BARTRAM'S GARDEN

# TEACHER RESOURCE PACKET

A Learning Resource for children in pre-K through 6th grade

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This document contains sample lessons and activities for teachers working in virtual and hybrid classrooms, collected and compiled from Bartram's educators.

**Objectives:** to help students become familiar with plant function and anatomy; to help students understand the importance of plants in relation to humans and animals; to stimulate students' interest in the environment; and to improve students' observation, critical thinking, and problem-solving skills.

## Index

# Follow the Water

A classic lesson on how plants use water— a good activity for classes interested in further study.

**Materials:** 1 large, clear glass or jar; 1 stalk celery with leaves still attached; 1 bottle food coloring (red or blue is most dramatic); knife or scissors; sponge

**Procedure:** Fill the glass or jar about two thirds of the way full with water. Add drops of food coloring until the water is dark (at least five drops) and stir until the color is evenly distributed. Cut a few inches of celery stalk off the bottom of the stem, so that you can clearly see the inside structure of the stalk. Place the celery stalk in the water with the leaf side facing up. Observe the celery at intervals throughout the day, then leave in the water overnight.

*This experiment could also be done with Bok Choy, as above!*

The next day, observe what happened to the celery leaves. Take the celery out of the water and examine the inside of the stalk. Cut the stalk in pieces so you can see how the color climbed up the stalk. Remind students that water is always traveling through plants from the roots to the leaves—the food coloring just makes it visible to our eyes!

**Background:** Plants are always pulling water up through their roots to distribute throughout their stems, leaves, and flowers. To demonstrate this, try placing a stalk of celery in a glass jar with no water and observe what happens. Compare to the celery in water. Water is one of the important ingredients for *photosynthesis*, the process by which plants make their own food. The water that comes from soil is full of important minerals and nutrients that a plant needs to be healthy.

Plants pull water up through their bodies using a process called *capillary action*. You can demonstrate capillary action by holding a dry sponge so that its bottom edge just touches a bowl of water. Watch how the sponge pulls the water up so that it gradually becomes wet.

Inside of a plant, water is traveling through tiny tubes called *xylem*. Xylem are like the veins of the plant, except they carry water instead of blood. The colored dots you see when you cut open the celery are cross-sectional views of the xylem.

Resources:


• “Transport of Water and Sugar in Plants”. Science & Plants for Schools. https://www.saps.org.uk/animations/plant_biology/index.html?video=1

• “Introduction to Vascular Tissues (Xylem & Phloem)”. Mahesh Shenoy. Khan Academy. https://www.khanacademy.org/science/in-in-class-10-biology/in-in-life-processes/in-in-transportation-in-plants/v/intro-to-vascular-tissues-xylem-phloem-life-processes-biology-khan-academy

# Trees in your Neighborhood

Go on a tree hunt! Just like animals, trees can be sorted into different species. In this outdoor lesson, students will observe the differences between tree species and explore what trees are growing in their neighborhoods.

**Materials:** Clipboard, paper, pencil & a crayon for making observations and rubbings.

**Procedure, pt. 1:** Conduct a tree survey at Bartram's Garden or another park. Choose a few different trees and see what you can observe about them. Try answering these questions that a *botanist* might ask to determine a tree's species:

- What shape are the tree's branches?
- What is the color and texture of the bark?
- What kind of fruits, nuts, cones or seeds does the tree have?
- What color and shape are the tree's flowers, if it has any?
- How would you describe the shape, color, texture, size, and *margin* (outside edge) of the tree's leaves?
- Do the tree's leaves have veins, and if so, how would you describe their pattern?

With a clipboard or at a table, you can use a low-hanging or fallen leaf to make a **leaf rubbing** with a crayon. Simply put the leaf underneath a sheet of paper, with the textured side facing you, and rub over it with the broad side of your crayon until you start to see the shape of the leaf appear!

**Procedure, pt. 2:** Conduct another tree survey on your block/around your neighborhood. Make the same observations as you did in your first survey and compare your previous leaf rubbings to the trees' leaves. Based on your observations, do you think any of the trees in your neighborhood are the same species as ones you surveyed earlier? Why do you suspect the same/different tree species would grow in the two places you surveyed? How do you think the trees you surveyed came to grow in these specific places?

*For students/classes who wish to identify precise tree species in their survey, I recommend the Sibley Guide to Trees or the "What Tree is That?" tool on the Arbor Day Foundation's website. The apps "iNaturalist" and "Seek by iNaturalist" can help students check their identifications against others who have identified the same trees. It will show you an interactive map of tree species that have been identified at Bartram's Garden and around Philadelphia!*

List of trees you might find (common & Latin names):

Eastern Redbud *(Redbud Cercis Canadensis)* • London Plane *(Platanus Acerifolia)* • Red Maple *(Acer Rubrum)* • Striped Maple *(Acer Pennsylvanicum)* • Swamp White Oak *(Quercus Bicolor)* • Red Oak *(Quercus Rubra)* • Honey Locust *(Gleditsia Triacanthos)* • Sweetgum *(Liquidambar Styraciflua)* • Tulip Poplar *(Liriodendron Tulipifera)* • Bald Cypress *(Taxodium Distichum)*

## Design a Leaf:

As a follow-up activity, now that students have become *botanists* by making scientific observations of the trees around them, ask them to prepare for an imaginary botanical convention where they will be giving a presentation on a new species of tree that has never been classified before. Using their observations, leaf rubbings, and the images later in this packet as inspiration, invent an imaginary new species of tree. Ask students to answer the same questions that they did about the real trees in the park & around their house, draw a pretend "leaf rubbing" from this imaginary tree, and name the tree. *Remember, this new tree is imaginary and so there's no right or wrong way to create it!*

Resources:

• "Teacher's Guide". Ken-ichi Ueda. iNaturalist. Oct 12, 2020. https://www.inaturalist.org/pages/teacher's+guide

• "What Tree is That? Tree Identification Field Guide". Arbor Day Foundation. 2021. https://www.arborday.org/trees/whatTree/

• "Leaf-ID Easy Tree Identification". Jost Benning. Leaf-ID.com. 2012. https://www.leaf-id.com/

• "Leaf Impression Art…". Artistics Tutorials. Youtube. Feb 13, 2018. https://www.youtube.com/watch?v=L55yyknsU3M

• *The Sibley Guide to Trees*, David Allen Sibley, Knopf, 2009.

## Worm Bins for Your Classroom—Create Your Own Healthy Soil!

Classroom worm bins provide an excellent opportunity for students to observe worms in action. It's easy to create a worm bin for the classroom, and the worm activities below are amenable to a hybrid virtual/in-person classroom! You can prepare the worm bin yourself, using the directions below, or involve students in the process of setting up the worm bin and feeding the worms.

Materials:

• Large plastic tub (5 gallons or larger) with lid or an old aquarium

• Shredded newspaper

• Tub of Red Wiggler worms from a local bait store (there are also online sources for vermicomposting, including the worms)

• 1 cup of soil (this can just be dug up from the ground!)

• 1⁄2 cup of sand

• Vegetables or other organic items to serve as worm food (***note:*** *Do not feed the worms meat, dairy products, or foods cooked with oil as this can cause the growth of undesirable bacteria and attract rodents.)*

Procedure:

• Clean the container to remove any chemicals that might harm the worms.

• Soak the newspaper in water overnight so the chlorine will evaporate and will not harm the worms.

• Fill half of the container with the shredded newspaper or worm bedding.

• Add a tablespoon of soil and a half-cup of sand to the bedding.

• Finally, add the worms and a little food.

• Make sure to bury all food at least 2 inches deep to deter fruit flies.

• Add food and spray with water regularly.

A worm bin can be made with anything from an aquarium covered with black paper to a plastic tub with vent holes in the lid. The soil contains microscopic creatures and molds that will help the worms decompose the vegetables that you add to the worm bin. Adding the sand actually helps the worms digest their food. They store the sand in their gizzard, like a bird, and they use the sand to grind their food.

Worm Activities:

• Have students observe the worm bin and record what happens. What changes do they notice over time? How long does it take the worms to consume the food you give them? Are there certain foods they seem to prefer over others?

• Have the students place various items inside the worm bin, such as plastic caps, pieces of wood, or peanuts in the shell. Observe what happens to these objects over time. Is there anything the worms won't eat?

• Place one or two worms on a Petri dish on top of a moist paper towel. Cover half of the dish with black paper, leaving the other side of the dish exposed. What happens? Do the worms move toward one side of the dish? Do they seem to prefer the light side or the dark side? Does this mean worms can see?

• Make one side of the Petri dish cold and the other side warm. Which side does the worm prefer? Try placing different foods on opposite sides of the Petri dish. Which does the worm prefer?

Resources:

• *Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting System*, 2nd edition. Mary Appelhof, Kalamazoo, Mich.: Flower Press. 1997.

• “Vermicompost: a Living Soil Amendment”. Cornell University. 2010. http://cwmi.css.cornell.edu/vermicompost.htm

• “Science Experiment: Worm Watch”. kidspot.co.nz https://kidspot.co.nz/activities/science-experiment-worm-watch/

• “Worms at Work - 20 Days Time Lapse of Vermicomposting”. Gregor Skoberne. Youtube. Oct 21, 2015. https://www.youtube.com/watch?v=n9Mnf9ysNSs

# What Do Seeds Need?

Encourage your students to design a series of experiments that will expand their creativity and knowledge of seeds & botany.

**Materials***:* A generous amount of uniformly small plant pots, a few different kinds of sproutable seeds, potting soil, and drawing materials. As far the pots are concerned, you can use eggshell halves, egg cartons, mini yogurt containers, or make simple newspaper pots following these instructions: https://www.instagram.com/tv/B_0AHuljeg7/

**Procedure:** *What do plants need to live*? Generate a list with your students. Food, water, space to grow, warmth, and air to breathe might all come up as a part of the discussion. If un-expected or inaccurate suggestions come up (for example, something along the lines of "Plants need MILK to live!"), you might consider including them in a separate list of theories that you can revisit later via experimentation or discussion.

There are lots of questions to ask surrounding the list you've just come up with: *What does it take to make a seed germinate? What happens if a plant doesn't get one of its needs filled? Is it possible to get too much of one resource? Do different types of plants need different amounts of these resources? How can we find answers to some of our questions?*

Have the students come up with ideas for some experiments that they can do to explore these questions. If you provide your students with some basic supplies and provide them with a few examples, they should be able to employ the scientific method to expand upon the knowledge that they gained at Bartram's Garden.

**Example Activity**: Have students plant matching pairs of beans (a good choice because they grow quickly and are easy to see) in separate pots. Introduce the idea of varying the amount of light the pot gets while holding all other variables constant. Encourage your students to make hypotheses. Have them observe the seeds periodically as they sprout and grow into seedlings and make careful notes of any differences between the bean-in-the-dark and the bean-in-the-light. Ask them to explain any difference that they saw in terms of what they know about what plant's growing requirements.

The same experiment can be repeated with different variables substituted for Light vs Dark:

- temperature (inside a darkened box in fridge vs. inside a darkened box in classroom)
- water (totally dry vs moist? Moist vs. wet?)
- space (many seeds in one pot vs. one or two per pot)
- sunlight vs. lamp light
- dirt vs. sand

Can your students come up with other ideas for experiments? Other things to add to soil? Lemon Juice? Baking Soda? *Will a plant grow in a sealed glass jar? Will seeds germinate if they're not in dirt at all? Will seeds grow from apples from the store? What if you were a mad scientist, then what experiment would you do?* Ask them to draw a picture of themselves as mad scientists, doing a crazy experiment of their own invention. If you can actually go through with one of the student's mad scientist experiments, why not try it out?

Over the course of your experiments, continue to reference the original list of "What Plants Need". If students are using an in-person classroom, display it on a classroom wall. Are there changes that you'll need to make to the list, after you've all seen how the experiments turned out?

Resources:

• "Biology of Plants" *(videos of seed dispersal!).* Missouri Botanical Garden. 2009. https://www.mbgnet.net/bioplants/seed.html

• Elena Ortiz. "Seed Anatomy" *(clear, anatomical view of the inside of a pea seed!).* ASU – Ask a Biologist. 7 Oct 2009. https://askabiologist.asu.edu/content/seeds

## Deciduous & Evergreen Leaves

Students will learn the difference between deciduous and evergreen trees. They will investigate the differences between the leaves of these trees and observe how deciduous and evergreen trees have different adaptations to help them conserve water. With their own leaf samples students can follow along with this lesson at home, or with no need for special materials they can make observations virtually!

**Materials:**

- Leaf samples, including deciduous leaves (maple, oak), broadleaf evergreen leaves (holly, magnolia) and conifer needles (pine, fir). Dried deciduous leaves from the ground are also good for comparison. If no leaf material is available pictures are also appropriate.
- Paper towels
- Wax paper
- Rubber band
- Water

**Discussion:** Show students examples or photos of different leaves and needles and discuss the vocabulary words *deciduous*, *evergreen*, *broadleaf evergreen*, and *conifer*. "Which of these leaves belongs to which tree? How are these leaves different (thickness, shape, texture)? What do you think is the reason for these differences?"

Remember what plants need to grow (space, soil, sunlight, and water are big ones). The different types of leaves that have evolved across tree species are all adaptations to help them meet these needs! Trees need water, but in the winter water freezes into ice and trees can no longer use it—think about trying to suck an ice cube through a straw, or have the students try it!—so in the winter trees need to keep the water they have and they can't lose any more. Water is usually lost through the leaves, so *deciduous* trees shed their leaves in the winter so they don't lose water through them, and *evergreen* trees cover their leaves with wax to keep from losing water through them.

**Activity:** We can visualize how different types of leaves retain/lose water differently by creating models of the leaves using paper towels. Spray each paper towel with water and create the three different leaf type models like so:

Model #1 (deciduous): Spread the wet paper towel flat.

Model #2 (conifer needle): Roll the wet paper towel tightly into a long tube, securing with a rubber band.

Model #3 (broadleaf evergreen): Fold the paper towel in half between layers of wax paper (representing the leaves' coating).

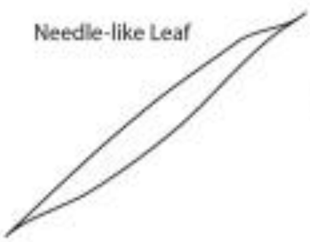
Have the students identify which "leaves" belong to which trees and predict which will dry out first. Why? Allow models to sit for approximately one hour, then test the students' predictions.

# Different Leaf Structures

Draw a line from each leaf shape to the correct example

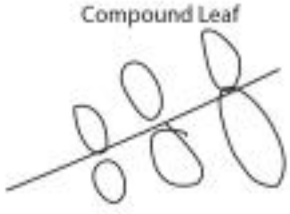
Lobed Leaf

Needle-like Leaf



Unlobed Leaf

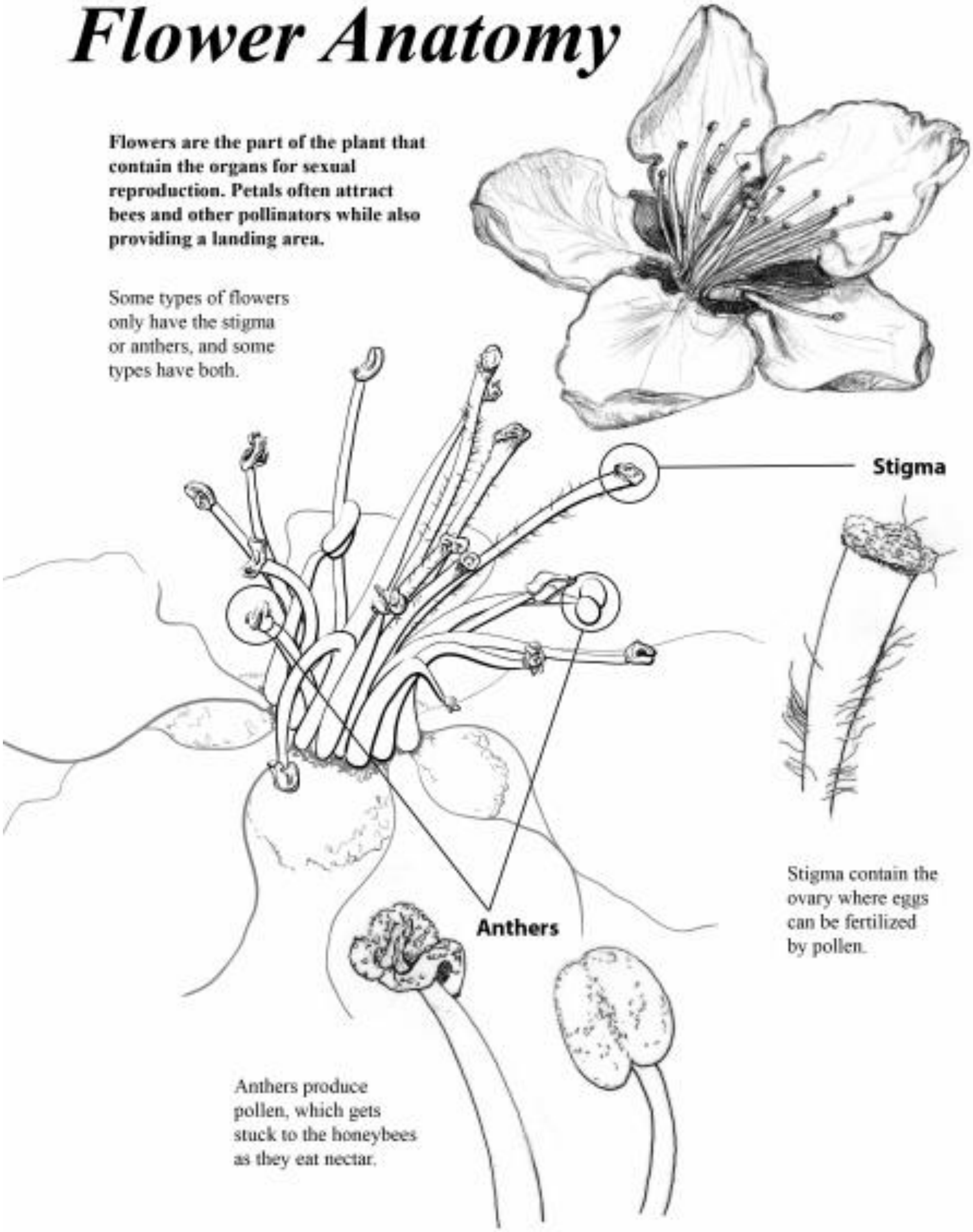
Compound Leaf



# *Flower Anatomy*

**Flowers are the part of the plant that contain the organs for sexual reproduction. Petals often attract bees and other pollinators while also providing a landing area.**

Some types of flowers only have the stigma or anthers, and some types have both.




Stigma contain the ovary where eggs can be fertilized by pollen.

Anthers produce pollen, which gets stuck to the honeybees as they eat nectar.

## A Long Way From Home

A food mapping activity inspired by "What Did Your Lunch Cost Wildlife?" by Project Wild (http://www.projectwild.org/).

**Materials:** Packaged snack, assorted food wrappers, large laminated world map, dry erase marker

**Introduction:** This is an optional introduction to help make the connection between food and agriculture. Start by asking students to list their favorite foods; list them on a whiteboard, virtual or real. Once the list is sufficiently large, ask students: *what are some ways we can sort these foods into categories?* After some suggestions have been thrown out, introduce the question: *which of these foods come from plants?*

Almost certainly, pizza will be somewhere on the students' list. *Is pizza a plant? Could I pick it from a tree like an apple, or dig it from the soil like a carrot? No! But then again, if I wanted to make a pizza right now, what ingredients would I need?* Students should think of crust/dough, sauce, and cheese. Following that: *what are those ingredients made of? Pizza dough is made out of dried & ground wheat (a.k.a., flour), the sauce is made of tomatoes & herbs, and the cheese is made from cows' milk.* To cement the plant connection, show students photos of tomato plants, wheat stalks, and herbs like thyme and oregano growing in soil.

*Since we now know that pizza is made up of processed plants & animal products, we can imagine that there are farmers who grew those plants and raised/milked those cows, and workers who processed the wheat into flour, tomatoes into sauce, and milk into cheese. Think to yourselves: where are those farmers? What about the workers?*

**Procedures:**

1. *Now let's shift gears and turn away from talking about pizza.* If possible, hand out a packaged food item (SunChips, for example). Instruct students to refrain from eating them for the time being. Eating will be a reward at the end!

2. Ask for definition of "Global Climate Change" as a way of kicking off the conversation &

setting the framework. *What sort of human activities can have an impact on our global weather patterns? Do we care? If so, why?*

3. Describe the role of food production/distribution on $CO_2$ emissions. *What sort of resources do farmers use in food production? What sort of resources are used in transporting foods over long distances, farm to shopping cart? How do these resources (tractors, trucks, airplanes, etc.) contribute to levels of $CO_2$ in the atmosphere? And once again, why is this important?*

4. For every mile that your food has to travel to reach you, more fossil fuels are burned, and more $CO_2$ is released in the atmosphere. How many total miles did this snack have to travel to reach our classroom here today? Allow students a chance to record their estimates.

5. Together as a group, place each of the snack ingredients on the map by making a dot with a dry erase marker (or with a virtual whiteboard). *Where was the ingredient grown?* Invite students to guess the origins of each ingredient. *What sort of a path did it take to get to the chip factory? What sort of a path do you think the snack took once they left the factory and made their way to us?*

6. Work together as a class to add the spiderweb segments together, calculating an estimated total distance traveled. This will be a lot of work, but you can divide up the heavy-lifting and take an opportunity to practice math skills! *What is the approximate total distance traveled? How did individual estimates compare to our final result?*

7. While munching on the snack, look at the ingredients of a few other foods, too. Apples? Cheetos? Little Debbie's? A banana? A frozen dinner? Pasta sauce? *Do any patterns emerge? How do you think that they would stack up to the snack in terms of distance traveled? Are there some ingredients you've never heard of before? Where do THOSE come from? Is there even a way to find out?*

Resources:


• "What Did Your Lunch Cost Wildlife?". Project Wild. https://www.fws.gov/uploadedFiles/Region_1/NWRS/Zone_2/Inland_Northwest_Complex/Turnbull/Documents/EE/Endangered_Species/What%20Did%20Your%20Lunch%20Cost%20Wildlife.pdf

• *French Fries and The Food System*: A Year-Round Curriculum Connecting Youth with farming and Food. Sarah Coblyn. The Food Project, 2001.

## Vocabulary

**Agriculture:** the production of crops, livestock, or poultry.

**Botany:** the scientific study of plants. Someone who practices botany is called a **botanist.**

**Farmer:** a person who cultivates land for food whether plants, livestock, or poultry.

**Gardener:** a person who tends or cultivates a garden as a pastime or for a living.

**Stem:** the main body or stalk of a plant.

**Leaves:** a plant's main organs of photosynthesis. They are usually green, flattened, and attached to a plant's stem, stalk, or branches.

**Photosynthesis:** plants' process of combining sunlight (usually absorbed through leaves), water (absorbed through roots) and carbon dioxide to make their own food.

**Flower:** the reproductive organ of a plant. When pollinated, flowers can produce fruit.

**Fruit:** the part of the plant which contains its seeds.

**Roots:** the part of the plant which draws up water and nutrients from soil and anchors the plant to the ground.

**Veins:** parts of a plant's leaves that nutrients and water can travel through.

**Seed:** a plant embryo, which can grow into an entirely new plant when cared for. Plants usually protect their seeds inside a seed pod, fruit, or other casing.

**Embryo:** an immature (baby) plant

**Seed coat:** the outside layer of a seed which protects the growing embryo.

**Seedling:** a young plant that has just recently begun to grow.

**Cotyledon:** the food stored inside a seed for the growing embryo to use until it can photosynthesize.

**Germination:** when a plant pops out of a seed and begins to grow.

**Conifer:** a plant which has cone fruit, such as a pine or spruce tree.

**Deciduous:** a plant which drops all its leaves for the winter.

**Evergreen:** a plant which keeps its leaves through the winter.

**Branch:** a natural subdivision (a part that "branches off") of a plant's stem.

**Trunk:** the main woody stem of a tree, distinct from its branches and roots.

**Carbon dioxide:** a colorless gas found in the air, which plants need for photosynthesis.

**Chlorophyll:** a green substance produced in plants which is required for photosynthesis.

**Compost:** decayed plant material used as fertilizer.

**Greenhouse** a building, room, or area in which the temperature is maintained within a desired range, used for growing plants out of season.

**Horticulture:** the science and art of growing plants.

**Harvest:** the gathering of crops.

## References & Resources: Books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• *One Bean* by Anne Rockwell, Walker and Co. , 1998.

• *Seeds! Seeds! Seeds!* Nancy Elizabeth Wallace. Marshall Cavendesh, 2004.

• *The Tiny Seed* by Eric Carle, Little Simon, 1987.

• *What Kind of Seeds are These?*, by H Bee Roemer. NorthWord, 2006.

• *Berries, Nuts and Seeds*, Diane L. Burns, illustrations by John F. McGee. NorthWord Books, 1996.

• *Eddie's Garden and How to Make Things Grow*. Sarah Garland. Frances Lincoln, 2004.

• *How Leaves Change* by Sylvie A. Johnson. New York. Learner Publishing Co. 1986

• *Nature Close—Up: Seeds and Seedlings*, by Elaine Pascoe, photography by Dwight Kuhn, Blackbirch Press, 1997.

• *Pick, Pull, Snap! Where Once a Flower Bloomed*. Lola Schaefer. Greenwillow, 2003

• *A Seed Is Sleepy* by D H Aston and Sylvia Long. Vancouver, BC. Chronicle Books LLC. 2007

• *The Ugly Vegetables*. Grace Lin. Charlesbridge, 2001.

• *The Sibley Guide to Trees*, David Allen Sibley, Knopf, 2009.

• *Tree Finder*, May Theilgaard Watts, Wilderness Press, 1991.

• *Trees, Leaves and Bark*, Diane L. Burns, Northward Books for Young Readers, 1997.

• *Trees of Pennsylvania*, Stan Tekiela, Adventure Publications, Inc., 2004.

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• *Seed to Seed : Seed Saving and Growing Techniques for Gardeners*. Suzanne Ashworth. Seed Savers Exchange, 2002.

• *Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting System*, 2nd edition. Mary Appelhof, Kalamazoo, Mich.: Flower Press. 1997.

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