Reading Plants

Objective of program: For students to be able to "read" from a plant's appearance how it is adapted to its environment. Students will visit gardens that represent two ecosystems (desert/arid regions and jungle/tropical rain forest), observe how plants have adapted to each environment, and make basic environmental measurements.

I. **GENERAL CONCEPTS** (the groundwork for concepts to be introduced in each garden):

A. **Parts of the plant and the functions of each:**

1. Roots – take up water and nutrients, anchor plant in ground
2. Stems – main supportive parts of the plant above ground, part of the transport system (water and minerals from roots, nutrients manufactured in leaves to other parts of the plant), sites of water loss by evaporation
3. Leaves – main sites of photosynthesis (process by which plants make their own sugars and generate oxygen using light, water, and carbon dioxide), sites of water loss
4. Flowers or cones – reproductive parts of a seed plant (pollination, fertilization, and seed production)

B. **Basic needs** of all plants:

1. Light – sunlight provides the energy to drive photosynthesis
2. Air – carbon dioxide for photosynthesis and oxygen for respiration
3. Water – needed for photosynthesis, to transport nutrients, and to provide structure
4. Nutrients – necessary ingredients for a plant's growth and survival, such as nitrogen or potassium, used to build complex molecules

C. **Environment** – the conditions around a plant or animal, including space in which to live, climate, soils, other plants and animals, etc. Climate includes weather elements such as rainfall, temperature, wind, sunlight, and seasons that are normal to an area.

D. **Adapting to an environment** – at the species level, changes in plants or animals over many generations that increase the chances of reproduction and survival in a particular environment; can contrast with how individuals adapt to their environment

E. **Limiting factor** – an environmental factor that limits the success or one or more organisms in a given community or ecosystem, acting to restrict one or more of its functions.

IDEAS FOR TEACHING THE INTRODUCTION

Advance organizers

What do you know about plants?

What do plants need to live? (try to get to LAWN)

Where/how do plants get these things they need?

This is the Reading Plants program. What could it mean to "read plants"?

The environment is not the same everywhere in the world: every place does not have the same amount of rainfall, sunlight, heat, or wind. Yet plants live just about everywhere on the planet. How do they manage to live in all these different environments?

II. **TROPICAL RAIN FOREST** / Jungle Garden

A. Characteristics of tropical rain forests: ample rainfall, humid, constant high temperatures, several layers of evergreen vegetation form levels from the emergent canopy to shady understory, soil is nutrient poor due to leaching, fallen plant material decays quickly and nutrients are immediately taken up by plants.

B. Environmental factors and plant strategies to deal with them:

1. **Light (limiting factor)**: Intense competition leads to a variety of ways of obtaining enough light.

    a. Some trees grow up very tall (up to 200') and overshadow the understory. Since they are buffeted by tropical storms, many tall trees have buttress or prop roots to support them in the shallow tropical soils.

    b. Rather than producing thick stems themselves, climbing vines with flexible, woody stems (lianas) use the tall trees for support to grow up out of the shady understory into the light.

    c. Other plants live upon other the branches or trunks of trees in order to take advantage of their height. These epiphytes do not derive their nutrients or water from their host plants, but gather rainwater and moisture from the air, and collect nutrients from plant debris.

    d. Large leaves are another strategy for gathering light in the dimly lit understory.

    e. Leaves are often very dark green to capture sunlight.

2. **Air**: Plants have adapted to tropical storms.

    a. Tall trees have buttress roots to help keep them upright.

    b. Plants growing at the edge of the forest may have parallel veins in their leaves; that way, when the leaves are ripped in the wind, they can continue to photosynthesize.

    c. Lobed leaves, leaves with small, flexible leaflets, or leaves with holes also allow wind to pass through without damaging them.

3. **Water**: To shed water quickly from frequent rain, many leaves have waxy surfaces, point downward, and have points at their tips (drip tips). This quick movement of water across the surface of the leaf also discourages the growth of epiphylls.

4. **Nutrients**: To quickly gather nutrients from decaying plant materials before it is washed away by rain, plants grow shallow roots that sometimes reach up into the leaf litter. Litter is recycled in six weeks in tropical rain forests.

QUESTIONS FOR THE JUNGLE GARDEN

Advance organizers

When I say the word 'jungle,' what images come to mind?

How would you describe a tropical rain forest?

Which of our four plant needs (LAWN) do you think might be in short supply in a tropical rain forest? Which might be plentiful?

Observation, comparison, prediction, and factual questions

O Tell me what you notice about this environment. What else do you notice?

C How does it compare to the lawn/Desert Garden?

O Tell me about the plants you see here. Tell me about their leaves, their shapes, their colors. What else do you see?

P How might large, dark-green leaves help a plant to live here?

O How do the leaves feel?

O When I squirt water on this leaf, what happens to it? Describe the path the water takes, tell me where it goes.

P What advantage might vines get from climbing up other plants?

O Using the light meter, decided which plants receive more light: the vines or the plants on the forest floor.

(On windy days)

C How does the air feel here compared to out in the open?

P How might it feel at the tops of the trees?

Review

Light: low light on forest floor, so large, dark green leaves

Air: usually still, but may be windy at forest edges or in the canopy top, so leaves may have holes to let wind pass, rip along their veins so wind won't damage them, or be small to avoid water loss

Water: plentiful, so leaves shed water with waxy coating and shape

Nutrients: not much in soil, so plants grow shallow roots to recycle nutrients quickly

III. **ARID ENVIRONMENTS** / Desert Garden

A. Characteristics of arid environments, like deserts: scarce water, poor soils, high light intensity, temperature extremes, plants tend to be close to the ground.

B. Environmental factors and plant strategies to deal with them:

1. **Light (liming factor)**: Intense light calls for specific adaptations.

a. Some plants grow mostly underground or only come up during cooler, wetter times of year to avoid the intense light and extreme temperatures.

b. Many plants furnish their own shade, through rosette shapes, spines, ridges, or by growing in clumps.

c. Light coloring (light green, gray or whitish), reflects light that may otherwise burn photosynthetic tissues.

2. **Air**: Deserts are windy places of extreme temperatures.

a. Spines and hair reduce wind speed over the surface of the leaves and stems.

b. Insulation protects plants from temperatures extremes. Hairs, felt, and succulence insulates some plants.

Water (limiting factor): Avoiding drought has been a driving force in the adaptation of plants in dry environments.

a. Strategies for storing and capturing water

i. Thick, fleshy, water-storing leaves (leaf succulence) or fleshy, green, photosynthetic stems with leaves reduced to spines or entirely absent (stem succulence)

ii. Expandable, accordion stems or funneling water to the roots (with rosette shapes, grooves, or ridges)

iii. Extensive, shallow roots, or deep tap roots

b. Strategies for minimizing water loss and evaporation

i. Tiny leaves that fall off in times of drought (drought deciduous)

ii. No leaves and photosynthetic stems (stem succulence)

iii. Waxy coatings on leaves and stems (cuticle)

iv. Exist as a seed or bulb during dry seasons or years (dormancy)

4. **Nutrients**: Available nutrients low, so plants grow rapidly when rains make nutrients available and have large, shallow root systems to catch the nutrients found in the upper soil.

QUESTIONS FOR THE DESERT GARDEN

Advance organizers

When I say the word 'desert,' what images come to mind?

How would you describe a desert?

Let's pretend we are going to the desert for the day. What would you bring along with you?

Which of our four plant needs (LAWN) do you think might be in short supply in a dry region? Which might be plentiful?

Observation, comparison, prediction, and factual questions

O Tell me what you notice about this environment. What else do you notice?

C How does it compare to the lawn/Jungle Garden?

O Tell me about the plants you see here. Tell me about their leaves, their shapes, their colors. What else do you see?

C How do these leaves compare with the leaves of plants in the Jungle Garden?

P Why do you think the leaves might look that way?

O How do the leaves feel?

P How might waxy, white leaves help a plant to live here?

P What might spines do for a plant?

O When I squirt water on this leaf, what happens to it? Where does the leaf direct the water?

P How might the shape of this plant help it in gathering water?

F Using the light meter, can you tell if the whitish plants reflect more light than the darker plants?

Review

Light: plentiful, so to moderate their exposure to heat and sunlight plants may grow underground (including as seeds), make their own shade, have light colored leaves or stems

Air: plentiful, but windy and extreme temperatures, so plant have hairs and spines so slow the wind and insulate from high and low temperatures

Water: scarce, so plants may have many forms of succulence, expandable stems, extensive shallow root systems, deciduous leaves, thick cuticles, and dormant periods

Nutrients: usually poor, so plants have large, shallow root systems to capture nutrients during rains.