2016 Massachusetts Arbor Day Poster Contest

Sponsored by
Massachusetts Department of Conservation and Recreation (DCR)
United States Forest Service (USFS)
Massachusetts Tree Wardens' and Foresters' Association (MTWFA)

Dear Educator,

You are invited to join other fifth-grade teachers across Massachusetts in the 2016 Arbor Day Poster Contest sponsored by the Department of Conservation and Recreation, the U.S. Forest Service, and the Massachusetts Tree Wardens' and Foresters' Association. This year's theme, "**Trees Grow with Us and for Us!"** is designed to increase students' understanding of trees and the role trees play in their community and in the world around them.

Trees are the dominant feature of all forest communities and can be found everywhere in our daily lives. They exist in parks, schoolyards, backyards, and along our roads. Whether we are in a city or small community, the urban and community forest is so ubiquitous that we often don't stop to think that we are actually part of a forest community and have a complex relationship with its ecosystem. Increasing students' understanding of their relationship with the urban forest and the trees around them is an important step toward appreciation of trees and of the environmental benefits they provide our communities.

For participation in the contest, the use of part or all of the activities in this guide is encouraged, but not mandatory. You may adapt, alter, or supplement these activities to meet the needs of your class. Follow the contest rules as they appear on page 5. Make sure your school's poster is signed with the student's first name and last initial and that the school winner report form (page 6) is completed and affixed to the back. Submit one entry per school.

The deadline for the Poster Contest is April 1, 2016.

Details are also available on the Internet. Visit our site at http://www.mass.gov/eea/agencies/dcr/conservation/forestry-and-fire-control/branching-out-additional-programs.html and view past state winners or download other great activities.

Julie Coop, the DCR Urban & Community Forester, will announce the state winners.

Contact Mollie Freilicher, mollie.freilicher@state.ma.us or 413-577-2966 for more information.

2016 Massachusetts Arbor Day Poster Contest
Trees Grow with Us and for Us!

Table of Contents

Welcome Letter 1

Table of Contents 2

Activities Overview 3

Create a Poster 4

Poster Contest Rules 5

Arbor Day Poster Contest School Winner Report Form 6

Celebrate Arbor Day 7

Arbor Day Foundation Classroom Activities Booklet 8

Activities Overview

Trees Grow with Us and for Us!

I. Discover how trees grow and function

Student Learning Objective:

- Students will identify structural components of a tree, be able to explain how these components help a tree grow and function, illustrate the process of photosynthesis, and reflect on the benefits trees provide to the environment.

Basic Activity (Page 5 of the Arbor Day Foundation booklet)

- Role-play the growth process of a tree.

Extension Activities

- Searching for Stoma (Page 20 of the Arbor Day Foundation booklet)
- Leaf Transpiration (Page 20 of the Arbor Day Foundation booklet)

II. Create a Poster:

Student Learning Objective:

- Students will create a poster that reflects their understanding of how trees grow, function, and benefit the environment.

Activity:

- Ask each student to create a poster around the theme **"Trees Grow with Us and for Us!"** that reflects their understanding of the role trees play in their community or, on a larger scale, in Massachusetts.

- Before they begin creating their posters, encourage students to think about how trees contribute to their lives in their school, in the community, or in Massachusetts.

Create a Poster

Ask each student to create a poster around the theme **"Trees Grow with Us and for Us!"** that reflects their understanding of the role trees play in their community or on a larger scale, in Massachusetts.

Before beginning to create the posters, encourage students to think about how trees contribute to their lives in their school, in the community, or in Massachusetts.

Students should follow the poster contest rules by using the **checklist on page 5**.

You may select the winner or have a judging panel for the classroom and school contest. Judges could include other students, garden club members, tree board members, nursery personnel, arborists, the city forester, teachers, PTA members, or individuals with an interest in trees who are willing to volunteer some time.

Submit your poster to DCR by **April 1, 2016**.

Poster Contest Prizes

First Place

- A tree is planted on the grounds of the winner's school (valued at $200)
- A certificate for art supplies and many other prizes
- and more…

Second Place, Third Place, and Honorable Mention Winners receive art supplies and many other prizes at a ceremony for all the winners.

Winner's teacher will also receive prizes that include educational materials that will support continued learning about forests and natural resource conservation.

Poster Contest Rules

2015 Arbor Day Poster Contest Winner (Dr. Albert F. Argenziano School, Somerville)

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

1. All entries must be original artwork created by a student who is currently in the fifth grade. A student may enter the contest only once.

