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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 2: Stems

Learning Objectives

This week kids will:

- Learn about the functions of stems
- Compare the two main types of internal stem structures
- Explore different stem adaptations

Materials Needed for the Week

Activity 1: Stems in Action

- Sensational Stems Reading Page
- Cup or jar
- Celery stem(s) with leaves*
- Water
- Food coloring (blue or red work best)
- Stems in Action Worksheet
- White carnation(s) (optional)

*Celery is actually a leaf petiole or "leaf stalk/stem" rather than a true stem, but it works great for this experiment

Activity 2: Inside a Stem

- Stem Cross Section Worksheet
- Straws (2 different colors, 5 of each would be best)
- Tape
- Modeling clay, Play-Doh®, or homemade "play-dough"*
- Tree Cross Section Worksheet
- Tree cookies/slices (thin cross-sections of branches available at craft stores; optional)

*Try your hand at making no-bake homemade play-dough (https://www.pbs.org/parents/crafts-and-experiments/no-bake-playdough-recipe) or traditional homemade play-dough (https://www.pbs.org/parents/crafts-and-experiments/rainbow-playdough)

Activity 3: Stem Scavenger Hunt

- Stem Scavenger Hunt Worksheet
- White paper
- Crayons

Introduction

Stems contain the plant's internal transport system. Inside the stems, water and dissolved nutrients absorbed by plant roots are moved up to the leaves where plants make their food. Once food is produced, it moves through the stems from the leaves to the rest of the plant and back to the roots. These separate functions are conducted through two types of cells.

Xylem (ZIE-lem) cells transport the water and dissolved nutrients.

Phloem (FLOW-em) cells transport the food made by the plant.

These cells are organized into tissues that serve as the plant's vascular system. For older students, you may want to compare them to the veins and arteries of people. For younger students, it may be helpful to think of them as a system of tubes or straws.

Water movement. Older students may also be interested to learn more about how water moves up the plant against the force of gravity. This feat is accomplished through a combination of factors. Water moving into the roots pushes water upward into the stem. Water molecules cohere to one another, forcing the water column further upward, and they adhere to the sides of the conducting tissue. In addition, transpiration, which is the evaporation of water through leaf openings, actually pulls the water column upward. So water is being pushed and pulled up through the plant at the same time. In some plants and in some conditions, water can move through stems as fast as 30" per minute.

Structural support. Stems complete a second very important function for plants. They are also tasked with providing structural support for the plant, allowing them to grow tall to reach the light their leaves need for food production. By lifting them off the ground, they are also keeping plant leaves from being trampled on and in some cases eaten.

Stems come in a variety of shapes and sizes. Some are soft and flexible. Most annual plants fit into this category. Larger, longer-lived plants like shrubs and trees generally have harder, woody stems. They may have special adaptations to help protect them, such as thorns. In the case of vining plants, the stems may have adaptations that allow them to cling to objects or other plants using features like tendrils, as well as the ability to make aerial roots. Some stems are short at maturity — for example those of the common dandelion. Others are tall like the trunks of a magnolia or oak tree.

In addition to the difference in the outward appearance of the different types of stems, the arrangement of the components inside of the stem also varies. Flowering plants are divided into two subclasses: monocotyledons (monocots) and dicotyledons (dicots). They get their names based on how many seed leaves first sprout out of their seeds.

Monocots, such as grasses and corn, have one seed leaf.

Dicots, which encompass a very diverse grouping of plants including woody, flowering trees, have two seed leaves that emerge from the seedling.

Monocots and dicots also have differing stem structures. Monocots usually have the xylem and phloem scattered throughout the stem in bundles. A cross-section of a bamboo plant may allow you to see this with a hand lens or magnifying glass. Dicots have their xylem and phloem arranged in rings.

Although young children may not be quite ready to fully explore this level of detail, the reason this is important is that the ringed nature of dicots plays a role in understanding tree rings and why tree trunks and branches get wider and wider each year. In activity number 2, we will explore the two different types of arrangements of vascular tissue in stems (the xylem and phloem) and introduce the idea that trees grow wider and wider each year in addition to getting taller. We do not specifically introduce monocots and dicots, but if you have older kids, this is something you can dig into a little deeper. For younger kids just knowing that there are two ways that stems can be organized on the inside and grow on the outside is more than enough information.

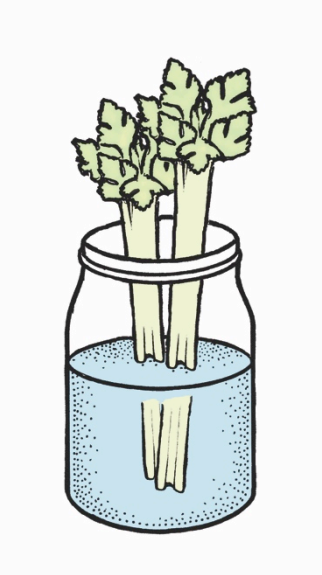
Finally, one last consideration of note: Most stems are located above the ground, but not all. There are some plants that have modified stems that grow below ground and typically serve as food storage sites. Irish potatoes are an example of below-ground stems, along with true bulbs like onions and tulips. (Fun plant-part trivia: Irish potatoes are stems and sweet potatoes are roots.) Some plants have horizontal stems called rhizomes that help the plant spread as it grows. Irises are common examples of plants with rhizomes. Strawberries also have horizontal stems; however, they grow above-ground and are referred to as stolons.

Potatoes, an example of a below-ground stem

Activity 1: Stems in Action

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

2. Next, set up an experiment to watch stems in action. A classic plant activity is to place celery stalks in a jar (or jars) of water with a few drops of food coloring added (red or blue work best). Botanically, celery is actually a leaf petiole or "leaf stem" rather than a true stem, but its structure and the some what transparent nature of celery allow you be able to see the colored water rise through its vascular tissue and into the leaves. For best results, make sure you have fresh celery samples with leaves still attached and cut the end of the celery before placing in the colored water. Also make sure to place your celery in a warm location — if it's too cold, water will not be pulled up through to the leaves.



3. Have kids use the **Stems in Action Worksheet** to track their observations for one week. Each day, have them measure how far up the stem they can see the color change and record the measurement.

4. You can make changes to the experiment to test out the impact of different variables on the movement of water. Try different colors of food coloring. Try placing the celery in rooms with different temperatures (or even place one sample in the refrigerator). Try placing jars in full sun and others in the dark. Try placing one outdoors and another indoors.

5. White carnations are a fun alternative for this activity. Although the carnations' stems are opaque so you will not be able to see the color rise on the stem, the color will slowly appear on the petals. If you place stems in different colors of water, you can make your own rainbow bouquet. See the KidsGardening activity, Make a Rainbow Bouquet (https://kidsgardening.org/garden-activities-make-a-rainbow-bouquet/) for complete instructions.

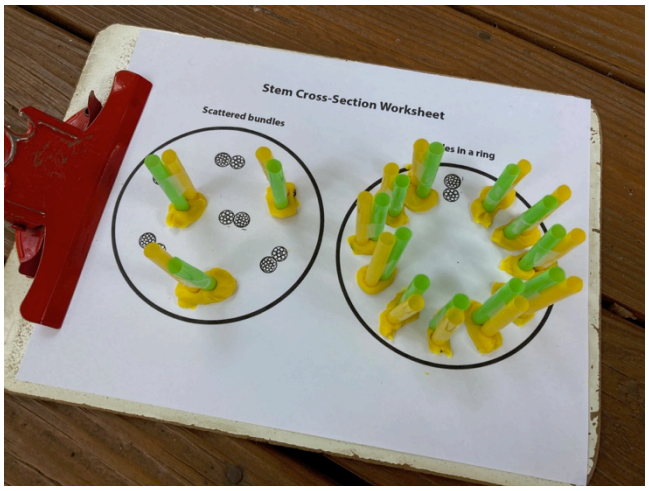
Activity 2: Inside a Stem

1. Water and dissolved nutrients travel up from the roots to the leaves in cells called xylem. The food the leaves produces moves around the plant in cells called phloem. Xylem and phloem cells are structured into tissues that create tubes running throughout the plant. Show kids two different colors of straws and explain that with this activity they are going to represent the xylem and the phloem in a plant. Cut about five straws into pieces of equal size that approximately 2" long.

2. Xylem and phloem are often bundled together. Tape one xylem straw and one phloem straw together and repeat to form 20 bundles.

2. Explain to kids that if you cut stems into slices to view a cross-section, you would find there are two main ways that xylem and phloem bundles are arranged inside of the stem. In some plants, the bundles are scattered throughout the stem. In other plants, the bundles are arranged in a ring. Use the Cross Section of the Stem Worksheet to explain the two types of arrangements.

3. Now make your Cross-Section of a Stem Worksheet into a 3D model. (See photo at right.) Place your worksheet on a flat surface and add a round, ½" thick slab of clay where indicated. Next, using the diagram as a guide, insert your homemade vascular bundles upright into the clay as indicated. Hopefully this model will help kids better visualize the inside of a stem.



4. Common plants that have scattered bundles include lilies, bamboo, grasses, and palm trees. If you can find a sample of bamboo, you can make a cross-section and use a hand lens or magnifying glass to look for the bundles.

5. Common plants with rings of bundles inside are plants that have woody stems. Cut a cross section of a larger tree limb or look at the inside of a tree stump. You can also find pre-cut tree “cookies” (cross-sections of tree branches) at craft stores if you do not have a way to make your own. Ask kids what they see. If real samples aren't available you can use the Tree Cross Section Worksheet.

6. Explain that the rings inside of the tree reflect the arrangement and growth of the xylem and phloem. As shrubs and trees grow, they keep making more xylem and phloem bundles around the outer edge. The newest xylem and phloem cells are doing the most of the transporting work. The older xylem can be found in the center of the tree. It no longer moves as much fluid as the newer bundles that are on the outside, but serves more as storage.

Since the tree is constantly growing and adding new cells to the outer edge of the stem, it gets wider and wider each year. During the spring and early summer when there is lots of rain and temperatures

are warm, the tree grows really fast and the cells are really big. Cells made during the early growing season appear as the lighter-colored rings. During the late summer and early fall, the tree grows very slowly and the cells are small and tightly packed. The darker rings represent the cells that are produced late months of the growing season.

7. Because you can distinguish between those cells grown in the early growing season and those in the late growing season, we can count the rings to find out how old a tree is. Look at the Tree Cross Section Worksheet. A pair of one white ring and one dark ring represents one year. How old is this tree?

Answer: 11 years old

7. Look at the worksheet closer. Do you see how some rings are bigger than others? In years where there is a lot of rain and temperatures are good, the tree will grow a lot and the rings will be wider. In years where there is little rain or harsh temperatures the rings will be thinner. So looking at tree rings is also like a history book. It can tells us about environmental conditions over the years that the tree has been alive.

8. If you are able to find real samples, have kids practice counting the years and making observations about the growing conditions based on the size of the rings.

Activity 3: Stem Scavenger Hunt

1. Stems come in a variety of shapes, sizes, and textures. They also have evolved various adaptations, such as thorns to deter hungry animals, and tendrils and aerial roots to help plants climb. Go on a nature walk in a local greenspace or garden and challenge kids to observe different types of stems. They can record their observations in a journal (in writing or through drawings), by taking photographs, or you can use the Stem Scavenger Hunt page.

2. The bark of trees of different species varies. To help kids observe and explore the textures, have them make bark rubbings. To make a bark rubbing, place a piece of white paper over the bark and use a crayon or piece of charcoal turned sideways to gently capture the texture on the paper. If possible, label each rubbing with the type of tree name and later discuss the differences and similarities you find.

Digging Deeper

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

Books and Additional Resources:

- **Tell Me, Tree** by Gail Gibbons
  A wonderful introduction to trees for young gardeners

- **Tops and Bottoms** by Janet Stevens
  Learn about tops, bottoms and middles in the garden with Bear and Hare

- **Tree rings provide snapshots of Earth's past climate** by Jessica Stoller-Conrad & NASA's Climate Kids: https://climate.nasa.gov/news/2540/tree-rings-provide-snapshots-of-earths-past-climate/

Videos

- **The Color-Changing Celery Experiment** by SciShow Kids: https://www.youtube.com/watch?v=Klug9Foou3s

- **How Do I Tap a Maple Tree** from The University of Maine: https://www.youtube.com/watch?v=o6B_5Qz_gpc

- **PBS Learning Media's Think Garden** - Plant Structure: https://www.pbslearningmedia.org/resource/5dea21b4-6c92-46ff-982c-8650f9429c01/think-garden-plant-structure/

Additional Related KidsGardening Lessons and Activities to Try

- **Exploring Tree Rings**: https://kidsgardening.org/lesson-plan-tree-rings/
- **Make New Plants and Keep the Old**: https://kidsgardening.org/lesson-plans-asexual-propagation/
- **Kohlrabi**: https://kidsgardening.org/kohlrabi-august-plant-of-the-month/
- **Bulb Botany**: https://kidsgardening.org/lesson-plans-bulb-botany/
- **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/

Sensational Stems

Plant Parts Week 2 Reading Page

What do sugar, paper, cinnamon, rubber, and maple syrup all have in common? They all come from plant stems!

Stems are the part of the plant between the root and the leaves. Stems give plants their structure. Their support allows plants to grow off the ground and reach towards the sunlight. Holding plants up can also help prevent them from being stepped on by large animals (like people).

The stems do another important job. They contain the plant's transport system. Inside the stems, water and dissolved nutrients that are absorbed from the soil by plant roots are moved up to the leaves. They are carried up the plant in special parts called xylem (ZIE-lem) cells. Once in the leaves the water and nutrients are used by the plant to make food. After the food it made, it is then moved from the leaves by the stems to the rest of the plant. The food is moved around through the stems in special parts called phloem (FLOW-em) cells.

Stems come in all different shapes and sizes. Some plants have short stems like the dandelions in your yard. Other plants have really big stems like the trunks of big oak or pine trees. Some stems are green and flexible and you can break them easily. Other stems are hard and covered in bark and you need a chainsaw to cut through them. Some stems have special features, like thorns, to protect the plant. Most stems are found above ground, but there are even some special stems that grow below ground and they help store food for the plant. Irish potatoes and "true bulbs" like tulips and onions are all classified by scientists as stems.

In addition to being important to the plant, stems are also important to people. A lot of useful products in our world come from plant stems. Here are some examples:

Sugar. Approximately 40 to 45% of our sugar is made from the stems of sugarcane plants. (Some sugar comes from beet roots.) Can you think of all of the treats that could not be made without sugar?

Maple Syrup. Maple syrup is made by boiling the sap of maple trees. Can you imagine pancakes and waffles without maple syrup?

Paper. We make paper from the stems of lots of different kinds of trees. What would be missing without paper? No books or newspapers (or homework!).

Lumber. Do you live in a home or go to school in a building that is made from lumber? Are you sitting on furniture made from wood right now?

Rubber. Rubber is harvested from the sap of the rubber tree and is one of the materials needed to make car tires. How much walking would you do without cars?

Medicine. Some medicines are made from stems. Aspirin was originally made from the bark of willow trees and is important for helping us feel better when we are sick or in pain.

Food. Stems provide us with food, too. Asparagus, broccoli, bamboo shoots, kohlrabi, and Irish potatoes are a few examples. (Fun Plant Fact: Irish potatoes are stems, but sweet potatoes are roots). Cinnamon is from the bark of trees and is a tasty spice added to many recipes. Who loves cinnamon rolls?

Whether short or tall, flexible or rigid, green or covered in wood, stems are sensational.

Reading Comprehension Questions

1. What do stems do for a plant?

A. They move water from the roots to the leaves.
B. The move food from the leaves to the roots.
C. They help the plant reach sunlight.
D. They help protect the plant.
E. All of the above.

2. What is the name of the special cells that help move water from the roots to the leaves:

3. What is the name of the special cells that help move food from the leaves to the rest of the plant:

4. Name an example of a plant that has bark on its stem:

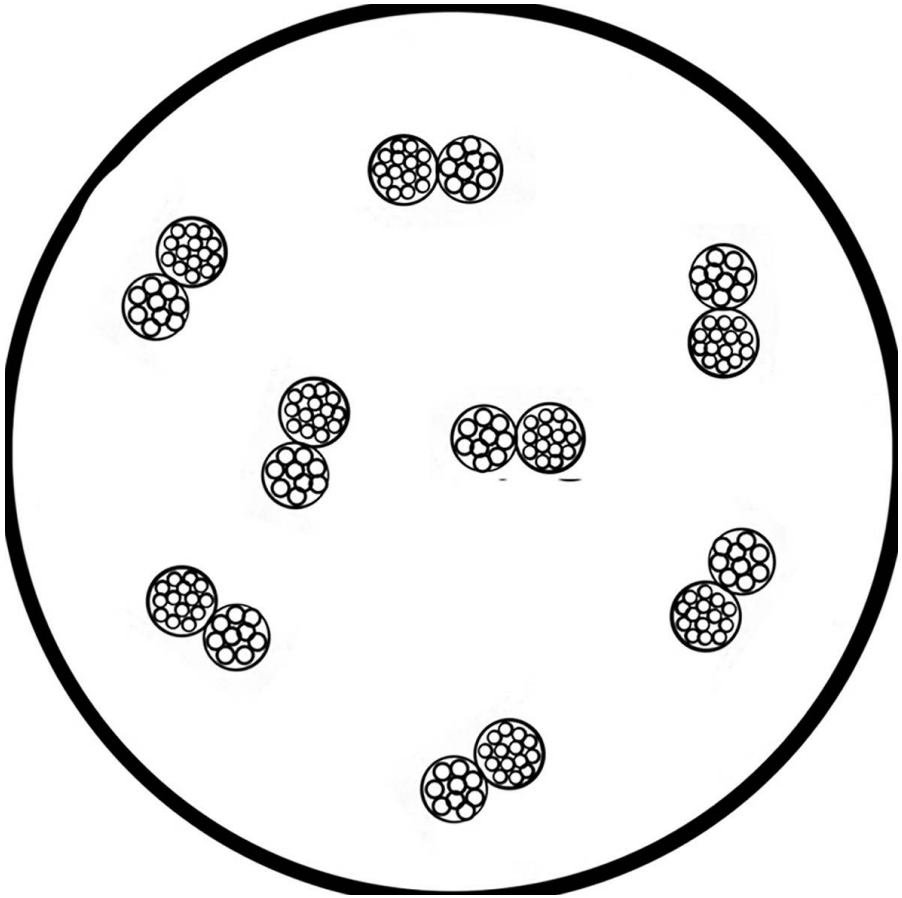
5. List one product made from stems that you would not want to live without and say why:

Stems in Action Worksheet

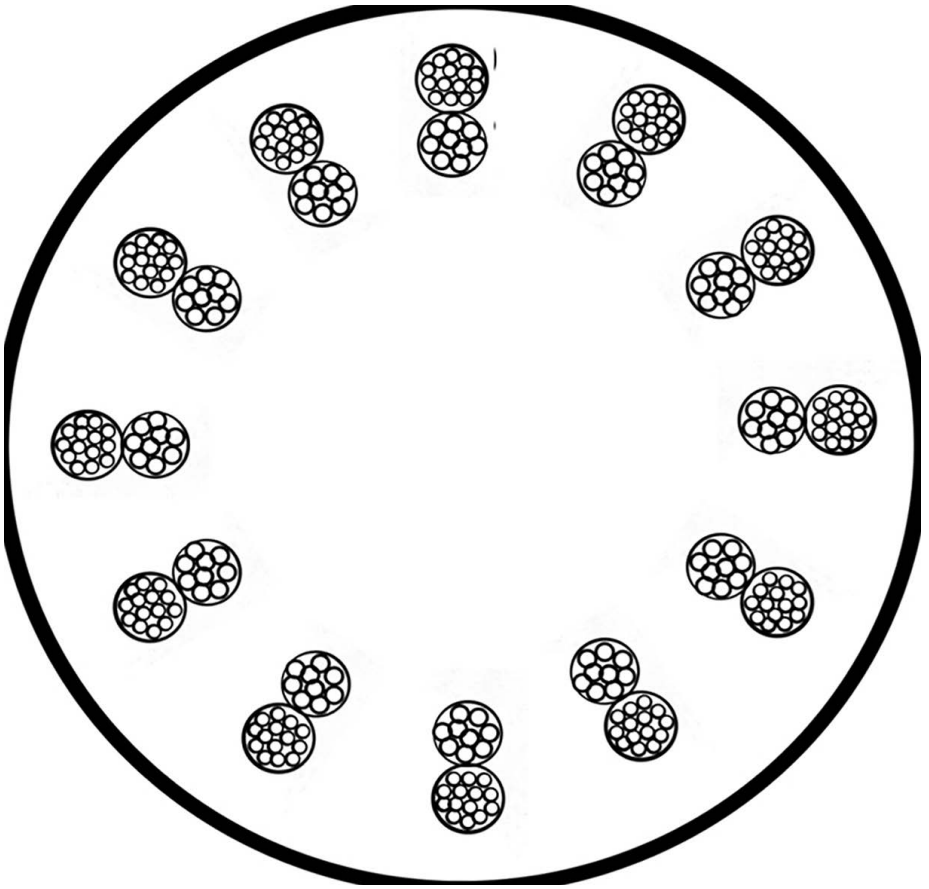
Sample #	Date Placed in Jar	Color of Dye Added	Environmental Conditions (light, temperature, etc.)	Measurement					
				Day 2	Day 3	Day 4	Day 5	Day 6	Day 7

Stem Cross-Section Worksheet

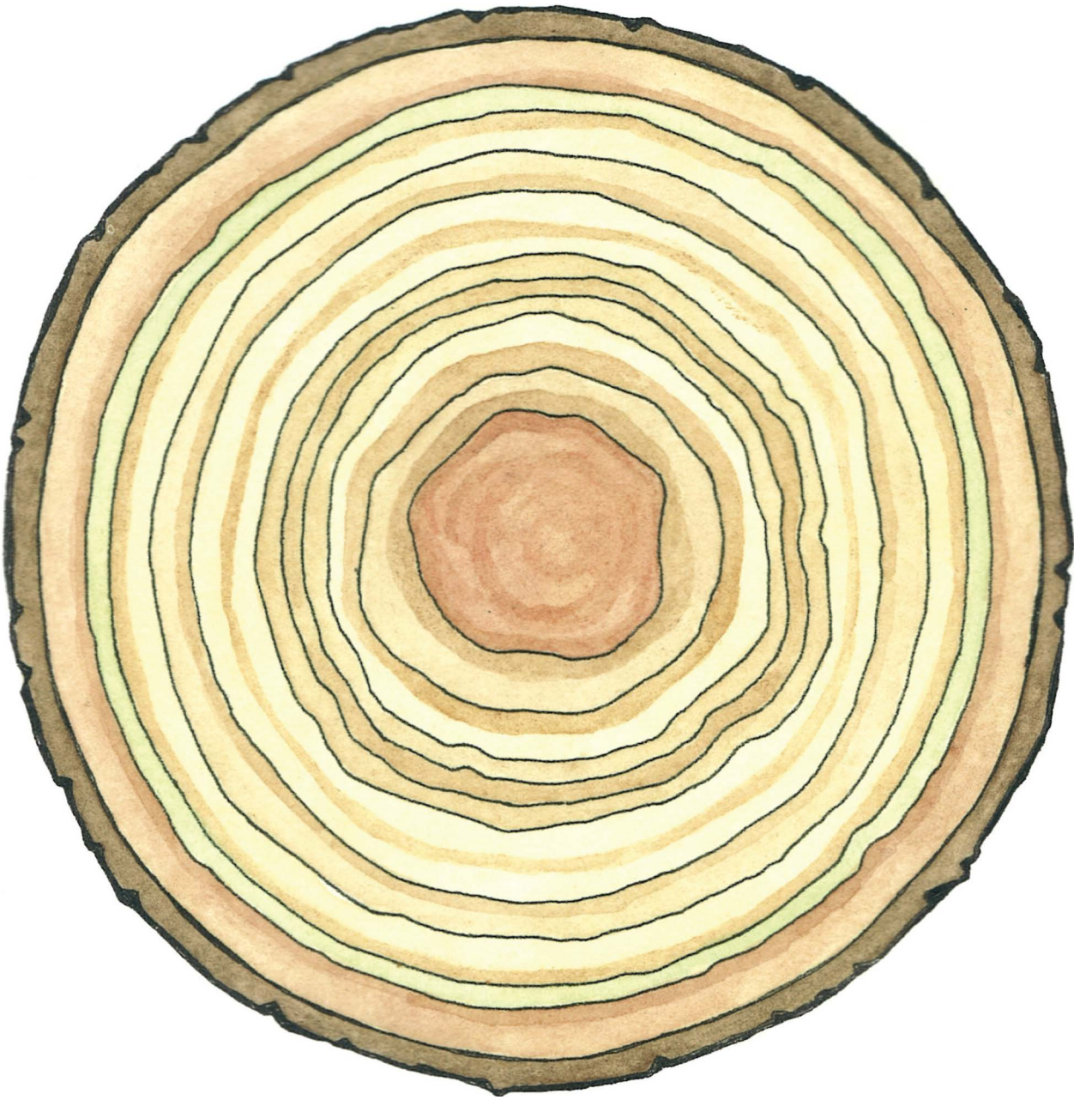
Scattered bundles



Bundles in a ring



Tree Cross Section Worksheet



Books In Bloom: Tell Me, Tree: All about Trees for Kids

Stem Scavenger Hunt

Find a stem that:

- ☐ is green
- ☐ is covered in smooth bark
- ☐ is covered in rough bark
- ☐ is a vine
- ☐ has tendrils to help it climb
- ☐ is edible (may want to look in your kitchen)
- ☐ smells good
- ☐ is flexible or bendy
- ☐ has thorns
- ☐ is soft
- ☐ is scratchy
- ☐ is tall
- ☐ is short
- ☐ is skinner than your finger
- ☐ is so big you can't reach all the way around it