WILD Kids

7-12 Published by the Arizona Game & Fish Department - Education Branch and the Heritage Fund Number 4

Desert Plant Adaptations

Plants that live in the desert have adapted to conditions such as lack of moisture, unrestricted sunlight and in many cases, high temperatures. Even though these conditions may seem harsh to us, many plants not only survive but thrive and reproduce. How do plants accomplish this?

There are three main strategies for desert survival. Some desert plants may even use more than one of these strategies. The first is the ability of many plants (and not only desert plants) to store water. This is called **succulence**. Succulent plants store water in fleshy leaves, stems or even roots. Examples of succulent desert plants include cacti and agave. In general, succulent plants have shallow roots, can begin growth within 24 to 48 hours of rainfall, and use crassulacean acid metabolism (CAM).

Shallow roots allow plants to quickly absorb any moisture, even moisture in the form of dew. Plants with shallow roots can even utilize some of the water from a torrential rainstorm, even though most is lost to runoff.

The best example of a plant that begins noticeable growth within 24 to 48 hours of rainfall is the *ocotillo*. For most of the year, ocotillo look like a bunch of dead, thorny branches sticking in the ground. But after the first really good rainstorm, ocotillo begin to produce leaves. The leaves begin photosynthesis immediately, to produce food that the ocotillo can store for later use. Once the desert begins to dry out again, the ocotillo drops its leaves. Leaves tend to leak moisture, so by dropping leaves the plant retains moisture. By growing only when water is available, a plant saves its resources until the conditions are right for it to grow.

Crassulacean acid metabolism (CAM) is a type of photosynthesis that many desert plants use to make food during the day without losing much water. Lets begin at the beginning. Photosynthesis occurs in all plants. It is the process that plants use to make food from sunlight, water and CO_2 (carbon dioxide). Plants also have little microscopic pores, called stomata, in their leaves that allow for the passage of CO_2 and O_2 (oxygen). Unfortunately, when stomata open to allow CO_2 in, water can escape, especially in the heat of the day. So, PROBLEM 1 - How do plants allow CO_2 in and avoid losing water? ANSWER 1 - Plants open stomata at night when temperatures are cooler. PROBLEM 2 - If plants take in CO_2 at night, how do they photosynthesize without sunlight? ANSWER 2 - Desert plants store the CO_2 in the form of crassulacean acid. As a new day begins and temperatures rise, the crassulacean acid is changed back into CO_2. It can then be used in photosynthesis.

The second strategy for desert survival for some plants is called **drought dormancy** or **drought deciduous**. These plants survive periods of drought by conserving water through reduced metabolism and dropping their leaves. Reduced metabolism is also called “idling metabolism.” **Metabolism** is the process of maintaining life through chemical and physical means. Thus the plant does not completely shut down, but greatly slows down its metabolism by recycling carbon dioxide and using stored water. The “idling metabolism” is just barely enough to keep the plant alive. In this manner, the plant does not have to start its metabolism up again from scratch when the conditions are just right for growth and reproduction. Think of it this way: Two cars come to a red stop light. Both stop. One car turns off its engine, while the other just idles. The light turns green. The car that was just idling can now go. The other car has to turn on its engine first, warm up and then go. If these cars were desert plants, the idling plant would be able to use the rainfall and begin growing before the other plant. This little bit of an edge may be all that is needed for the one plant to survive while the other died.

Desert plants will also drop their leaves during drought or times of excessive heat. Examples include mesquite, acacia, palo verde and ironwood trees, creosote and ocotillo. Remember, leaves are leaky. They can lose water through stomata. By dropping leaves the plant is conserving water. Water can no longer escape through the stomata. But then, how do plants photosynthesis without leaves? Some do not, but others do. Look carefully at a palo verde tree. What does its name mean in English? Palo verde trees have the mechanisms for photosynthesis in their bark (making the bark look green!). Thus they do not need leaves to photosynthesis, they can photosynthesis with their green bark. Can you think of other examples?

The third type of desert survival strategy that plants use is called **drought avoidance**. There are two kind of drought avoidance. The first is used by **annual plants** - plants that live for only one season. These desert plants dry up and die during drought but store moisture, oil, fat, sugar and protein in seeds. The seeds are protected by a thick, almost waterproof coating. This coating may contain "anti-germination" chemicals. These chemicals do not allow the plant to germinate as long as they are present in the seed coat. But the chemicals can be washed out by rainfall. Thus, if there is enough water to wash out the chemicals, there will probably be enough water for the seed to germinate, mature, reproduce and make new seeds before the moisture is gone.

Another type of drought avoidance is used by plants with tap roots. Tap roots are extra long roots that can grow down to the water table underground. There the roots have an almost constant source of water. This allows the plants to stay green and growing through the long hot and dry season. Mesquite trees are a good example of a plant with a tap root. The average length of the tap root on a mesquite tree is 60 feet!

There are other ways in which plants retain moisture in the desert. Some plants have waxy or oily leaves (creosote and jojoba). The wax and oil prevents water from escaping through the stomates. Wax and oil are also somewhat shiny, reflecting light and reducing the temperature of the leaves. Cooler leaves lose less water. Other plants have "hairy" leaves. These hairs are not true hairs like on mammals but a extension of the **epidermis** (skin or upper most surface). The hair shades the surface of the leaf, reducing the temperature of the leaf and thus water loss. Other plants have very small leaves or no leaves at all. Cacti have no leaves! Small leaves means there is less surface from which water can evaporate. Even spines can help the plant retain water.

Activity I: Shade and Spines

This is an outside activity so get permission from your teacher before you do it. You will need a pencil, paper, ruler, a spiny cactus and maybe gloves.

Find a cactus that is small enough for you to measure and not shaded by other plants. One day go out and measure the total surface area of the cactus. If it is a prickly pear-type cactus measure both the front and back sides of each pad. If it is a barrel-type cactus, measure the pleats in and out and its height.

The next day go back to your plant around mid-morning or mid-afternoon. Now comes the tricky part. Measure all the area that is in shade. Make note of the amount of shade due to spines and the amount due to another part of the cactus shading itself.

How much of the plant is in shade? What percentage is due to spines? Do spines substantially shade your cactus or others in your class? If your cactus has pleats, what percentage of shading is due to pleats alone? Spines? Both?

Activity II: Evaporation

This is an indoor activity, but you need a window. You could even do this at home and report your findings back to your class. You will need three glasses that are exactly the same, water, cooking oil, and hair from a hair brush.

First, in the morning, fill each glass with the same exact amount of water. Mark the glasses on the outside at the water level. To one glass, add 1 tablespoon of cooking oil. To the second, add hair from your hair brush (or your moms, sisters, friends, etc.). To the third, add nothing. Note the temperature near the window. Set all three glasses on the window sill and leave them there all day.

After 24 hours, mark on the outside of the glasses where the new water line is. What volume, if any, of water was lost? Which glass lost the most water? Why? Which glass lost the least water? Why?

Repeat this experiment another day when it is warmer or cooler. Does temperature affect the outcome? Why or why not?