Exploring Buds in the Winter

Overview: Leaves and flowers start out as buds — compressed or undeveloped tissue — that usually protrude from the surface of a plant's stems. Use this lesson to explore how environmental conditions influence the growth of buds, and how plants developed adaptations to keep buds from growing during challenging conditions.

Grade Level/Range: 6th- 8th Grade

Objective:
Students will learn:

- Many plants enter a period of dormancy to help them survive winter conditions.
- Most plants begin developing leaf and flower buds for next spring's growth during the end of the previous growing season.
- Some plants require a certain number of chilling hours before their buds will begin growing in spring.

Time: 3 to 4 weeks

Materials:
Pruners
Exacto knife or hammer (optional)
Deep container (e.g., bucket or tall vase)
Variety of branches from fruit trees and/or shrubs

Background Information:

In all but the warmest regions, most plants go through a period of dormancy during the winter. Actively growing plants cannot withstand freezing temperatures for an extended time. As a result, plants have adapted by entering a state of rest during the coldest months, until good growing conditions return in spring.

How do trees know that the cold weather is coming? What makes them begin slowing down and preparing for dormancy? The "hardening-off" process is, at least in part, a photoperiodic response; that is, it is a response to changes in day length. As the days grow shorter, plants slow and finally stop any new growth. Deciduous plants withdraw nourishment from the leaves and enter a fully dormant phase.

How do plants know when spring has arrived and it's safe to begin growing again? What if there are some unseasonably warm winter days that could "fool them" into thinking winter is over? Suppose a tree were to break dormancy during a January thaw. The new delicate growth would quickly succumb to the next cold spell. Plants native to temperate regions have evolved strategies to prevent such mishaps.

One strategy is to have specific chilling requirements. A plant's chilling requirement is the number of hours that the plant must be exposed to temperatures between 32F and 45F before the plant breaks dormancy (most notably to trigger the growth of the flower buds). Times when the temperature drops below 32F or rises above 45F do not count toward the chilling requirement. Chilling requirements are generally measured in hours; incredibly, plants are somehow able to keep track of the number of hours they are exposed to this very specific range of temperature!

This phenomenon of chill hours is most closely followed in fruit trees because it so greatly influences the fruit harvest. Prior to choosing a type or variety of fruit tree to plant, it's critical to research its chilling requirements to ensure they match your conditions. If fruit trees do not get enough chill hours, their flower buds will not break dormancy and little fruit will develop. However, if you plant a fruit tree that has a lower chill requirement than typically found in your location, it will fulfill its chill requirement too early and the sensitive flowers might bloom before winter is truly over.

Chill hours vary greatly by crop and even by varieties within a crop. Here are some ranges of average chilling hours required by different types of fruit trees:
Apple: 800 – 1,000 chill hours
Cherry: 700 – 1,000+ chill hours
Fig: 100-200 chill hours
Peach: 300 – 800 chill hours
Pear: 400-900 chill hours
Plum: 400-700 chill hours

This wide range in chill hours may seem confusing, but that is due to a diversity of varieties within the same species. Bringing it down to practical terms, as you research fruit trees, you will notice that you do not find trees labeled solely as "apple" or "pear." Rather you will find labels like 'Golden Delicious' apples and 'Bartlett' pears.

Plants are grouped by similar characteristics, and each species is given a two-word classification (a Latin genus and species name) to distinguish it from other plants. However, a new seedling or vegetative shoot may exhibit characteristics that 1) are different enough from the species to warrant a special classification but not so different as to be considered a separate species, and 2) make it worthy of cultivation in its own right. We call these plants varieties if they occur in nature, and hybrids or cultivars (short for "cultivated variety") if scientists develop them in plant-breeding programs. Both are the result of genetic material being mixed during sexual reproduction.

Using apples as an example, the scientific classification (genus and species) for most edible apples is *Malus domestica*. However, according to the U.S. Apple Association there are over 2,500 of varieties of apples. Varieties and cultivars may differ from each other in several ways that include, but are not limited, to:

- Physical characteristics (e.g., 'Red Delicious' apples produce red fruit and 'Golden Delicious' apples produce yellow fruit)
- Tolerance for different growing conditions (e.g., 'Dorsett Golden' apples need just 100 chill hours to produce fruit, but 'Granny Smith' apples need 600 chill hours)
- Harvest time ('Ginger Gold' apples ripen five weeks earlier than most other varieties, while 'GoldRush' is a late-ripening apple)

On a scientific level, the different classifications among varieties and cultivars can be very complex, but on a practical level, they make it easier for gardeners to find the plants that will perform best in their garden.

Laying the Groundwork:

- Contact your local extension service for a list of the best fruit tree varieties for your area. For links to your local extension office, visit https://www.extension.org/. Most likely their list will include the chill hour requirements, but if not, research this information.
- Also, determine how many chill hours your area has received this year. Mississippi State University Extension has

developed an App called Chill Hours (https://webapps.msucares.com/chill_hours/) to help you uncover this information. You could also determine this information on your own by compiling temperature data from local weather stations.

Exploration:

1. Obtain samples of branches from a variety of fruit trees in your area. If you do not have any fruit trees on your school grounds, reach out to local farmers, your local extension office and/or local botanical garden or arboreta and ask if they might be able to provide you with sample branches. Make sure to carefully label your samples with the name of the tree and variety. Look up the chill hour requirements for each of the samples obtained.

2. Allow students to dissect a few of the buds present on the branches. Ask them to predict whether they are flower or fruit buds. Flower buds tend to be present on younger branches and tend to be a bit more plump than leaf buds. If you cannot tell them apart, label your predictions and go back and compare after they are given time to grow.

3. Based on your research of the number of chill hours your area has experienced this year and the number of chill hours your samples require, have students make predictions on whether they think the flower buds are ready to begin growing.

3. Try to bring your branches into bloom in the classroom by placing them in water. To make sure the branches quickly absorb water use one of the following methods: 1) Scrape off a 3-inch strip of bark with a knife or scissors along the side of the stem near the bottom, 2) Use an Exacto knife to cut an X into the base of the branch, or 3) Use a hammer to gently crush the end of the branches. (Try experimenting with each of these techniques.) Next, place the branches in lukewarm water for a day or, if possible, submerge the whole stems in water overnight.

4. Put the cuttings into a container of cool water and place it away from heaters and direct sun. Mist the branches daily to simulate spring rains and keep the buds moist and full. Change the water and cut an inch off stems each week.

5. Watch your branches for 3 to 4 weeks. Record observations and at the end discuss why your branches bloomed or did not bloom when brought indoors to warmer conditions.

Making Connections:

As a class discuss some of the following questions:

- Why are chill hours important? Why is this a valuable adaption for a plant?
- How is this adaption linked to the plant's survival? Why is it so important for a plant to make fruit each year?

Branching Out:

- Buds can be used to help identify deciduous trees and shrubs during winter months. Find a plant ID guide that includes pictures of buds and test your skills identifying common trees and shrubs in your schoolyard or a local nature area using this plant characteristic.

- Explore the buds of other types of plants and enjoy an early spring by bringing in other types of branches into bloom in your classroom. Here are a few you may want to try:

Good Candidates for Forcing Blooms	
Early-flowering trees and shrubs (cut in late January/February) ash, azalea, birch, elm, forsythia, hazelnut, maple, mulberry, redbud, plum, pussy willow, sumac	**Later-flowering trees and shrubs** (cut in late February/March) apple, cherry, crabapple, dogwood, elderberry, honey locust, honeysuckle, magnolia, mountain ash

Link to Standards:

NGSS: MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.