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 and learn how these components help the tree function**

Objectives:

Students will be able to:

- **Identify structural components of the tree and explain how these components help the tree function**
- **Identify the major components in the process of photosynthesis**
- **Name several benefits or products that come from trees**

Time Recommended:

- **One 60 minute class period**

Materials Needed:

- **Overheads or copies of handouts on pages 9 and 13**
- **Small plant**
- **One 20'-25' piece of brown yarn**
- **Blue and green yarn**
- **One or two examples of tree fruits/seed (i.e. acorn, walnut, apple with seeds)**
- **Microscope & slides or hand lens**
- **Pencil and paper**
- **Tree cross-section or picture of a cross-section**
- **Small cup of water, eyedropper, and a penny (one of each for every four students)**
- **Scarf**

National Science Standard Correlation:

Students will develop an understanding of:

- **Structure and function in living systems**
- **Populations and ecosystems**

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: 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.

Paragraph #2

The young student went on 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 medicine. 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 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 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 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 (roots, trunk, cambium, xylem, phloem, bark, and leaves with chlorophyll) that are essential for the tree to grow and function.

Roots

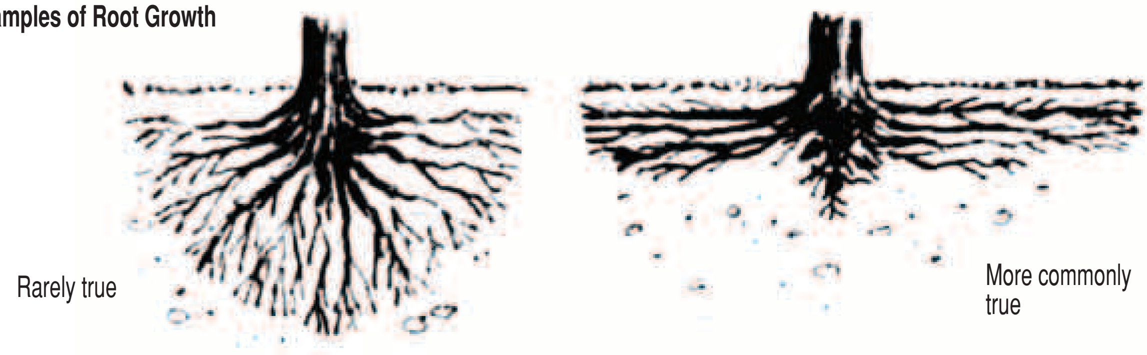
Background information:

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 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 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 portions of the tree that are above ground. They 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** (my-koh-ry-zee) where the fungi becomes an extension of the tree's own root system. The mycorrhizae are very absorptive and more efficient than the plant's roots 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 from 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.

Examples of Root Growth



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 hand. Explain a tree needs roots to keep them from falling over.

Repeat the demonstration with the student standing with legs slightly apart and feet flat on the floor. Explain to 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 from the soil that the tree needs to live. 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 of the root system. (See example on page 7.)

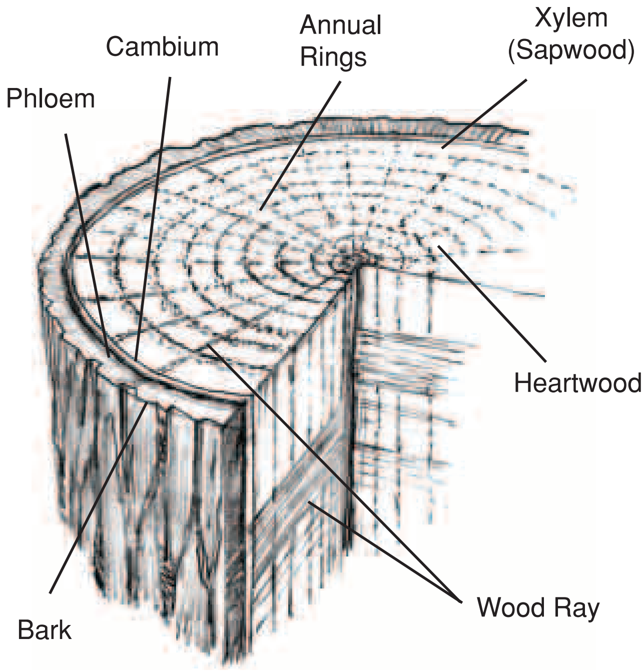
Root Activity:

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 the root and allow children to make observations as they look at them with a hand lens or microscope, if available. 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 rooting in cracks in the sidewalks. Have students make observations about the strength of roots.



Trunk Form and Function

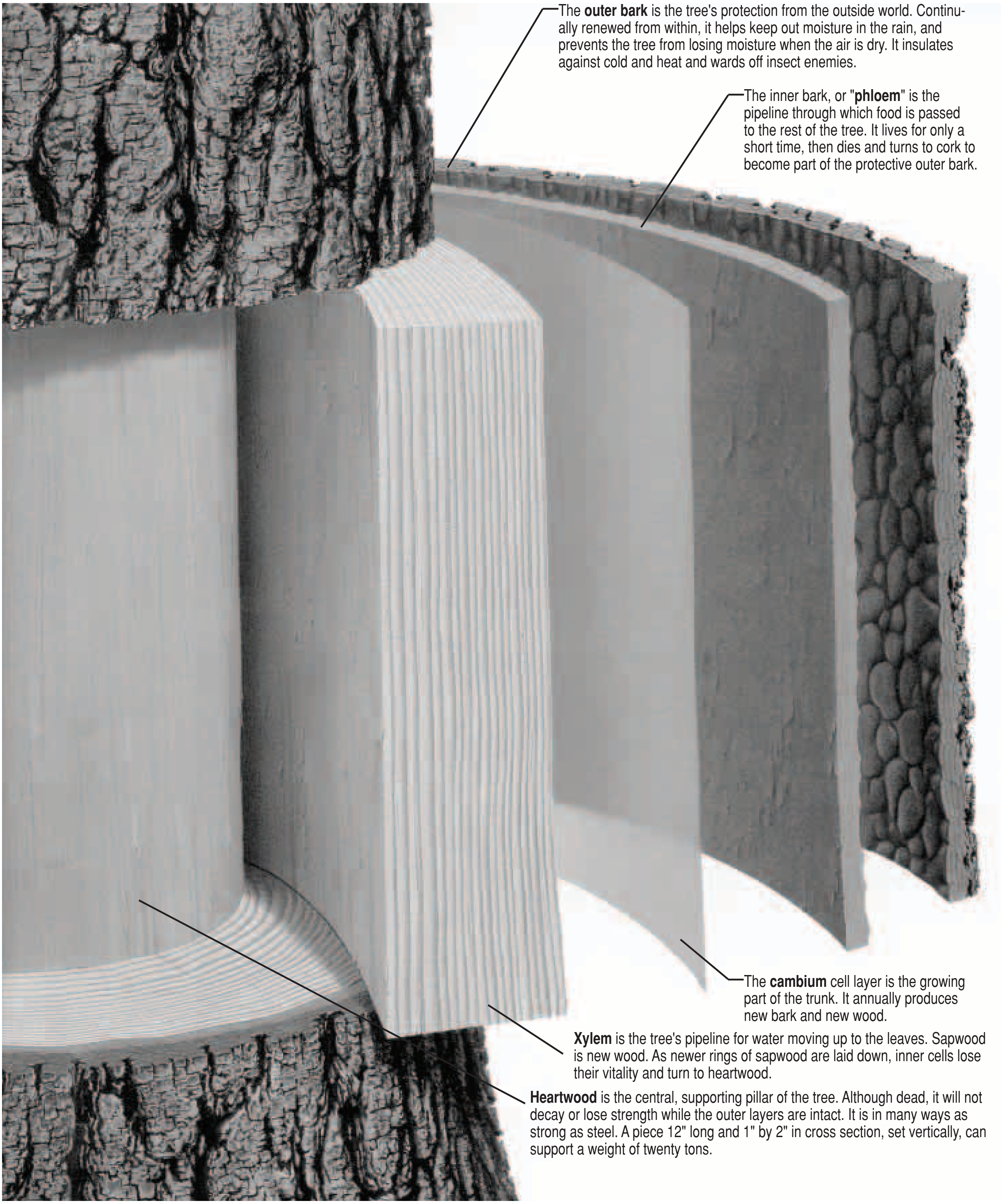
Background information:

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 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.

Copy the Tree Cross-Section Sheet on page 9 and use as an overhead or handout for your students as you discuss the parts of the trunk.

Tree Cross-Section Sheet



Artwork courtesy of International Paper

Artwork courtesy of International Paper

Cambium

Background Information:

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 girth, the cambium moves outward, pushing the bark before it and leaving the wood behind.

Cambium Activity:

Ask one student to come to the front of the room and extend arms perpendicular from the body, pretending to be a tree. Tie a scarf or ribbon around one of the student's arms. Ask if the student were an actual tree and the arm a branch, would the scarf move upwards as the tree grew?

The answer is no. Trees grow in diameter from the inside out and height is added by new growth from the tips of the branches. Cells are not transported like building blocks; they are created where needed and stay there.
Next tie the scarf firmly around the student's waist. Ask if the student were a tree, would the scarf be affected by the annual growth?
The answer is yes. New cells are formed by the cambium inside the bark. These new cells push the bark outward which would cause the scarf to become tighter and tighter. If the scarf did not break, it might be forced into the bark as the tree grew around it. Should that happen, it might injure the food transportation system and eventually kill the tree.

Xylem

Background Information:

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, thus 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-foot 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 1:
Have students examine a stump or tree cross-section and figure the age of the tree when it was cut down. (The tree section on page 10 shows 62 years of growth.)

Xylem Activity 2:
A penny, an eyedropper, and water can demonstrate the cohesive nature of water, which is partially responsible for the way the xylem tubes work. Instruct students to predict how many drops of water they think they can place on the surface of a penny before it overflows. Explain that water sticks to itself because of molecular cohesion. Students should carefully place one drop of water at a time on a penny; counting how many drops it takes before it overflows.

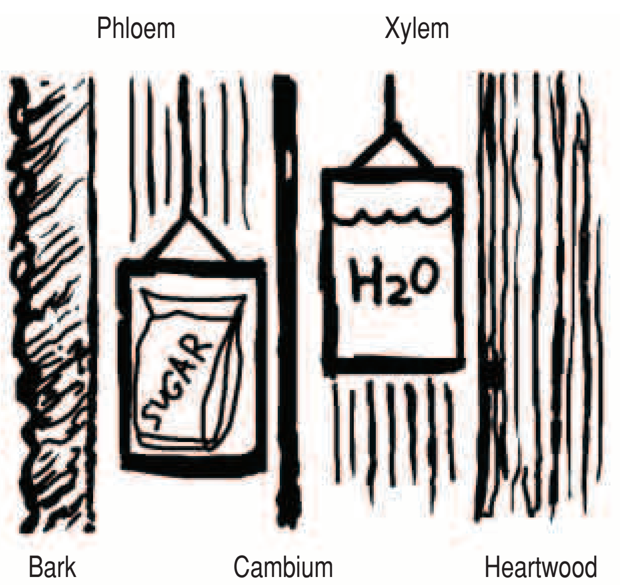
<u>Heartwood</u>

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 non-living cells that provide structural support rather than active fluid conduction.

<u>Phloem</u>

The cell layer exterior to the cambium is called **phloem**. It is 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.



<u>Bark</u>

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. 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.

Concept #3: Trees take in carbon dioxide and water and, using sunlight and chlorophyll, make a sugar-food to feed the tree and create oxygen through the process of photosynthesis.

<u>Leaves</u>

Background Information:

Leaves come in many shapes and sizes and provide the easiest means of identification of an individual tree. Some leaves 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 make this possible is called **photosynthesis.**

Photosynthesis is a combination of "photo" which is a prefix meaning "of or produced by light" and "synthesis" which is a root word that 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.

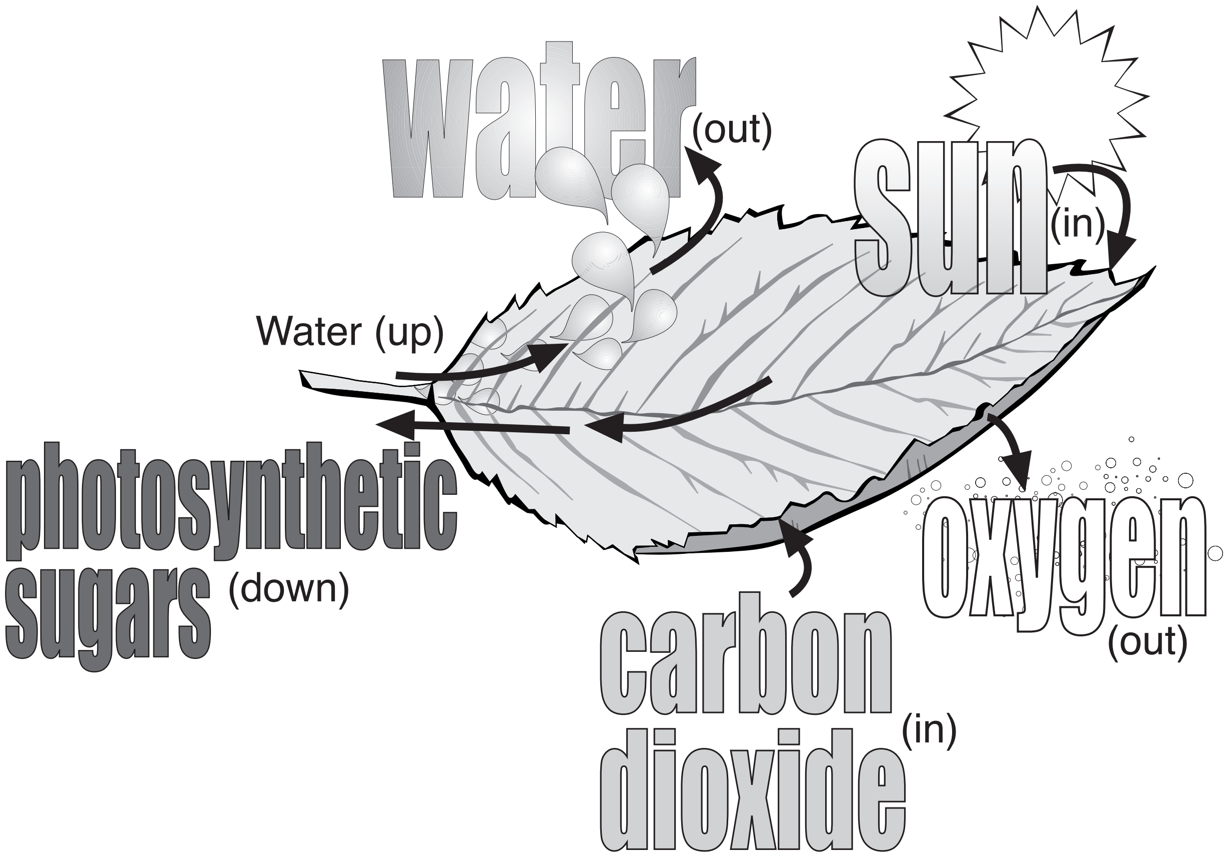
Carbon dioxide (CO_2) is exhaled by animals, created by microorganisms through the process of decomposition, and released during the combustion of fossil fuels. In the leaf of a green plant, carbon dioxide comes in contact with water (H_2O) and nutrients that have been drawn up from the soil by the roots 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 ($C_6H_{12}O_6$) 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 all food chains upon which all animals depend, plants also produce oxygen, a gas that all animals need to survive.

Copy the Photosynthesis Sheet on page 13 and use as a handout or overhead as you discuss the photosynthesis process. As CO_2 enters the leaf and O_2 exits the leaf, water is 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 activity, see Extension Activities, page 17).

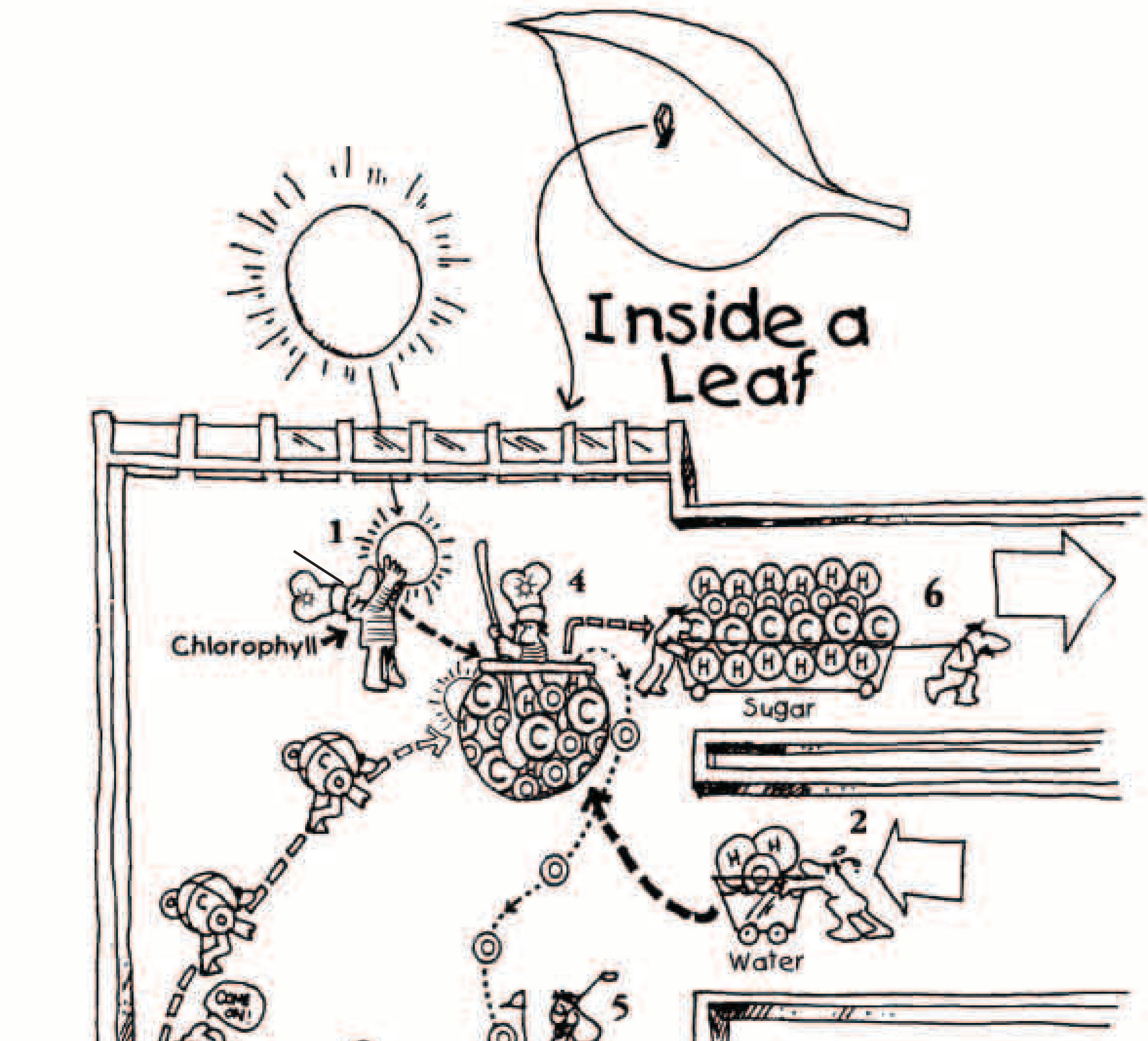
Seeds/Fruits

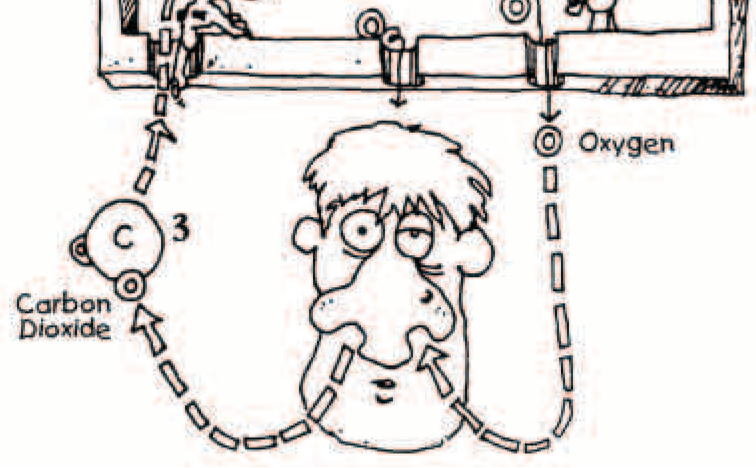
Most trees grow from seed. Many kinds of seeds exist- but the function of seeds is always the same…to produce a new plant. A mature plant produces seeds that have the genetic blueprint for a new plant of the same kind.

Pass around several examples of seeds for students to observe. Point out to students the hard outer seed coat that 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.



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 other parts of the plant for use or storage.

BASIC 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 several years. Each student will represent an important part of the tree. Building the tree will start with the cambium layer. The cambium layer produces wood (xylem cells) towards the inside of the tree and inner bark (phloem cells) towards the outside of the tree; these layers add to the girth of the tree. Each year the cambium adds new phloem and xylem cells. The old xylem cells eventually 'hand over' the job of transporting water to the new xylem cells and become heartwood, the supporting pillar of the tree. The old phloem cells 'hand over' the job of transporting food to new phloem cells and become outer bark, protecting the tree from damage. All the while, the leaves and roots are working to provide food and water to the tree. As layers are added to the tree each year, students will understand how the tree grows.

In Advance: Based on the number of students, write the names of tree parts needed for the activity (i.e. Phloem 2) on slips of paper. (The illustrations shown use 27 students - Adapt tree part numbers to best fit the size of your class. See Chart A, page 16.) Cut as many blue and green 6' pieces of yarn as you have leaves and roots. Labels for Heartwood and Outer Bark need to be made in advance by the teacher for use later in the activity. Write Heartwood on as many labels as you have Xylem 1s. Write Outer Bark on as many labels as you have Phloem 1s and Phloem 2s.

1. Explain to students that they are going to "build" a tree. Have students draw slips to determine the tree part they will play. Students should write the name and number of their tree part on a sticky label and attach it to their shirt.

2. Have the students playing Cambium (C) come to the front of the room and stand about two feet apart, back to back in a circle. (With fewer than 15 students have the single Cambium stand near a wall- the wall representing the inside of the tree.) Tell the class these children represent the cambium layer of a young tree. Remind them the cambium is the growing part of the tree. Explain that each year new cells formed in the cambium move outward to become phloem cells. Others move inward to become xylem cells.

3. Have the Cambium pretend to make xylem cells. Have the first year xylem, Xylem 1 (X_1), come up and stand behind (inside) the Cambium (C) layer. Ask students to recall what the function of the xylem is. (*Water transportation from the roots to the leaves.*)

4. Have the Cambium pretend to make phloem cells. Have the first year phloem, Phloem 1 (P_1) come up and stand in front of (outside) the cambium (C) layer. Ask students to recall what the function of the phloem is. (*Food transportation from the leaves to the roots.*)

5. Have the Roots (R) come to the front of the class. Ask students to recall the function of the roots. (*Absorption of water and nutrients from the soil.*) Give each Root one blue and one green piece of yarn. Explain that the blue yarn represents the water the xylem transports from the roots to the leaves. The green yarn represents the food the phloem transports from the leaves to the roots. Have each Root hand one end of their blue yarn to a Xylem 1 and one end of their green yarn to a Phloem 1. (Xylem 1 and Phloem 1 should hold all connections to Roots in their right hand.)

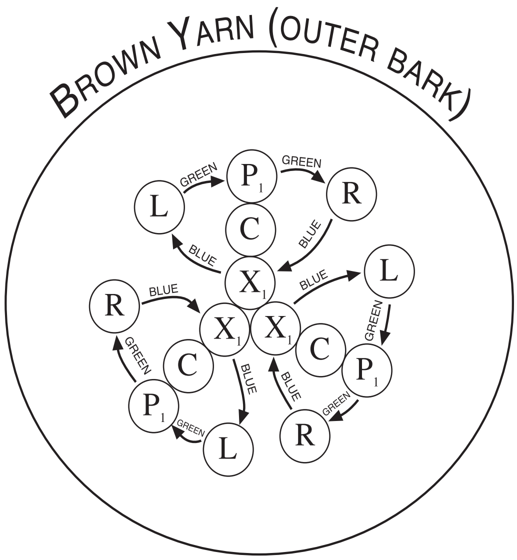
6. Have the Leaves (L) come to the front of the class. Ask students to explain the function of the leaves. (*Make food to feed the tree. In making food, the leaves produce oxygen and clear carbon dioxide from the air.*) Give each Leaf one blue and one green piece of yarn. Ask students to review what the blue yarn and the green yarn represent as described in #5. Each Leaf hands one end of their blue yarn to a Xylem 1 and one end of their green yarn to a Phloem 1. (Xylem 1 and

Phloem 1 should hold all connections to Leaves in their left hand.)

(Note: Make sure each Xylem 1 connects to at least one Leaf and one Root and each Phloem 1 connects to at least one Leaf and one Root.) (See Illustration 1.)

Illustration 1

Year 1



7. Take the long piece of brown yarn and tie it loosely around the group of students. Phloem 1s can hold it up in the crook of their arms. Explain this yarn represents the outside bark of the tree after one year of growth.

8. Explain to the students that this now makes up the main parts of a tree. As water is used in photosynthesis and transpired out of the leaves, the leaves need more water. Have the Leaves pull on the blue yarn to signal to the Xylem more water is needed. In turn, the Xylem pulls on the other piece of blue yarn connected to the Roots to signal to the Roots to pull in more water. After the Roots send water up, food energy is needed for the Roots to continue to seek out more water. The Roots pull on the green yarn connected to the Phloem to signal food is needed. In turn the Phloem pulls on their other piece of green yarn connected to the Leaves to send food down to "feed" the tree. As the Leaves make more food through photosynthesis, the cycle continues. Go through several cycles of moving water up and food down.

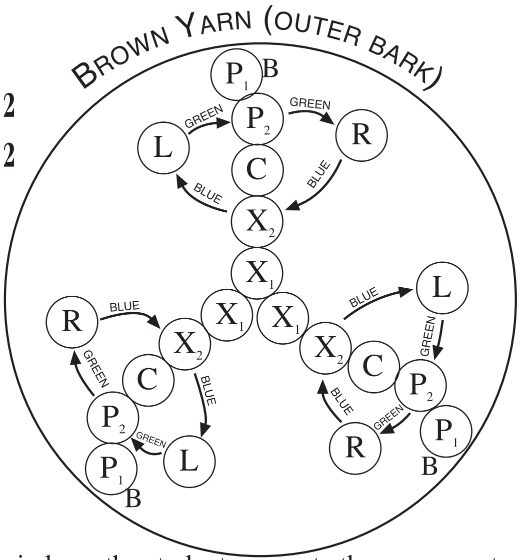
9. Imagine that another year has passed. It is spring and the cambium is making new xylem and phloem cells. Have the Cambium (C) make room in front and behind itself for new cells to grow.

10. Have the second year xylem, Xylem 2 (X_2), come up, go under the brown yarn and stand directly behind the Cambium (C) and in front of the Xylem 1 (X_1). Ask students what this xylem layer would represent in a tree cross-section (*a new tree ring*). Explain that the first year xylem, Xylem 1, may still transport some water, but most of the water is transported by the new xylem, Xylem 2. Xylem 1 students hand their ends of yarn to the Xylem 2 students who act as the new water transport system.

11. Have the second year phloem, Phloem 2 (P_2), come up, go under the brown yarn and stand directly in front of the Cambium (C) and behind Phloem 1 (P_1). Ask students what happens to old phloem (*it gets pushed outward to become outer bark*). Phloem 1 students hand their ends of yarn to the Phloem 2 students. Phloem 2 becomes the new food transport system and Phloem 1, still holding the brown yarn, becomes part of the Outer Bark. Give every Phloem 1 (P_1) an additional label for Outer Bark (B). The brown yarn around the group will be tight now. (See Illustration 2.)

Illustration 2

Year 2



12. Once again have the students recreate the movement of water and food through the tree.

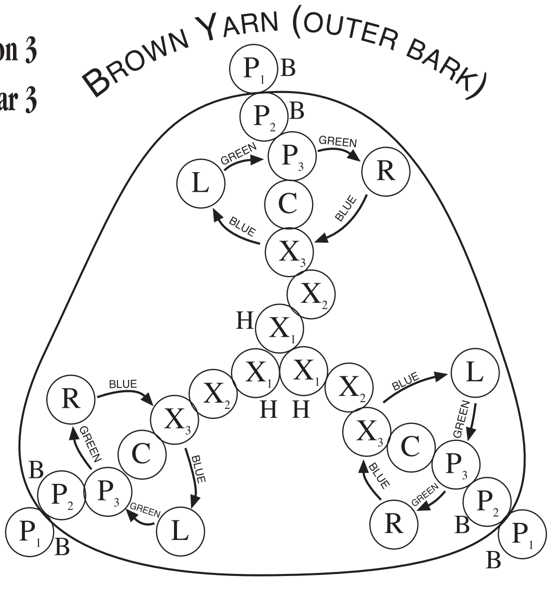
13. Imagine a third year has passed. Once again it is spring. The cambium makes new xylem and phloem

cells. Have the Cambium (C) make room in front and behind itself for new cells to grow.

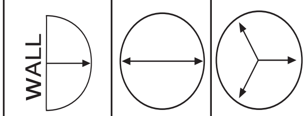
14. Have the third year xylem, Xylem 3 (X_3), come up, go under the brown yarn and stand directly behind (inside) the Cambium (C) and in front of the Xylem 2 (X_2). Ask students what Xylem 3 would represent. (*Another annual ring/ the new main water transport system for the tree.*) Xylem 3 now handles the main transportation of water. Have Xylem 2 students hand their ends of yarn to the Xylem 3 students. Xylem 1 (X_1), still at the center of the tree, hardens and becomes Heartwood. Ask students if they recall what the heartwood does. (*It is the strong, supporting pillar of the tree.*) Give every Xylem 1 an additional label for heartwood.

15. Have the third year phloem, Phloem 3 (P_3), come up, go under the brown yarn, and stand directly in front of the Cambium (C) and behind Phloem 2 (P_2). Ask students what the Phloem 3 will do. (*Food transportation system for the tree.*) Ask what will happen to Phloem 2. (*It will become part of the outer bark.*) Have Phloem 2 students hand their ends of green yarn to the Phloem 3 students. Give Phloem 2 (P_2) a label for Outer Bark (B). Phloem 1 (P_1) is still holding the brown yarn, which by now will be very tight. (See Illustration 3.) If the yarn is too tight, Phloem 1 students may "crack" and move to the outside of the yarn. As bark, they soon will be shed from the tree.

Illustration 3
Year 3



Tree Parts	I llustration Symbol	# of Students 9 - 17	18 - 26	27 - 3
ylem 1	1	1	2	3
ylem 2	2	1	2	3
ylem 3	3	1	2	3
Phloem 1	P_1	1	2	3
Phloem 2	P_2	1	2	3
Phloem 3	P_3	1	2	3
Cambium	C	1	2	3
Leaves	L	1 - 5	2 - 6	3 - 6
Roots	R	1 - 5	2 - 6	3 - 6
Chart A		Make the radius of the tree	Make the diameter of the tree	Make 3 radii of the tree



16. Once again have the students recreate the movement of water and food through the tree. This time encourage students to think about the function of their assigned tree part and come up with a short word description and action for what their tree part does. Have each part of the tree say their part separately (i.e. We're the leaves... we make food) and then put the chant and the actions of the tree functions all together.

Assessment:

Refer students back to the questions written on the board at the start of the period. Have students record the questions on a piece of paper. Students may answer the questions in a written narrative or create a diagram to illustrate the process.

- *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 leaves at the top of the tree?*

Step 1

Discover how trees grow and function

The following are activities that further extend learning about the form and function of trees. These activities have the same objectives and national science standard correlations as the Basic Activity (listed on page 6).

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 gives off moisture try this experiment. Have each student find a leaf on a broadleaf tree that is in a sunny location. Cover the leaf 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 from the soil, take the other 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.