



What Do Plants Need to Grow?

Grades 2-4

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Agriculture in the Classroom

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California Foundation for Agriculture in the Classroom

Vision: An appreciation of agriculture by all.

Mission: To increase awareness and understanding of agriculture among California's educators and students.



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Introduction

The framework for California public schools emphasizes the need to make education meaningful to students so they can apply what they learn in the classroom to their daily lives. Since all students eat food and wear clothing, one natural connection between academic education and the real world is agriculture.

Agriculture is an important industry in the United States, especially in California. As more rural areas become urbanized and more challenges exist to maintain and improve the quality of the planet and feed the people of the world, it is extremely important to educate students about their environment, agriculture, and the modern technologies that continue to make Earth a viable and productive planet.

What Do Plants Need to Grow?, a second through fourth grade unit, introduces students to the important role plants play in sustaining life as we know it. Plants are among the most important resources on Earth, providing us with food to eat and oxygen to breathe. In addition to adding beauty to our surrounding environment, plants also keep our soil healthy through decomposition, provide habitats for animals, and are the source of many materials we use every day—including wood, clothing, medicine, plastic, and more. In this unit, students will study plant parts and understand what plants need to grow and survive. They will also learn important concepts for second through fourth grade, such as photosynthesis and decomposition.

Students will practice hands-on laboratory experiments that involve observation, prediction, data collection, and analysis. Many lessons are based on student participation in partnerships or teams, providing opportunities for cooperative learning. Throughout the unit, students are encouraged to explore the vital connection between the plant systems they are studying and the way plants are connected to their daily lives.

This unit reinforces the current standards for California Public Schools including Common Core State Standards and Next Generation Science Standards. The standards, located on the sidebar of each lesson, specify grade level, subject matter, and standard number. A standards matrix for the entire unit, with descriptions of each standard, is located on pages 108-115. *What Do Plants Need to Grow?* is one of many educational units developed and distributed by the California Foundation for Agriculture in the Classroom. *What Do Plants Need to Grow?* leads into our 5-8 grade unit, *Too Much? Too Little?*, which focuses on soil nutrients.

Unit Overview

Unit Length

Twelve, approximately 60-minute sessions. Some lessons will require ongoing investigation and long-term observation and will extend over the course of one or several weeks.

Objectives

Students will:

- ▶ Identify the basic parts of plants and their functions.
- ▶ Observe the differences between dicot and monocot seeds.
- ▶ Investigate different types of fruits.
- ▶ Identify the differences between a plant's needs and a human's needs.
- ▶ Demonstrate that plants require sunlight, water, air (carbon dioxide), and nutrients to grow.
- ▶ Determine the importance of seed spacing when planting vegetables and flowers.
- ▶ Determine that water quality is important to plant health.
- ▶ Investigate soil composition and build a soil model.
- ▶ Determine the effects of fertilizers on plant growth.

Brief Description

This unit contains twelve lessons designed to teach students how plants grow and thrive in a variety of environments. They will experiment with the basic needs of plants, including water, air, light and nutrients, and learn that plants have roots that allow water and nutrients to be absorbed from the soil. Students will also learn how green plants make their own food from sunlight.

The lessons can be used separately or together and may be taught in any order. To fully address the concepts, however, teaching the unit in the provided sequence and in its entirety is recommended.

California Standards

A concerted effort to improve student achievement in all subject areas has impacted education throughout California. The California Foundation for Agriculture in the Classroom provides educators with numerous resource materials and lessons that can be used to teach and reinforce the Curriculum Content Standards for California Public Schools and Common Core State Standards. The lessons in this unit are also aligned to the Next Generation Science Standards, which were released for state adoption in April 2013. Our lessons encourage students to think for themselves, ask questions, and learn problem-solving skills while learning the specific content needed to better understand the world in which they live.

This unit, *What Do Plants Need to Grow?*, includes lessons that can be used to teach and reinforce many of the educational content standards covered in grades two through four. It can be used as a self-contained unit, to enhance themes and lessons already in use, or can provide technical information about plant life and agriculture. Emphasis is also placed on the importance of maintaining a healthy environment.

Each standard that is addressed is listed on the sidebar of each lesson. A matrix chart showing how the entire unit is aligned with current California standards is included on pages 108-115.



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Unit Overview

- ▶ Observe roots and determine that roots absorb nutrients and water to help the plant grow.
- ▶ Investigate how light affects plant growth.
- ▶ Understand how decomposers are part of the soil formation process.
- ▶ Describe newly gained knowledge while writing or drawing a story.

Key Vocabulary

A glossary of terms is located on pages 116-119.

Acidic
Alkaline
Amendment
Anther
Bacteria
Carbon dioxide
Carpel
Cell
Chlorophyll
Compost
Consumer
Control
Cotyledon
Decomposer
Dicot
Embryo
Endocarp
Exocarp
Fertilizer
Filament
Flower

Evaluation

This unit incorporates numerous activities and questions that can be used as evaluation tools, many of which can be included in student portfolios. With an emphasis on student inquiry, few lessons have “right” or “wrong” answers, but rather engage students in thinking critically about their learning experience and applying what they learn to real-life experiences. Embedded assessment includes oral and written responses to open-ended questions, group presentations, and other knowledge-application projects.

Visual Display Ideas

- ▶ Create a *What Plants Need* chart. Build a plant out of construction paper or draw one on the board. As your students learn what plants need (sunlight, water, air, and nutrients), add a picture of each item.
- ▶ Create a living “KWL” chart that documents what students know (K), want to know (W), and learned (L).
- ▶ Make a unique display of new words your students learn. Create a word wall by matching up new vocabulary words with a photo or illustration as a visual definition.
- ▶ Make a large bowl out of butcher paper. Fill the bowl with information your students learn. Call it “The Salad of Knowledge.” At the end of the unit, make a real salad for your students to enjoy. Discuss how the salad parts grew.

Before You Begin

1. Skim over the entire unit. Make appropriate changes to the lessons and student worksheets to meet the needs of your students and to match your personal teaching style.
2. The following resources may be helpful in learning about various plants and plant systems:
 - ▶ California Foundation for Agriculture in the Classroom’s Teacher Resource Guide. This guide provides recommendations for lessons, activities, field trips, information sources, and literature that relates to agriculture. The Teacher Resource Guide is available online at www.LearnAboutAg.org.



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Unit Overview

Fruit
Fungi
Germination
Hypothesis
Leaf
Legume
Manure
Mesocarp
Monocot
Nitrogen
Nutrients
Organic matter
Ovule
Oxygen
Petal
Phosphorus
Photosynthesis
Phototropism
Plant
Pollen
Pollination
Potassium
Producer
Reproduction
Root
Saline
Seed

- ▶ California Department of Food and Agriculture's website, www.cdfa.ca.gov. This site contains general and specific information on various aspects of agriculture.
 - ▶ California Farm Bureau Federation's website, www.cfbf.com. This site has articles on current issues in agriculture as well as agricultural information on each county.
 - ▶ The agricultural organizations listed on pages 95.
3. Read "Answers to Commonly Asked Questions" on pages 91-94 to gain background knowledge to use during the unit. Also review the glossary on pages 116-119. Use these definitions with your students as you see appropriate.
 4. Arrange classroom visits from people involved in the plant health industry. Guest speakers may include farmers, ranchers, soil scientists, compost specialists, and fertilizer specialists.
 5. Organize appropriate field trips. Possibilities include nurseries, farms, greenhouses, compost centers, and landfills.
 6. Obtain the necessary supplies for the unit.

Thank you for recognizing the importance of helping students understand and appreciate agriculture. We hope you find this resource useful in your teaching endeavors.

Plant Parts

Purpose

The purpose of this lesson is for students to learn the six basic plant parts and their functions.

Time

Teacher Preparation:
30 minutes

Student Activity:
60 minutes

Materials

For the teacher demonstration:

- ▶ White carnation flower
- ▶ Celery
- ▶ Food coloring
- ▶ Glass jar filled with water

For each partnership of 3-4 students:

- ▶ Carrot with leaves attached (tap root)
- ▶ Small corn plant, grass, or weed (fibrous root)
- ▶ Colored markers
- ▶ Newspaper

For each student:

- ▶ Toothpick or craft stick
- ▶ Paper towel

Background Information

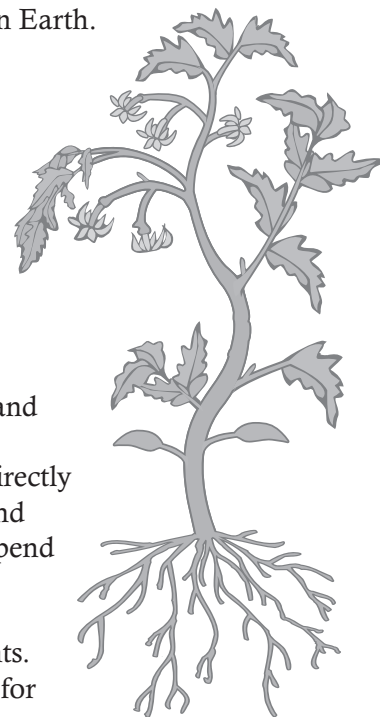
Plants are extremely important to life on Earth. They grow on mountains, in valleys, in deserts, in fresh and salt water—almost everywhere on the planet. Plants come in all shapes and sizes from the smallest seedling to the towering Giant Sequoias. Not only are plants beautiful to look at, but they also play a vital role in keeping people, animals, and the Earth healthy.

Plants provide food, medicine, shelter, and the oxygen we need to breathe. In fact, everything we eat comes directly or indirectly from plants. Herbivores (plant eaters) and omnivores (animal and plant eaters) depend on plants for survival. Even carnivores (meat eaters) depend on plants because they often prey on animals that eat plants. Plants also provide shelter and habitats for many animals.

Our precious soil also needs plants. When plants die they decompose and provide topsoil that is rich in nutrients and helps seeds to germinate and grow into seedlings. Plants also help to slow erosion because their roots hold soil in place. When plants carry out photosynthesis, they take in carbon dioxide from the atmosphere and release oxygen for us to breathe.

The basic parts of most land plants are roots, stems, leaves, flowers, fruits, and seeds. The function of each plant parts is described below.

- ▶ **Roots** anchor the plants in the soil and absorb nutrients and water that are needed by the rest of the plant.
- ▶ **Stems** support the upper part of the plant and act as a transport system for nutrients, water, sugar, and starches. Photosynthesis can occur in the stem of some plants such as: cacti, celery, asparagus, and bananas.
- ▶ **Leaves** are the parts of the plant where photosynthesis usually occurs—where food for the plant is made. The green substance,



Plant Parts

- ▶ Ruler
- ▶ Hand lens
- ▶ *Plant Parts* handout (pages 13-14)

chlorophyll, captures light energy and uses it to convert water and carbon dioxide into plant food and oxygen.

- ▶ **Flowers** are the reproductive part of plants. They often have showy petals and fragrances to attract pollinators such as birds, bees, and other insects. Most flowers have four main parts: petals, stamen (anther and filament), pistil (stigma, style and ovary), and sepals. After flowers are pollinated and fertilized, they produce seeds in the ovary of the flower.
- ▶ **Fruits** are the fleshy substances that usually surround seeds. They protect the seeds and attract animals to eat them. This helps in seed dispersal.
- ▶ **Seeds** contain plant material that can develop into another plant. This plant material is called an embryo. Seeds are covered with a protective seed coat and have one or two cotyledons. Cotyledons are the food for the baby plant until it can make its own food from light and are often the first embryonic leaves of the plant.

Procedure

1. Tell students that scientists consider plants to have six basic parts. Each of these parts has an important function, or role, in the life of the plant. Have students brainstorm different plant parts and record them on the board. Responses should include roots, stems, leaves, flowers, fruits, and seeds. Explain that in this activity, the class will be taking a closer look at plant parts.
2. Use the celery or white carnation to demonstrate how water, food, and minerals are transported up a stem into the leaves. Cut the bottom of a celery stalk or carnation stem and place in water with food coloring added. Throughout the day, students will see how the food coloring travels up the stem into the leaves and flowers.
3. Divide students into groups of three or four. Distribute newspaper, carrot plant, grass plant, hand lens, ruler, and *Plant Parts* worksheet. Instruct students to lay their plants on the opened newspaper and gently spread the roots out.
4. Have students use a colored marker and draw a circle around the roots of each plant. Invite students to use the hand lens to make close observations of the roots. Ask students to compare each root system by measuring and drawing the roots on their worksheet.

Plant Parts

California Standards

Grade 2

Common Core English Language Arts

W2.7
SL.2.1a
SL.2.1c

Next Generation Science Standards

2-LS2.A
2-ETS1.A
2-ETS1.B

Grade 3

Common Core English Language Arts

W3.8
SL.3.1b
SL.3.1c

Next Generation Science Standards

3-LS1.B
3-LS4.C

Grade 4

Common Core English Language Arts

W4.8
SL.4.1b
SL.4.1c

Next Generation Science Standards

4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

5. Brainstorm with the students why the roots look different and discuss the possibility of the different functions of the fibrous root verses the taproot. Write their responses on the board.
6. Ask students if they can see the stems on the carrot and corn plants. Explain that the carrot plant has a very small stem located above the root and below the leaves. The corn plant has a very long stem called a stalk. Monocotyledons like the corn or grass plant have a fibrous root, whereas dicotyledons like the carrot plant begin with a taproot and often grow secondary roots.
7. Have students compare the leaves of the carrot and grass plant. What do these leaves have in common? (They are green.) What is different about these leaves? (The shape, size and the veins on the leaves are different.) Explain to the students that all monocots have parallel veins. (The veins on the leaf do not intersect.) Plants that are dicots may have many different leaf shapes and vein patterns. *Monocots have parallel leaf veins, fibrous roots and flower petals in multiples of three. Examples are grasses, orchids, lilies, and palms. Dicots have net-like veins, taproots, and flower parts in multiples of 4 or 5. Examples are columbine, roses, peas, sunflowers, oaks, and maples.*
8. Ask the students why the plant leaves are green. For simplicity, share with students that plants produce their own food through a process called photosynthesis. Plants take in carbon dioxide, water, and sunlight and make glucose (sugar) and oxygen. *Plant leaves contain chlorophyll pigment which is responsible for capturing the sun's energy to carry out photosynthesis. Pigments are chemicals that absorb visible light. Chlorophyll absorbs red and blue light and reflects green light. This is why we see leaves as green.*
9. Have students discuss their observations with the class. At this point, students should be able to discuss basic plant parts and their particular functions, like transport of food and water, growth, and reproduction.

Extensions

- Wash and cut enough celery so that each student will be able to taste two stalks of cut celery. Wash and cut celery into five-inch sections. Place half of the celery in a saltwater solution (6 tbsp. salt dissolved into 2 cups water) and the other half into a sugar water solution (6 tbsp. sugar into 2 cups of water). Leave celery overnight in the different water solutions. Take the celery out

Plant Parts

of the refrigerator at least one hour before the students' taste test. Give students one of each kind of stalk. Ask them if they can taste a difference between the two different stalks of celery. Explain to students that the water moves up the stem in celery through a vascular system called the xylem.

- ▶ Go on a "field trip" around the school campus. Have students collect leaves as they walk around the campus. Ask students to sort the leaves by shape when they return to the classroom. Ask students if they can tell which leaves come from a monocot plant and which leaves come from a dicot plant (monocot plants have parallel leaves).

ELL Adaptations

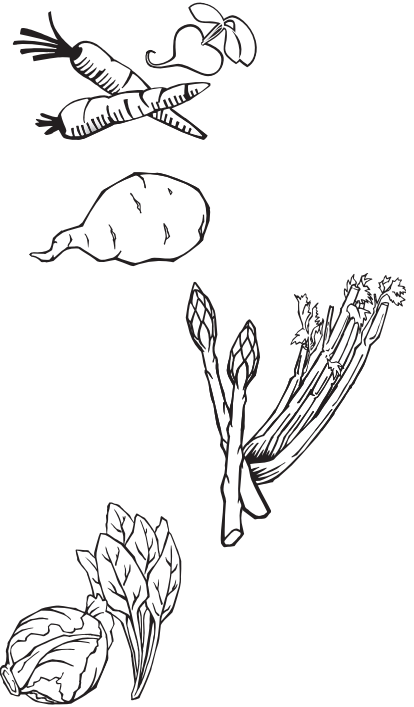
- ▶ This lesson incorporates hands-on activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ Add new vocabulary to a word wall and match photos to the new words.

Plant Parts

Name: _____

Plants typically have six basic parts: roots, stems, leaves, flowers, fruits, and seeds. Draw a diagram of your plants and label each part.

Carrot Plant



Grass Plant



Plant Parts *(continued)*

Plant Part	Description	Visual Observations
	Takes in water and nutrients.	
	Attracts pollinating insects.	
	Protects or holds seeds.	
	Collects sunlight and makes food for the plant.	
	Transports nutrients, water, sugar, and starches.	
	Contains the embryo.	

Role of the Roots

Purpose

Students will examine plant root systems and learn about their basic functions. Students will also learn that roots absorb and transport water and nutrients—two elements essential to plant health.

Time

Teacher Preparation:
30 minutes

Student Activity:

- ▶ Two 30-minute sessions
- ▶ Five 10-minute observation sessions (one per day for one week)

Materials

For the class:

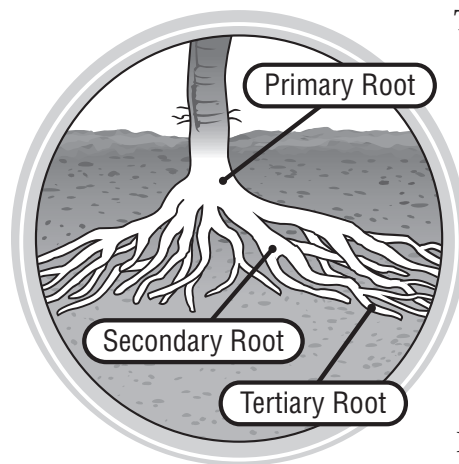
- ▶ Tap water
- ▶ Two spray bottles filled with water
- ▶ Paper towels

For each student:

- ▶ Clear plastic cup
- ▶ Radish seed
- ▶ Return address label
- ▶ Ruler
- ▶ Hand lens (optional)
- ▶ *Role of the Roots* handout (pages 18-19)

Background Information

Roots have four major functions. They anchor the plant in the soil, absorb water and minerals from the soil, store food, and transport nutrients from the root into the stem (or from the stem down into the root). The root system of a flowering plant begins its development from the radicle of the embryo of the seed that produces the primary root. Roots are geotropic, which means they always grow vertically downward under the influence of gravity. When seeds are planted, it doesn't matter which way is "up," the root will always grow downwards. Roots do not bear leaves, and therefore do not have nodes.



There are two primary root systems: fibrous and tap. Fibrous roots are usually thin roots that spread laterally. Most grasses (monocots) have fibrous roots. Dicots, have a central, large tap root. The tap root is the most common root we eat. Examples of edible tap roots include carrots, beets, radishes, and turnips.

Both fibrous and tap roots have root hairs. Root hairs are fine, hair-like, growths formed on the surface of the root, and are invisible to the naked eye. A root-hair consists of the following parts: a thin cell wall, a thin lining of cytoplasm that contains the nucleus, and a comparatively large vacuole containing cell sap. The main function of the root hairs is to increase the surface area of the root, helping the plant absorb water and nutrients efficiently.



Role of the Roots

California Standards

Grade 2

**Common Core English
Language Arts**
W.2.8

Common Core Mathematics
2.MD.1
2.MD.4

**Next Generation Science
Standards**
2-LS2.A
2-ETS1.A
2-ETS1.B

Grade 3

**Common Core English
Language Arts**
W.3.8

Common Core Mathematics
3.MD.4

**Next Generation Science
Standards**
3-LS3.B

Grade 4

**Common Core English
Language Arts**
W.4.8

Common Core Mathematics
4.MD.4

**Next Generation Science
Standards**
4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

Procedure

1. Prior to the lesson, cut out paper towel squares to line the inside of each clear, plastic cup. In this experiment, students will propagate radish seeds in the cup by placing a seed between the cup wall and the paper towel.
2. Show students a variety of root vegetables, including carrots, beets, radishes, and turnips. Ask students: "What part of a plant is this? How can you tell?" Have students discuss their response with a partner. Use a discussion to review the characteristics of the roots, including color, growth direction, lack of leaves or nodes, and shape. Compare these features to other parts of the plant, such as the stem, seed, and fruit. Note: Root vegetables store a lot of food for the plant in their roots. The plant will use this food for energy when it flowers. This is why we harvest root vegetables before they flower.
3. Explain to the class that today they will be starting a week-long activity to examine plant root systems and learn about their basic functions.
4. Give each student a plastic cup, piece of paper towel, radish seed, and copy of the *Role of the Roots* handout on page 18. Help students moisten their paper towel using the spray bottle. Instruct students to line the cup with the damp paper towel. Students will carefully place the radish seed between the cup wall and the paper towel, approximately half an inch from the top of the cup.
5. Have each student fill their cup with approximately ½-inch of water. The water should not contact the radish seed directly. Assist in repositioning the seeds as needed.
6. Instruct students to write their name on a label and place it on their cup. The label should not obstruct their view of the radish seed. Place the cups in a well-lighted location, such as a window sill.
7. Each day, students will observe and record the growth of their radish seed. Add water as needed, the water should always be in contact with the bottom of the paper towel lining.
8. As the radish seed grows, it will begin to sprout roots and root hairs. Inform students that root hairs grow in the soil and increase the surface area of the roots, allowing it to absorb more water and more nutrients. Emphasize that without root hairs, plants would die.

Role of the Roots

9. After five days, or after significant growth has occurred, ask students to carefully pull the radish seed out of the cup. Instruct students to observe the seed's root system with a hand lens and record their observations. Help students identify the primary root, secondary roots, tertiary roots, and root hairs.

Variations

- ▶ Place a damp paper towel in aluminum pie plates. Scatter radish seeds on the paper towel. Cover the seeds with another damp paper towel. Use a spray bottle to keep the towels moist, but not wet, for about four days. Remove the top paper towel and observe the root development.
- ▶ Have students observe the roots of a mature plant. Instruct students to pull weeds from a school garden or another section of the school grounds. Compare and contrast the different types of root systems. Have students observe the plant's root system with a hand lens and record their observations.

Extensions

- ▶ As a class, grow a hyacinth, red onion, or avocado houseplant in a clear jar. Instructions for growing an avocado houseplant can be found on page 10 of the 11th edition of *What's Growin' On? Elements for Life* (www.LearnAboutAg.org/wgo). Observe and record root growth.
- ▶ Introduce students to root vegetables by having them taste carrots, radishes, turnips, or beets. Students can respond to the tasting opportunity by describing the taste or voting for their favorite root vegetable. Make a graph to represent class preferences.

ELL Adaptations

- ▶ This lesson incorporates hands-on activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ Add new vocabulary to a word wall and match photos to the new words.

Role of the Roots

Name: _____


1. Make daily observations of your radish seed. Draw and record your observations below.

Day	Drawing	Description	Height (mm or cm)
1			
2			Growth from previous day:
3			Growth from previous day:
4			Growth from previous day:
5			Growth from previous day:

Role of the Roots *(continued)*

2. Does a radish have a taproot or fibrous root? How do you know?

3. Use a hand lens to examine your root. Draw your observations of the plant root hairs.



4. What is the function of the root hair?

5. Draw and label the primary root, secondary roots, tertiary roots, and root hairs.

5. Draw and label the primary root, secondary roots, tertiary roots, and root hairs.

6. What are the functions of roots?

[illegible]

Flower Hour

Purpose

Students will learn the four main parts of a flower and each part's role in plant reproduction.

Time

Teacher Preparation:
30 minutes

Student Activity:
60 minutes

Materials

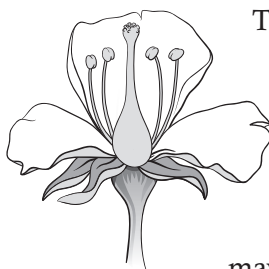
For each lab group of 3 students:

- ▶ *Flower Hour* handout (pages 25-26)
- ▶ Composite flower, such as a daisy, dandelion, or sunflower
- ▶ Simple flower, such as a tulip, lily, or daffodil. *Florists may have older flowers available at a discount.*
- ▶ Hand lens
- ▶ Ruler
- ▶ Paper towel
- ▶ Colored pencils

Background Information

All living organisms depend on plants to provide food, shelter, or oxygen. Therefore, plant reproduction is crucial to all other life on this planet. Different parts of the flower are specialized to help plants reproduce—to produce seeds that are used in new plant growth.

Typical flowers have four main parts: pistil (stigma, ovary, and style), stamen (anther and filament), petals, and sepals.



The female part of the flower, the pistil, includes the ovary, style, and stigma. Pollen attaches to the sticky stigma and this begins the process of pollination. The pollen travels down the style until it reaches the ovary where ovules are fertilized and will develop into seeds. Depending on the plant species, a flower may have male, female, or both males and female reproductive structures. Most flowers depend on bees, birds, or insects to help with the pollination process. Smell, color, and nectar attract pollinators to the flower.

The male part of the flower, the stamen, consists of the anther and filament. The anther carries the pollen that fertilizes the female part of the flower and is held up by the thread-like filament.

Petals are the colorful structures that help the flower attract pollinators. Petals also serve as a landing platform for insects and birds. For example, when a bee lands on the lower petal of a snapdragon, its weight causes the stamen to swing down and dust the bee with pollen. Petals of some plant species have stripes or other markings that guide pollinators to the nectar.

The green, outermost petal-like structures of the flower are the sepals. Generally, there are the same number of sepals in a flower as petals. Sepals form the protective layer around a flower in bud.



Flowers come in many shapes and sizes. Not all flowers contain the four flower parts featured in this lesson. Flowers that contain both male and female parts are called complete flowers. Flowers that contain only male or only female parts are called incomplete flowers. Flowers can also be categorized as simple or composite. Simple flowers have only one set of parts, while composite flowers may contain hundreds

Flower Hour

California Standards

Grade 2

**Common Core English
Language Arts**
W.2.8

Common Core Mathematics
2.MD.1
2.MD.4

**Next Generation Science
Standards**
2-LS2.A
2-ETS1.A
2-ETS1.B

Grade 3

**Common Core English
Language Arts**
W.3.8

Common Core Mathematics
3.MD.4

**Next Generation Science
Standards**
3-LS1.B
3-LS3.A
3-LS3.B

Grade 4

**Next Generation Science
Standards**
4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

of tiny individual florets. Common composite flowers are sunflowers, daisies, and dandelions.

Procedure

1. Prior to the lesson, obtain the simple, and composite flowers. The simple flowers should be complete, containing both male and female reproductive parts. Simple flowers, such as tulips, daffodils, and lilies have larger reproductive parts and are easier for students to dissect. Many demonstrations of flower dissection can be found on YouTube. These short videos provide a great way to review flower parts prior to the dissection activity.
2. Have students brainstorm the names of flowers they know. List flowers on the board. Explain that in today's activity students will be dissecting different types of flowers to help them understand how flowers reproduce.
3. Use a large flower, such as a lily, to identify the different flower parts and discuss each part's role in reproduction. Explain that the flower is called a complete flower because it contains both male and female parts.
4. Divide students into groups of three. Give each group a *Flower Hour* handout, hand lens, and simple, complete flower such as a tulip. Instruct students to use the hand lens to investigate the parts of the flower. Students should create a detailed drawing of each part as they record their observations.
5. Begin the dissection. First, demonstrate how to carefully remove the sepals on the calyx. Have students remove the sepals on their flower before they count, sketch, and measure them. Next, have students carefully remove the petals and count, sketch, and measure them.
6. Before having students remove the stamen, caution students that the pollen on the tip of the anther can brush off, making a mess and staining clothes. Instruct students to carefully remove the stamen over the paper towel, count the stamen, and record their observations. Identify pollen-dusted anthers and the thread-like filaments that support the anthers.
7. Only the stem of the flower and the pistil should remain. Explain to students that the pistil is composed of the style, stigma, and ovary. Have students gently remove the pistil and touch the stigma. Record observations. Explain that the stigma is the sticky part of the flower

Flower Hour

that collects pollen grains. When pollen attaches to the stigma, it travels down the narrow style into the ovary. The ovary has ovules containing egg cells. When an egg cell has contact with a pollen grain, fertilization occurs. Following fertilization, a seed begins to grow. Have students record their observations of the pistil, making special notes about its size, shape, and structure.

8. Once the simple flower is dissected, distribute a composite flower to each group. Instruct students to use the hand lens to examine the flower. As a class, compare and contrast the simple and composite flowers using a Venn diagram.

Extensions

- ▶ Identify and discuss flowers that are typically considered vegetables, such as broccoli, cauliflower, and artichokes. Distribute a variety of vegetables, some flowers and some not, and have students use their knowledge about flower parts to determine and justify if the food is, indeed, a flower.
- ▶ Students can create their own microscope slides by using index cards and clear packing tape. Cut a small window in the middle of the index card; place a piece of tape over the window. Place the plant part on the sticky side, in the middle of the window. Place another piece of clear tape over the flower part, securing it in place. Instruct students to label their slides and observe each specimen under the microscope.

Variations

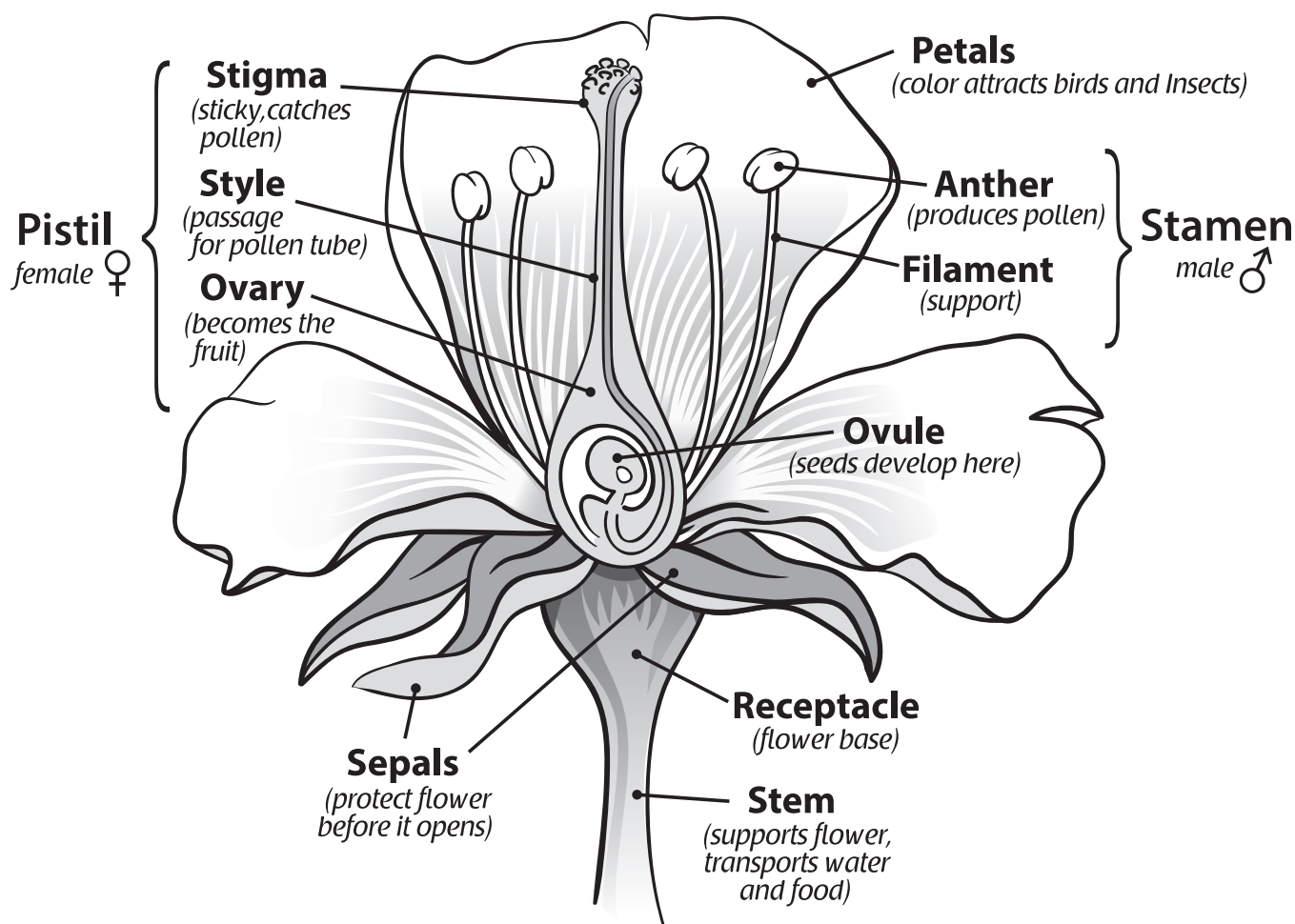
- ▶ Rather than drawing each plant part, have students tape each plant part to the *Flower Hour* handout.
- ▶ Introduce plant reproduction through an educational video on pollination. Check out the video “Pollination” on BrainPOP (www.brainpop.com) or search YouTube using the term “Flower Reproduction.”

ELL Adaptations

- ▶ This lesson incorporates hands-on activities as well as drawing and labeling of flower parts. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ Post new vocabulary words and matching illustrations on a word wall.



Parts of a Flower



Flower Hour

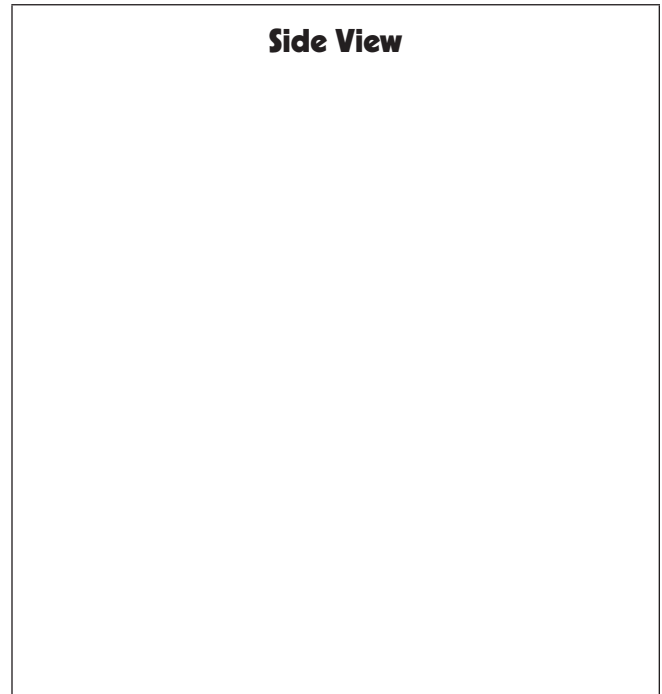
Name: _____

What are the different parts of the flower and what is their role in reproduction?

Word List

Petal	Anther	Pistil	Stigma
Sepal	Filament	Ovary	Ovule
Stamen	Pollen	Style	Seed

1. Using the hands lens, look closely at your flower. Use colored pencils to sketch your flower.



2. List four observations you can make about your flower. Think of the size, color, smell, texture, and quantity of each flower part. Use the word list above.

Flower Hour *(continued)*

3. Sketch, count, measure, and identify the function of each flower part.

Flower Part	Sketch	Color	Number	Length (cm)	Function
Sepals					
Petals					
Stamen					
Pistil					
Stem					

4. How do pollinators like bees and birds help fertilize flowers?

Seed Science

Purpose

Students will dissect monocotyledon and dicotyledon seeds and identify the seed coat, embryo, and cotyledons. Students will discover each part's function in seed survival and propagation.

