The Truth About Trees – 3-5 Life Science

In this lesson, students will learn about important parts of a tree and how they function to support growth and reproduction. Through an experiment and optional modeling craft, students will learn the internal and external structures of a tree. By focusing on two important native trees (cottonwoods and willows), they will understand that trees rely mainly on sunlight and water for survival. Then, students will learn how different tribes/individuals around Montana have used and continue to use plants. Finally, students will engage in a "tree walk" in their backyard, nearby park, or school grounds. They will choose a tree to fill out a worksheet related to the lesson, which includes leaf and bark rubbings.

**This is a two-part lesson. The first part focuses on the parts and structures of trees/plants, using a demonstration experiment and modeling craft to explore those parts. The second lesson will focus on American Indian uses of cottonwood and willow, including tree exploration and journaling.*

Montana Science Content Standards

4-LS1 From Molecules to Organisms: Structures and Processes

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Students who demonstrate understanding can: **Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.** [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin. ****Each structure has specific functions within its associated system.]** [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct an argument with evidence, data, and/or a model.	**LS1.A: Structure and Function** • Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**Systems and System Models** • A system can be described in terms of its components and their interactions.
Connections to other DCIs in this grade-level: N/A		
Articulation of DCIs across grade-levels: **1.LS1.A**; **3.LS3.B**; **MS.LS1.A**		
Montana Content Standards Connections: *ELA/Literacy –* W4.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.		

5-LS1 From Molecules to Organisms: Structures and Processes

5-LS1 From Molecules to Organisms: Structures and Processes		
Students who demonstrate understanding can: **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education*:		
Science and Engineering Practices **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model. (5-LS1-1)	**Disciplinary Core Ideas** **LS1.C: Organization for Matter and Energy Flow in Organisms** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1)	**Crosscutting Concepts** **Energy and Matter** • Matter is transported into, out of, and within systems. (5-LS1-1)
Connections to other DCIs in fifth grade: **5.PS1.A**		
Articulation of DCIs across grade-bands: **K.LS1.C**; **2.LS2.A**; **MS.LS1.C**		
Montana Content Standards Connections: *ELA/Literacy –* RL 5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. RL 5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. W 5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.		

IEFA Essential Understandings

Essential Understanding 1: Tribal Diversity

There is great diversity among the twelve sovereign tribes of Montana in their languages, cultures, histories, and governments. Each tribe has a distinct and unique cultural heritage that contributes to modern Montana.

Key concepts of Essential Understanding 1

- The twelve sovereign tribes, located in what is now the state of Montana, are distinct from one another in their history, culture, and language.
- Tribal sovereignty is the inherent right of tribes to independent self-governance.
- Tribal governments are fully functioning governments that provide an array of services similar to those of federal, state, and local governments.
- The political, demographic, and cultural landscape of Montana has rapidly changed in the last two hundred years.
- American Indian individuals and tribes are still here with distinct and intact governments, languages, and cultures that contribute to modern Montana.

Essential Understanding 2: Individual Diversity

Just as there is great diversity among tribal nations, there is great diversity among individual American Indians as identity is developed, defined, and redefined by entities, organizations, and people. There is no generic American Indian.

Key Concepts of Essential Understanding 2

- There exists no universally accepted rule for establishing an individual's identity as Indian. However, as a general rule, an Indian is a person who has some biological Indian ancestry and is recognized as an Indian by a tribe.
- For millennia, individual tribal groups successfully educated their children using highly effective indigenous pedagogies that imbued Indian children with all the knowledge and skills they needed to thrive in their world.
- Boarding schools and other federal policies of assimilation brought disruptions to the traditional transference of knowledge in tribal communities and have had wide-ranging and lasting impacts on American Indian individuals and communities.
- Students who maintain a strong sense of pride in their language and culture tend not to experience school failure.
- Ideally, school curricula will offer equal recognition of the contributions students' home cultures bring to the learning situation and will help all students develop the self-esteem and self-confidence that can enhance their learning.

Essential Understanding 3: Oral Histories as Valid as Written Histories

The ideologies of Native traditional beliefs and spirituality persist into modern day life as tribal cultures, traditions, and languages are still practiced by many American Indian people and are incorporated into how tribes govern and manage their affairs.

Additionally, each tribe has its own oral histories, which are as valid as written histories. These histories predate the "discovery" of North America.

Key Concepts of Essential Understanding 3

- The term spirituality within a cultural context can be limiting and misconstrued. Spirituality to Indigenous peoples generally refers to one aspect of their worldview in which all things are connected. Spirituality in this context does not necessarily equate to nor denote religion.
- A complex history of pre-Columbian tribal migrations and intertribal interactions, European colonization and Christianization efforts, and federal assimilation policies have contributed to the broad range of spiritual beliefs held by American Indians today.
- Despite this history, Native people have retained their spiritual beliefs and traditions – tribal languages are still spoken, sacred songs are still sung, and rituals and ceremonies are still performed.
- It is not important for educators to understand all the complexities of modern day American Indian cultures; however, they should be aware of their existence and the fact they can influence much of the thinking and practice of American Indians today.
- Humor plays an important role in American Indian cultures, there was no "stoic" Indian.
- Tribal oral traditions, ideologies, worldviews, and the principles and values associated with them, are as valid as other such traditions from around the world and should be accorded the same respect and standing.

- Educators should be aware that portions of these principles and values are private and are to be used and understood by certain individuals, groups, or the entire tribe. Tribal culture bearers, experts, and others can assist educators in navigating these situations.

Learning Objectives

Students will . . .

- understand that trees have many different structures that help with reproduction and growth.
- understand and model the different parts of a tree, including roots, leaves, bark, heartwood, xylem, cambium, and phloem.
- learn about adaptations of cottonwood and willow.
- understand American Indian uses of native plants.
- use observation skills and translate those into a worksheet/nature journaling.

Background Information

For these lessons please review the following topics and/or links you will need to teach these lessons:

Internal parts of a tree

Celery experiment

Information about hydroponics

Montana Natural Heritage Program Field Guide or USDA Fact Sheets and Plant Guides

For more information on plant uses by Montana tribes, refer to the book *Montana Native Plants & Early Peoples* by Jeff Hart and *A Taste of Heritage* by Alma Hogan Snell.

Materials

- Whiteboard and markers
- Cup
- Water
- Food coloring (red or blue)
- Celery (with leaves)
- Scissors/knife
- Cutting board
- Microscope (optional)
- Science journal or paper and pencil
- Access to an outdoor area with trees (school grounds, backyard, nearby park)
- Student Handout 1 and 2
- Student Worksheet 1

Optional craft materials (per student): One toilet paper roll, four different colors of paper or four pieces of paper, markers or pencils, four paperclips, scissors, tape, two pipe cleaners

Procedure

Part One: Tree Structures (45 min. - 1 hr.)

Teacher tip Set up the celery experiment before the lecture. You can have groups of students conduct the experiment or set up the experiment as a class. Make sure to cut off the very bottom of the celery so the end is fresh. As you are doing this, ask students to write a hypothesis on what they think will happen to the celery once the food coloring has been added to the water. This experiment should be done before the tree parts have been discussed to allow it to sit for a whole day. Then, move on to the class discussion.

Class Discussion

Start the lesson by asking students to draw and label all the parts of a tree they know. Have them pair and share their drawings. Ask your students about the common parts they identified and what they think their purpose is.

After this general introduction, have students copy down the internal and external structures of a tree and their purposes. After you introduce a new structure, have students draw a picture next to the definition that will help represent that structure's purpose. Examples below:

Leaves – The leaves are the "kitchen" of the tree because they provide the plant with the necessary food for growth through the process of photosynthesis. Example drawing: food or kitchen appliance

**5th Grade details: Photosynthesis occurs in the leaves, specifically in the chloroplasts. It is a process that converts carbon dioxide and water into glucose (sugar/food) for the tree, with the help of sunlight. Carbon dioxide and oxygen enter and exit the leaves through small holes called stomata.*

$6CO_2 + 6H_2O$ ---sunlight energy---> $C_6H_{12}O_6 + 6O_2$

Roots – Roots help anchor trees to the ground and absorb both water and nutrients from the soil. Example drawing: anchor

Trunk – It is easy to only focus on the bark or "wood" when you think about the trunk of a tree. Really, there are many different parts to the trunk that are necessary for tree survival.

Heartwood – The heartwood is the innermost part of the trunk and is actually dead. The main purpose of heartwood is to provide strength to the tree. Example drawing: flexing arm or hand weight

Xylem – Xylem surrounds the heartwood and will replace heartwood when it dies. The function of xylem is to bring water and nutrients up the trunk from the roots to the leaves. Example drawing: a straw or elevator

Cambium – Cambium is a thin layer that provides new cell growth for xylem, cambium, or phloem. It is often the edible layer of the trunk. Beavers eat the cambium of trees. Example drawing: expanding layers

Phloem – Phloem works in the opposite direction of the xylem, transporting the sugars/glucose produced from photosynthesis in the leaves down to the non-photosynthetic parts of the tree, like the stems and roots. Example drawing: waterfall

Outer bark – The outer bark is what we typically think of when we hear the word "bark". The function of the outer bark is to protect the tree, especially the inner layers, from insects, animals, fire, disease, and other plants. Example drawing: shield

Once you have gone over the tree parts with your class move on to the activity section of this lesson.

Activity 1: Celery Experiment

By this time, the food coloring should have been absorbed by the celery and reached the leaves. If this has not happened, wait longer or cut off a piece of the celery to see if the color has started moving up the stalk. Then instruct students to do the following:

1. Look back at the hypothesis you wrote before the lesson. Now, write down any observations you notice about the celery after it has spent time in the colored water. Are there any changes?

2. Now that you know the different parts of a tree, write another hypothesis on why the color has reached the leaves of the celery and what internal structure might be responsible.

3. Cut the celery into cross sections so you have an individual piece, or work with a partner. Draw a picture of the celery in your journal. Then, pair and share with a partner or in groups your hypothesis and what internal structure you think is now visible from the food coloring.

Teacher tip Discuss with students how the xylem is now visible in the celery. If microscopes are available, have students look at the celery cross sections underneath the microscope.

Activity 2: Tree Parts Modeling Craft (*optional*) (15-30 min.)

Modeling craft instructions can be found in Student Handout 1.

Part Two: Cottonwood and Willow - Plant Survival and American Indian Uses (1 hr.)

Class Discussion

Review the process and formula for photosynthesis. Have students critically look at the photosynthetic formula and create an argument, individually or as a group, for why growing plants with just water and sun can be successful. Have them write down their argument in their journal.

Plants do not need soil to grow, but the soil provides mineral nutrients close to the roots. You can grow plants successfully with only a mineral water solution and sunlight or grow lights. This type of growth is called hydroponics, which translates roughly to "water labor". (Wonderopolis 2020)

Every plant needs water and sunlight, but there are two local plants that are more dependent on water for survival than others. Ask students to think of a time they have been near a body of water, for example, the Yellowstone River. Are there any plants they found in abundance near those water sources?

Cottonwood and willow are plants in the same family, and therefore share similar traits. They are highly water dependent and can be found along the banks of bodies of water. This water dependency has led to some unique adaptations.

Activity 3: Learning about The Trees

Show students pictures of cottonwood and willow from Student Handout 2 (an alternative is taking students to visit these plants if they are accessible to the school). Have students pair and share observations from the pictures and make educated guesses as to some of the unique adaptations these plants have. Some answers may include:

Willow – Willow is a highly flexible plant. It can sway and easily bend when rivers flood. It is highly suited to grow in sandy soil and thrives along riverbanks. Therefore, it is purposely planted for bank stabilization.

Cottonwood – Cottonwood depends on flooding to spread its seeds and create new populations. The "cotton" carrying the seed will land in water. When the water rises and floods, it will deposit the seed on the now moist banks. Cottonwood can grow very large and be almost completely hollow and still remain alive. In times of drought, cottonwoods can cut off water to certain branches. This sacrifice allows the rest of the tree to survive.

IEFA Connection: Transition into talking about how students use plants in their everyday life. Have students write down some of these examples in their journals. Prompt students to think of general categories that plant uses can be put into.

Three main uses include food, medicine, and materials. (Have students write these in their journals.) For a long period of time, American Indians of our area have used, and continue to use, native plants *(native plants meaning plants that exist and that have evolved on a specific landscape naturally)* in these ways. When Europeans arrived, they brought their own uses and knowledge of European plants. They learned a lot from American Indians. Shared knowledge of native plants has been passed down from generation to generation, especially in Indigenous cultures.

Ask students how they could use cottonwood and willow after understanding some of the plant's properties.

Next, have a discussion on how American Indians in Montana have, and continue, to use cottonwood and willow.

Plains Cottonwood Uses

In the sacred Cheyenne Sundance Ceremony, the central pole of the lodge is constructed from a cottonwood tree. (Hart 1976 p130)

"Mary Fisher, a Cheyenne woman, said that the fruits produced various colors - red, green, yellow, purple and white. She tested the colors by marking them on sandstone, claiming that different fruits gave different colors, and with them painted tipis and suitcases." (Hart 1976 p 131) The fruits referred to are the buds.

William Clark and his expedition constructed canoes from the trunks of cottonwood trees for transportation down the Yellowstone River.

Salish, Pend d'Orielle, Kootenai, and Blackfeet used the sweet inner bark and sap of the cottonwood for eating (Hart 1976 p 131). Deer, elk, and beaver also enjoy this sweet inner bark, known as cambium.

Willow

Willow's highly flexible nature makes it ideal for making rings and hoops. "Ring the Stick" is an "almost universal American Indian youth game," (Traditional Games 2009 p 2) that uses willow to make a ring held together with sinew and attached to a stick. The goal of the game is to start with the ring on the floor, jerk the stick up, and catch the ring on the end of the stick as it flies through the air.

Willow bark contains salicin, which when digested, turns into salicylic acid - the active compound in aspirin. Alma Hogan Snell, a Crow medicine woman, mentions that Crow elders would make a ball out of the sweet layer underneath the willow bark and chew on it as a headache remedy (Snell 2006 p 150). "Cheyenne Indians employed willow bark shavings . . . to make a tea for diarrhea and other stomach complaints." (Hart 1976 p 115)

Activity 4: "Tree Walk" (30 minutes)

Teacher tip Demonstrate to students how to do a leaf and bark rubbing before you have them do Student Worksheet 1 and/or independent nature journaling. Note: you can have students do the prompts and answer the questions from Student Worksheet 1 in their journal rather than on the actual worksheet.

Activity

Using their learned knowledge of trees, students will now go on a tree walk to incorporate some of their knowledge into nature journaling. Instruct students to find a tree on their school grounds, backyard, or nearby park and complete Student Worksheet 1.

Assessment

Activity 1 Review science journals. Points may be awarded for completion of written hypotheses and observations. Points should also be awarded for notes taken during the structures lecture.

Formal Assessment of Celery Experiment

Points Earned	Experiment Participation 5 pts total	Journaling and Hypotheses 10 pts total	Comments
	Student handled materials safely and acted appropriately during activity. (5 pts)	Student took thorough notes on structures and wrote well thought out and complete hypotheses. (10 pts)	
	Student had to be reminded how to behave appropriately during activity. (1-3 pts)	Student took notes on structures and wrote complete hypotheses. (5-9 pts)	
	Student actively did not participate in activity. (0 pts)	Student barely took/did not take notes on structures and did not write complete hypotheses. (0-4 pts)	

Total: ____/15 points

Activity 2 (optional) Points should be awarded based on the completion of the modeling craft and the correct labels for tree structures.

Formal Assessment of Modeling Craft

Points Earned	Completion of Model 10 pts total	Understanding of Topic 10 pts total	Comments
	All tree structures are present in the model and neatly visible; overall a successful effort was made in the presentation. (10 pts)	All seven structures are properly labeled in the correct order. (10 pts)	
	Most of the tree structures are present and visible; more effort could have been made in the presentation. (5-9 pts)	Structures are labeled but one to three are in the incorrect order. (5-9 pts)	
	Model is missing half or more tree structures; little to no effort was made in the presentation. (0-4 pts)	Structures are not labeled correctly, or most are in the incorrect order. (0-4 pts)	

Total: _____/20 points

Part Two: Below is a rubric to formally assess each student's worksheet/journal entry.

Points Earned	Tree Description/ Observations 5 pts total	Leaf and Bark Rubbing 5 pts total	Plant Use 5 pts total	Comments
	Student wrote at least three complete sentences using descriptive language linked to their senses. (5 pts)	Leaf and bark rubbings are distinctive and clear; an overall effort was made. (5pts)	Includes logical way(s) people may use the plant. (5 pts)	
	Student wrote less than three complete sentences. (3-4 pts)	Leaf and bark rubbings are not very clear. (2-4 pts)	Includes illogical way(s) people may use the plant. (2-4 pts)	
	Student did not write complete sentences. (0-2 pts)	There is no leaf or bark rubbing or it is completely unclear. (0-1 pts)	Doesn't include ways people may use the plant. (0-1 pts)	

Total: ____/15 pts

Resources and References

Culturally based tree resources

The Native Way: Aspen

The Native Way: Outdoor Tip

Bark-Peeled Trees are Cultural Resources

Ancient Bark-peeled Trees in the Bitterroot Mountains, Montana: Legacies of Native Land Use and Implications for Their Protection

Native American Uses of Utah Forest Trees

American Indian Challenges to Environmental Challenges: Akwesasne Mohawk

References

"Can Plants Grow Without Soil?" Wonderopolis.

Hart, Jeff. *Montana Native Plants & Early Peoples*. Helena, MT: Montana Historical Society and Montana Bicentennial Administration, 1976

International Traditional Games Society. *Indian Education for All: Traditional Games Unit*. Helena, MT: Montana Office of Public Instruction, 2009.

Snell, Alma Hogan. *A Taste of Heritage: Crow Indian Recipes & Herbal Medicines*. Edited by Lisa Castle. Lincoln, NE: Bison Books, 2006

Student Handout 1: The Truth About Trees Modeling Craft

Materials: A toilet paper roll, paper, paper clips, pipe cleaners, scissors, tape, and markers/pencils (straws and extra pipe cleaners are optional)

<u>Overview</u> Students will use their knowledge of tree structures (internal and external) to create their own tree model, using paper layers and a toilet paper roll.

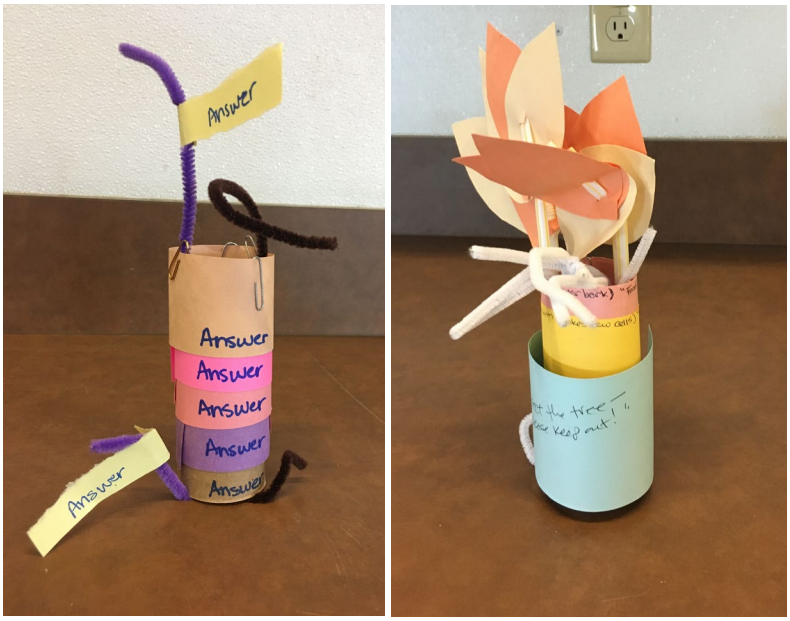
1. The toilet paper roll represents the innermost structure of the tree. Write down the name of this structure at the bottom of the toilet paper roll. *Tip: use the notes your teacher provided you either from the board or in your notebook.*

2. Cut out four pieces of paper that are no taller than the toilet paper roll, and wide enough to wrap around the roll with overlap.

3. Wrap one of the pieces of paper around the toilet paper roll so the bottom of the paper is above the structure name you already wrote. On the bottom of the paper, write the name of the next structure. Using paperclip or tape, attach the paper to the roll.

4. Continue layering the paper to represent the order of the trunk layers, making sure your answers are still visible for each structure. Remove and reattach the paperclip after each layer is added so they stay in place.

5. Once you've attached all the structures that make up the trunk, place the pipe cleaners on the inside of the "trunk" so an even amount sticks out from the top and bottom of the tube. Paperclip the pipe cleaners to the roll. Tape labels to the pipe cleaners that would represent the structures above and below the trunk respectively. You can also bend the pipe cleaners to better represent these structures.



Finished products. Note the optional addition of leaves in the second image.

Student Handout 2: Cottonwood and Willow

Plains Cottonwood

All photographs used with permission. Photo credit Alina Garner.

Willow

All photographs used with permission. Photo credit Hannah Finch.

Student Worksheet 1: The Truth About Trees "Tree Walk"

Use four of your senses (sight, sound, touch, and smell) to explore and observe your tree. Then write at least three sentences describing your tree. This can include observations you made with your senses, like how your tree smells or feels, or it can be physical descriptions. For example, you could talk about the color of the bark, or the height of your tree.

Sketch your tree below, on the back of this sheet, or on a new piece of paper.

Provide a leaf and bark rubbing below or on a separate page if the boxes are not large enough.

Leaf Rubbing	Bark Rubbing

Using your learned knowledge of ways that people use trees for food, medicine and materials, what do you think are ways humans can use, or receive the gifts from, this tree? Remember, this is just an educated guess.

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