2. The student's **first name** and **last initial** must be **written** in the lower right-hand corner on the front of the poster. Do not include the last name on the front of the poster.

3. Entry Media

a) Entries may be done in marker, crayon, paint pens, watercolor, ink, acrylic, colored pencil, and/or tempera paint.
b) Collages are not acceptable. (Do not glue anything on your poster.)
c) Computer or photo-generated art and/or printing is not acceptable.

4. Entries must be no smaller than 8.5 x 11" and no larger than 14 x 18".

5. Entries must be done on paper that will allow for duplication, display, and framing.

6. The poster must be related to the contest theme in some way. The theme "**Trees Grow with Us and for Us!"** must be on the poster. All words must be spelled correctly.

7. Entries should not be matted, mounted, laminated, framed, or folded.

8. Submit entry by April 1, 2016 to DCR's Urban and Community Forestry Coordinator, Julie Coop, as described on the "School Winner Report Form" on the next page. Affix School Winner Report Form to the back of the school's winning poster.

School Winner Report Form

2016 Massachusetts Arbor Day Poster Contest

All information should be complete to expedite notification of winners.
All artwork becomes the property of contest sponsors.

After selecting a winning poster for the school, copy and complete this form, attach to the back of the winning poster, and send to:
Julie Coop, DCR Urban & Community Forester
251 Causeway St. 9th floor,
Boston, MA 02114

Winner's Name _____

Winner's Home Address _____

City State ZIP_____

Winner's parent or guardian name _____

Teacher's Name _____

Teacher's e-mail address _____

School Name _____

School Address _____

City County State ZIP _____

School Phone (____) _____ - _____

Important:

***Please indicate the number of posters entered or drawn in the school contest _____.**

***Number of teachers in school who participated_____.**

Celebrate Arbor Day
Friday, April 29, 2016

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 contest 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 their years!

•**Entertaining** – Students compose poems or songs 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!

Get your students outside and celebrate Arbor Day!

For ideas on incorporating Arbor Day into lesson planning, go to http://arborday.org/arborday/classroom.cfm

The Massachusetts Department of Conservation and Recreation prohibits discrimination in employment on the basis of race, color, creed, religion, national origin, ethnicity, gender, gender identity or expression, age, sexual orientation, Vietnam Era Veteran status, or disability.

Step 1 Discover how trees grow and function

BASIC ACTIVITY - Role-play the growth process of a tree

Classroom Activity:

- Students will role-play the growth process of a young tree to become familiar with the structural components of a tree and learn how these components help the tree function

Objectives:

Students will be able to:

- name 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:

- Photocopied student handouts on pages 11-13
- One or two examples of tree fruits/seeds (i.e. acorn, walnut, apple with seeds)
- Several samples of bark, if available
- Small plant in pot (optional)
- Hand lenses (optional)
- Approximately 6 foot piece of ribbon or yarn
- Pencil and paper
- Tree cross-section or picture of a cross section
- 2 small bottles of water
- 6 small packets of sugar
- Red, blue, green, yellow & brown construction paper
- Tree Labels on pages 18 & 19 photocopied, cut and pasted onto strips of colored construction paper
- Ball of string or twine
- Paper clips (one per label)

National Science Standards Correlation:

Students will develop an understanding of:

- structure and function in living systems
- populations and ecosystems
- populations, resources and environments

Instructional Sequence:

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

Start the classroom discussion by reading Paragraph #1.

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 from soil erosion after a heavy rain. The air was hazy because of the smog. The city's buildings and pavements reflected so much heat that the summer temperature was uncomfortably hot. The people in the city were concerned and were looking for some way to improve conditions in their community. A bright young student told the city 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, muffle 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 students if 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.

Paragraph #2

The young student went on to describe other features of the unique invention. She said that along with helping the environment, this invention 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 medicine. And when it was no longer useful, this invention was biodegradable or could be used for fuel. She said this thing was not new, 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 may need to spend extra time as you introduce and go through each of the following concepts.

With student input, do a quick review of the benefits we get from trees. List the benefits on the board. Encourage students to add additional environmental benefits or tree products to the list.

Write the following questions on the board. Explain they have just discussed the first question, but by the end of the lesson, they should know the answer to all these questions.

1. How do trees benefit the environment?
2. How does a small seed grow into a huge tree?
3. What are the important parts of the tree that work together to help the tree grow and reproduce?
4. How does a tree use sunlight to make its own food?

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

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 grow.

Roots

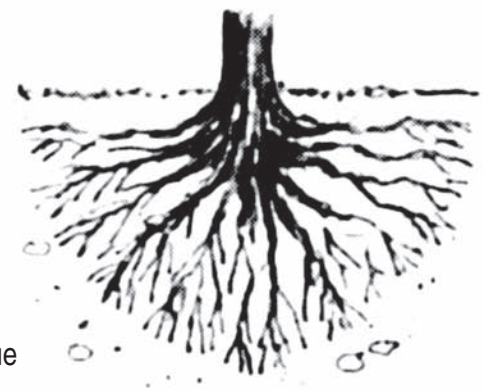
Tell students that when a seed **germinates** (starts to grow), the first thing the seed sends out is a tiny root to hold its position in the soil and start drawing in water.

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

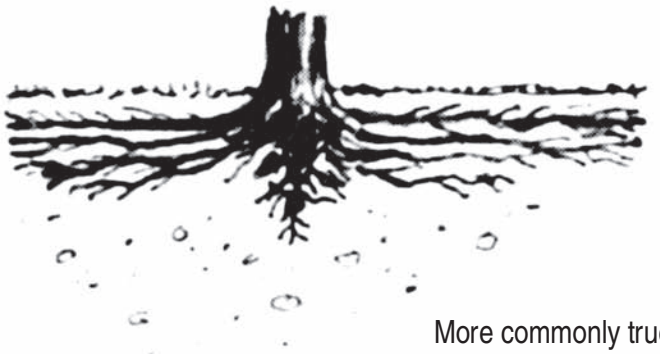
Concept #2: A tree has many interdependent structural components that are essential for the tree to grow and reproduce.

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.

Examples of Root Growth



Rarely true



More commonly true

As a tree grows larger it develops several kinds of roots. A few trees have long **taproots** that go deep down 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" of soil! Most trees are likely to have roots extending out about one and a half to two times the branch spread. (See illustration)

Make a similar 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 of the root system.

Have students work as pairs. One student in each pair should extend their arms like branches, standing on tiptoe with feet together, and pretend to be a tree. *Ask what they think would happen if the wind came up?* The other student in each pair should simulate this by supporting their partner with one hand and giving their partner a very gentle push with the other hand. Repeat the demonstration with the student standing with legs slightly spread and feet flat on the floor. *Ask students what they think this activity showed.* Confirm that one function of the roots is to keep the tree anchored in the soil so it doesn't fall over. In some ways, tree roots are like your feet – when they spread out, the tree is more stable.

The taproot and lateral roots are large, hard and woody; they contain cells for the storage of sugar, just like the trunk and branches. But as these larger roots spread out, they branch into smaller and smaller roots called rootlets, fine fibrous roots covered with tiny **root hairs**. These root hairs suck in water and nutrients from the soil that the tree needs to live. These fibrous roots cling firmly to the soil in order to better absorb water and nutrients. By doing so, the roots also hold the soil in place and protect it from erosion. 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.

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 off sections of root and allow children to look at them with a hand lens. *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 or set the plant in container of water and observe it over the next several days to see what happens after roots have been damaged.

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 rooting in cracks in the sidewalks. Have students make observations about the strength of roots.

Trunk Form and Function

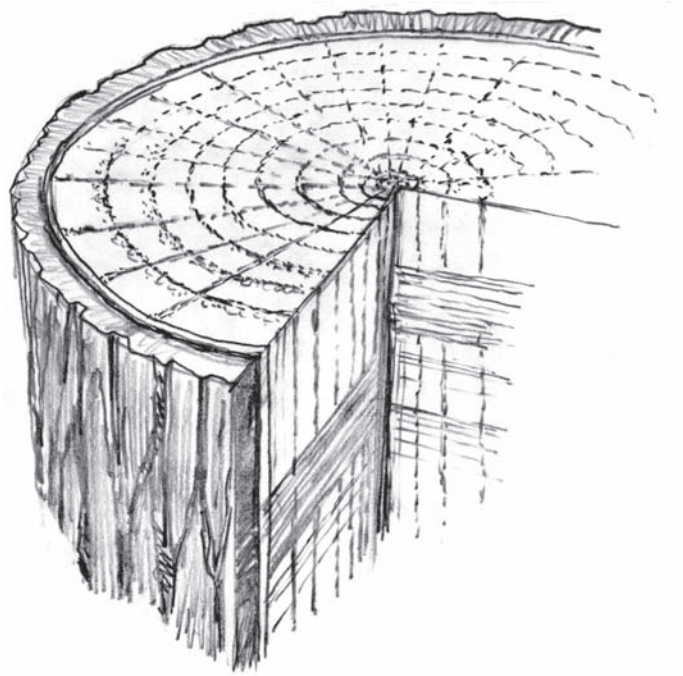
Many of these internal tree parts will be new to your students. Background information is included for all the tree parts to share as you look through the Student Handouts 1 & 2 together (pages 11 & 12). Encourage student questions and observations as you examine the Tree Cross-Section illustration on the handout. Student Handout #3 on page 13 contains a vocabulary list of bolded words and a rubric.

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. Others cells, called **phloem**, or **inner bark**, carry the sugar food made by the leaves back down to the living parts of the tree. Located between these 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 protective covering for 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 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 from 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 it, what might happen to the ribbon. *Will it move higher (further up from the ground) as the tree grows?*

After 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 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 scarf 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.

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 years past, increasing the width of the tree. 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. The wood formed in summer grows more slowly and is darker colored because there is less available 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.

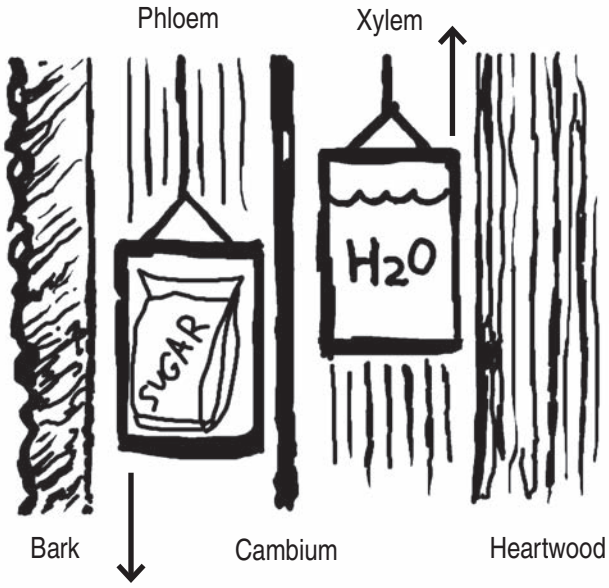
Dendrochronology is the study of a tree through its annual growth rings. Scientists not only use these rings to determine the age of the tree, but they can also get information about the climate, the spacing of trees and the presence of fire around the individual tree. A wide ring often indicates that 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 high 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 was cut down. If an actual cross-section is not available, a picture of one can be viewed and/or printed at arborday.org/annualrings.

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. The vast majority of a living tree (99%) 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 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.

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 and grew from the inside out. You may wish to use pencils and paper to do bark rubbings that will reveal the different patterns in tree bark.

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.

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 function: they create the sugar food that feeds the tree and, through the web of life, feeds all other living things. The amazing process that makes this possible is called **photosynthesis**. Refer to the illustration on Student Handout #2 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." Photosynthesis occurs only in plants that contain a green 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_20) 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_20. This combination results in the creation of a sugar food called glucose ($C_6H_{12}O_6$) that provides energy for the plant and all animals that eat that plant, or eat the animal that ate the plant. Not 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.

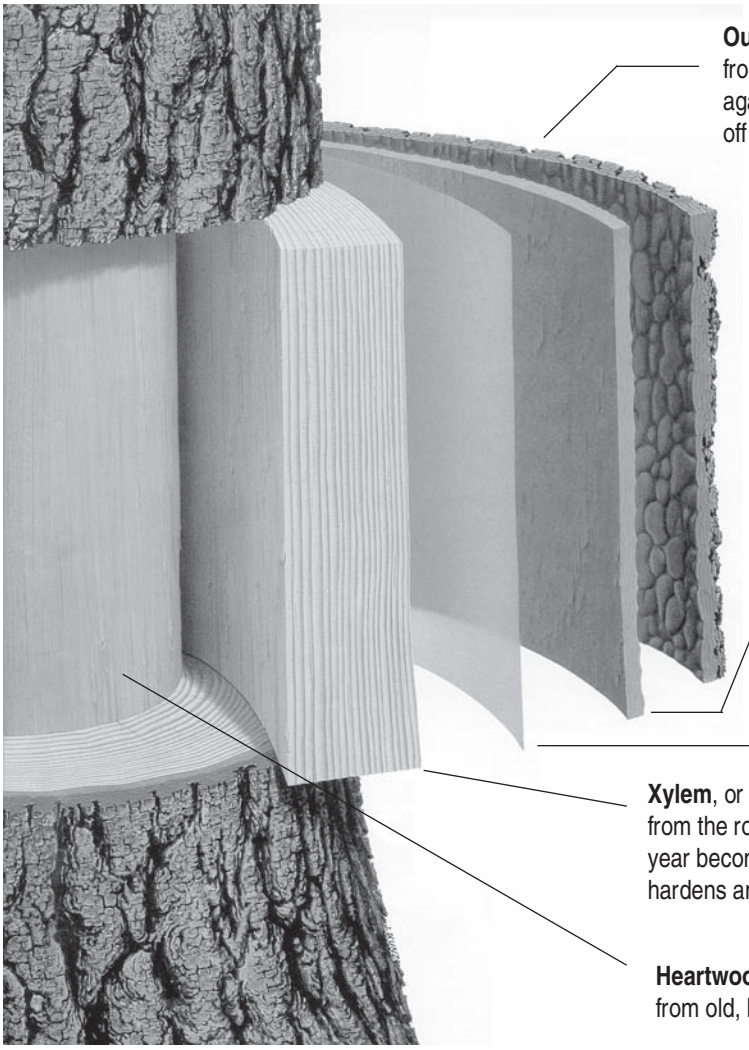
Carbon dioxide enters the leaf and oxygen exits the leaf through tiny holes called stoma, usually found on the undersurface of the leaves. At the same time, water is also released in a process called **transpiration**. Most plants in temperate climates transpire about 99% of the water the tree has taken in by their roots. The plant transpiration helps modify the temperature and humidity of the surrounding area. For a leaf transpiration activity, see Extension Activities, page 20.)

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 kind. 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 inside. Explain that a seed is like a baby plant in a box with its lunch. There is enough food stored in the seed to get the baby plant started growing until it can make leaves and start to produce its own food through the process of photosynthesis.

Additional Suggested Reading
The Giving Tree by Shel Silverstein

Tree Cross-Section



Outer bark is the tree's protection from the outside world. It insulates against cold and heat and wards off insect enemies.

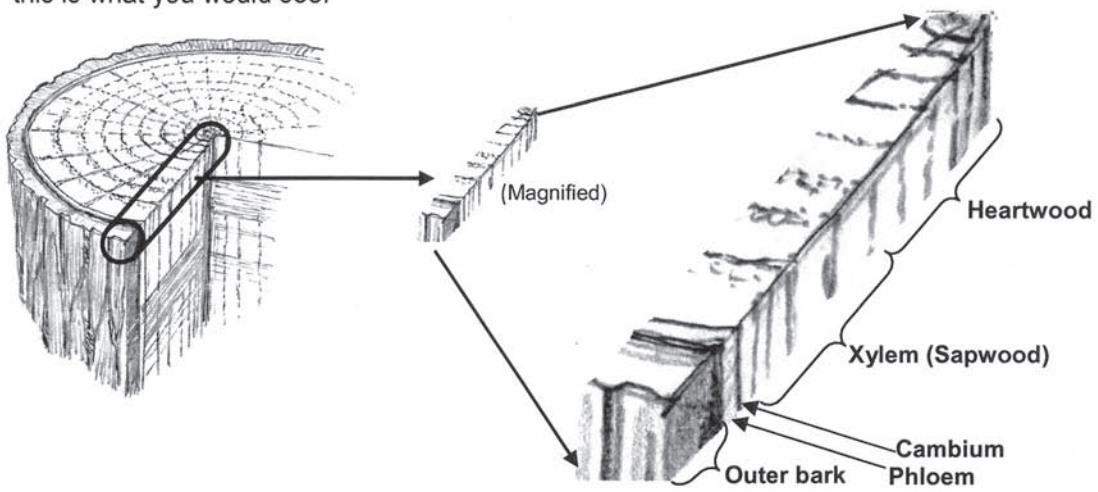
Phloem, or inner bark, is the pipeline through which food is passed to the rest of the tree. It lives for a short time, and then dies and becomes part of the protective outer bark.

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 water from the roots to the leaves. The new xylem laid down each year become the 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.

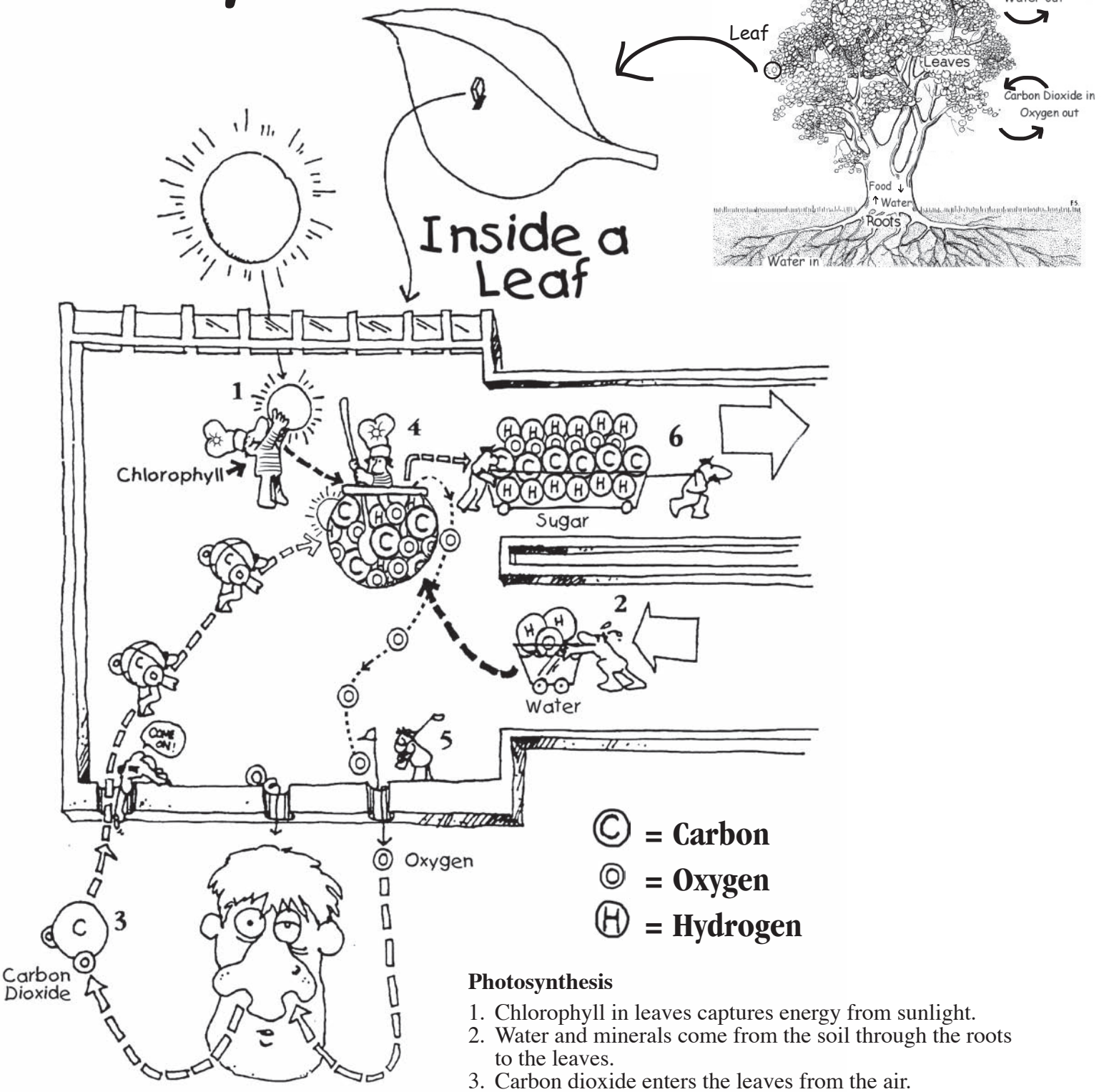
If you could pull a chunk from the trunk of a tree, then cut a radial piece out of that chunk, then magnify it... this is what you would see.



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!

Student Handout #2

Photosynthesis Sheet



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 other parts of the plant for use or storage.

Student Handout #3

Vocabulary

Annual rings – The fast then slow growth of xylem each year creates a concentric ring pattern in the trunk. Count the rings and you know the age of the tree, as well as past weather conditions.
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 released from burning fossil fuels or decomposition. Trees clean the air by taking in carbon dioxide to use in photosynthesis. Often shown as CO_2.
Chlorophyll – The green pigment in leaves that makes photosynthesis possible.
Deciduous – Trees that lose their leaves each year.
Evergreen – Trees that lose their leaves gradually over time so they appear green 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 to survive. Often shown as O.
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 anchor 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 same kind.
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 leaves of the tree. Xylem is the wood of the tree.

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

#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.			
	No growth **0 points** if you can't name any environmental benefits or tree products.	**Germination** **1 point** if you can name one environmental benefit trees provide and one tree product.	**Vigorous growth** **2 points** if you can name two environmental benefits trees provide and at least one tree product.	**Fully grown** **3 points** 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.)			
	No growth **0 points** if you can name fewer than four tree parts and can't describe what the tree parts do for the tree.	**Germination** **1 point** if you can name five tree parts and describe what these parts do for the tree.	**Vigorous growth** **2 points** if you can name six or seven tree parts and describe what these parts do for the tree	**Fully grown** **3 points** if you can name all eight major tree parts and clearly describe what these parts do for the tree.
#3	Photosynthesis, the process by which 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.)			
	No growth **0 points** if you can name fewer than three components of photosynthesis and can't describe how this cycle works.	**Germination** **1 point** if you can name at least 4 components of photosynthesis and generally describe how this cycle works.	**Vigorous growth** **2 points** if you can name at least 5 components of photosynthesis and clearly describe how this cycle works.	**Fully grown** **3 points** 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 actively and cooperatively participating in the Tree Growth Activity.

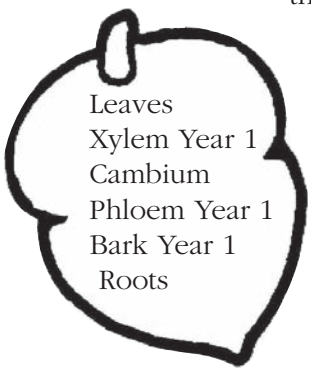
The Activity: Role-play the growth process of a tree to understand its form and function

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 starts with a tiny seed as it germinates. It then moves to a young tree in its growth over 5 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 from pages 18 &19. Cut and paste the labels onto the suggested colored strips of construction paper and attach a paper clip to each so children can create 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 5 years of growth. (Go to arborday.org/treelabels to see a label list based on class numbers.) 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 to 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 all 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 role-play narration. (Read the bolded text aloud.)



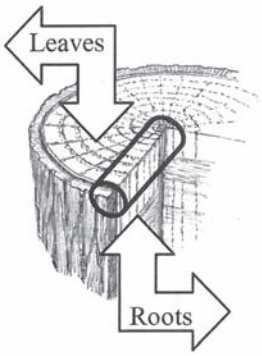
GERMINATION

1. **A small seed falls to 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 hold 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.)*

2. **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 now 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. That section of

trunk contains tubes that run from the roots below the tree to the leaves high above.

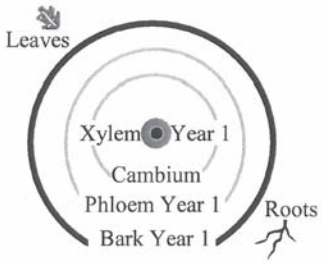


Students representing leaves should stand with arms raised, their hands representing the leafy canopy. Students representing roots should sit on the floor with feet out in front of them to represent spreading roots. Students inside the tree trunk should stand. It is important for them to stay in a straight line during the activity to get a true sense of the tree's expanding 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 him/her to hold onto those until it's time to pass them to newly formed bark (one each year). Divide sugar packets among the students with "Leaves" labels. Give a water bottle to the student with "Roots" label.

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

EXAMPLE 1
Tree Trunk – Year 1
● denotes center of tree



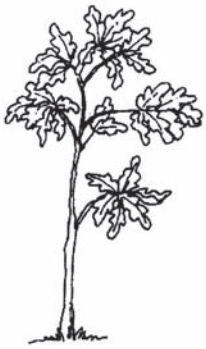
The narration for the role-play is printed in bold and should be read by the teacher.
Actions for the role-play are printed in italics and are also on the role labels the students will draw.
NOTE: During the first round of the role-play the teacher may need to prompt students when it's their turn. As the role-play 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 string 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 handing 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 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 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.

TREE GROWTH - YEARS TWO THROUGH FIVE
(**TEACHER'S 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 stand between the "Cambium" and "Xylem Year 1 ".
YEAR THREE - "Xylem Year 3 " comes to 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 the "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 handing a new bark label to the "Phloem Year 1 " student who should cover his/her Phloem label with the new Bark one.
YEAR THREE – Same as Year Two only with New Bark label passed to "Phloem Year 2 ".
YEAR FOUR – Same as Year Two only with New Bark label passed to "Phloem Year 3 ".
YEAR FIVE – Same as Year Two only with 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.** *Student representing "Bark Year 1 " should kneel or lay on the floor to represent the shed bark.*

5. Spring rains soak into the soil.
Teacher hands 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" make 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 AT 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 student representing "Xylem Year 1 " the Heartwood label. Instruct that student to now say, "Standing Strong!")

8. Leaves release most of water into the air. Through photosynthesis the Leaves make sugar food for the tree. *("Leaves" hand the water to the teacher."Leaves" put their hands up and shake them saying, "Making food!")*

The Leaves pass food to the new Phloem. *("Leaves" pass a sugar packet down to the student currently representing "Phloem".)*

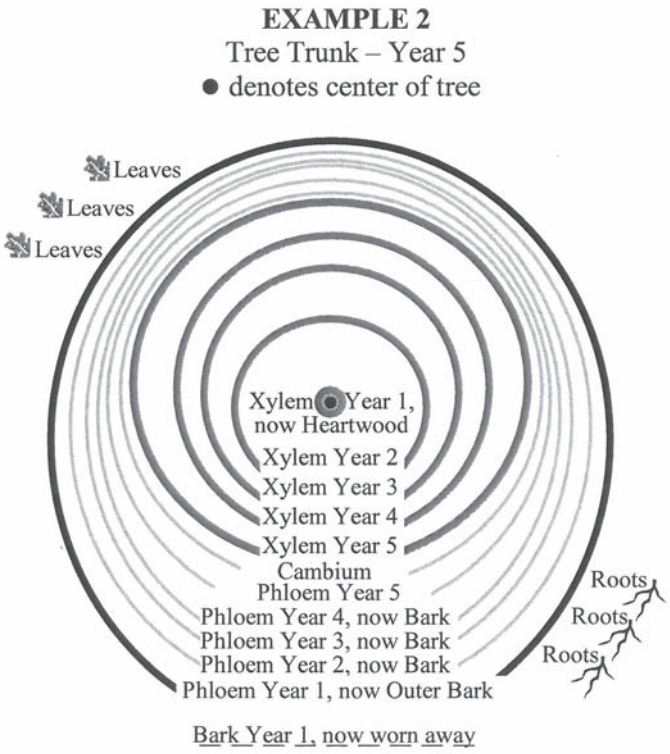
9. Phloem passes food through the tree, down to the Roots. *(The student currently representing Phloem should say, "Yum, yum" while passing the sugar packet down to the "Roots".)*

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 AT YEAR FIVE for activity conclusion.) 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 role-play with class discussion. Ask: *What parts of the tree got thicker? What parts of the tree ended up where they started?* What other observations about tree growth did you make?

Assessment:

Refer students back to the questions written on the board at the start of the lesson. Have students record the questions on a piece of paper. Students may answer the questions in a written narrative or create and label a diagram to illustrate the process. See Rubric on page 13.

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.

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 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 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 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 3 (sapwood)
YOUR JOB - You transport water from the roots to 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 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 welcome them by saying “HELP PROTECT!”

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 through the trunk to the roots.
At your turn you say, “YUM, YUM”

PHLOEM YEAR 5
(inner bark)
YOUR JOB - You transport food from the leaves through 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 through 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 to through 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 to through 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!”

EXTENSION ACTIVITIES

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 5).

Searching for Stoma Activity

Time Recommended:

- One class period

Materials Needed:

- Lettuce leaf
- Iodine
- 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 chloroplasts (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 the process of 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 30 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. Have students draw and label what they see under the microscope.

Leaf Transpiration

Time Recommended:

- One class period for the activity with follow up observations over the next week

Materials Needed:

- 1 clear plastic bag with a twist tie per student
- 1 or 2 potted plants (5" pot or larger)
- 1 or 2 large, transparent plastic bags with twist ties
- Scale

Leaf Transpiration Activity Description:

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. Leave 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.

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 when you begin the experiment and then set the plant in the sun. Ask students to predict what might happen. Weigh the potted plant everyday. The pot will get lighter as the moisture in 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 temperature affect the rate of transpiration?

Does the size of the leaf's surface affect transpiration?

Does wind affect the rate of transpiration?

Do broadleaf trees transpire more moisture than conifers?

More Great Activities...

Additional activities that support these materials are available on-line at arborday.org/youthed. Download "Tree Ring-Around", a fast paced activity that reinforces vocabulary introduced in this Activity Guide. "Life of the Forest" offers students a visual image of how trees grow.