Activity: Turning Over a New Leaf

Grades K-6

Overview

Students examine variations in leaves and consider how leaf adaptations can help plants survive in different environments.

Background: Adaptations

Diversity among living things occurs, in large part, due to adaptations to environmental conditions. Any particular trait that appears randomly through sexual reproduction (the combining of genetic information) may give an organism a better chance of surviving a particular environmental condition. Certain plants may have characteristics (e.g., slightly harder seed coats, hairier leaves, or stronger odor) that increase their chances of survival in a particular environment. For example, if a milkweed plant has a particularly nasty poison in its leaves that helps it survive and spread more milkweed seeds, its offspring will likely have more poison in its leaves as well. Over many generations, these qualities become finely tuned and are known as "adaptations." Plants lacking these traits have a poorer chance of survival in that environment. Their descendants will eventually die out.

Characteristics such as flower color, shape, texture, and odor, for example, are adaptations that evolve over many thousands of years in response to the vital need to have pollen transferred from flower to flower. In many cases, flowers and pollinators co-evolved adaptations (e.g. the long tongues and tubular flowers of butterflies). Because we use the term 'adapt', a common misconception is that individual things can consciously develop adaptations to different environmental conditions. Remind students that adaptations are chance structural and behavioral features that an organism already possesses that enable it to survive and reproduce in its particular environment.

Specific Plant Adaptations

Every living thing is actually a conglomeration of many adaptations. All of those features help plants meet needs and survive, as covered in other chapters (e.g., how plants transport water, produce food, or get pollinated), are actually adaptations.

In addition to seed dispersal and germination, leaves are adaptations as well. Leaves come in as many shapes and sizes as the habitats in which they live. They have many adaptations that help the plant meet its needs. For example:

- To reduce water loss: small surface area (fennel), a thick, waxy coating (jade plant), and surface hairs (porterweed)
- To resist insect predation: toxins in leaf tissue (milkweed), and rapidly-growing vines (passionvine)
- To transpire excess water easily: larger leaf with more stomata (hibiscus)

Weeds are plants with many adaptations to help them compete with other crops. The term "weed" is very subjective. A plant is labeled a weed when it grows where we don't want it. Depending on one's perspective, a field of mustard can be an unwanted nightmare or a valuable cash crop.

Groundwork

Objective: To recognize that leaves have many structural variations.

1. Set the stage by asking: "How would you describe a leaf? How are all leaves alike? What are some of the differences?" Generate a list of different leaf characteristics.
2. Initiate a leaf scavenger hunt. Using the leaf characteristics generated by you and your students, create a scavenger hunt list. Give each small group of students the list, and walk into the garden to discover how many leaves they can find on the list. Be sure to look under the leaves of larval plants, such as milkweed, to discover any butterfly eggs that may be there.
3. Students should draw the leaves they find or mark on a map where they're located (rather than collecting them). Touching or smelling the leaves can add to the characteristics observed.

Time:

Groundwork: One-to-two days
Exploration: One-to-two days
Making connections: Ongoing

Materials:

- **6 plastic bags, 2 large enough to fit over a potted plant**
- **2 sponges of 2 different thicknesses**
- **Hand lenses**
- **Collect 6 different leaves from the garden (or find 6 observation stations in the garden) (small vs. wide, aromatic vs. non, hairy vs. smooth)**
- **Bring one potted plant, and one silk plant, into the classroom a day ahead of time, and tie a plastic bag around each. Water droplets should form on the inside of the bag before this activity.**

Standards At-A-Glance

Next Generation Sunshine Standards Met:

SC.K.N.1.1, SC.K.N.1.2, SC.K.N.1.3, SC.K.N.1.4, SC.K.N.1.5, SC.K.P.8.1, SC.K.L.14.3, SC.1.N.1.1 SC.2.N.1.1, SC.3.N.1.1, SC.4.N.1.1, SC.1.E.5.3, SC.1.N.1.2, SC.1.N.1.3, SC.3.N.1.3, SC.1.N.1.4, SC.1.L.14.1, SC.1.L.14.2, SC.1.L.14.3, SC.2.L.16.1, SC.3.N.1.3, SC.3.N.1.6, SC.3.N.1.7, SC.3.P.8.3, SC.3.L.14.1, MA.3.A.4.1, MA.3.A.6.2, SC.4.N.1.4, SC.4.N.1.5, SC.4.N.1.6, SC.4.N.1.7, SC.5.N.1.1, SC.5.N.1.2, SC.5.N.1.5, SC.5.N.1.6

4. Once the leaves have been drawn, have students discuss:
   How are all these leaves the same?
   How are they different?
   Why do you think there is so much variation among leaves?
   Which leaf characteristics do you think might be useful to the plant? How?

Exploration

Objective: To comprehend that leaves have different adaptations that enable them to survive in specific environments.

1. Create four stations with leaves from the butterfly garden and plants from elsewhere, and discussion questions related to each station.
   a. Station 1: Function of leaves. Students examine each plant, record the differences between them, and infer the function of leaves from what they found. Hand lenses allow students to explore stomata in a leaf.
   b. Station 2: Water storage. Students examine how quickly a large leaf wilts, as compared to a smaller leaf. Cassia and hibiscus leaves are good to compare. Use the two different sponge widths to talk about the volume of leaf area related to water storage. (Share that thicker leaves can hold more water, and waxy coatings help keep water inside a leaf.)
   c. Station 3: Aromas. Have students explore different leaves with and without smell, and hypothesize as to what advantage the aroma could have to the plant. (Share that many plants produce scents that repel predators or attract pollinators.)
   d. Station 4: Hairs. Have students compare the hairy and non-hairy leaves, and hypothesize as to what function the hairs could serve. Ask: "Do you think a bald head or a hair-covered head would dry out faster? How do you think leaf hairs might feel to an insect looking for a meal?"
2. Have pairs of students visit each of the stations, in numerical order, during the course of a day or two. They can do so during free time. Let students know that each station focuses on one or more leaf adaptations. Have each pair of students record their observations.

Enrichment

1. Discuss why there isn't one generic, all-purpose leaf shape.
2. Give students an imaginary scenario and have them create a "designer plant," specifically adapted to those conditions.
3. What adaptations do plants and animals have in common to help fend off predators?
4. Write a story from the standpoint of a weed desperately trying to convince a gardener of its virtues.

Extensions for Middle and High School Students

1. Many plants open their stomata only at night. Why did this adaptation evolve? (Stomata lose less water at night.)
2. Research human uses of plant leaves for such things as food, fiber, medicines, spices, and cosmetics. Consider how we make use of certain plant adaptations, e.g., for flavoring.
3. Have students discuss weeds. Why do we have negative images of weeds? Some insects and butterflies use weeds (dandelions etc.) as food sources.
4. Research ways people try to eradicate weeds. Debate the pros and cons of weed control.
5. Have students "take a stand" on a virtual opinion line. If one end of the classroom represents the opinion that all weeds should be eradicated, and the other end represents the view that all weeds should be allowed to stay, where do you stand?
6. Observe butterfly behavior in the garden. Which flowers do they prefer at what times of day? How do butterflies drink from different flower shapes? Create a graph of these observations.

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Sample Pre-Post Assessment

1. A thick, fleshy leaf is an adaptation that helps a plant:
   a. Protect itself from predators
   b. Follow the sun across the sky
   c. Store water in its tissues
   d. Reproduce quickly to ensure its genetic viability

2. Circle all these that are adaptations:
   a. Leaves
   b. Roots
   c. Stems
   d. Flowers

3. Design a plant that is well-adapted to a Martian environment that is hot, windy, crowded with other plants and has many predatory insects. Label the adaptations:

4. A plant living in a cold area with very little rainfall would likely have a (circle one):
   a. Large, thin leaf
   b. Small, thick leaf