LESSONS TO GROW BY

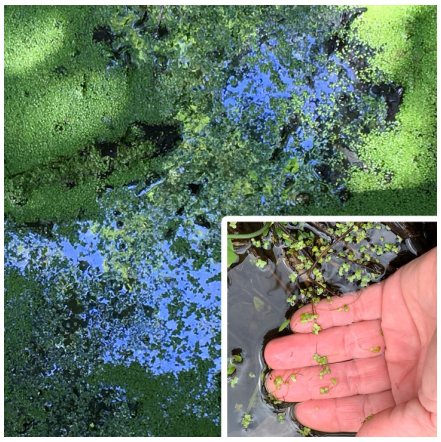
Lessons to Grow By – Plant Needs

Week 5: Space to Grow

Learning Objectives:

This week focuses on the plant need of space to grow. Kids will:

- Learn that in addition to the needs of light, air, water, and nutrients, plants must also have adequate space to grow and thrive.
- Investigate how the space available to a plant impacts its growth.
- Explore how plants can adapt to growing in different kinds of spaces as long as their other needs are met.



Plants come in all shapes and sizes! Tiny duckweed plants, above, are less than 1/10" long, while the giant sequoia tree, below, is 275' tall.

Materials Needed for the Week

Activity: 1 A Place to Call Home

- A Place to Call Home Reading Page
- Flexible measuring tape or string and a ruler
- Plant Observation Worksheet
- Clipboard or piece of cardboard
- Pencil

Activity 2: Space to Grow Experiments

- Radish or lettuce seeds
- Potting soil

- 5 pots (or repurposed plastic containers) that are all the same size — at least 4” in diameter if using radish seeds and 6” in diameter if using lettuce seeds
- Space to Grow Experiment Data Collection Worksheet

Activity 3: Straw Hydroponics

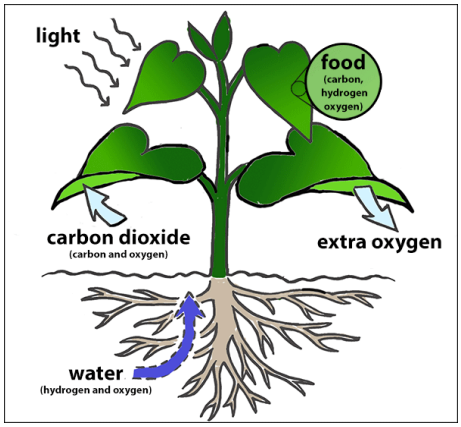
- Rockwool* or cotton ball
- Lettuce seeds
- Plastic container with lid
- Hydroponic nutrient solution (optional)*
- Drinking straw

*Rockwool is made from molten rock that is spun into fibers and then compressed into mats or cubes. Both rockwool and hydroponic nutrient solutions are available from hydroponics suppliers and on Amazon.

Introduction

All plants need water, air, light, nutrients, and a place to grow. Here is a brief review of the needs discussed in the previous Lessons to Grow By:

Light. Energy from light is captured to use during photosynthesis. Photosynthesis is the process by which plants make their food.



Air. Plants take in carbon dioxide to use during photosynthesis. They also take in lesser amounts of oxygen to help fuel their metabolic processes.

Water. Plants need water for a number of important processes, including photosynthesis (production of food) and transpiration (evaporation of water from the leaves into air that cools the plant and creates pressure to move water from roots to leaves). Water also aids in the absorption of some nutrients.

Nutrients. Just as people need vitamins, plants need certain nutrients to help them grow properly and for their biological processes to function. Plants obtain most of their nutrients from the soil. Nutrients occur naturally in the soil as a byproduct of decomposition of organic matter and the weathering of rocks. They can also be added through man-made fertilizer applications.

The last need plants must fulfill if they are to survive is a place to grow. Unlike most animals, plants are rooted in place. They must have a spot where they can anchor their roots, grow their stems and leaves, and obtain all of the other needs listed above. In nature, roots are usually anchored in the soil; however, there are exceptions, such as plants with aerial roots that live in rainforests and some floating water plants.

Plants come in all different shapes and sizes, so there is no set amount of space every plant needs to be thrive. Additionally, plants are extremely good at adapting. They can find ways to grow despite limited space, as long as their other needs are met.

Gardeners often push the limits regarding the space plants need to grow. Sometimes our gardens are more about our own needs and desires, rather than the plants' optimal conditions. This can have unfortunate consequences. For example, have you ever seen a sidewalk that has been cracked or buckled by tree roots because the tree wasn't given enough space to grow? Or a tree whose canopy had to be cut back because it was planted too close to power lines?

Bonsai artists prune the stems and roots of trees over many years to achieve miniature forms that can grow in small pots.

In some cases, however, limiting a plant's space to less than it needs in its native environment can have favorable results, as long as the gardener meets the plant's other needs.

For example:

- In the Japanese art of bonsai, gardeners prune the roots and stems of trees and shrubs to create healthy plants in miniature form.
- In urban areas, we grow plants in containers, in vertical gardens, and on rooftops.

These approaches allow people with limited space to be surrounded by green. Another example of this is a growing technique called hydroponics.

With enough light, water, and nutrients to meet their needs, plants can adapt to growing in small spaces.

Hydroponics, in its simplest form, is growing plants by supplying all necessary nutrients via the plants' water supply, rather than through the soil. The word derives from the Greek root words *hydro*, meaning water, and *ponics*, meaning working.

Growing plants hydroponically helps gardeners and farmers grow more food in smaller areas, such as classrooms, greenhouses, rooftops, and living rooms. It also allows them to produce food in parts of the world where space, good soil, and/or water are limited, such as in an urban warehouse, in a desert, in Antarctica, or even on the International Space Station!

Activity 1: A Place to Call Home

1. Together or independently, read the A Place to Call Home Reading Page. Have your kids complete the reading comprehension questions and then discuss your answers together.

2. Talk about how plants come in all shapes and sizes. Venture out on a nature walk and take time to observe all the different sizes of plants. You can use the Plant Observation Worksheet as a guide. Bring along a measuring tape so you can record various plants' height and width and the circumference of tree trunks.

   If you do not have a flexible measuring tape, use a long piece of string and a ruler. Wrap the string around the object and mark it to record the height or diameter of the plant. Then use the ruler to measure the length of the string.

   As you make observations, you may also want to mention to kids that the size and shape of a plant can be influenced by its age.

3. At the end of the walk, reflect on the diversity of plants you observed. Did you find many large plants on your walk? Were there more small plants? Were there some plants too big or too small to measure? Did you find any examples of plants whose size might have been influenced by the space available?

Activity 2: Space to Grow Experiments

By growing different numbers of the same plants in the same-sized containers, kids can see the impact of adequate space vs. crowding on plant growth. Lettuce and radish seeds make good test subjects.

The recommended spacing for radish and lettuce seeds planted in the garden is to sow them approximately 1" apart; then, when they're an inch or two tall, thin the radish seedlings to approximately 3" apart and lettuce seedlings to 5-6" apart. For this experiment, you'll plant one or two pots that demonstrate the recommended spacing (with just 1 or 2 plants per pot), and other pots that are overcrowded.

1. Obtain at least 5 pots of equal size. You can also repurpose plastic food containers, but be sure to punch holes in the bottom for drainage. Fill pots with moist soil.

2. Decide how many seeds to plant in each pot. Have at least one pot that has 1 plant and then choose different numbers of seeds based on the sizes of your pots. For easy comparison, you could plant in multiples of 5 for example (1, and then 5, 10, 15, 20, 25, etc.). Have kids record how many seeds were planted on the Space to Grow Experiment Data Collection Worksheet. Then have them write down a hypothesis of what they expect to see as the plants grow.

3. Provide equal amounts of water and sunshine to all the pots. Have kids record the number of seeds that germinate in each pot on their worksheets.

4. Have kids measure and record the height of the plants each week. It may be hard to measure every plant; if so, they can record the height of the tallest plant in each pot.

5. After 4 weeks, remove the plants from each container and measure the length of the longest roots. If possible, weigh the biggest plant.

6. Ask the following questions to discuss the experiment:

    - Did the measurements of the radish/lettuce plants vary based on the amount of space they had to grow?
    - Did this data match your predictions?
    - Which plants looked the healthiest?
    - Can you make any conclusions about plant needs based on this experiment?

Activity 3: Straw Hydroponics

1. In nature, plants naturally adapt to the space they have to grow. In crowded conditions, many types of plants will grow taller to reach more light. When growing in nutrient-deficient soil, they will send their roots out further in search of nutrients to fill their needs. If they have lots of space available, they will spread out to their fullest.

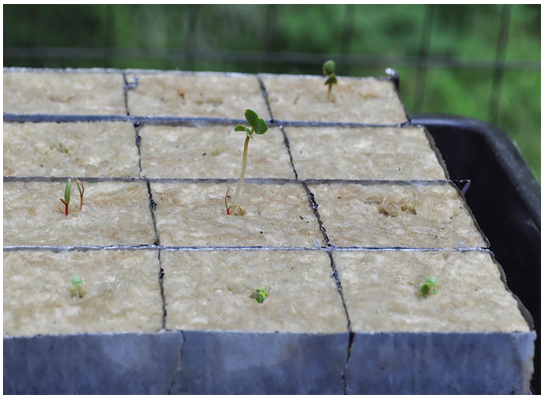
    As gardeners, sometimes we try to grow plants in spaces that look very different than where they usually grow in nature. Share some of the examples listed in the Background Information or look for additional examples.

These plants are growing in different types of hydroponic setups.

2. Try this simple straw hydroponic system to show kids how you can meet plant needs even in spaces that do not look like what we would find in nature. Kids are always amazed to see plants growing without soil. This kid-powered system gives them a chance to learn about hydroponic basics. Collect the materials:

    - Cotton balls or rockwool*
    - Lettuce seeds
    - Plastic container with lid
    - Drinking straw
    - Hydroponic nutrient solution (optional)**

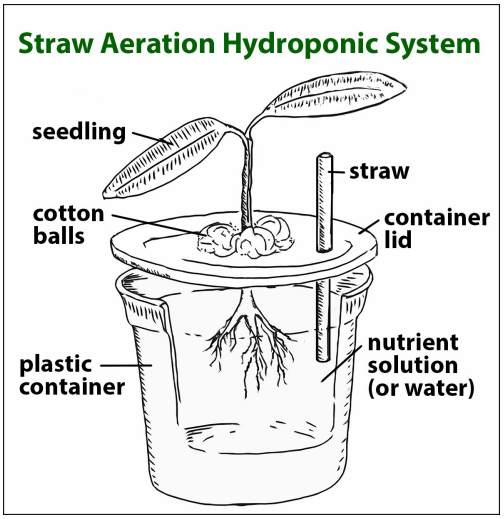
*Rockwool is made from molten rock that is spun into fibers and then compressed into mats or cubes. Both rockwool and hydroponic nutrient solutions are available from hydroponics suppliers and on Amazon.
**Though it's fairly inexpensive and recommended for optimal growth, hydroponic nutrient solution is not essential for this activity. Like all seeds, lettuce seeds contain enough food and nutrients for the plants' initial growth. The seedlings will grow for several weeks without added nutrients.



Seedlings germinating in rockwool cubes.

3. Soak small squares of rockwool or cotton balls in a dilute hydroponic nutrient solution (or plain water if you're not using the nutrient solution). Plant two or three lettuce seeds in each one, and then place them on a waterproof tray or shallow container and keep moist until seeds germinate.

4. Find a small plastic container with a lid to repurpose, such as a margarine, cottage cheese, or yogurt container. Use a utility knife to carefully cut a 1" X shape in the center of the lid. Cut a second, smaller X shape in the lid, about 1" from the edge, large enough to insert a drinking straw.



5. Gently insert the rockwool or cotton ball with the seedlings halfway through the large X so that it is held securely in place in the lid.

6. Fill the container with dilute nutrient solution (or plain water) so that the very bottom of the cotton ball or rockwool square will touch the solution, then secure the lid.

7. Insert a drinking straw through the smaller hole into the solution. Twice a day, gently aerate the solution by blowing into the straw. *Depending on the age and maturity level of your kids, this may be a job for a supervising adult. Please make sure you are blowing air into the container and not drinking any of the nutrient solution.

8. Change the nutrient solution (or water) every 1 to 2 weeks.

9. As the plants grow, talk to your kids about how they are delivering the plants needs of water and air (and nutrients, if using) in a unique way. Discuss the benefits of growing plants in hydroponic systems, such as:
    - They can be used in locations where quality soil is not available.
    - They can be used in urban locations close to population centers so that food does not need to travel far from harvest to market.
    - Plants can be grown year-round.

- The systems use less water than traditional gardening.
- Growers can control nutrient availability
- There are no weeds and usually fewer insect and disease problems.

Check out the Digging Deeper section below for some suggested videos about hydroponics that may pique their interest in this alternative growing technique.

Digging Deeper

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

Books and Additional Resources:

Flower Garden by Eve Bunting

Errol's Garden by Gillian Hibbs

Seed School by Joan Holub

Jack's Garden by Henry Cole

Up in the Garden and Down in the Dirt by Kate Messner

Plantzilla by Jerdine Nolen

A Place to Grow by Stephanie Bloom

Videos:

San Diego Hydroponic Farm
https://www.youtube.com/watch?v=zod-246VCkg

NASA's Doug Ming on Technologies Required for Living on Mars:
https://www.youtube.com/watch?v=QCOIHrt6eTU

Exploratorium Subzero Water Works in McMurdo Station on Ross Island, Antarctica:
https://www.exploratorium.edu/video/subzero-water-works

Exploratorium Polar Paradise:
https://www.exploratorium.edu/video/polar-paradise?autoplay=true

Can living walls reduce air pollution? BBC News:
https://www.youtube.com/watch?v=CcAAeGpLN4c

Virtual Tour of the National Bonsai & Penjing Museum:
https://www.youtube.com/watch?v=iR-XGOXWJNI

Additional Related KidsGardening Lessons and Activities to Try:

Room to Grow:
https://kidsgardening.org/lesson-plan-room-to-grow/

Square Foot Gardening:
https://kidsgardening.org/garden-how-to-square-foot-gardening/

Plants in Space:
https://kidsgardening.org/lesson-plans-plants-in-space/

Exploring Hydroponics:
https://kidsgardening.org/exploring-hydroponics/

Container Gardening for Kids:
https://kidsgardening.org/garden-activities-container-gardening-for-kids/

A Place to Call Home

Plant Needs Week 5 Reading Page

Plants need five main things to stay alive. They need air and light to make their food through photosynthesis. They need to take in water and nutrients through their roots so they can be used by all parts of the plant for healthy growth. And there is one more thing on their list — they also need space to grow.

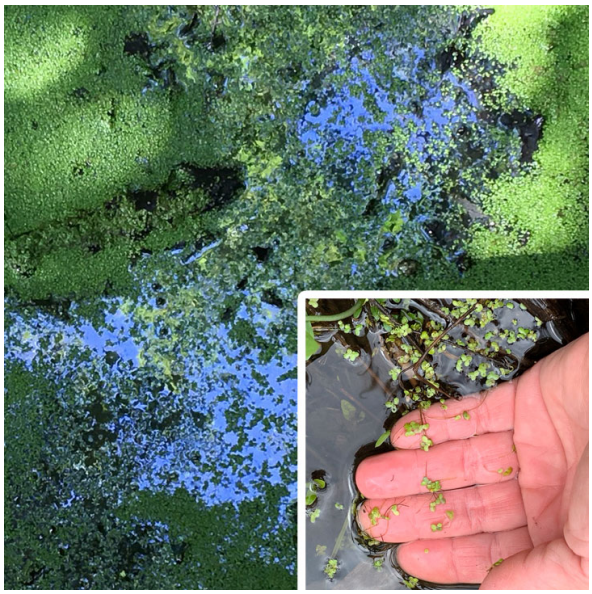
Just like animals, plants come in all shapes and sizes. For example:

- The watermeal plant is about 1/42" long and 1/85" wide, which is about the size of a candy sprinkle or the salt on a soft pretzel. (Some people think the plant, which grows in water, looks like cornmeal, which is how it got its common name.)
- The tallest tree in the world is a giant sequoia in California that is 275' tall and has a trunk that is about 32' wide. It is just a little bit shorter than the Statue of Liberty.

That is a big difference in size!

So, if a plant is given all the space in the world, along with the perfect amounts of water, nutrients, light, and air, will it keep getting bigger? Nope! Each type of plant has a specific size and shape it will reach when it's all grown up, ranging from teeny tiny to humongous.

Do plants always grow to their full size? Unlike animals that can move around to find the space they need, plants are rooted into place. So, if they are planted in a spot with limited room to grow, they will adapt to the space they have and may be thinner or shorter than normal. Also, when plants are crowded in their space they are competing with the plants around them for their other needs (light, water, air, and nutrients), and this can also keep them smaller.



Floating on the surface of a pond, common duckweed plants are less than 1/10" long. Watermeal plants are even tinier!

Can you imagine a tree so big it would take 25 kids reaching hand-to-hand to form a circle around its trunk? The General Sherman sequoia tree stands 275' tall and is more than 36' in diameter at the base. If you wrapped a tape measure around the trunk it would measure more than 100'.

Have you ever seen a garden packed with lots of plants and noticed the plants are tall and skinny? They may be stretching to try to get more sunlight. How about a tree planted in a narrow strip of land between a sidewalk and a street that never seems to get any taller? The size of its roots may be limiting how much its trunk and leaves can grow.

This ability to adapt to the space available is a cool thing about plants.

Although each type of plant has an ideal environment and amount of space where it will grow best, individual plants can adjust to less-than-ideal spots and still thrive. This is a very good thing for gardeners who like to grow plants in places and in ways that are not necessarily found in nature.

One example of this is the Japanese art of bonsai. Gardeners prune the stems and roots of plants to make them grow much smaller than they would be in nature. Towering trees can become container plants that fit on a shelf.

An example of a growing method that provides plants with a place to grow that is much different than where they grow in nature is hydroponics. In hydroponics, gardeners grow plants with their roots getting nutrients from water, instead of soil. This growing technique can be useful in environments where good soil is not available. For example, it can be used to grow plants in the desert, in Antarctica, and even on the International Space Station!

A hydroponic garden looks very different than a regular outdoor garden, but as long as all of a plant's needs can be met, it will be happy to call it home.

Bonsai artists prune the stems and roots of trees over many years to achieve miniature forms that can grow in small pots.

With enough light, water, and nutrients to meet their needs, plants can adapt to growing in small spaces.

These plants are growing in different types of hydroponic set-ups.

Reading Comprehension Questions:

1. List the 5 basic needs of plants:

2. True or false: All plants need the same amount of space to grow.

3. What does a plant do if it does not have enough space to grow:
   - ☐ Move to a new location
   - ☐ Adapt to its space by growing differently
   - ☐ Nothing
   - ☐ File a complaint

4. Hydroponics is a way to grow plants in:
   - ☐ Soil
   - ☐ Milk
   - ☐ Water
   - ☐ Quicksand

5. List one unusual place that you have seen a plant growing:

Plant Observation Worksheet

Plant # or Name	Height	Circumference	Does this plant look like it has enough room to grow? Why or why not?

Space to Grow Experiment Data Collection Worksheet

Pot #	# of seeds planted	# of plants growing	Height of tallest plant:				Length of longest root after 4 weeks	Weight of one plant after 4 weeks	Observations
			After 1 week	After 2 weeks	After 3 weeks	After 4 weeks			