Learning from Leaves: From Observation to Inference

Grades 4–6

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).

The purpose of this lesson is to teach students how one can examine a plant and learn about how it meets these needs. First, students examine leaves from plants found in three habitats: desert, tropical rain forest, and wetland. Then, they research those habitats, share their discoveries, and return to examining the leaves, now armed with enough information to make inferences about the plants.

II. Objective

- Students will employ the scientific processes of observation, comparison, and description to make inferences about the habitats in which particular plants have evolved.

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).
- Ecosystems can be characterized by their living and nonliving components (4-3.a).
- 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).

Grades 3–5 (cont.)

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 differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations (4.6.a).

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).

The Living Environment

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

- Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce (5.A 6-8).
- 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).

IV. Background

The subject of this lesson is the adaptation of plants to their environments. Environment includes all the living (biotic) and nonliving (abiotic) conditions that surround an organism (its habitat). Abiotic factors include climate, soils, and events like lightening. Biotic factors include surrounding organisms and the actions of those organisms that affect the plants, like eating them. Plants' basic requirements for living include both biotic and abiotic factors, but this lesson focuses on abiotic factors reflected through leaf structure.

Light: Through photosynthesis, plants convert energy from the sun into energy for their growth and maintenance; green plants need the sun. Many plant structures ensure the exposure of leaves to light, as branches hold leaves up to the sun. However, there is a limit as to the amount of light a plant's photosynthetic system can absorb without being destroyed. Plants sunburn when moved suddenly from a low light to high light situation. In environments with lots of sunlight, plants protect themselves from overexposure to the sun.

Air: The sugars produced through photosynthesis are made of carbon molecules from the air. Without access to carbon dioxide, photosynthesis would not occur. Carbon dioxide is a naturally occurring component of the Earth's atmosphere, and, fortunately for aquatic plants, of most water. In addition, plants require oxygen for respiration, the breakdown of sugars to release energy for use in metabolic processes.

Water: Water is the stuff of life. The sugars produced by photosynthesis and many other compounds will mix with this universal solvent. Water is the source of pressure within individual plant cells that keep them inflated, rather than limp. (Think of what happens when plants begin to dry out: they wilt.) Water moves constantly throughout the plant and is constantly being lost as vapor escapes from the leaves through tiny openings called stomata. In tropical plants from wet areas, loss of water may not be a problem. In plants that grow in water, it is usually no limitation, but in the desert, development of adaptations to conserve water has been paramount.

Nutrients: Plants get their nutrients from the soils in which they grow. The abiotic mineral portion of soils supplies anchorage and nutrients. Abiotic water in the soil is the solvent in which nutrients enter plants through their roots. A biotic source of nutrients in soil is organic matter, including plant and animal matter undergoing decomposition, and soil organisms and their products.

V. Materials Needed

- reference materials on wetland habitats, deserts, and tropical rain forests, which may include textbooks, encyclopedias, nature books, or web sites
- leaf or cutting of *Elodea* or another aquatic species (from an aquarium store); make sure they don't dry out before class
- leaf or cutting of *Philodendron* or another tropical forest species (from plant store); make sure they don't dry out before class
- leaf or cutting of *Crassula* or another species from a dry environment (from plant store or the yard); make sure they don't dry out before class
- magnifying lens
- data sheets (see below)
- pencils or pens

VI. Procedure

Guide students through a discussion of the needs of living things. Discuss how plants might meet those needs in different environments.

1. Divide the class into three groups.
2. Hand out data sheets and leaves of the three plant types, one to each group.

3. Ask the students to examine the leaves, observing their structure and shape. Have them use a magnifying lens, if one is available. Observation: What do they notice? Description: How would they describe the leaves' size, shape, color, and texture? Comparison: How are the leaves similar and how are they different? Have the students record their observations by drawing their three leaves, and making written notes on the data sheet.

    - Desert leaf: small, spherical, light gray, waxy
    - Tropical rain forest leaf: large, flattened, dark green, waxy
    - Aquatic leaf: small, flattened, dark green, delicate

4. Now, moving away from direct observation of the leaves to research, assign one habitat to each group: wetland, desert, and lowland tropical forest. Ask each group to prepare a brief verbal presentation about the environmental conditions of their habitat: climate (light, water, air), and soils (nutrients). Students should use reference materials to create their presentations, but the reports should be brief.

5. Next, return to observation of the leaves. Tear the leaves and observe their internal structure. Can you infer why the leaves have their structure?

    - Desert plants generally have waxy coverings on their leaves to reduce water loss through the leaf surface. These leaves may be almost spherical to reduce surface area, again to reduce water loss. These leaves are often light green or gray, to limit the amount of light that enters the leaf. Many desert plants also store water in their leaves.
    - Tropical rain forest plants live in low light environments, under the canopy of taller trees. Their dark color and large size gathers as much light as possible. These leaves also have a waxy coating to repel water.
    - Aquatic plants generally have very soft, delicate leaves as they do not have to contend with water shortages. These leaves are usually very dark green since they gather light while under water.

VII. Discussion Questions

1. What are the basic needs of a plant and how do leaves help a plant meet those needs?
2. Why are leaves generally green?
3. What do the soft, delicate leaves of aquatic plants suggest about the habitat in which they live? Would you expect to find them in ponds, slow rivers, or rushing creeks?
4. How do desert plants protect themselves from being eaten?

5. Other than growing larger and larger leaves, how to tropical rain forest plants gather enough light?

6. Did your ideas about the leaves change once you knew something about where they lived?

Vocabulary

abiotic	nonliving, as opposed to biological or biotic
adaptation	a change in plants and animals over many generations in response to environmental conditions
biotic	the living factors of an environment
climate	the temperature, humidity, precipitation, light, wind, and other weather normal in an area
environment	conditions; all the conditions around a plant or an animal, such as, amount of space in which to live, climate, other plants and animals, etc.
habitat	the natural environment in which a plant or animal lives
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): $6CO_2 + 6H_2O + \text{light energy} \longrightarrow C_6H_{12}O_6 + 6O_2$
respiration	the process in living organisms by which sugars ($C_6H_{12}O_6$) are combined with oxygen (O_2) to form carbon dioxide (CO_2) and water (H_2O), and to release energy for the organisms' use in growth, etc.: $C_6H_{12}O_6 + 6\,O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$
stoma (*pl. stomata*)	a very small pore in the surface of a leaf (oxygen and carbon dioxide from the air enter through the stomata; oxygen, carbon dioxide, and water vapor leave through the stomata)

Learning from Leaves:
From Observation to Inference

Name:_____ Date:_____

Observations	Leaf 1	Leaf 2	Leaf 3
Size			
Color			
Shape			
Texture			

Environmental Conditions	Desert	Wetland	Tropical Rain Forest
Light			
Air			
Water			
Nutrients			

Adaptations to Environment:	Leaf 1	Leaf 2	Leaf 3
Light			
Air			
Water			
Nutrients			

Environment