growth in both pots at least once a week.
10. Carry out the experiment for 6–8 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.

VII. Discussion Questions

1. What happened to the seeds that were planted in soil? How tall were they by the end of the experiment?
2. What happened to the seeds that were planted in the pot with no soil (just a paper towel)? Did they germinate? Did they grow as tall as the seed planted in soil? Why or why not?
3. Do you think plants need soil in order to grow? Why or why not?

VIII. Discussion Questions Related to ***Reading Plants***

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

1. Soil characteristics vary tremendously from place to place and environment to environment, depending on the underlying rock types as well as the plant cover (vegetation type). How would you describe the soils in the Jungle Garden?

(*Potentially tropical soils could contain lots of organic matter, although organic matter quickly disappears in the tropics!*)

2. What would you guess about the basic needs of plants growing in soils in the rain forest? (*They require ample nutrients and water*.)
3. How would you describe the soils in the Desert Garden? (*Desert soils are low in organic matter, often rocky and well drained*.)
4. What would you guess about the basic needs of plants growing in desert soils? (*They tolerate low (and sporadic) amounts of moisture and organic matter in the soil*.)
5. How would you describe the soils in the Lily Pond Garden? (*High in organic matter, poor to no drainage*.)
6. What would you guess about the basic needs of plants growing in soils in the pond environment? (*They require ample nutrients and are tolerant of waterlogged soils.*)

IX. Extension Activites & Web Links

See lesson plan Rooting into the Soil on the Huntington's web site, as the two go together very well.

Many students may have heard that some plants can grow in trees (epiphytes) or in water (hydroponics). Here is a brief explanation of each.

Plants that grow in the branches of trees and other plants are called epiphytes. Epiphytes that are ferns or flowering plants have roots, stems, and leaves, just like their terrestrial cousins. Epiphytes are most abundant in the tropics in areas where there is sufficient moisture so that the roots do not dry out too much. Often seeds of epiphytes will germinate in a small amount of soil that may have accumulated in the fork of a tree branch. Nutrients may be absorbed from those leached by the leafy canopy above. Epiphytes may be observed during a visit to the Huntington Botanical Gardens in the Jungle Garden.

Hydroponics is a means of growing plants in nutrient solutions; these solutions are comprised of water that contains dissolved fertilizers, instead of the more common culture of plants in soil that contains nutrients. Plants grown hydroponically may be cultivated with or without the use of an artificial medium (vermiculite, sand, gravel, perlite, peat moss, and others) to provide structural support. A visit to a local greenhouse where plants are grown hydroponically might be arranged.

Hydroponics (University of Arizona)
Article from Hortscience giving an overview of hydroponics.
< http://ag.arizona.edu/PLS/faculty/MERLE.html >

Digging Deeper: Kidsgardening (The National Gardening Association)
Lessons, stories, and activities related to soils and hydroponics.
< http://www.kidsgardening.com/Dig/dig.asp?act = t >

Soil Investigation: The GLOBE Program (National Oceanic and Atmospheric Administration)
Background and activities to record soil characteristics.
< http://www.globe.gov/sda-bin/wt/ghp/tg + L(en) + P(soil/Contents) >

Soiled Again: Great Plant Escape (University of Illinois at Urbana-Champaign)
Online "case" to solve involving soils.
< http://www.urbanext.uiuc.edu/gpe/case2/case2.html > (online mystery)
< http://www.urbanext.uiuc.edu/gpe/tg/tg-case2.html > (teacher guide)

Vocabulary

epiphyte	a plant that grows upon another plant, but does not derive nutrients from the host plant (not a parasite)
hydroponics	the growing of plants in water and liquid nutrients
nutrient	a necessary ingredient for a plant's growth and survival, such as, nitrogen or potassium

Do Plants Need Soil?

Name:_____ Date:_____

Name of plant: _____

What the seeds look like:

Procedure I used:

Soil		No soil (paper towel)	
How many days to germinate? _____		How many days to germinate? _____	
Date:	Height:	Date:	Height:
Date:	Height:	Date:	Height:
Date:	Height:	Date:	Height:
Date:	Height:	Date:	Height:
Date:	Height:	Date:	Height:
Date:	Height:	Date:	Height:
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Results and conclusions: