LESSON 17

Plant Adaptations

Grade level: K-8
Subject Areas: Life science
Duration: 1 class session (includes a brief walking trip which perhaps can be done right around your school neighborhood) OR one 15-minute session on one day followed by a 30-minute session the next day
Setting: Classroom and a field site
Season: Spring, Summer, Fall
Conceptual Framework Topic: Plant adaptations to environment

OBJECTIVES

Students will understand that some plants have very specific adaptations that allow them to exploit different environments and survive under a range of conditions. How plants conserve water is one important adaptation that is readily observable.

METHOD

Students observe different kinds of plants and their leaves and discuss how they are adapted to differing levels of water availability. They compare plant types in varying micro-habitats around the schoolyard or other field site. They then predict traits of successful invasive species and compare their predictions to invasive species in Montana.

MATERIALS

- ✎ A variety of leaves (wide, narrow, hairy), conifer needles, a cactus plant if available.
- ✎ Hand lenses (enough for each student or to share)
- ✎ **Adaptations Worksheet**
- ✎ Photos of plants from very different environments (e.g., rain forest, desert, alpine)
- ✎ *Optional:* A stalk of fresh celery or a white carnation, jar of water and a few drops of food coloring

BACKGROUND

Plants have evolved into millions of species that have been able to survive in virtually the entire range of habitats on earth, from under the sea to the tops of high mountain peaks, from rainforests to the driest deserts on earth, from sweltering heat to freezing cold. Unlike animals, plants cannot move around to get what they need, including protection from weather and predators, and food and water. But they have developed an incredible range and variety of features that help them deal with this challenge.

One basic need of plants that varies hugely in the amount needed by type of plant and its availability from place to place is water. Some species can spend their entire lives submerged in it. Others can live on amazingly little. (In fact, there are species of geophytic (ground-loving) cacti that live in the driest places on earth, including the Atacama desert in South America, parts of which haven't had rain for hundreds of years, and receive only moisture from ocean fogs. The cacti live entirely underground, which helps them retain moisture, receiving light through the translucent desert sand.)

In Montana we have no such extreme. But we do have a wide range of moisture conditions, from the temperate rainforest of cedar and hemlock in the Northwest where more than 60 inches of precipitation fall each year, to the plains of eastern Montana where annual precipitation is usually less than 15 inches. Overall, Montana, like most of the West, is relatively arid compared to the rest of the country.

Many plants have evolved strategies for minimizing water loss. Since almost all water loss occurs when water evaporates from the leaves (through tiny openings called *stomata*), many adaptations are to the leaves. These include reduced surface area on narrow and/or small leaves (think of grasses and needles), tiny "hairs" on leaves which reflect the sun and keep leaves cooler, and thicker, tougher leaf walls and waxy leaves which help keep water in. The most extreme examples are the cacti, most of which have reduced their leaves to spines so they lose very little water, and do all their photosynthesizing through their green stems.

PROCEDURE

1. Ahead of Time: Look for an outdoor site where you can see patterns of plant distributions due to moisture conditions (e.g., a slope and flat area, different slope aspects (directions), a depression, drainage, or source of surface water, etc.). You may observe primarily narrow-leaved species such as grasses and small forbs growing on dry sites like south-facing slopes or well-drained flat areas, coniferous trees on north slopes, and larger-leaved plants like deciduous shrubs and trees in low areas or near surface water. In some areas these patterns may be very obvious, while in others there may be very subtle variation on a smaller scale. One thing to keep in mind is that humans may create artificial environments through ditches or other water sources.

2. In the classroom, ask your students what everything needs to survive. They may mention several things such as food, water, shelter, etc. Tell them you're focusing on water today.

3. Ask why plants need water. What do they use it for? How does water move in plants? You may want to review with them the photosynthetic process, and show them with a simple drawing how water is taken in through the roots, moves up the stems and into leaves, and then evaporates through *stomata*, tiny openings in the leaves.

4. *Optional* (if you do this step, you may want to resume the lesson the following day with step 4.) Cut the bottom inch off the stalk of celery and place the stalk into a jar of water that has several drops of food coloring in it. Ask your students what they think will happen. Leave this overnight next to a window. (The food coloring should move up the celery stalk gradually.)

5. Ask your students if they think plants ever end up without enough water to survive. What, if anything, can they do about it? Can they move to a better place? If necessary, explain that plants can't move but they have adapted over time (generations) so that some species can live in dry areas.

6. Ask them what they would do if they were hot and dry in the sun. (They may come up with wearing a sun hat, using an umbrella, getting in the shade, turning away from the sun, drink water, etc.)

7. Now show them the variety of leaves you have brought. Discuss what they see. Why might they be so different from one another? Which type grows in what kind of environment? Remind them of how water moves through plants. If necessary, help them understand how each type of adaptation (size, hairiness [called *pubescence* in plants], thickness, etc.) helps plants reduce water loss. Ask them if they can think of any drawbacks to having smaller leaves or hairy leaves. (Because plants need to gather sunlight through green leaves and stems, there is a trade-off to reducing water loss in these ways.)

8. Take a walk and look at what types of plants grow where. For example, you may notice trees growing on north slopes but not south or west slopes. Trees and bushes may grow only in draws on some mountains or hills. Deciduous trees and shrubs may be by streams and lakes or other sources of water. In the driest places you may see mostly grasses and other narrow-leaved plants. Ask students if they can explain some of the patterns they see based on what they know about plants conserving water.

9. While near one of the driest areas you find on your walk, discuss other adaptations plants might have for water loss and other factors. If you planted 2 plants in this location, one more adapted for conserving water than the other, which would probably do better?

10. Imagine that seeds from a plant that grows far away, perhaps on the other side of the world, are brought to Montana by humans in some way. What kinds of plants would probably grow best in our climate? Knowing what they now know about adaptations to conserve water and the kinds of plants that grow in their area, can they predict some of the traits that might allow plants from other areas to thrive here? Have students make a list of some of these traits, using the worksheet provided. Use this list to compare to the traits of some of Montana's noxious weed species. Students may want to look at photos or descriptions of invasive species on a web site such as **www.mtwow.org** or **montana.plant-life.org**, or in a printed resource like the *Montana's Noxious Weeds* booklet published by MSU Extension.

Extensions

Examine photos of plants from very different parts of the world (rain forests, deserts, swamps, etc.) and observe different adaptations to conditions.

Name _____

Plant Adaptations Worksheet

Traits that make it easier for plants to thrive in Montana:

Invasive plant species in Montana that have these traits: