Lessons to Grow By – Plant Parts

This month we are investigating important botany basics by studying plant parts. Take a look around your yard or a nearby green space and you will most likely notice a great diversity of plants. From tall trees with woody stems to the soft, creeping grass along the ground, plants can be found in a wide variety of colors, shapes, and sizes. Despite their differences in appearance, plants share a common set of parts. Learning about how the different parts function is essential to exploring plant growth and development. This foundational knowledge also contributes to our understanding of how to care for the plants in our gardens and environment.

Week 3: Leaves

Learning Objectives:

This week kids will explore the questions:

- What is photosynthesis and why is it so important?
- Why do leaves change color in the fall? What other ways do leaf adaptations help plants to survive in their environment?
- How can the characteristics of leaves help us identify plants?

Materials Needed for the Week

Activity 1: Photosynthesis

- Leaves Support Life Reading Page
- Where's the Plant? Worksheet

Activity 2: Deciduous Versus Evergreen Leaves

- Examples of deciduous leaves
- Examples of evergreen leaves
- Leaf Comparison Worksheet

Activity 3: Leaf Characteristics

- Common Leaf Characteristics worksheet
- Plant journal or Leaf Characteristics Data worksheet
- Digital camera (optional)
- App, online or printed tree identification guide

Introduction

Plant leaves might just be the most underappreciated essential workers on the planet. It is inside the leaves where plants perform the amazing feat of turning water, carbon dioxide, and energy from the sun into the food energy that all living things rely on for survival. Plus, as a bonus byproduct, this process also puts oxygen back into the air for us to breathe. Pretty amazing stuff! Check out the KidsGardening article Photosynthesis Runs the World: https://kidsgardening.org/lesson-plan-photosynthesis/ for a more extensive description of photosynthesis.

Another cool thing about leaves is their wide diversity of sizes, shapes, colors, and textures. From the fine, tough needles of a pine tree to the delicate, intricate designs of a thin Japanese maple leaf to the thick, waxy leaves of philodendron, it is hard to believe they all represent the same plant part. Many of the differences found in leaves reveal how the plants have evolved to adapt to their environment. Here are some examples:

Large leaves. Many plant species that live on the forest floor or in the understory have large leaves that maximize the surface area for catching what little sunlight filters down to their level. The more shade you grow them in, the larger their leaves will be.

Thick, fleshy leaves. Some leaves, like those on succulent plants, have the ability to store water, helping them survive conditions of infrequent and/or scarce water availability.

Needles. The waxy coating and thin shape of the needles of evergreen plants like pine trees help them survive winter conditions. The waxy coating prevents water loss in cold winds and the shape helps snow slide off rather than accumulate.

Drip tips. Many tropical plants have leaves with pointy tips and waxy surfaces that help water slide off quickly. These help prevent water buildup that could lead to decay and mold. Ficus, philodendron, and monstera leaves provide good examples.

Yuck factor. Some leaves have characteristics that discourage animals from eating them, such as poisonous compounds, scratchy textures, and pungent smells.

These are just a few examples of leaf characteristics that contribute to plant survival. Studying leaves can be a fun way to talk about adaptations of organisms in response to environmental conditions. Comparing evergreen and deciduous leaves can be a good place to start exploring adaptations because samples are usually readily available.

Some plants have adapted to the cold temperatures of winter by dropping their leaves and going dormant for the season. These plants are categorized as deciduous plants. Deciduous plants lose their

leaves in the fall and essentialy go dormant during the winter, often putting on a spectacular show of fall color first. Alternatively, evergreen plants with needles, including the pine tree described above, have adaptations that help them survive winter conditions. Depending on where you live in the world, the winter conditions may or may not be that harsh and so adaptations of evergreen plants also vary greatly. For example, evergreen trees on the top of a mountain will need to be better adapted for snow and harsh winds, so you will find more trees with thin and scaly leaves like pine trees and other conifers. However, an evergreen tree in the South may just need to have slightly thicker leaves with a waxy coating for extra protection during winter months. It is important to note that even evergreen plants lose their oldest leaves each year, too, but they form their new leaves before they drop the old ones (hence they are ever/always green).

As you explore this adaptation, you can also investigate the always-intriguing question, why do the leaves on deciduous trees, such as maples, change color? The answer is that most plant leaves appear to us in varying shades of green because they contain lots of a plant pigment called chlorophyll. Chlorophyll isn't the only pigment contained in plant foliage, but it dominates. However, come autumn, as the growing season winds down, the amount of chlorophyll in the leaves begins to decrease. No longer dominating the scene, the scarcity of chlorophyll allows the yellow and orange carotenoid pigments that are found in the leaves to take center stage. Other pigments that make a showing in fall are the anthocyanins which are deep red pigments. Depending on the amounts of these other pigments, the result is a display of leaf colors that ranges from bright red to purple. Uncover more details about in the KidsGardening article Fall Foliage: Why Leaves Change Colors: https://kidsgardening.org/garden-how-to-why-leaves-change-colors/

In addition to telling us about how a plant survives, leaf characteristics are also an important feature to help us identify plants. Although a well-trained plant enthusiastic can identify plants based on its shape, structure, or bark characteristics, most of us rely on leaf and/or flower appearance for a positive identification. In activity 3 below, we describe some of the common characteristics of leaves and send you on a nature walk to try your hand at plant identification.

Activity 1: Photosynthesis

1. Together or independently, read the **Leaves Support Life Reading Page**. Have your kids complete the reading comprehension questions and then discuss your answers together.

2. Next, use the **Where's the Plant?** worksheet to follow the origins of your favorite foods or meals. How many levels or steps does it take to get to a plant?

Activity Extension: If your kids are ready to look beyond the basics of photosynthesis providing food energy and oxygen to living things, you can broaden your view and help them explore the importance of photosynthesis in the carbon cycle. When plants take in carbon dioxide for photosynthesis, they decrease the amount of carbon in the air and then the carbon gets stored in the plant as a carbohydrate. In addition to being used and stored in the plant, they also move excess carbohydrates out of the roots, returning carbon to the soil. Therefore, photosynthesis is a key process for keeping the balance of carbon in our air, soil, and water throughout our ecosystem. Learn more in the lesson Soil-Air Connection: https://kidsgardening.org/lesson-plan-soil-air-connection/ and/or check out the US

Department of Energy's Global Carbon Cycle graphic at:
https://public.ornl.gov/site/gallery/detail.cfm?id=312

Activity 2: Deciduous Versus Evergreen Leaves

1. Use the introduction above to explain to your kids the difference between deciduous and evergreen plants. Here are some characteristics to share:

Deciduous Plants	Evergreen Plants
Lose leaves during the fall. May also lose leaves in times of drought or other stress.	Do not lose their leaves all at one time. Will have new leaves present before old leaves drop.
Leaves tend to be broad and flat.	Tend to have adaptations for water retention and protection against wind and cold temperatures such as a needle shape, thicker leaves, or a waxy coating.
Plants remain dormant in the winter.	Plants slow their growth dramatically but don't go fully dormant.

Please note that these terms are used primarily with woody plants (plants with bark on their stems) such as trees and shrubs. Herbaceous plants (those that do not have bark) are usually characterized as either annuals or perennials. Annual plants will die at the end of a growing season and they will not grow back again from that same plant (although some will drop seeds and come back from seed each year). Perennials return each year. The leaves and above ground growth of perennial plants will also die back at the end of the growing season; however, their roots remain alive during the winter and their top growth will return in the spring.

2. Take a walk in your yard or at a near by natural area and look for examples of different kinds of plant leaves representing a variety of shapes, sizes, colors, and textures on the trees and shrubs you see.

3. Use the Leaf Comparison Worksheet to make observations about the differences and similarities between the leaves you find. As a last step in the observation process, have your child make a prediction whether they think the plant is deciduous or evergreen.

4. Confirm their hypothesis. You may know the answer just from observations you have made in past seasons. If you are not sure, you can use the tips in Activity 3 to help identify the plant and then research whether it is classified as deciduous or evergreen.

5. Look for other examples of leaf characteristics might help a plant survive, such as succulents that store water or large leaves in shaded areas. A tour through the indoor houseplant section at a garden center will provide lots of additional opportunities to note different leaf adaptations.

Activity 3: Leaf Characteristics

1. Plant leaves are a key feature to help identify the plant. They are also a great way to study shapes and patterns in the natural world, enriching science knowledge while also inspiring both artistic and mathematical thinking. Leaves come in a wide variety of shapes, sizes, arrangement patterns, and textures. Learning how to observe leaf characteristic similarities and differences helps us identify plants and also understand how they are grouped into families.

These following are common characteristics of plant leaves (see the Common Leaf Characteristics handout for line drawings of each).

Leaf Category

- Needle-like leaves
- Scaly leaves
- Broadleaf or flat leaves

Leaf Structure

- Simple: Each leaf is made up of one blade attached to a stem
- Compound: Each leaf is made up of several smaller leaflets. The leaflets can be joined at one based and called palmately compound or spread out along a stem and called pinnately compound

Leaf Arrangement on the Stem

- Opposite: Leaves are positioned on the stems opposite of each other
- Alternate: Leaves are staggered on the stem (not opposite of each other)
- Whorled: Three or more leaves are attached to the stem at about the same place

Common Leaf Shapes

- Elliptical
- Oval
- Oblong
- Ovate
- Linear
- Lanceolate
- Deltoid
- Cordate
- Leaf Margins
- Entire
- Toothed
- Lobed

Leaf Venation

- Palmate: Veins appear to originate from a common spot at the base of the leaf
- Pinnate: Leaf has one central vein down the middle with more spreading out along the sides of the central vein
- Parallel: Veins run parallel to each other

2. Take a walk in a school garden, schoolyard or a local natural area. You can choose to identify plants while out in the field or take digital photos and/or samples to identify inside. (If you collect samples,

please make sure not to damage the plant in the process.) If you decided to identify using photos, take several photos of each plant:

- closeup shots of individual leaves
- pictures of a stem showing the leaf arrangement
- picture of the entire plant to note plant shape

3. Use the **Common Leaf Characteristic** handout to help you describe: leaf category, leaf shape, leaf structure, leaf margins, leaf venation, and leaf arrangement. Record your answers in your plant journal (include a sketch of the leaf) or on the **Leaf Characteristics Data Collection Worksheet**.

4. Next, use a field guide to help you identify your plant. There are a number of printed field guides that can be purchased or checked out from a local library. There is also a growing body of online identification guides available. The Arbor Day Foundation's What Tree is That?™ online guide is a handy resource that might be helpful; find it at: https://www.arborday.org/trees/whattree/. There are also a number of ID Apps like Seek by iNaturalist from California Academy of Sciences and National Geographic: https://www.inaturalist.org/pages/seek_app.

5. After kids identify a number of plants, reflect on the process. Ask questions like, Was identifying your plant easier or harder than you thought it would be? What characteristics did you find most useful in helping you to identify your plants? Do you think leaves are good tools to use for identification? Why or why not?

Digging Deeper

You can use the following resources to dig deeper into this week's lessons:

Books and Additional Resources:

Why Do Leaves Change Color? by Betsy Maestro

Leaf Man by Lois Ehlert

Seek by iNaturalist from California Academy of Sciences and National Geographic: https://www.inaturalist.org/pages/seek_app.

Videos:

National Geographic Definitions in the Field: Photosynthesis: https://www.nationalgeographic.org/video/definitions-field-photosynthesis/

National Geographic Definitions in the Field: Chlorophyll: https://www.nationalgeographic.org/video/definitions-field-chlorophyll/

Travel Deep Inside a Leaf from the California Academy of Sciences:

https://www.youtube.com/watch?v=pwymX2LxnQs

Big Green Video Library – Garden Lesson: Simple vs Compound Leaf: https://biggreen.org/edresources/video-library/

Trees Can Dance From The Magic of Nature: https://www.youtube.com/watch?v=qImPJo6Nc9I&t=43s

Additional Related KidsGardening Lessons and Activities to Try:

Photosynthesis Runs the World: https://kidsgardening.org/lesson-plan-photosynthesis/

Fall Foliage: Why Leaves Change Colors: https://kidsgardening.org/garden-how-to-why-leaves-change-colors/

Photographing Shapes and Patterns in Nature: https://kidsgardening.org/lesson-plan-photographing-shapes-and-patterns-in-nature/

Tropical Rainforests: https://kidsgardening.org/lesson-plan-tropical-rainforests/

Indoor Greening: https://kidsgardening.org/lesson-plans-indoor-greening/

Lettuce Be Healthy: https://kidsgardening.org/lesson-plans-lettuce-be-healthy/

Let There Be Light: https://kidsgardening.org/lesson-plan-let-there-be-light/

Fruit and Vegetable Art: https://kidsgardening.org/garden-activities-fruit-and-vegetable-art/

Plant Parts Salad: https://kidsgardening.org/garden-activities-plant-parts-salad/

Kitchen Scrap Gardening: https://kidsgardening.org/garden-activities-kitchen-scrap-gardening/

Exploring Oliver's Vegetables: https://kidsgardening.org/lesson-plan-exploring-olivers-vegetables/

Leaves Support Life

Plant Parts Week 3 Reading Page

Skinny pine needles, wide palm fronds, yummy salad greens — leaves can be found in many different sizes, shapes, and colors. Some plants have leaves year-round while others lose their leaves during winter months (many times turning beautiful colors before they fall). However, they all have one thing in common: they make the food and release the oxygen that all other living things need to survive. Without plants — and specifically plant leaves — all other creatures, including people, would disappear.

Plants have the special ability to make their own food through a process with a very long named: photosynthesis (foe-toe-SIN-the-sis). Here is a simple look at how plants make food through this process:

1. Plants take in water from their roots and move it up into their leaves.

2. Plants take in carbon dioxide, which is in the air all around us, through tiny little holes in the leaves. These tiny holes are called stomata.

3. Plants catch energy from sunlight with special structures in their leaves called chloroplasts (CLOR-oh-plasts). Chloroplasts contain chlorophyll (CLOR-oh-fill), a natural substance found only in plants that makes most leaves look green.

4. The water and carbon dioxide that the plant took in through their roots and leaves are drawn into the cholorplasts.

5. When placed in light and with the help of the chlorophyll in the cholorplasts, plants can make new things from the water and the carbon dioxide. They make food and release oxygen.

6. The oxygen is released back into the air through those tiny holes, the stomata, for living things to breathe.

7. The food plants make is also known by another long name – carbohydrates (car-bo HIE-drates). They move this food throughout the plant and use it to grow and stay healthy. Animals and other living things eat plants, so they can get energy from plant food too.

As you can see, through photosynthesis, plants make food not only for themselves, but for all other living creatures too. Photosynthesis is not just a big word, it is also a really big deal in our world. The food produced in the leaves supports all life on our planet.

You might be thinking, but I don't eat only plants, I think I can live without them. Let's look at a favorite dish – a cheeseburger. Here is a list of all the ingredients and where they come from:

Hamburger meat: Hamburger meat is made from cows and cows eat grass, which is a plant.

Buns: Buns are made from grains, which are plants.

Cheese: Cheese is made from milk, which is made by cows. Cows eat grass, which is a plant.

Lettuce, tomatoes, pickles and ketchup: All made from plants.

Throw in some French fries or potato chips (from potatoes, which is a plant) and you have a plant-fueled meal.

Try tracing back other foods you eat that are not plants. Can you figure out how they eventually link back to food from plants?

The next time you take a look at a leaf, think about how important those little green things are for us. Use your imagination to picture factories inside turning sunlight into food and oxygen. As you eat a meal or take a deep breath, don't forget to thank a plant!

Reading Comprehension Questions:

1. True or false: All plant leaves look alike.

2. What is the name of the process inside of a plant that makes the plant food?

3. Which of the following ingredients are needed for plants to make food:

    A. Water
    B. Flour
    C. Chlorophyll
    D. Carbon dioxide
    E. Chocolate

4. True or false: All living creatures rely on plants for food.

5. Like the hamburger example in the reading, list your favorite meal and then make a chart showing how the main ingredients link back to plants:

Where's the Plant? Worksheet

Food Item	Main Ingredients	Comes From	Comes From	Comes From	# of Levels to Plants
Ex. mac and cheese	1. pasta	wheat			1
	2. cheese	milk	cows	grass	3

Leaf Comparison Worksheet

Sketch your leaf or attach a sample if possible.	What does the leaf feel like? Is it smooth or rough? Is it the same on both sides? Does it have a waxy coating?	How thick is the leaf? Does it feel like it would tear easily?	What is the shape of the leaf? Do you think the shape helps the plant in extreme weather?	Do you think this leaf is evergreen or deciduous?	Were you right?

Common Leaf Characteristics

Leaf Category

Needle-like | Scaly | Broadleaf

Leaf Margins

Entire | Toothed | Lobed

Leaf Structure

Simple

Compound

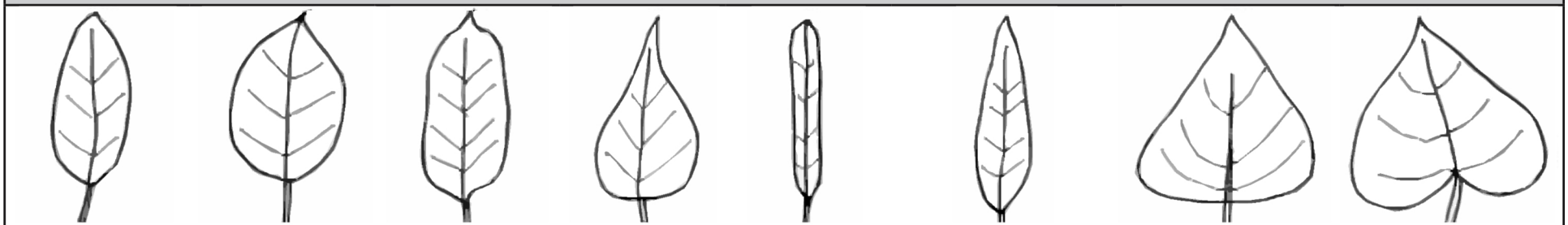
Leaf Arrangement on Stem

Opposite | Alternate | Whorled

Leaf Venation

Palmate | Pinnate | Parallel

Leaf Shapes



Elliptical | Oval | Oblong | Ovate | Linear | Lanceolate (lance-shaped) | Deltoid (triangular) | Cordate (heart-shaped)

Leaf Characteristics Data Collection Worksheet

Sketch your leaf or attach a sample if possible	Leaf Category	Leaf Structure	Leaf Venation	Leaf Arrangement	Plant Identification