

Unit: Become an Urban Forester

Lesson 1: How Does a Tree Work?

Lesson Goal: Introduce basic tree anatomy to understand how a tree works.

- ❖ Develop an understanding of tree parts and function.
- ❖ Learn how trees survive.
- ❖ Gain a foundation to which each lessons in the unit builds.

Although there are thousands of different kinds of trees in the world, most trees work the same way. Here's a look at how the parts of a tree work together to help a tree get the food, water, and minerals it needs to survive. **Let's learn about the tree structure and their functions.**

Let's start by drawing a tree. Include as many parts as you know and label each part. Do you know their function?

With the diagram below, let's go over each part and talk about how it serves a tree. Crown, Trunk, Roots are the main parts and are all needed to create a strong, healthy tree.

Anatomy is the study of structures, physiology, and their functions.

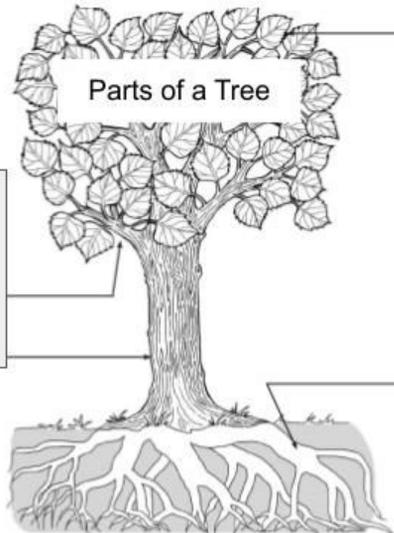
4 Essential Tree Needs:

- Sunlight
- Water
- Nutrients (food)
- Space

Crown: The crown is made up of leaves, branches, and twigs, that form the top of the tree. Q1. What else does the crown do?

Branches: Part of the crown, branches provide the support to distribute the leaves efficiently. They also serve as conduits for water and nutrients and as storage for extra sugar. Q3. What else can be found on branches?

Roots: **Roots:** A complex root system exists beneath the ground. There are two basic types of roots, woody and non-woody. Q5. What are the functions of the roots?



Leaves: Part of the crown, leaves are the food factories of a tree, converting carbon dioxide from the atmosphere, water from the soil, and energy from the sun into a chemical reaction that produces glucose and oxygen. Q2. What is this process called?

Trunk: The trunk of the tree provides its shape and support while holding up the crown. Q4. How does water get to the leaves in the tops of trees?

Unit: Become an Urban Forester

Lesson 1: How Does a Tree Work?



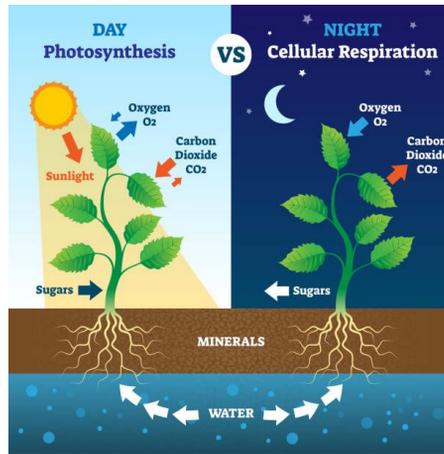
Before we start the discussion find a leaf and grab a magnify glass.

Leaf Attributes

Leaves are an essential part of a tree and without them a tree wouldn't survive.

Manufacture of food through **photosynthesis**. Leaves have chloroplasts that contain chlorophyll. The chlorophyll is a green pigment that absorbs the light energy from the sun. Sunlight provides the energy for the process of photosynthesis. Water and carbon dioxide are used to make the sugar and oxygen. Oxygen is released through openings in the leaf called **stomata**. *Photosynthesis provides the oxygen in the atmosphere that living things need. Only plants can do photosynthesis!*

Respiration is when plants or animals break down sugar and use the energy to perform life functions. The food (sugar) created through photosynthesis provides the plant with energy to perform life functions. To get energy from the food it produces, plants must break down the sugar through respiration. Oxygen from the air combines with the sugar and produces carbon dioxide and water which is given off through the leaves. Energy is released so it can be used by the plant.



Evaporation of water. Transpiration is when plants lose water through the leaves. Plants lose most of their water through their leaves, the other water is used in photosynthesis. Plants must control the amount of water they lose through leaves or they would wither and die. Plants slow down transpiration by closing **stomata** (pores). Guard cells open and close the stomata to keep water from escaping from the leaf.

Parts of a Leaf Structure

The leaves of different plants vary widely in size, shape, and color. Most leaves have a broad, flat part called a **blade**. Usually, a stalk called a **petiole** attaches the blade to the plant's stem. A leaf that has only one blade is called a simple leaf. A compound leaf has two or more blades attached to the petiole.

Veins inside a plant's leaves work much like blood vessels inside an animal's body. They carry water and food to and from the leaves. Veins also provide the strong support that gives a leaf its shape. Veins can form a netlike pattern throughout the leaf or lie parallel to each other.

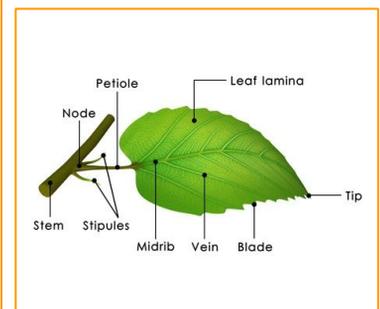
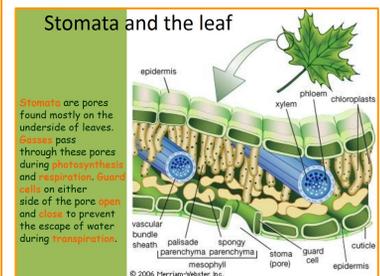
Different types of leaves may be rounded, oval, spear shaped, heart shaped, or triangular. Some leaves have smooth edges. Other leaves have tiny points, called teeth. **Q6. Why might leaves have waxy or hairy coverings?**

Photosynthesis: The process of converting carbon dioxide, water, and energy into sugar (glucose) and oxygen.

Chlorophyll: A substance which give leaves their green color and helps absorb light for photosynthesis.

Chloroplast: Cell organelles that capture and store energy for photosynthesis.

Stoma: Numerous, minute openings on the leaves through which gaseous exchange - photosynthesis and respiration, takes place between the atmosphere and the plant body. Multiple stoma are stomata/stomates

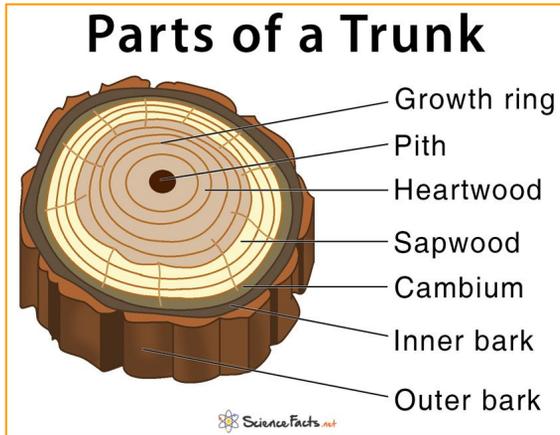


Unit: Become an Urban Forester

Lesson 1: How Does a Tree Work?

Trunk Attributes

Understanding the trunk of a tree is key to understanding how a tree works, and a primary reason why trees are so useful. The easiest way to illustrate how a tree grew is by looking at a cross section of the trunk, called a cookie. A cookie shows a similar view to when a tree is cut down.



Bark: The outermost layer of the trunk, branches, and twigs of trees. Bark serves as a protective layer for the more delicate parts of wood inside the tree. **Q7. Do all barks look the same?**

Phloem: The scientific name for the inner layer of bark. This inner layer carries food and water – sap full of sugar - from the leaves to the rest of the tree. **Q8. In which direction do phloem move substances?**

Cambium: The thin layer of living cells just inside the bark that makes new cells allowing the tree to grow wider each year. **Q9. What is the growing part of a tree trunk? Does a tree trunk grow taller?**

Xylem or Sapwood: The scientific name for sapwood is xylem. It's made up of a network of living cells that bring water and nutrients from the roots to the branch, twigs, and leaves. Xylem is the youngest wood of a tree. **Q10. In which direction do xylem move substances?**

Heartwood: The dead sapwood in the center of the trunk. It is the hardest wood of the tree giving it support and strength. **Q11. Is heartwood lighter or darker than sapwood?**

Pith: The tiny dark spot of spongy living cells right in the center of the tree trunk. Essential nutrients are carried up through the pith. **Q12. Is the pith the most protected part of the tree? Why?**

Tree Adaptations:

- Some trees have thick bark, thorns, leaf hairs, thick cuticles that serve as protection.
- Some trees use chemical defense to deter insects, pathogens, infection, and decay.
- Some trees use **Compartmentalization**, the ability to form boundaries around decay or wounded areas, to limit the wound from spreading.

Growth Rings:

- Each year, trees add a new layer of bark. The tree rings provide a lot of information about the tree (e.g., age) as well as clues to the local (e.g., drought, fire) and global environment (e.g., climate change) while the tree was alive.
- Scientists study tree rings to learn about changes in climate over the past thousand years. The rings provide clues to changes in the earth's climate while the plant was alive. This field of science is called **dendroclimatology**.



Module 1.1: Draw a tree cookie (recommended for all ages)

Goal: Tell a story about a tree's life by drawing a tree cookie



Materials:

- Construction paper
- Glue sticks
- Colored markers
- Colored pencils
- Scissors

Procedure:

1. Create your own tree cookie by drawing circular shapes around one another (rings).
2. Color in each ring with colored pencils in a light and dark shade of color to symbolize the early season and late season growth.
3. Label the different parts.
4. Tell a story about your tree.

Questions:

- How old is your tree?
- Can you find a good tree year? How about a bad year?
- How would your tree look like if there was a drought? A wildfire? Or grew on a slope?
- How could you use your knowledge about tree growth to manage a forest for wood production? For wildlife habitat? (Hint: consider size and age of a tree)

Module 1.2: Build a 3D Tree (suitable for K-2 but time consuming to prepare)

Goal: Build a 3D tree showing off the different parts and features

Materials:

- 3 different colors of construction paper, such as green, brown, red
- Glue stick
- Marker
- Scissors

Procedure:

1. With the construction paper, cut out different parts of the tree
 - 2 tree trunks
 - Leaves (at least 10)
 - Flowers (at least 2)
 - Fruits (at least 2)
1. Glue leaves, flowers, and fruits onto the branches of the tree.
2. Label the parts of the tree
3. Cut each tree halfway down the middle:
 1. First tree from **roots to mid trunk**.
 2. Second tree from **crown to mid trunk**.
4. Slide the cut from the first tree over the cut in the second tree.
5. Fan out and stand your 3D tree.



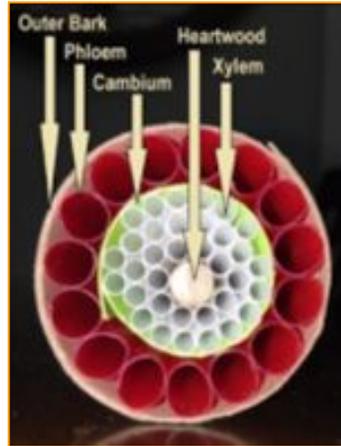
Questions:

- What do the roots carry to the rest of the tree?
- Why do trees need nutrients from the soil?
- If a tree had no roots, could it still stand tall?
- What is the purpose of the trunk?
- What parts of the tree make up the crown?
- Why are the leaves green?



Module 1.3: Build a Tree Trunk (recommend MS)

Goal: Create a model to explain the inner parts of a tree



Materials:

- 1 Toilet paper roll (or cut a paper towel roll) (**Outer Bark**)
- 17 Paper drinking straws cut to 4-inch length (**Phloem**)
- 1 Piece of colored card stock paper (**Cambium**)
- 25 Paper stirrers cut to 4-inch length (**Xylem**)
- 1 Chopstick cut to 4-inch length (**Heartwood**)
- 1 Marker (to mark the center of the chopstick, **Pith**)
- 1 Rubber band
- 1 Ruler
- 1 Scissors
- 1 Scotch tape
- Note: If you do not have these exact materials at home, find a substitute. For example, a pipe cleaner instead of a chopstick.*

Procedure:

1. Now it is time to put everything together! Use the materials and what you have learned from the lesson to build your tree trunk.
2. Share your tree trunk arrangement with a friend or family member and explain why you made your trunk this way.
3. BONUS: Share what each part of the tree trunk does.

Questions:

- What does each layer/part of the tree do?
- How old is your tree?

Module 1.4: How does water move in plants?

Goal: Experiment on how the xylem, the small network of tubes in the trunk, transports water.

Materials:

- 2 Celery stalks with leaves
- 2 Cups or containers
- Water
- 1 Cutting board
- 1 Food coloring
- 1 Knife

Procedure:

1. Measure 1-2 cups of water in the two containers.
2. Add food coloring to ONE of the containers of water until the water is dark in color.
3. With adult supervision, cut the bottom off the two celery stalks, about 1-2 inches from the bottom. Keep the leaves on.
4. Place the cut ends of the celery stalks into each container of water
5. Let stalks sit for 30 minutes.
6. Observe any changes to the outside of the celery.
7. Also cut the celery halfway up to observe the inside.

Questions:

- What happened to the celery?
- What does the inside of a stalk look like?
- What does the food coloring represent?
- What structure in the celery was stained by the food coloring?
- How does water move up a celery stalk?



Unit: Become an Urban Forester

Lesson 1: How Does a Tree Work?

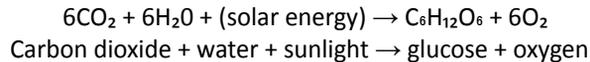
Lesson 1 Answer Sheet

Q1. What else does the crown do?

Crown: The crown shades the roots, collects energy from the sun (photosynthesis), and allows the tree to remove extra water to keep it cool (called transpiration, which is similar to sweating in animals).

Q2. What is this process called?

Leaves: The process is known as **photosynthesis**. Trees use the glucose (or sugar) as a food source to help them grow, storing glucose in their branches, trunk, and roots. Oxygen is released back into the atmosphere as a byproduct of the reaction. Chemists use the following equation to represent photosynthesis:



Q3. What else can be found on branches?

Branches: Leaves, flowers, fruit.

Q4. How does water get to the leaves in the tops of trees?

Trunk: The trunk acts as the central "plumbing system" in a tree, forming a network of tubes that carries water and minerals up from the roots to the leaves, and food (sugar) from the leaves down to the branches, trunk, and roots. Xylem carries everything up, and Phloem brings everything down.

Q5. What are the functions of the roots?

Roots: Roots serve a variety of functions for the tree: 1) absorb and transfer moisture (water) and minerals, 2) provide support for the above ground portion, and 3) store starch and nutrients. Non-woody roots, often called feeder roots, are found mostly in the upper few inches of soil with the primary function of absorbing water and nutrients. Woody roots are large lateral roots which form near the base of root and stem (the root collar) and provide support and anchorage for the tree. Roots require water, oxygen, minerals, support, and warmth and will grow wherever the environment is favorable.

Q6. Why might leaves have waxy or hairy coverings?

The waxy covering helps keep the plant cool and reduces evaporation loss. Hairs reduce the rate of transpiration.

Q7. Do all barks look the same?

Bark: No, barks can look very different from each other. Trees have an inner bark and outer bark - the inner layer of bark is made up of living cells and the outer layer is made of dead cells, sort of like our fingernails.

Q8. In which direction do phloem move substances?

Phloem: Down. Phloem brings sap, food, and sugar from the leaves, down to the roots.

Q9. What is the growing part of a tree trunk? Does a tree trunk grow taller?

The trunk grows thicker, tips of twigs/shoots grow longer

Q10. In which direction do xylem move substances?

Xylem: Up, Xylem brings water and nutrients up from the roots, to the leaves in the crown of the tree.

Q11. Is heartwood lighter or darker than sapwood?

Heartwood: It is usually darker in color than the sapwood.

Q12. Is the pith the most protected part of the tree? Why?

Pith: Yes, It's placement right in the center means it is the most protected from damage by insects, the wind or animals.

Module 1.4. How does water move up the stalk?

Although plants don't have circulatory systems like animals, they do have something quite similar—a network of small tubes called *xylem*, used for carrying water.