



Botanical Garden Programs: Reading Plants

WHAT PLANTS NEED IN ORDER TO SURVIVE AND GROW: LIGHT



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 light 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 use carbon dioxide (CO₂) and energy from light to build molecules of sugar and release oxygen (5.2.f).

Grades 3–5 (cont.)**The Living Environment**

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

- ◆ Some source of “energy” is needed for all organisms to stay alive and grow (5.E 3-5).
- ◆ 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).

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).

Grades 6–8**Life Sciences**

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

- ◆ Plant cells have chloroplasts, in which photosynthesis takes place, as well as cell walls (7.1.a).
- ◆ Energy entering ecosystems as light is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs (6.5.a).

The Living Environment

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

- ◆ Food provides molecules that serve as fuel and building material for all organisms. Plants use the energy in light to make sugars out of carbon dioxide and water. This food can be used immediately for fuel or materials or it may be stored for later use. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms (5.E 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).
 - 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 the “L” in LAWN—light. Leaves capture energy from the sun and convert it to glucose (sugar), a process called **photosynthesis**. Plants use this energy to power the construction of living tissue so that they can grow and reproduce.

Leaves contain **chloroplasts** where photosynthesis occurs. During photosynthesis, chlorophyll (the green pigment contained in chloroplasts) captures the energy of sunlight and transfers it to other molecules within the chloroplast. There, radiant energy from sunlight, carbon dioxide from air, and water and nutrients absorbed by the roots are combined to make glucose (sugar). Oxygen is a byproduct of photosynthesis and is used by most living things (including plants) to carry on **respiration**.

Sunlight provides energy, and it also gives off heat. All plants survive within a range of temperatures that provide the appropriate warmth in which to carry out metabolic processes, and sunlight is the primary source of this warmth. Temperatures and light levels vary seasonally in temperate zones, having a profound effect on the yearly growth (and dormancy) cycles of plants in these regions. Day length is known to be a cue for the internal production of flowering and fruiting hormones for some plants. This is the reason that some plants that have been brought to southern California from other latitudes may not flower, fruit, or leaf out as they would in their native environment.

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

- ◆ 2 identical plants that grow in full light under ordinary conditions in a garden (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
- ◆ cupboard in which plants can be placed
- ◆ labels to place on sides of pots
- ◆ marking pens
- ◆ data sheets (see below)
- ◆ measuring cups
- ◆ water

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 light as a natural resource. Help students understand the concept of photosynthesis, during which radiant energy (sunlight) is converted to chemical energy by plants. There are many lesson plans available on photosynthesis (see extension activities).

Explain to the students that they will be doing an experiment to see if plants really need light in order to grow. 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 “light” (for instance, “**Table 1—light**”). Label the other plant with group name/number and the words “no light” (“**Table 1—no light**”).
4. Use the worksheet 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 “light” in one area in a sunny location outside or on a sunny windowsill.
6. Place all the plants that are labeled “no light” in a cupboard that is completely dark when the door is closed. Place black construction paper over the shelf or opening so that, if the cupboard door is opened, the plants do not receive light.
7. Establish a routine for watering the plants that are labeled “light”—check them every day, and water them when the soil begins to dry out. Also check the plants in the cupboard and keep them watered, if needed. (Note: in this experiment, the amount of light is the only experimental (independent) variable, so it is important to keep plants in both locations evenly moist.)
8. Repeat measurements of both plants at least once a week.
9. 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.
10. Discuss the results.

VII. Discussion Questions

1. What happened to the plants that received ample light during this experiment?
2. What happened to the plants that did not receive any light?
3. Do you think plants need light to grow? Why or why not?
4. How long did it take for the plants that did not receive any light to show signs of stress? What signs of stress did you notice?
5. Discuss the difference between a plant’s need for light and your own needs. Do you both need light on a regular basis? Why or why not? Upper grades might explore how the human body manufactures Vitamin D in the presence of light. Most organisms depend on the sun for optimal temperatures in which to live.

VII. Discussion Questions Related to *Reading Plants*

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

1. Notice that even in the shade of the floor of the Jungle Garden there is measurable light. You have learned from your experiments what happens if plants receive no light at all. What types of features do you see in the leaves of the rain forest plant that you think helps them to maximize the amount of light they receive? How does this compare with desert plants?

VIII. Extension Activities & Web Links

See lesson plan **Learning From Leaves: Adaptations to Differing Light Levels.**

Using the plant that was kept in the dark during the experiment, see if it is possible to revive the plant grown in the dark at this point by placing it out in the light. Move it out into bright, indirect light, possibly on a windowsill, and continue recording observations. If the plant is unable to recover, what happened to it? (*Its tissues were too badly undernourished to revive.*)

A next step to the study of photosynthesis is the exploration of food chains and food webs. Discuss the idea of energy flow in a natural system and emphasize the dependency of all of life on the sun as a source of energy. Discuss the linear transfer of energy, food chains, food webs, and decomposition.

What is Photosynthesis? Photosynthesis Center (Arizona State University)

Links to web sites on photosynthesis with many lesson plans.

< <http://photoscience.la.asu.edu/photosyn/education/learn.html>>

Virtual Cell (University of Illinois)

Model of a plant cell with a chloroplast.

< <http://www.life.uiuc.edu/plantbio/cell>>

Vocabulary

<i>chlorophyll</i>	the green pigment in plants that captures the energy of light and enables them to make sugars
<i>chloroplast</i>	an oval-shaped body in plant cells that contains chlorophyll and is the site where photosynthesis and starch formation occur
<i>photosynthesis</i>	<p>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 (CO₂) and water (H₂O) to make sugars (C₆H₁₂O₆) and release oxygen (O₂):</p> $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
<i>respiration</i>	<p>the process in living organisms by which sugars (C₆H₁₂O₆) are combined with oxygen (O₂) to form carbon dioxide (CO₂) and water (H₂O), and to release energy for the organisms' use in growth, etc.:</p> $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}$

Do Plants Need Light?

Name: _____ Date: _____

Name of plant: _____

My hypothesis:

Procedure I used:

Light	No light
<i>Baseline—first day of experiment</i>	<i>Baseline—first day of experiment</i>
Date: Height of main stem: # leaves: color of leaves: # flowers: color of flowers:	Date: Height of main stem: # leaves: color of leaves: # flowers: color of flowers:
Date: Height of main stem: # leaves: color of leaves: # flowers: color of flowers:	Date: Height of main stem: # leaves: color of leaves: # flowers: color of flowers:

<p>Date:</p> <p>Height of main stem:</p> <p># leaves:</p> <p>color of leaves:</p> <p># flowers:.</p> <p>color of flowers:</p>	<p>Date:</p> <p>Height of main stem:</p> <p># leaves:</p> <p>color of leaves:</p> <p># flowers:.</p> <p>color of flowers:</p>
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Results and conclusions: