9. Winter Bud Activity

Description: Students closely observe tree and shrub buds and make detailed drawings while on a winter hike. Back in the classroom, students connect twig structures to their functions.

Objectives: Students will:

- develop skills of observation and recording;
- observe and ask questions to make discoveries; and
- learn the structures and functions of twig parts.

Materials:

- Field Journals or plain white paper
- Handouts (add to Field Journals before trip): *Winter Buds - Student Guide; Winter Buds -- Twig Terms -- Student Reference Sheet*. For classroom, *Plant Function Analogy Challenge!*
- Tape/glue
- Pencils
- Colored pencils
- Hand lenses or magnifiers
- Rulers

Optional preparation for classroom:

- Shears or pruner
- Large bag to hold twigs of assorted broad-leaved plants

Phenomenon: Many plants in winter just look dead, but they can grow again in spring.

Lesson Questions:

- *What features of winter twigs can I identify?*
- *What analogies can I use to explain the functions of twig parts?*

9. Winter Bud Activity

Grades: 1–12

Time: one or two class periods and field exploration

Subjects: science, art

Terms: *analogy, axillary bud, bud, bud scales, bud scale scar, bundle scar, chill hours, deciduous, gibberellin, internode, leaf scar, lenticel, node, phenology, pith, prickles, spine, terminal bud, thorn, whorled*

New Mexico STEM Ready! / Next Generation Science Standards

NGSS DCIs

NOTE: see **NGSS Connections to *Going Out: Field Activities*** at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

1.LS1.A Structure and Function
4.LS1.A Structure and Function
MS.ESS3.D Global Climate Change

NGSS CCCs

Patterns; Structure & Function

NGSS SEPs

Asking Questions & Defining Problems; Developing & Using Models

Background:

> "The approach of autumn, with its showers of many-colored leaves, spells the end of the season's activities in the identification of deciduous trees and shrubs. Without leaves the members of the forest community, unless they be relatively large, seem to lose much of their summer's identity and may even descend to the level of 'brush'. This is in reality not the case, as may be easily discovered by examining any leafless twig with a 10X pocket lens, or even with the naked eye. A casual glance. . .will also serve to show that woody plants in winter are anything but featureless."
>
> —William M. Harlow, Ph.D., 1941 (as reprinted in *Winter Guide to Central Rocky Mountain Shrubs*, 1976)

Deciduous trees and shrubs (those that lose their leaves in winter) may look dead without their leaves, but in reality, they are preparing for the growing season to come. Each type of plant is very different when examined carefully. Trees may be identified during the winter by observing the position, size, shape and texture of the buds and leaf scars on their twigs. This activity encourages students to carefully look at twigs.

Buds begin to form in the autumn when the leaves fall from the trees. **Buds** are the plants' protection from cold and dryness for their new growth. The **bud scales**, which form a cover for this growth, are actually modified leaves. Most buds are usually covered with overlapping scales, but some **scales** are joined along the edges like the two shells of a clam.

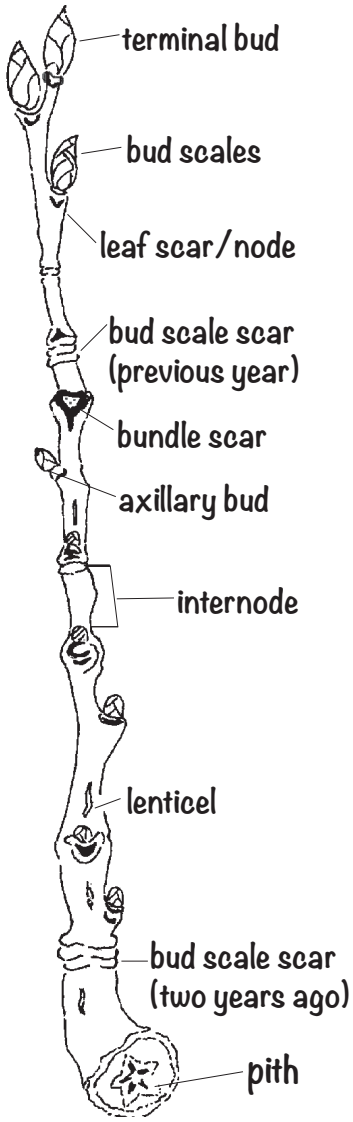
Deciduous plants must enter a period of dormancy in the winter in order to survive freezing temperatures. This dormancy prevents the plant from flowering or producing fruit during winter when it is likely that these tender tissues would be damaged. Each plant species requires a certain number of **chill hours**, with cold temperatures between 34° F and 45° F (1° C and 7° C), in order to leave dormancy and continue growing in the spring. In the seemingly dead twigs, the hormone **gibberellin** (jib-er-EL-in) that is needed for spring growth is forming. This takes place only when it is cold. To use a non-bosque tree as an example, apple trees

need 1,000 to 1,400 hours of these cold temperatures to produce gibberellin, which is necessary for the trees to flower and produce fruit. Warmer winter temperatures due to climate change are already affecting the life cycles of deciduous plants, as the required number of chill hours are no longer being met for some species. This may affect the distribution of many plant species, as well as agricultural crop production, if temperatures continue to rise.

All deciduous trees and shrubs develop new leaf buds after that year's leaves fall off in the autumn, and also develop new flower buds after the existing flowers are spent and fall off. The leaf bud appears at the **leaf scar** where the old leaf was attached to the twig; this is also called the **node**. The buds grow slowly all winter, but in spring they develop very quickly. Look at buds any time, from after the old leaves fall off in the autumn to when the new leaves emerge in the spring. Our spring extends over many months. Siberian elms are one of the first plants to open their flowers, in January or February, while cottonwoods are 2-3 months behind them in April. Note that emergence dates may change as winter temperatures continue to rise. *How would you predict those emergence dates will change, in that case?*

See *Winter Buds—Twig Terms—Student Reference* sheet included below for definitions of terms.

> If you pay attention to the cottonwoods as they wake up in spring, they do not all flower and leaf-out at the same time. We have our native Rio Grande Valley Cottonwood as well as other species of cottonwoods that have been planted here from other areas in the U.S. The transplants tend to leaf-out earlier than our native Rio Grande trees.
>
> See if you can tell where there are differences!



Here are some things to look at closely when inspecting buds:

The bud at the tip of the twig is the **terminal bud**. The **axillary (lateral) buds** on the twig may be attached with a pair of buds **opposite** each other or **alternating** along the stem. Or, several buds may be located at one position on a stem, which allows several leaves to emerge from all sides at that position; this type of arrangement is referred to as **whorled**. These characteristics can be used to help identify a plant even during the winter.

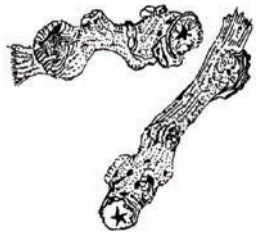
In the scar left after last year's leaf falls, look for several small dots. These were the transportation bundles where the leaf exchanged water and nutrients with the rest of the plant; they are now called **bundle scars**.

Along the stem you can often see small warty spots. Look closely. *Are they bugs?* They are **lenticels**, which are breathing pores for the cells of the inner bark that enable them to take in and release gasses from the atmosphere.

The number of years of a twig's growth can be counted by looking for rings around the twig. Each year at the terminal bud scale, the twig moves into its new growth and leaves a new circular scar, resulting in a set of small rings encircling the twig over time. You can count the number of terminal **bud scale scars** along a twig and know how many years it has grown. You can also compare different years by measuring the distance between the terminal bud scars—*did it grow more one year compared to another year? Why might that be the case?*

Does the plant have prickles, spines or thorns? Is the bark smooth, waxy, fuzzy or hairy? These characteristics may help differentiate the plant from other plants. *How do these features help the plant?*

When you break or cut the twig cross-ways, what does the center look like? In the cross-section of a cottonwood you should find a surprise: the inner **pith** (central stem tissue) is in a star shape! This is a characteristic of all trees in the genus *Populus*.



In this activity, students will carefully observe buds of different shrubs and trees while in the bosque or other outdoor setting. Students will illustrate and label one twig and make written notes describing the twig. Back in the classroom, students will write analogies about the functional connections of twigs and buds.

Procedure:

- Make a KWL chart with your students.

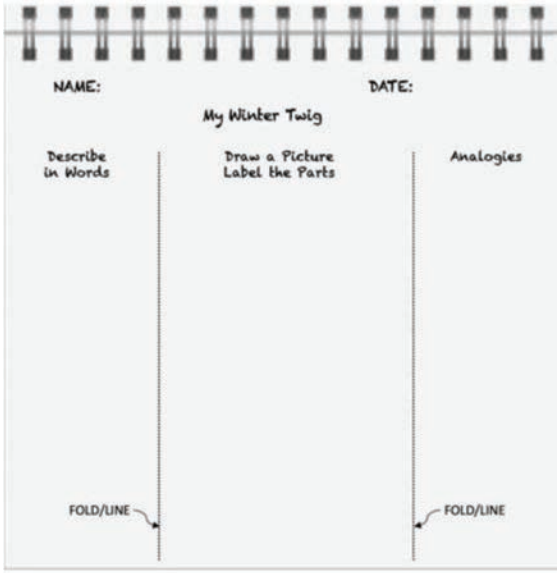
  *What do you **Know** about buds on trees and shrubs?*

  *What do you **Want** to know about buds on trees and shrubs?*

  Ask students how we can find out about buds. Encourage them to think about observation as a method for answering their questions. After the lesson, revisit the chart and ask, *What have you **Learned** about buds on trees and shrubs?*
  (Asking Questions & Defining Problems)

  NOTE: This activity looks at trees and/or shrubs that lose their leaves in the winter (deciduous plants). Evergreen trees and shrubs do not lose their leaves in the winter and do not have the characteristics we are highlighting here.

- Trip to the bosque:
  - Before your trip, copy the *Winter Buds—Student Guide* and the *Winter Buds—Twig Terms—Student Reference* handouts below, trim and glue into Field Journals (or fold and glue along part of the page) for reference while doing drawings.
  - In the bosque, take a "bud hike." Observe buds on many different shrubs and trees. Feel them, smell them, observe their position, color, sheen, etc. Use magnifiers to observe closely.
  - Each student should choose a bud to draw, measure and describe. In their Field Journals, have them make three columns, labeled as in the picture below, with the middle column wider than the outer two columns. Alternatively, give each student an 8.5" x 11" piece of white paper. Fold the paper into three sections like a science fair display board by having the two sides of the paper meet in the middle. Open it back up and have them put their name on the paper and add the labels as shown below. Have available magnifiers, rulers, pencils and colored pencils.
  - In the center, **draw and label the twig with the buds**. Use the *Winter Buds – Student Guide* and *Winter Buds—Twig Terms—Student Reference* sheets to help identify the parts of the twigs while in the bosque. **For younger students**, you may simplify by looking only at terminal buds, bud scales, bud scale scars and leaf scar.
  - On the left side of the page, students should **write down as many observations as they can about the buds and the twig**. Use descriptive adjectives.
  - You will use the right side of the paper back in the classroom, so just leave that blank while in the field.



OPTIONAL PROCEDURE:

- If weather or other conditions make it impossible to make observations and do illustrations while in the bosque, you may choose to do this activity entirely in the classroom, or take a walk in the schoolyard or neighborhood to look at winter twigs and then do all of the illustrations and other observations back in the classroom.
- In this case, the teacher can cut (using pruning shears) a few short, sample twigs from different trees and shrubs, **preferably from downed branches**. A couple of different twigs for every three or four students are needed.

NOTE: Please limit the amount of cutting you do. There are places such as the Rio Grande Nature Center where cutting will not be allowed. We don't want to have a major impact on the vegetation in the bosque so take only a minimal amount. Look for a downed cottonwood branch with visible buds; these twigs will work well for this activity.

- Classroom
  - Review the parts of the twigs that students labeled in their drawings, and use the *Plant Function Analogy Challenge!* handout to briefly discuss the functional connections of these parts. Depending on the level of the students, you may choose one or all of the following:

    Leaf arrangements along the twig are how the plant places its leaves so that each leaf can get light. *Why is this important?*

    Bud scales protect the tiny growing leaves and flowers through the winter.

    Bundle scars, the dots in the leaf scar where the leaf was attached last summer, are where water and nutrients flowed to and from leaves and the rest of the plant.

    Lenticels, the warty bumps along the twig, are breathing pores for the cells of the inner bark, where air is taken-in and released. Plants take in carbon dioxide from the air and give off oxygen during photosynthesis.

    Prickles, spines and thorns protect the plant from being eaten, especially by larger herbivores (plant-eating animals).
  - Students will now make **analogies** to the functions of the twig parts. An **analogy** is a comparison between two things; to say that something is "like" another thing in some way. *How is a plant part **like** some other thing they know about?* Research shows that students retain information when they think of analogies about what they are learning. Analogies help students make personal connections to the object being observed. The students should think about how the twig or bud is similar in some way to something else they know about or have seen. This also can give students practice in theorizing about the natural world and lead them to question why something looks the way it does. This format is adapted from Kerry Ruef's *The Private Eye*.
  - On the right side of the paper, students **should write down analogies** about the functions of the twig parts and how different parts help the plant using the *Plant Function Analogy Challenge!* handout.
  - Here is an example for a non-winter plant feature: many flowers are scented. *What is an analogy for the function of the smell of a flower?* Humans make and wear perfume to "attract" other people; to smell nice for other people to notice. A flower makes a scent to attract pollinators. Be creative! Have students draw their analogy using the correct plant term(s). **(1.LS1.A; 4.LS1.A; Structure & Function; Developing & Using Models)**

Younger Students

Focus on seasons. When it is winter and the leaves have fallen off the trees, think about, *What will happen to the tree in the spring? What will it look like?* **(Patterns)**

Older Students

- Label drawings with correct terms.
- Compare buds from different types of trees.
- Compare tree buds from different locations, such as the schoolyard or neighborhood and the bosque. *Are the plant species growing at the two locations the same or different?*
- Dissect one bud from the branch. Observe and draw. *What do you think the leaves and flowers will look like in the spring?* Draw their predictions.
- Consider the effects of climate change on the timing of plant life cycles, including the role of gibberellin. *How might increasing winter temperatures affect winter dormancy? The timing of bud and leaf emergence? Flowering and setting fruit? How might such changes in plants affect humans?* **(MS.ESS3.D)**

Assessment:

Students' bud observation sheet/drawing can be used as an assessment.

After the lesson, revisit the KWL chart and ask, *What have you **Learned** about buds on trees and shrubs? Do the students show an understanding of the function of the different structures of the winter twig?*

Extensions:

- Begin this activity in the fall and repeat during the late winter and spring. If a trip to the bosque is impossible, observe tree buds on the school grounds or have someone bring in sample buds from the bosque. Have the students make a bud book to take on their bud-observing trips through the school year—looking for differences as the season changes. (Materials for bud books are white copy paper, cardboard for covers, stapler, colored pencils, or use Field Journals.) Or make a class bud book including all the types of plants observed on a single trip.
- Record the date that each kind of plant emerges with flowers and leaves; seasonal changes like these are called **phenology**. Join the BudBurst project, a community science data collection website from the Chicago Botanic Garden. Students are helping scientists understand the effects of climate change across the country by contributing their own observations to this project.
- In the spring, short branches can be cut, brought into a warm room and placed in a vase of water to force the buds to open earlier than they would outside. With this activity, students can observe the flowers or leaves emerging and see the shape of the plants' leaves. Have the students predict which buds will become flowers and which buds will become leaves, and justify their predictions.

- Write poems about the buds and twigs using the adjectives in their descriptions.
- After the trees have leafed out, students could tape the leaves or do leaf rubbings from the plants they studied into their Field Journals or observation sheets.
- Tree silhouettes: Observe the shapes of trees and shrubs during the seasons. Sketch or photograph.
- Observe leaf cells with a microscope.
- Investigate the differences in the structure of flowers that use wind vs. insect pollination.
- Investigate trees like the cottonwood that have male flowers and female flowers on separate trees (from Greek/Latin **dioecious** = "two houses" [dai-EE-shuhs]).
- Research plant hormones. *How are plant hormones formed and how do they affect plant functions?*
- Investigate the effect of pruning on branch growth.
- Compare results from year to year with your students.

References:

Capon, Brian. 1990. Botany for Gardeners—An Introduction and Guide. Timber Press, Portland, OR.

McKean, William T. 1976. Winter Guide to Central Rocky Mountain Shrubs. State of Colorado Department of Natural Resources/ Division of Wildlife, Denver, CO.

Ruef, Kerry. 1992. The Private Eye: Looking/Thinking by Analogy. The Private Eye Project, Seattle, WA.

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Winter Buds—Student Worksheet

Make a table in your journal with three columns to look like this picture. In the center column, draw your twig. Find the features listed below and add to your drawing. Label the features.
In the left column, use words to describe your twig. Save the right column for use back in the classroom. Terms in **bold** are listed on Twig Terms Student Reference page.

a. Draw and describe the surface of your twig. Does it have a special color or textured covering? (smooth, waxy, fuzzy or hairy) Are there prickles, spines or thorns?

b. Look closely at the bud at the tip of the twig, the **terminal bud**. Draw and/or describe it.

c. What is the arrangement of **leaf scars** along the twig? (opposite, alternate or **whorled**)

d. Draw the **bundle scars**—the scars you can see where last year's leaf fell off (use a magnifier!)

e. Find and examine any warty bumps (**lenticels**) along the twig. Add those to your drawing.

f. Look for rings that circle the twig; each ring is a **bud scale scar**. The distance between bud scale scars indicates the length of one year's growth. Count and record the number of years of growth of your twig.

g. Draw any pointy parts on your twig. Identify them. (**prickles, spines, thorns**)

h. Break the twig at a **node** or cut the twig crossways. Describe any color or shape of the **pith** inside.

The Bosque Education Guide

Plant Function Analogy Challenge!

Use the right column for analogies.

How is a plant part like some other thing you know about? This is an analogy. An **analogy** (a-NAL-oh-gee) is a comparison between two things; to say that something is "like" another thing in some way. Make analogies to the functions of the following twig parts.

Leaf arrangements along the twig are ways in which leaves grow in order to get light to each leaf.

Bud scales protect the tiny growing leaves and flowers through the winter.

Bundle scars, the dots in the leaf scar where the leaf was attached last summer, are where water and nutrients flow to and from leaves and the rest of the plant.

Lenticels, the warty bumps along the twig, are breathing pores for the cells of the inner bark, where air is taken-in and released. Plants take in carbon dioxide from the air and give off oxygen during photosynthesis.

Prickles, spines and thorns protect the plant from being eaten, especially by larger herbivores (plant-eating animals).

Winter Buds--Twig Terms--Student Reference

General

Buds are the place on a plant where a leaf, flower, or stem shoot will grow.

deciduous: (dee-SID-you-us): a plant that sheds all of its leaves in one season

Bud features

bud: the encased, developing leaf or flower. They are just above the leaf scar of one of last year's leaves.

bud scales: modified leaves that cover and protect terminal and axillary (lateral) buds and flower buds; they drop off in spring when the leaves or flowers emerge.

Bud arrangement

terminal bud (also called an apical bud [APE-i ck-al]): the bud at the end of a twig. These begin to form in the fall when the leaves drop off, but continue to change even through the cold of winter.

axillary bud (AX-ill-air-ee) (also called a *lateral bud)*: the buds growing on the side of the twig. The arrangement of axillary buds (and eventually the leaves) can be:

a. *opposite*-a pair of buds at the same point or node

b. *alternate*-one bud at a time a long the twig, usually spiraling along it

c. *whorled* (pronounced like "whirled," but with "or" in place of "i" sound)- several leaves will emerge from all sides at one node.

After buds & leaves drop

bud scale scar: (skaar): place where a previous terminal bud leaves a ring around the stem showing the beginning of a year's growth. You can count the number of bud scale scars (rings) along your stem to find how many years of growth this stem has had.

leaf scar: where last year's leaf was attached to the twig

bundle scar: spot in the leaf scar where the exchange of water and nutrients between the leaf and the rest of the plant occurred

Twig features

lenticels: (LENT-i-sells): breathing pores for the cells of the inner bark, where gases (carbon dioxide and oxygen) are taken in and released

node: the place on a stem where one or more buds, leaves or branches originate

internode: the area and distance between two nodes of the stem

pith: the soft, spongy cells in the middle of the twig; they may darken with age and have a distinct shape in cross-section

prickles: (pronounced like "pickles" with a "pr"): are sharp outgrowths from the bark or skin

spines: are modified leaf parts, hard and pointed

thorns: are modified stems, hard and pointed