Interdisciplinary Curriculum Guidebook

Trees are terrific...

inside and out!

2021 Revision

Step: #1

Discover how trees grow and function

BASIC ACTIVITY — Roleplay the growth process of a tree.

Classroom Activity:

Students will roleplay the growth process of a young tree to become familiar with the structural components of a tree.

Students will learn how the components of a tree help the tree function.

Objectives:

Students will be able to:

List several environmental benefits and products trees provide.

Identify structural components of a tree and explain how these components help a tree function.

Describe the process and major components involved in the process of photosynthesis.

Time Recommended:

60-90 minutes

Materials Needed:

Approximately 6 foot piece of ribbon or yarn

Ball of string or twine

Hand lenses

One or two examples of tree fruits/seeds (i.e. acorn, walnut, apple with seeds)

Paper clips (one per label)

Pencil and Paper

Photocopied students handouts on pages 8-11

Red, blue, green, yellow and brown construction paper

Several samples of bark

Six small packets of sugar

Small plant in pot

Tree cross-section or picture of a cross section

Tree Labels (found after page 15) photocopied, cut and pasted onto strips of colored construction paper

Two small bottles of water.

National Science Education Standards Correlation:

Students will develop an understanding of:

- Structure and function of living systems
- Populations and ecosystems
- Populations, resources and environments

Instructional Sequence:

Concept #1: Tree benefits all living creatures and their environments in various ways

Start the classroom discussion by reading Paragraph #1:

Recently I read a story in the newspaper about a community that was experiencing environmental problems. The stream in the city was always brown with soil erosion after a heavy rain. The air was hazy because of the smog. The city's buildings and pavement reflected so much heat that summer temperature was uncomfortably hot. The people in the city were concerned and were looking for some way to improve the condition of their community. A bright young student told the leaders she had a solution to their problem. She had an invention that could clean the air, produce fresh oxygen, prevent soil erosion, cool the sidewalks, muffled traffic noise, and could last many years with just a little care. And, she added, it could operate on solar power from the sun.

Ask the students: Do they think with modern technology, such an invention is possible? Could there really be something that would clean and cool the air, make fresh oxygen, prevent soil erosion, and muffle noise, all operated on solar energy? If so, what do they think something like this might cost? Allow students to respond without comment. After students have had an opportunity for input, continue by reading Paragraph #2 on the next page.

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Step: #1

BASIC ACTIVITY

Discover how trees grow and function

Paragraph #2

The young student went to describe other features of the unique invention. She said that along with helping the environment, this creation would provide homes and food for birds and other animals, kids could climb on it, and it would make the community more attractive. If many of these things were available some could eventually be made into things people could use —- like paper, houses, baseball bats, or even medicines. And when it was no longer useful, this invention was biodegradable or could be used for fuel. She said this thing was not some new invention but something that had been around for years.

Ask students: Can you guess what "invention" this young student was referring to?

By now many students may have guessed that you have been describing a tree. If students are still mystified, continue to give more clues (i.e. This invention is a living thing, it bears fruits and seeds, it grows, it provides shade etc.) If students still do not realize you have been describing a tree, you man need to spend extra time as you introduce and go through each of the following concepts. With the students input, do a quick review of the benefits we receive from trees. List the benefits on the board. Students may wish to add additional benefits or tree products to the list.

Write the following questions on the board:

- How does a tree use solar energy to make its own food?
- How does a tree build a trunk that can live for centuries and hold the weight of many tons?
- How can water absorbed by the tree roots travel all the way up to the leaves at the top of the tree?

Tell students that by the end of the period, they will know the answers to those questions.

Concept #2: A tree has a number of structural components that are essential for the tree to grow and function.

Starting as a Seed

Hold up an acorn, or any available tree seed. Tell students that a tree starts very small — as small as a tiny seed. This seed could someday grow into a tree taller than a house. A tree produces many seeds, but not all seeds fall where conditions will allow them to grow. Only a few seeds actually survive and grow to a tree. But when a seed lands in a good location... and rain comes at the right time — the little seed softens and begins to grow.

Ask students what they think happens first when a seed starts to begin the process of growing

Roots Background Information:

When a seed germinates, the first thing it sends out is a tiny root to hold its position in the soil and start drawing in water. As tree grows larger, it develops several kinds of roots. A few trees have long taproots that go deep into the soil, but most trees have shallow, **lateral roots** that lie closer to the surface of the ground. About 85% of a tree's roots are within the top 18 inches of soil. Most trees are likely to have roots extending one and a half to two times the branch spread.

The taproot and lateral roots are hard and woody. They anchor the tree and transport water and soil nutrients to above ground parts.

Concept #1: Trees benefit people and the environment in many ways

Concept #2 A tree has many interdependent structural components that are essential for the tree to grow and reproduce.

Concept #3: Through a process called photosynthesis leaves take in carbon dioxide and water, and using chlorophyll and sunlight, create oxygen and make a sugar food that feeds the tree.

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Trees also contain cells for the storage of sugar just like the trunk and branches. As these larger roots spread out, they branch into smaller and smaller roots called **rootlets** (fine fibrous roots covered with tiny **root hairs**). These tiny root hairs work in a symbiotic relationship with a kind of soil fungi to form **mycorrhizae** (m-koh-ry-zee) where the fungi becomes an extension of the tree's own root system. The mycorrhizae are very absorbent and more efficient than the plants root themselves. They take up water and mineral nutrients from the soil and then pass some of these minerals to the tree. In return, the fungi receive sugars and other nutrients form the tree's photosynthetic processes in a relationship that benefits both the fungi and the tree.

The fibrous tree roots cling tenaciously to the soil in order to better absorb water and nutrients. By doing so, the roots also hold the soil in place, keeping the soil from eroding and being washed away by heavy rains. Tree roots are tenacious in their search for moisture and nutrients . Where soft earth is lacking they will move through clay and gravel, and even into rock.

Select a student to come forward or have students work in pairs and pretend to be a tree. Ask them to extend their arms like branches and stand on tiptoe. What do they think would happen if the wind came up? Simulate this by giving the student a very gentle push with one hand, while supporting them with the other. Explain a tree needs roots to keep them form falling over.

Repeat the demonstration with the student with legs slightly apart and feet flat on the floor. Explain to the students that in some ways tree roots are like your feet—spreading out to keep the tree stable. Further explain that roots also have another very important function—they suck in water and nutrients form the soil that the tree needs to survive.

Make a quick sketch picture of a tree and its spreading root system on the board to give students a sense of the lateral, rather than downward, spread the root system.

Root Activity (optional): A first hand observation of a root is important. Even though a smaller plant won't have the same woody root structure as a tree, it is worth the time to study its roots.

Remove a small plant from the pot. Point out to students how the soil remains packed around the bottom of the plant. Ask them to speculate why that is so. (The roots are holding the soil in place.) Ask students to think of ways plants could be used to prevent soil erosion.

Shake the soil off the roots. Break of sections of the root and allow children to make observations as they look at them with a hand lens or microscope, if available. *Ask students to make observations about the roots they examine.* Can they see the tiny root hairs? How are the plant roots like the tree roots just discussed; how are they different?

Ask students if they think the plant can survive without its roots. Put the plant and soil back in the pot, water it, and observe it over the next several days to see what happens.

As an extension activity, if time permits, take students on a walk and notice the above ground tree roots that may be visible, especially in an urban setting. Discuss their similarity to the branches on the same tree. Are the roots causing problems with the cement or ground around them? Observe small trees or plants rotting in cracks and sidewalks. Have students make observations about the strength of the roots.

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Trunk Form and Function:

Many of these internal tree parts will be new to your students. Background information is included for all the tree parts to share as you look through the Student Handouts 1 & 2 together (pages 8 & 9). Encourage student questions and observations as you examine the Tree Cross-Section illustration on the handout. Student Handout #3 on page 10 contains a vocabulary list of bolded words and a rubric on page 11.

Background Information:

Every tree trunk resembles a cylinder whether long and slender or short and stout. The tall, stately trunk of the eastern white pine and the small, short trunk of the redbud both perform the same function.

A tree trunk is largely composed of a compact mass of tiny tubes made of cells. Great numbers of these hollow tubes serve as pipelines that conduct water and nutrients absorbed by the roots up to the leaves. These are called xylem cells, or sapwood, and they make up what we commonly refer to as the wood of the tree. Other cells, called phloem, or inner back, carry the sugar food made by the leaves back down to the living parts of the tree. Located between those two pipelines is the **cambium**, the growing layer of the tree. Deep in the center of more mature trees are old xylem cells that have become thick and solid, providing strength for the tree. This part of the tree is referred to as the **heartwood**. Surrounding the outside of the trunk and branches are old dead phloem cells commonly called outer bark that serve as a covering that both protects and insulates the tree.

Cambium

In a layer only one cell thick that completely encloses the entire trunk, limbs, and all the branches, rests the tree's ability to grow and create new cells. This layer is called the vascular **cambium**. Some new cells formed in the cambium move outward to become phloem cells, others move outward to become phloem cells, others move inward to become xylem cells. Essentially this layer creates new wood on one side of itself and new bark on the other. As it increases the tree's internal girth the cambium moves outward, pushing the bark before it, leaving the wood behind.

Cambium Activity:

Ask one student to come to the front of the room and extend his or her arms perpendicular form their body, pretending to be a tree. Tie a ribbon around the child's waist. Ask the class to predict, if this was actually a tree with a ribbon around, what might happen to the ribbon. *Will it move higher (further up form the ground) as the tree grows?*

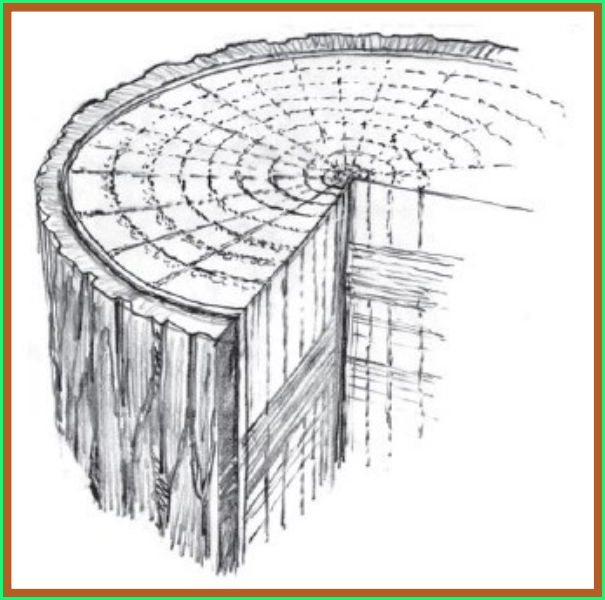
After the students have had a chance to guess, explain that the answer is no. Trees grow in diameter from the inside out, but tree height comes from the new growth at the very tips of the branches… so the ribbon would remain at the same height, no matter how tall the tree might grow. If the ribbon were left in place for a long time however, the cambium would keep adding to the width (thickness) of the tree. That would eventually either break the ribbon or force the bark to actually grow around it. Should that happen it might injure the food transportation system and eventually kill the tree.

Explain that's why people should never tie anything permanently around the trunk of a tree or nail anything to a tree.

Photo Credit - L. Langelo

Xylem

The cell layer interior to the cambium is called xylem or sapwood. Each spring and summer the cambium makes new xylem cells, adding new layers of wood around layers laid down in the years past, increasing the width of the tree over time.



The wood formed in the spring grows fast and is lighter-colored because it consists of large cells created when there is plenty of moisture so the cells are smaller and more compact. When a tree is cut, the layers appear as alternating rings of light and dark wood. Count the dark rings, and you know the tree's age.

Dendrochronology is the study of a tree through its annual growth rings. Scientists not only use these rings to determine the age of the tree, but they can also get information about the climate, the spacing of trees and the presence of fire around the individual tree. A wide ring often indicates that plenty of moisture was available that year. Rings that are very close together often suggest there was a drought.

The xylem is the "up" system in the tree. The cells in the xylem layer fuse to form uninterrupted tubes that conduct the moisture and nutrients from the roots up through the trunk to the leaves. Consider a 200' tall tree. Imagine the challenge of raising water that height without a giant pump, but trees have managed to adapt.

Because water molecules have a cohesiveness or a tendency to stick together, there is a constant, continuous "string" of water in each tube of xylem cells. Water continually evaporates or is transpired out of the leaves. This water shortage in the leaves results in a tremendous pull on the water in the xylem tubes causing the water to move up through the xylem into the leaves.

Xylem Activity — Have students examine the tree cross-section and figure the age of the tree when it weas cut down. If an actual cross-section not available, a picture of one can be viewed and/or printed at http://www/arborday.org/trees/RingsTreeNatomy.cfm

Heartwood — The center, supporting pillar of the tree is called heartwood. Although it is non-living it will remain strong and will not decay as long as the outer layers of the trunk are intact. As a tree grows in diameter the inner, older xylem layers fill with gum and resin and harden providing support to the tree as it grows taller and wider. Ninety-nine percent of a living tree is nonliving cells that provide structural support rather than active fluid conduction.

Phloem — The cell layer exterior to the cambium is called phloem, sometimes referred to as inner bark. It is the "down" transport system in the tree. Only a few cells wide, it carries the jelly-like sugar food produced in the leaves throughout the tree. Phloem cells are stacked one on top of the other. Their connecting cell wall is perforated like a strainer when one cell is full of the jelly -like food as the contents ooze slowly into the next. Eventually the food finds its way down from the leaves to the roots. When phloem cells die they become part of the outer protective layer of bark.

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Bark

The outer layer of the trunk is covered with bark. Tree bark can be smooth, rough, or scaly. Although bark may look different from tree to tree it serves the same purpose, to protect the tree from injury and disease, somewhat like your skin. Often bark has bad tasting chemicals, which discourage hungry insects or gnawing rodents from harming the tree. Some trees have very thick bark, which prevents damage from fire.

Every year the cambium layer produces new phloem cells that are squeezed between last year's phloem cells and the cambium. Outer bark is formed as old phloem cells die and are forced outward. When smooth, tight-fitting young bark is unable to expand or stretch because of the addition of new cells the bark may crack, split or be shed from the tree. Each tree species has a characteristic way of expanding or breaking its bark forming patterns by which many trees can be identified.

Bark Activity — Look at samples of different kinds of tree bark. Notice the thickness of the bark and examine it for evidence of how the bark expanded an grew from the inside out. You may wish to use pencils and paper to do bark rubbings that will reveal the different pattern in tree bark.

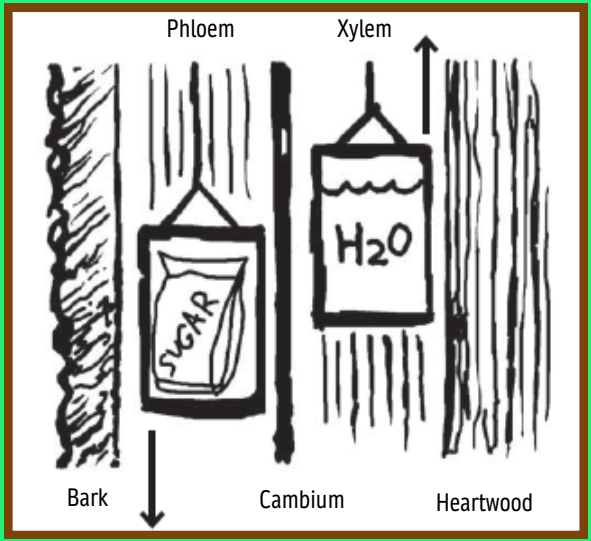
Concept #3 : Though a process called photosynthesis leaves take in carbon dioxide and water and using chlorophyll and sunlight, create oxygen and make a sugar food that feeds the tree.

Leaves

Background Information:

Leaves come in many shapes and sizes and provide the easiest means of identification of an individual tree. Some are needle-shaped, some are flat and thin. Some leaves remain on the tree throughout the year (**evergreen**) and some leaves are shed annually (**deciduous**). But regardless of size or shape, all leaves have the same functional they create the sugar food that feeds the tree and, though the web of life, feeds all sorts of living things. The amazing process that makes this possible is called **photosynthesis**. Refer to the illustration on Student Handout #3 as you discuss this process with students.

Photosynthesis is a combination of "photo" meaning "produced by light" and "synthesis" which means "putting together" parts or elements to make a whole substance called **chlorophyll**. Chlorophyll is the enabler for the photosynthetic process. During photosynthesis, chlorophyll, carbon dioxide, water and light energy from



the sun are used to make a sugar-like food that becomes the basic source of energy for the plant and other living things. While making this food, the green plant gives off oxygen and water vapor into the air.

Carbon Dioxide (CO_2) is exhaled by animals, created by microorganisms through the process of decomposition and released during the combustion of fossil fuels. In the leaf of a green plant, carbon dioxide comes in contact with water (H_2O) and nutrients that have been drawn up from the soil by the roots of the plant. In the presence of sunshine chlorophyll within the green leaf combines the CO_2 and H_2O. This combination results in the creation of a sugar food called glucose, ($C_6H_{12}O_6$) which provides energy for the plant and all animals that eat that plant, or eat the herbivorous animal itself. Not

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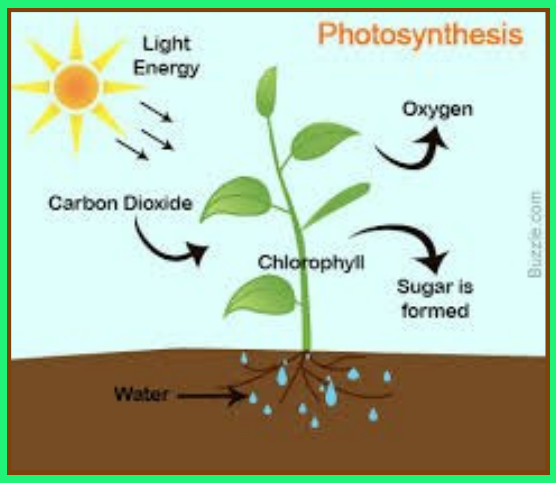
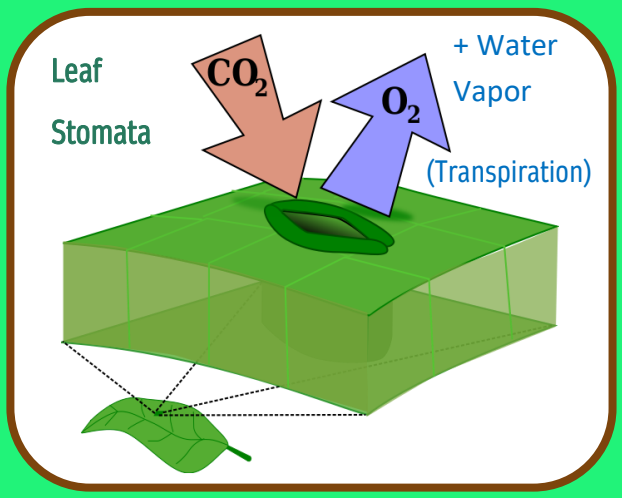
only are plants the base of food chains upon which all animals depend, plants also produce oxygen, a gas that all animals (including humans) need to survive.



Carbon dioxide enters the leaf and oxygen exits the leaf through tiny holes called stoma, usually found on the undersurface of the leaves at the same time, water is also released in a process called **transpiration**. Most plants in temperate climates transpire about 99% of the water the tree has taken in by their roots. Plant transpiration helps modify the temperature and humidity of the surrounding area. (For a leaf transpiration activity, see Extension Activities, page 16)



Seeds/Fruits

Most trees grow from seed. Many kinds of seeds exist but the function of seeds is always the same-- to produce a new plant. A mature plant produces seeds that have the genetic blueprint for a new plant of the same species. Fruits or cones serve as outer protection for the seeds inside.

Pass around several examples of seeds for students to observe. Point out to students the hard outer seed coat which protects the tiny plant in a box with its lunch. There is enough food stored in the seed to get the baby plant growing until it can make leaves and start producing its own food through the process of photosynthesis.

Additional Suggested Reading:

The Giving Tree by Shel Siverstein

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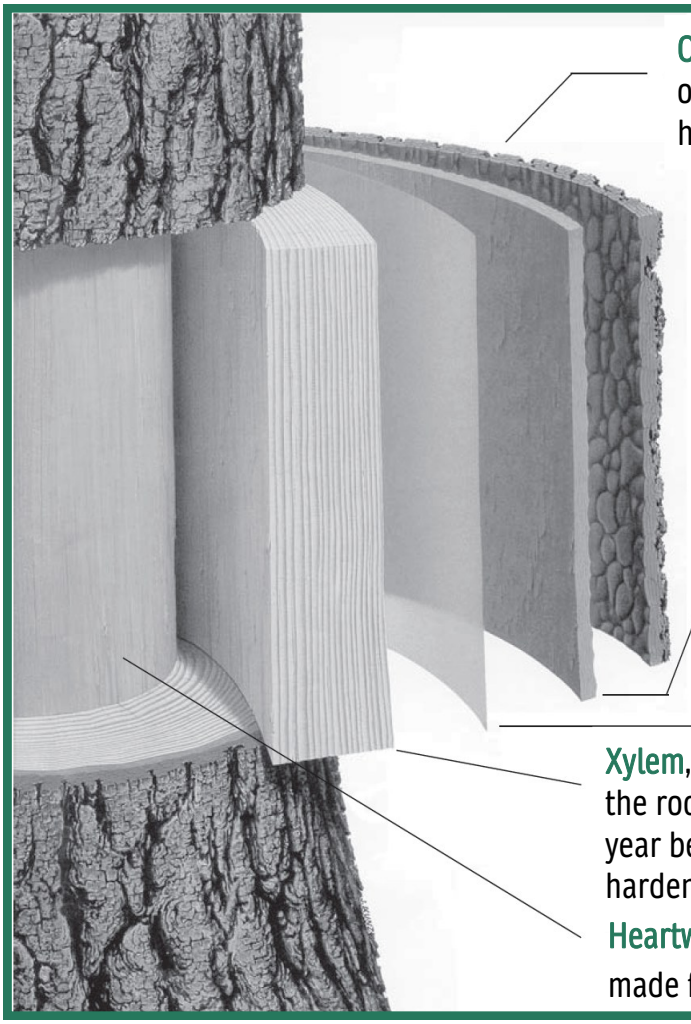
Student Handout #1 Tree Cross-Section



Outer Bark is the tree's protection from the outside world. It insulates against the cold and heat in addition to warding off insect enemies.

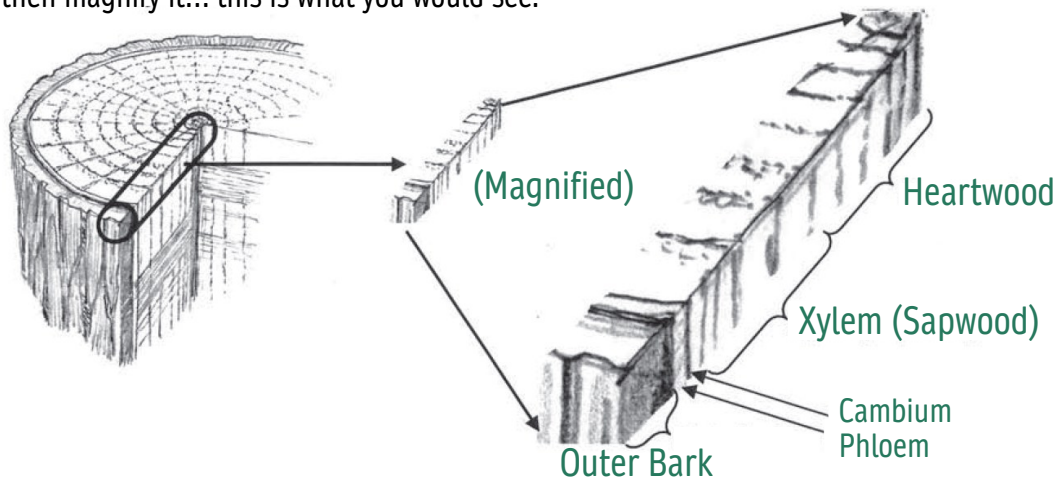
Phloem, or inner bark, is the pipeline through which food is passed to the rest of the tree. It lives for a short time, and then dies and becomes part of the protective outer bark.

The **cambium** cell layer is the growing part of the trunk. It annually produces new bark (phloem) and new wood (xylem).

Xylem, or sapwood, is the tree's pipeline for moving from the roots to the leaves. The new xylem laid down each year become annual rings of the tree. Eventually xylem hardens and turns to heartwood.

Heartwood is the central, supporting pillar of the tree made from old, hardened xylem layers.

If you could pull a chunk from the trunk of a tree, then cut a radial piece out of that chunk, then magnify it... this is what you would see.



In the activity you'll do, you will pretend to become part of a section of trunk, like this picture at the right, as you discover how a tree grows and functions!

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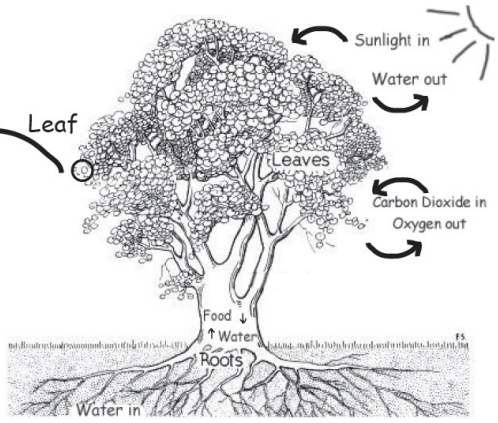
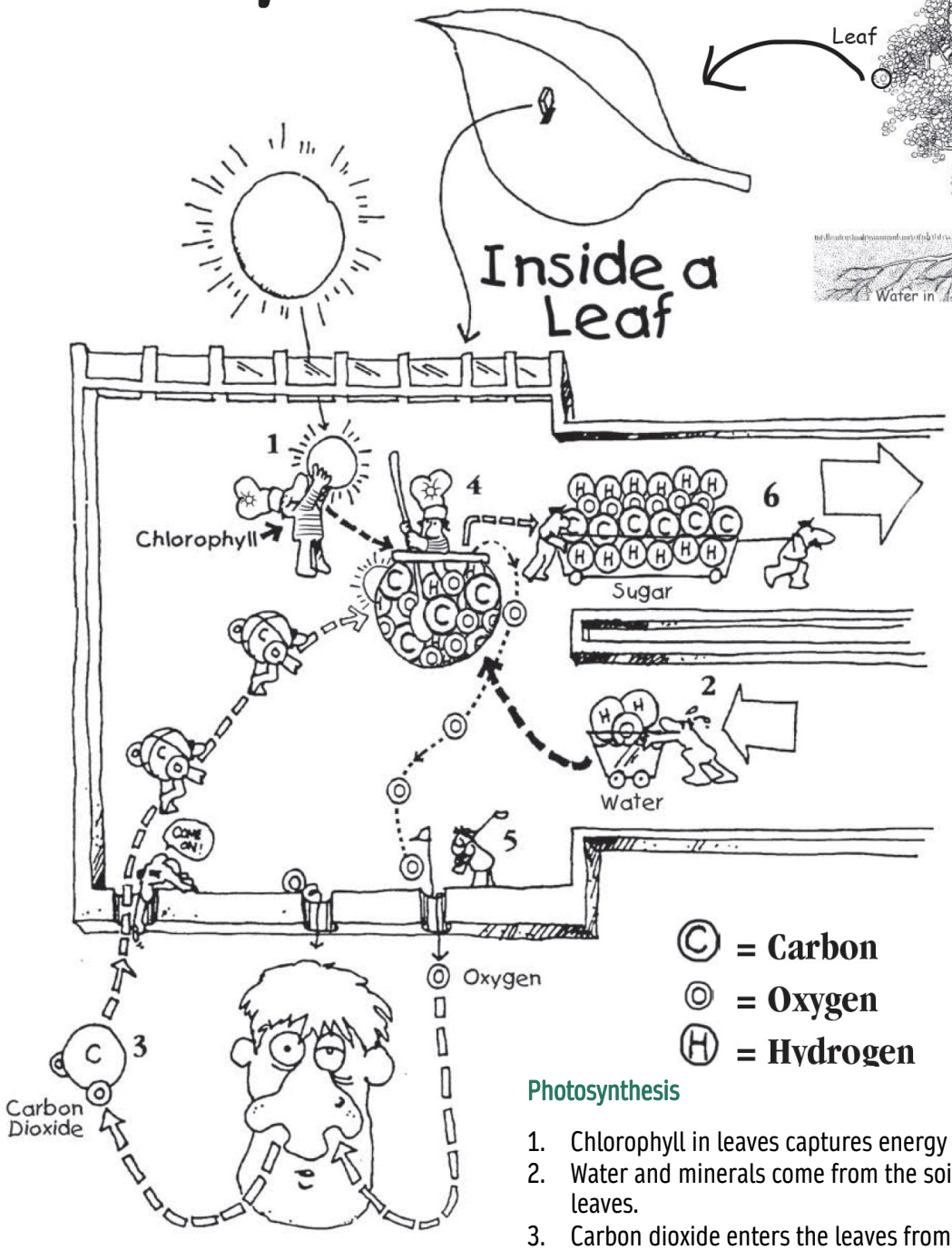
Photosynthesis Sheet





Ⓒ = Carbon
◎ = Oxygen
Ⓗ = Hydrogen

Photosynthesis

1. Chlorophyll in leaves captures energy from sunlight.
2. Water and minerals come from the soil through the roots to the leaves.
3. Carbon dioxide enters the leaves from the air.
4. Chlorophyll uses the sun's energy to combine water and carbon dioxide to make special kinds of sugars which are food for the plant.
5. The leaves give off oxygen into the air
6. The sugar food moves to the other parts of the plant for use of storage.

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Student Handout #3 Vocabulary

Annual Rings: The fast then slow growth of xylem each year create a concentric ring pattern in the trunk. Count the rings and you know the age of the tree, and past climate.

Bark: Outer bark protects the tree from weather extremes and insect pests.

Cambium: The thin, growing part of the tree that makes new xylem and phloem.

Carbon Dioxide: A gas exhaled by animals and release from burning fossil fuels or decomposition. Tree clean the air by taking in carbon dioxide to use in photosynthesis. Often shown as CO2.

Chlorophyll: The green pigment in leaves that make photosynthesis possible.

Deciduous: Trees that lose their leaves each year.

Evergreen: Trees that loose their leaves gradually over time so they appear green all year round.

Germination: The beginning of seed growth.

Heartwood: The central supporting wood of mature trees made up of dead xylem.

Leaves: The food producing part of the tree where photosynthesis takes place.

Oxygen: Trees produce oxygen, a gas needed by animals and humans to survive. Often shown as O2.

Phloem: Inner bark of the tree that carries food from the leaves down to the rest of the tree.

Photosynthesis: The process by which plants make food.

Roots: The wide spreading woody roots of a tree that anchors the tree in the soil. Often called lateral roots.

Root Hairs: Tiny roots growing off the lateral roots that take in water and nutrients from the soil.

Seeds: The part of a plant containing a tiny plant that may someday grow to be a mature plant of the

Taproot: A long, deep root grown by only a few kinds of trees.

Transpiration: The passage of water vapor from leaves into the air.

Xylem: The tube-like water transportation system in the trunk of the tree that moves water up from the roots to the trees leaves. Xylem is the part of the tree that is referred to as wood.

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Rubric- Determine how your tree knowledge has grown. Are you a 10?

	No Growth **0 points**	Germination **1 Point**	Vigorous growth **2 points**	Fully grown **3 points**
#1	Trees are amazing; they help people and the environment in so many ways. You should understand and be able to name some of the environmental benefits and products that trees provide			
	If you can't name any environmental benefits or tree products	If you can name on environmental benefit trees provide and one tree product	If you can name two environmental benefits trees provide and at least one tree product	If you can name three or more environmental benefits trees provide and at least two tree products.
#2	Knowing the essential parts of a tree and understanding the interdependent role those parts play in helping the tree grow and reproduce are important to ultimately understanding how to plant or care for trees in your-community. (Main tree parts include roots/root hairs, outer bark, phloem, cambium, xylem, heartwood, leaves, and seeds.)			
	If you can name fewer than four tree parts and can't describe what the tree parts do for the tree	If you can name five tree parts and describe what these parts do for the tree.	If you can name six or seven tree parts and describe what these parts do for the tree	If you can name all eight major tree parts and clearly describe what these parts do for the tree.
#3	Photosynthesis, the process by plants make their own food, is one of the most important cycles of nature. All life on earth (through food chains) depends on a plant's ability to make food using energy from the sun. (Main photosynthesis components include sun, water, chlorophyll in the leaf, carbon dioxide, oxygen, and sugar.)			
	If you can name fewer than three components of photosynthesis and can't describe how this cycle works.	If you can name at least 4 components of photosynthesis and generally describe how this cycle works/	If you can name at least 5 components of photosynthesis and clearly describe how this cycle works.	If you can name all six main components of photosynthesis and clearly describe how this cycle works, including the process of transpiration.

Get 1 EXTRA BONUS POINT for active and cooperative participation

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Step: #1

BASIC ACTIVITY

Discover how trees grow and function

Germination

The Activity: Roleplay the growth process of a tree to understand its form and function.

Activity Description: The purpose of this activity is to reinforce the understanding of how a tree grows and functions over a number of years. Each student will represent an important part of the tree. The activity states with a tiny seed as it germinates. It then moves to a young tree in its growth over five years.

In Advance: Make sure you select a large space for the activity where the tree will have room to "grow". Gather string, paper clips, 2 small bottles of water and six sugar packets. Photocopy the labels after page 15. Cut and paste the labels onto the suggested colored strips of construction paper and attach a paper clip to each so children can created wrist bands. **Note: After labels are made, set aside the labels for "Heartwood" and "New Bark" to use later in the activity.** The number of labels in this guide works for a group of 18 students. If you have more students, make more Leaves and Roots labels. With fewer students, use fewer Leaves and Roots labels, keeping at least one of each. A minimum of 14 students is needed to demonstrate the five years of growth. Make a dot on a piece of paper and place it on the ground to indicate the central, starting point for the tree.

Introductory Sequence: Explain to students that they are going to "build" a tree. Pass a container holding the labels (with exception of Heartwood and New Bark labels) from which students can draw to determine the tree role they will play. Have them use the paperclips to secure their tree part label around their left wrist. Group students by color of wristbands.

Before you start, encourage students to use their bodies to creatively express the growth process of the tree based on what they hear in the narrative. Instruct students with the following wrist labels to come into the open area and line up in the order shown in the acorn.

(Just have one leaf and one root student come forward at this time.) Have the student with the "Xylem Year 1" label sit on the paper with the dot. Have the six students curl up and imagine they are still together inside a seed. Put the string close around the group of six students to represent the outside of the seed, then begin the germination roleplay narration. (Read the bolded text aloud).

A small seed falls on the ground. It lands on good soil. Gentle rains come and soften the seed. The little seed germinates. As it starts to grow, it sends out a tiny root to its position in the soil and starts drawing in water.

Have the "roots" student move just outside the string circle and act like a tiny root searching for water.

A baby tree with tiny leaves pushes its way to the sun. The seed has enough food stored inside to help the little tree grow until the leaves can use sunlight to make food.

(Have the "Leaves" student move just outside the string circle. Encourage students to act like the little tree, emerging from the soil.) Tell students this is a seedling tree. As the role play continues, they will see how the little tree grows. Remind students to think about the illustration they looked at earlier that showed the cross-section of tree trunk with the small piece shown running from the center of the tree to the outer bark. That is the part most of them will role play in the activity. The section of trunk contains tubes that run form the roots below the tree to the leaves high above.

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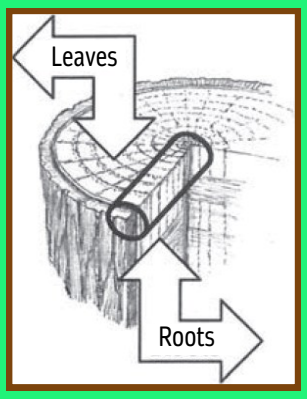
Students representing leaves should stand with arms raised, their hands representing the leafy canopy. Students representing roots should sit on the floor with feet out in front of them to representing spreading roots. Students inside the tree trunk should stand. It is important for them to stay in a straight line during growth. The "Xylem Year 1" student needs to always stay on the dot-marked paper representing the center of the tree.

Instruct everyone to look at their tree part information on their wrist so they know what to do and say when the teacher points to them at their turn. Before resuming the activity, hand the "New Bark" labels to the student representing "Bark Year 1" and tell them to hold onto those until it's time to pass them a newly formed bark (one each year). Divide sugar packets among the students with "Leaves" labels. Give a water bottle to the students with "Roots" label.



The standing arrangement for the Tree Growth activity should like Example 1. Continue to expand the string ring each year to reflect the tree's growing circumference.

The narration for the roleplay is in bold and to be read by the teacher.

Actions for the role-play are printed in italics and are also on the role labels the students will draw.

NOTE: During the first round of the roleplay the teacher may need to prompt students when its their turn. As the roleplay progresses, the teacher may be able to simply point to a student(s) when it's their turn to act/speak.

Tree Growth-Year One

1. The little tree adds more roots and leaves. *Have the remaining students with Roots and Leaves labels join the first "Roots" and "Leaves just outside the sting ring, Roots all on one side, Leaves on the other.*

2. Roots suck up water and nutrients from the soil and pass them on to the Xylem. *Have the student(s) with "roots" label make a slurping sound while banding one of the water containers to the student with "Xylem Year 1" label.*

3. Xylem passes water to leaves. *Have the student with "Xylem Year 1" label make a swish sound while handing the water to the student(s) with "Leaves" label.*

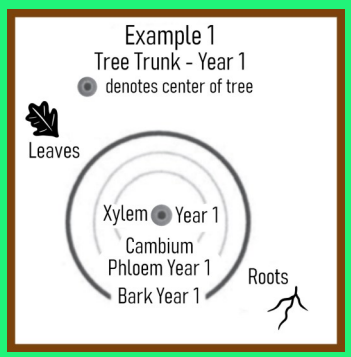
4. Leaves release most of water into the air. Through photosynthesis Leaves make sugar food for the tree. *Have the student(s) with "Leaves" Label hand the water to the teacher. Leaves put their hands up and shake them saying "Making food!"* **The leaves pass food to the Phloem.** *Have the student(s) with "Leaves" label pass one sugar packet down to the student with "Phloem Year 1" label*

5. Phloem passes food through the tree, down to the Roots. *Instruct the student with "Phloem Year 1 label to say, "Yum Yum" while passing the sugar packet down to the student(s) with the "Roots" label.*

6. With plenty of food and water, the Cambium helps the Xylem and Phloem get fatter. *Instruct the students representing "Xylem" and "Phloem" in the tree to puff out their cheeks.*

7. The cycle continues. *REPEAT STEPS 2-7 with actions and narration.*

8. When winter comes, the cycle slows down and the tree rests.



*Taken in part with permission by the Arbor Day Foundation.

Tree Growth-Years Two Through Five

Teachers Note: *REPEAT steps # 1-12 four times to represent years two through five. Any adjusted actions to reflect the tree growth are indicated, year by year, in the text. An asterisk denotes several additional narrative statements that are to be used only at year five.*

1. Spring comes and the tree "wakes up". *Everyone in the "tree" stretches.*

2. The Cambium makes new Xylem toward the inside of the tree. This makes a new ring in the trunk of the tree. *The student representing the cambium should call, "New Xylem!"*

Year Two: *Have the "Xylem Year 2" student come and stand between the "Cambium" and "Xylem Year 1".*

Year Three: *"Xylem Year 3" comes stand between the "Cambium" and "Xylem Year 2" .*

Year Four: *"Xylem Year 4" comes to stand between the "Cambium" and "Xylem Year 3".*

Year Five: *"Xylem Year 5" comes to stand between the "Cambium" and "Xylem Year 4".*

3. The Cambium also makes new Phloem toward the outside of the tree. *The student representing the Cambium should call, "New Phloem!"*

Year Two: *Have the "Phloem Year 2" student come stand between the "Cambium" and "Phloem Year 1".*

Year Three: *"Phloem Year 3" comes to stand between the "Cambium" and "Phloem Year 2".*

Year Four *"Phloem Year 4" comes to stand between the "Cambium" and "Phloem Year 3".*

Year Five: *"Phloem Year 5" comes to stand between the "Cambium" and "Phloem Year 4".*

4. Last year's Phloem hardens and turns into Bark, making the outer bark thicker.

Year Two: *Have "Bark Year 1" student say "Help me protect!" while banding a new bark label to the "Phloem Year 1" student who should cover their Phloem label with the new Bark one.*

Year Three: *Same as Year Two only with the New Bark label passed to "Phloem Year 2".*

Year Four: *Same as Year Two only with the New Bark label passed to "Phloem Year 3".*

Year Five: *Same as Year Two only with the New Bark label passed to "Phloem Year 4".*

***(READ ONLY AT YEAR FIVE.) After many years, the oldest Outer Bark has worn away or fallen off. It decomposes and adds nutrients to the soil.** *Students representing "Bark Year 1" should kneel or lie on the floor to represent the shed bark.*

5. Spring rains soak into the soil. *Teacher bands the water containers to the "Roots".*

6. Roots suck up water and nutrients from the soil and pass them on to the Xylem.

Year Two: *"Roots makes a slurping sound while handing one of the water containers to the student with "Xylem Year 2" label.*

Year Three: *Same as Year 2 but "Roots" pass water to "Xylem Year 3"*

Year Four: *Same as Year 2 but "Roots" pass water to "Xylem Year 4"*

Year Five: *Same as Year 2 but "Roots" pass water to "Xylem Year 5"*

7. Xylem passes water to leaves. *"Xylem" students in the tree make a swishing sound while handing the water to the "Leaves."*

***(READ ONLY AFTER YEAR FIVE.) After many years, the oldest Xylem no longer transports water. It dies and becomes Heartwood, the strong supporting center of the tree.** *(Teacher hands students representing "Xylem Year !" the Heartwood label. Instruct that students to now say "Standing Strong!"*

8. Leaves release most of water in the air. Through photosynthesis the Leaves make sugar food for the tree. *"Leaves" hand the water to the teacher. "Leaves" put their bands up and shake them saying. "Making food!"* **The leaves pass food to the Phloem.** *"Leaves" pass a sugar packet down to the student currently representing "Phloem".*

9. Phloem passes food through the tree, down to the Roots. *The student currently representing Phloem should say, "Yum Yum" while passing the sugar packet down to the "Roots".*

10. With plenty of food and water, the Cambium helps the Xylem and Phloem get fatter. *Students representing the new "Xylem" and "Phloem" should puff out their cheeks."*

11. The cycle continues. *At end of Year Five, if time permits, have students repeat their actions and words.*

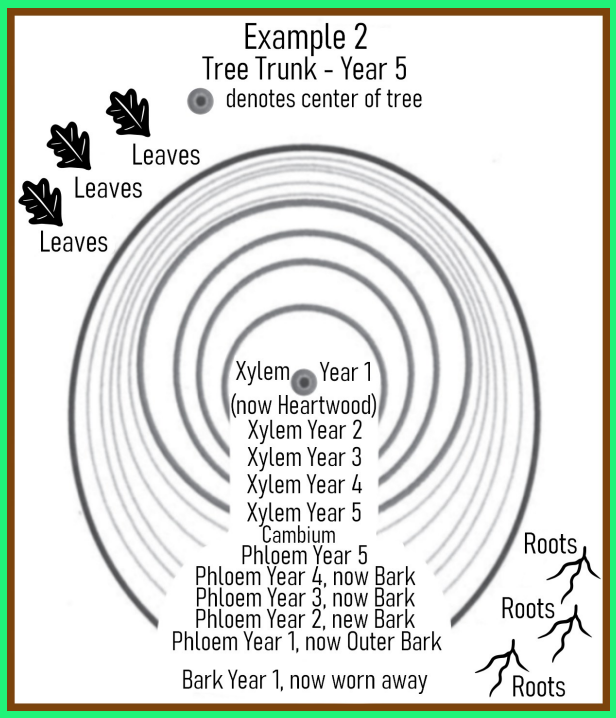
12. When winter comes, the cycle slows down and the tree rests.

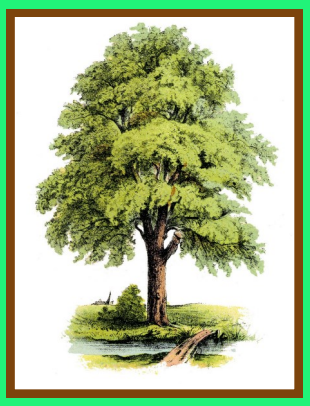
***(READ ONLY AFTER YEAR FIVE.) Next year the tree may produce seeds. These seeds may fall to the earth and grow into new trees! After many, many years, the tree may finally die. It will slowly fall to the earth and decompose, making the soil rich so new trees can grow.** *Have students all carefully fall to the earth*

Follow Up the roleplay with class discussion. Ask, "What parts of the tree got thicker? What parts of the tree ended up where they started? What other observation about tree growth did you make?"

Assessment: Refer students back to the question written on the board at the start of the lesson. Have students record the questions on a piece of paper. Students may answer the question in a written narrative, or create and label a diagram to illustrate the process. See rubric on page 11.

Alternative Assessment: Have students draw a cross-section of tree trunk with the number of annual rings that correspond to their age. Starting with year 1, at the inside of the tree "cookie", have students write or illustrate some event that happened in their life during each year in the life of the tree.





*Taken in part with permission by the Arbor Day Foundation.

Paste each label on a 11” x 3” strip of colored construction paper as indicated.

CUT THESE LABELS OUT AND PASTE ON BLUE PAPER

XYLEM YEAR 1 **(Sapwood)** YOUR JOB: You transport water from the roots to the leaves. You are part of the wood of the tree! At your turn, you say “SWISH SWISH”	**XYLEM YEAR 5** **(Sapwood)** YOUR JOB: You transport water from the roots to the leaves. You are part of the wood of the tree! At your turn, you say “SWISH SWISH”
XYLEM YEAR 2 **(Sapwood)** YOUR JOB: You transport water from the roots to the leaves. You are part of the wood of the tree! At your turn, you say “SWISH SWISH”	**ROOTS/ROOT HAIRS** YOUR JOB: You take in water and some nutrients from the soil which get passed up the tree. You also hold the tree in place. At you turn, you say “SLURP SLURP”
XYLEM YEAR 3 **(Sapwood)** YOUR JOB: You transport water from the roots to the leaves. You are part of the wood of the tree! At your turn, you say “SWISH SWISH”	**ROOTS/ROOT HAIRS** YOUR JOB: You take in water and some nutrients from the soil which get passed up the tree. You also hold the tree in place. At your, turn you say “SLURP SLURP”
XYLEM YEAR 4 **(Sapwood)** YOUR JOB: You transport water from the roots to the leaves. You are part of the wood of the tree! At your turn, you say “SWISH SWISH”	**ROOTS/ROOT HAIRS** YOUR JOB: You take in water and some nutrients from the soil which get passed up the tree. You also hold the tree in place. At your turn, you say “SLURP SLURP”

CUT THIS LABEL OUT AND PASTE ON RED PAPER

HEARTWOOD

YOUR JOB: Your xylem cells have hardened and you no longer transport water. You are now the strong heart of the tree. At your turn, you say

“STANDING STRONG”

CUT THIS LABEL OUT AND PASTE ON YELLOW PAPER

CAMBIUM

YOUR JOB: You are the growing part of the tree. As thin as a piece of paper, you make new xylem (wood) and new phloem (inner bark). At your turn, you say

“NEW XYLEM” AND “NEW PHLOEM”

CUT THIS LABEL OUT AND PASTE ON BROWN PAPER

BARK YEAR 1

YOUR JOB: You are rough and tough. You are Outer Bark that protects the tree. At your turn, you say

“I PROTECT”

When others become bark, hand them a New Bark card and say,

“HELP PROTECT”

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Paste each label on a 11” x 3” strip of colored construction paper as indicated.

CUT THESE LABELS OUT AND PASTE ON GREEN PAPER

PHLOEM YEAR 1 **(Inner Bark)** YOUR JOB: You transport food from the leaves though the trunk to the roots. At your turn, you say “YUM YUM”	**PHLOEM YEAR 5** **(Inner Bark)** YOUR JOB: You transport food form the leaves though the trunk to the roots. At your turn, you say “YUM YUM”
PHLOEM YEAR 2 **(Inner Bark)** YOUR JOB: You transport food from the leaves though the trunk to the roots. At your turn, you say “YUM YUM”	**LEAVES** YOUR JOB: You are the food factory for the tree. Through photo-synthesis you make food for the tree. At your turn, you say “MAKING FOOD”
PHLOEM YEAR 3 **(Inner Bark)** YOUR JOB: You transport food from the leaves though the trunk to the roots. At your turn, you say “YUM YUM”	**LEAVES** YOUR JOB: You are the food factory for the tree. Through photo-synthesis you make food for the tree. At your turn, you say “MAKING FOOD”
PHLOEM YEAR 4 **(Inner Bark)** YOUR JOB: You transport food from the leaves though the trunk to the roots. At your turn, you say “YUM YUM”	**LEAVES** YOUR JOB: You are the food factory for the tree. Through photo-synthesis you make food for the tree. At your turn, you say “MAKING FOOD”

CUT THESE LABELS OUT AND PASTE ON BROWN PAPER

NEW BARK
(Outer Bark)
YOUR JOB: You are no longer phloem, you have become outer bark that protects the tree. At your turn, you NOW say
“I PROTECT”

NEW BARK
(Outer Bark)
YOUR JOB: You are no longer phloem, you have become outer bark that protects the tree. At your turn, you NOW say
“I PROTECT”

NEW BARK
(Outer Bark)
YOUR JOB: You are no longer phloem, you have become outer bark that protects the tree. At your turn, you NOW say
“I PROTECT”

NEW BARK
(Outer Bark)
YOUR JOB: You are no longer phloem, you have become outer bark that protects the tree. At your turn, you NOW say
“I PROTECT”

Step: #1

Discover how trees grow and function

Extension Activity

The following are activities that further extend learning about the form and function of trees. These activities have the same objectives and National Science Education Standard correlations as the Basic Activity (listed on page 1).

Searching for Stoma Activity

Objectives:

Students will be able to:

Identify the stoma cell through a microscope

Time Recommended:

One class period

Materials Needed:

Iodine — Lettuce Leaf

Microscope — Slides and cover slip

Background Information: The exchange of oxygen and carbon dioxide in the process of photosynthesis and the release of water from the leaf into the air in the process of transpiration take place through tiny openings in the leaf called stoma. The stoma are opened and closed by surrounding guard cells, which contain chloroplast (structures within a cell containing chlorophyll). Providing students the opportunity to see under the microscope some of the cells that play a major part in photosynthesis helps them better grasp the process.

Stoma Activity Description: Place a drop of iodine on the center of a clean slide. Break a lettuce leaf at a vein on the underside of the leaf and tear off the thinnest layer of leaf epidermis possible. Carefully place the layer in the drop of iodine stain on the slide; making sure it is laid out flat, not folded back. Place another drop of iodine on top of the lettuce leaf layer. Wait about 20 seconds and add a cover slip then let the students start searching for stomas using the microscope. Guard cells that are open are easier to spot than guard cells that are closed. They will resemble two green jellybeans formed around an oval.

Leaf Transpiration

Objectives:

Students will be able to:

See that moisture is coming into the leaf

Time Recommended:

One class period

Materials Needed:

1 or 2 potted plants (5” pot or larger)

1 or 2 large, transparent plastic bags as well a plastic bag for each student with twist ties

Scale — Transparent Food Wrap

Leaf Transpiration Activity: To prove that leaves give off moisture try this experiment. Have each student find a leaf on a broadleaf tree that is in a sunny location. Cover the leaf on the tree with a plastic bag, securing the bag with a twist tie around the leaf stalk or the twig. Check the bag in 24 hours. Water vapor will gather on the inside of the bag due to the transpiration of moisture through the leaves. If broadleaf trees are not leafed out, this experiment can be done with a potted plant. Cover a healthy potted plant tightly with a transparent plastic bag. Do not cover the entire pot, just the plant. Leaved the covered plant in the sunshine for a day or two. Note the water formation on the inside of the bag. Ask students to speculate what this might be from.

*Taken in part with permission by the Arbor Day Foundation.

To prove that this moisture is coming into the leaves from the soil, take a second plant and cover the pot and soil tightly with the transparent wrap (this limits the evaporation of moisture directly from the pot). Do not cover the plant. Weigh the potted plant everyday. The pot will get light as the moisture form the soil is used by the plant and given off into the surrounding air through transpiration.

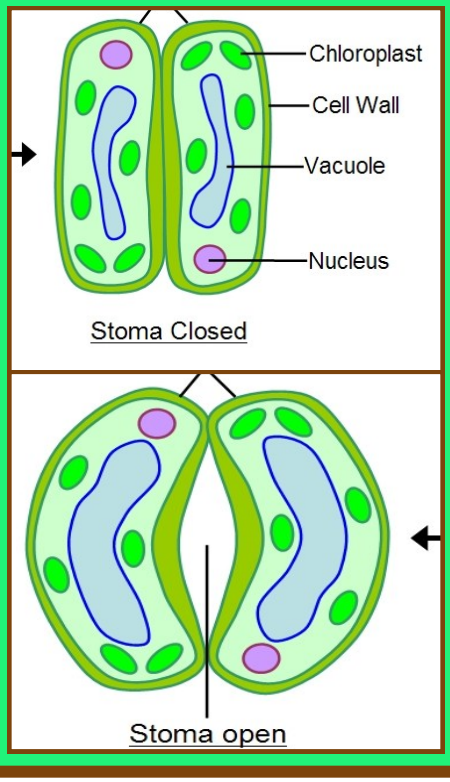
Questions that could lead to additional experiments might include:

Does the temperature affect the rate of transpiration?

Does the size of the leaf surface affect transpiration?

Does wind affect the rate of transpiration?

Do broadleaf trees transpire more than conifers?



Tree Information Web Sites

National Arbor Day Foundation: information on regional trees available at www.arborday.org/regionaltrees AND www.arborday.org/trees/treeguide

U.S. Department of Agriculture Plant Database: www.plants.usda.gov/

United States Forest Service: www.fs.fed.us/

University of Georgia collaboration: www.discoverlife.org/nh/

National Wildlife Federation: http://enature.com/fieldguides/

Center for Plant Conservation: www.centerforplantconservation.org/ASP/CPC_PlantLinks.asp#90

South Dakota's Native Trees: https://sdda.sd.gov/conservation-forestry/forest-woodlands-trees/south-dakota-native-trees/

Tree Reference Books

Field Guide to Trees and Shrubs by George Petrides (Houghton Mifflin) 1972

National Audubon Society Field Guide to North American Trees: Eastern Region and Western Region by Elbert Luther Little (Alfred Knopf) 2000

The Complete Trees of North America by Thomas Elias (Van Nostrand Reinhold) 1980

Trees of North America by C. Frank Brockman (Golden Press) 1986

Western Trees by George and Olivia Petrides (Houghton Mifflin) 1992

What Tree Is That? A Guide to the more common trees found in the Eastern/Central and Western United

More Great Activities

Additional activities that support these materials are available online at http://www.arborday.org/arborday/actvitiy-for-the-classroom.cfm

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Step: #2

Create a Poster

Objectives:

Students will create a poster the reflects their understanding of a healthy diverse forest.

Deadline:

Make certain that your school winner meets the entry deadline as stated in the enclosed cover letter or contact your state coordinator listed on page 19.

Time Recommended:

A minimum of one class period is recommended.

Materials needed:

Paper no smaller than 8 1/2 x 11" and no larger than 14 x 18"

Markers, crayons, colored pencils, paint pens, water, ink, acrylic, and/or tempera paint.

National Art Education Achievement Standards:

Students generalize about the effects of visual structures and functions and reflect upon these effects in their own work.

Students employ organizational structures and analyze what makes them effective or not effective in the communication of their ideas.

Students select and use the qualities of structures and functions of art to improve communications of their ideas.

Students integrate visual, spatial, and temporal concepts with content-- to communicate intended meaning in their artworks.

Poster Contest State Prizes

1st Place:

- $125 cash prize
- Certificate of Achievement
- Special Recognition with poster distributed across the state
- Poster featuring in the annual South Dakota Arbor Day Poster Contest Calendar
- $175 in supplies for supplies for their classroom

2nd Place:

- $100 cash prize
- Certificate of Achievement
- Poster featured in the annual South Dakota Arbor Day Poster Calendar

3rd Place:

- $75 cash prize
- Certificate of Achievement
- Poster featured in South Dakota Arbor Day Poster Contest Calendar

4th-12th Place:

- Certificate of Achievement
- Poster featured in the Arbor Day Calendar

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Poster Contest Rules

Use this checklist to make certain all entries are eligible for judging. Entries not meeting these guidelines will be disqualified.

- ☐ **Eligibility:** All South Dakota 5th grade students are eligible to enter their schools' poster contests. *Each School may submit only* one poster *to the State Arbor Day Poster Contest.*
- ☐ **Originality:** Posters must be original. Copyrighted cartoon characters, TV figures, and photographs are not acceptable.
- ☐ **Medium:** Posters may be drawn in marker, crayon, colored pencil, painted pens, watercolor, ink, acrylic or tempera paint. Bright colors that reproduce well are best.
- ☐ **Presentation:** Posters may be on poster paper or drawing paper. The posters will not be accepted for judging if they are matted, framed, or laminated. Posters must be flat and not folded or rolled, or have evident seams if avoidable.
- ☐ **Size:** Posters cannot be smaller than 8 1/2" x 11" and cannot be larger than 14" x 18". Oversized or undersized posters will not be accepted.
- ☐ **Theme:** Include the theme, "*Tree are Terrific... Inside and Out!"* in the poster design. The theme must be free drawn and spelled correctly. Stencils, computer-rendered text, clipart, collages, and pressed letters are invalid.
- ☐ **Signatures:** Posters must be signed by the student in the lower right-hand corner on the front of the poster with the student's first and last name.
- ☐ **Entry Forms:** Complete one School Report Form (page 20) and attach it the back of the poster. Methods that don't puncture the poster or add bulk are best. (Tape, glue stick)
- ☐ **Posters Will Not Be Returned:** Due to mailing costs, if you would like your school's poster back, they will have to be picked up or other methods used. They will be discarded on June (TBA), (TBA).

Posters are Due: March (TBA), (TBA)

Please Mail Posters To:

John Hartland

Department of Agriculture and Natural Resources

4305 S Louise Ave. Suite 107, Sioux Falls, SD 57106

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School Winner Report Form

After selecting a school winner, copy and complete this form, attach it to the back of the poster, and send it to your contest coordinator (John Hartland, 4305 S Louise Ave, Suite 107, Sioux Falls, SD 57106).

TBA School Winner Report Form

(All information should be complete to expedite contact of winners.)

Winner's Name: _____

Winner's Home Address: _____

City: _____ State: _____ Zip: _____

Winner's Parent or Guardian Name: _____

Teacher's Name: _____

Teacher's Email: _____

School Name: _____

School Address: _____

City: _____ State:_____ Zip _____

School Phone (_____) _____

Important:

Please indicate the number of posters entered or drawn in the school contest in the box to the left:

Number of teachers in school or participated.

**All artwork becomes the property of contest sponsors .*

**Taken in part with permission by the Arbor Day Foundation.*

Arbor Day Poster Contest

TBA

Certificate of Participation

This certifies that

_____

Has successfully presented an understanding of environmental stewardship practices and the importance of trees.

Through artistic expression, the above named individual has communicated a message of hope for the future of our planet.

Let it be known that the South Dakota Department of Agriculture and Natural Resources, Division of Resource Conservation and Forestry, along with the Dakotas Society of American Foresters, Aspen Arboriculture Solutions, and the South Dakota Arborists Association recognize the unique and creative contributions offered by our state's youth and extends special appreciation for these efforts.

_____ _____

Gregory J Josten State Forester Teacher

ASPEN ARBORICULTURE SOLUTIONS
Sioux Falls' Tree Care Expert

South Dakota Arborists Association

SAF
forests. resources. community.

Arbor Day Poster Contest

TBA

School Winner

This certifies that

_____

Has successfully presented an understanding of environmental stewardship practices and the importance of trees.

Through artistic expression, the above named individual has communicated a message of hope for the future of our planet.

Let it be known that the South Dakota Department of Agriculture and Natural Resources, Division of Resource Conservation and Forestry, along with the Dakotas Society of American Foresters, Aspen Arboriculture Solutions, and the South Dakota Arborists Association recognize the unique and creative contributions offered by our state's youth and extends special appreciation for these efforts.

_____ _____

Teacher

ASPEN ARBORICULTURE SOLUTIONS
Sioux Falls' Tree Care Expert

South Dakota Arborists Association

SAF
forests. resources. community.

Step: #3

Celebrate Arbor Day

Get your students outside and celebrate!

Since 1872, Arbor Day has been celebrated throughout the United States and Arbor Day celebrations in schools have always played an important role. An Arbor Day celebration can be:

Simple: Plant a tree in honor of your school poster context winner or to recognize an outstanding volunteer.

Inspiring: Have your graduating class plant a tree with the younger students. This is a tradition that honors the students leaving and gives new students something to enjoy throughout the years.

Entertaining: Students could compose poems about trees or perform an Arbor Day play (a sample play is available at www.arborday.org/arbordayplay). This could be performed for fellow students, families, or senior citizens.

Whatever you choose for your celebration, go outside and enjoy the trees and environment that surround you!

The 2013 South Dakota Arbor Day Poster Contest winning art by Kendra Kaiser who attends the Hoven Elementary School in Hoven.

State Tree of South Dakota

Black Hills Spruce

(Picea Glauca var. densata)

Black Hills spruce is a naturally-occurring variety of white spruce native to South Dakota. It is more compact and slower growing than its northern counterparts. Also, its needles are more dense and are darker in color, varying from bright green to bluish green. It was seen by French explorers in 1743.

Black Hills spruce ranges from 30-60 feet in height and 15-25 feet in width. The tree is fairly drought resistant and prefers full sun exposure. It makes a good yard or ornamental tree and is good winter cover for birds and other wildlife. The tree was adopted as the official state tree by the State Legislature on March 10, 1947.

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