Time

Teacher Preparation:
30 minutes

Student Activity:
50 minutes

Materials

For the class:

- ▶ Dicot and Monocot Seed Anatomy diagram (page 31)
- ▶ Transparency film (optional)
- ▶ Document or overhead projector

For each student:

- ▶ Wet lima bean seed
- ▶ Dry lima bean seed
- ▶ Wet corn seed
- ▶ Dry corn seed
- ▶ Round toothpick
- ▶ Hand lens
- ▶ *Seed Science* handout (pages 32-34)

Background Information

Most plants naturally originate from seeds. The development of the seed completes the process of reproduction in seed plants, which began with the development of flowers followed by pollination. Flowering plants produce seeds in the ovary of the flower. The ovary helps to protect the seed from being eaten. Once the flower dies, the seeds may be encased in a shell, surrounded by a fleshy fruit, or may blow away in the breeze.

The size of the seed has no correlation to the size of the fully mature plant. Small seeds can produce giant trees like oaks, coast redwoods, and sycamores. Seeds can be big or small, but they all contain three main structures: the seed coat, cotyledon, and embryo. The seed coat is a protective covering over the entire seed to protect the embryo. The cotyledon is a “seed leaf” that usually stores food for the embryo plant. It is considered a leaf because it is often the first part of a seedling that will be able to undergo photosynthesis. The embryo is an immature plant from which a new plant will grow under proper conditions. The food surrounded by the embryo is called the endosperm.

Plants develop and disperse seeds for species survival. The number of seeds a plant produces depends on the conditions in which it grows. Unlike animals, plants are limited in their ability to seek out favorable growing conditions. Many seeds have structures that aid them in dispersal, such as the hairs of a dandelion seed, which can be carried by the wind, and the barbs of a thistle seed, which can attach to an animal's coat.

Botanists and agriculturists divide seeds into two main groups. Plants with seeds that have only one cotyledon, or seed leaf, are called **monocotyledons**. Plants with seeds that divide into two separate cotyledons are called **dicotyledons**. Here are some examples of both:

Monocotyledons	Dicotyledons
Rice	Bean
Wheat	Pea
Garlic	Almond
Corn	Peanut
Tulip	Sunflower
Lily	Apple
Barley	Peach

Seed Science

California Standards

Grade 2

Common Core English

Language Arts

RI.2.4

W.2.7

W.2.8

L.2.6

Next Generation Science Standards

2-ETS1.A

2-ETS1.B

Grade 3

Common Core English Language Arts

RI.3.4

W.3.7

L.3.6

Next Generation Science Standards

3-LS1.B

Grade 4

Common Core English Language Arts

RI.4.4

L.4.6

Next Generation Science Standards

4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

Procedure

1. Prior to the lesson, soak half the lima beans and half the corn seeds in water, in separate containers for approximately 24 hours. Additionally, collect a variety of seeds for students to observe. Prepare an overhead transparency of the Dicot and Monocot Seed Anatomy diagram (page 31).
2. Facilitate a classroom discussion on seeds. Ask the following questions to assess what students already know:
 - ▶ What are seeds?
 - ▶ Where are they found?
 - ▶ Where do they come from?
 - ▶ Why do plants have seeds?
 - ▶ Do we eat seeds?
3. Tell students that today they will be investigating seeds. Explain that seeds can be divided into two categories: dicotyledons and monocotyledons. Practice saying the words in unison. Show students the Dicot and Monocot Seed Anatomy diagram (page 31.) Explain that plants with seeds that have only one cotyledon, or seed leaf, are called monocotyledons. Plants with seeds that divide into two separate cotyledons are called dicotyledons. Share with the class a list of dicot and monocot seeds.
4. Give each student a hand lens and a copy of the *Seed Science* handout on page 32.
5. Starting with the lima beans, give each student one dry and one wet seed. Ask them to compare the two seeds. Have students document their observations on the *Seed Science* handout.
6. Instruct students to use their fingernail or a toothpick to carefully remove the seed coat from the wet lima bean. Remind the students that the seed coat is used to protect the seed from predators, such as insects, and from infection caused by bacteria, viruses, or fungi. Have students gently separate the two cotyledons and locate the embryo. Direct students to identify the embryonic leaves. Have students document their observations on the *Seed Science* handout.
7. Distribute one dry and one wet corn seed to each student. Ask them to compare the two seeds. Have students document their observations on the *Seed Science* handout.

Seed Science

8. Instruct students to use their fingernail or a toothpick to carefully remove the seed coat from the wet corn seed. Explain that the corn seed is much more fragile than the lima bean seed and the structures are smaller. Have students identify the seed parts. Have students document their observations on the *Seed Science* handout.
9. After completing both dissections, ask students to compare and contrast each seed type and answer the questions on the *Seed Science* handout.

Variations

- ▶ Provide a variety of seeds, including nuts, for students to choose for dissection. Challenge students to identify and justify whether their seed comes from a monocot or dicot plant.
- ▶ When introducing the terms “monocotyledon” and “dicotyledon,” use root-word strategies to determine each word’s meaning.

Extensions

- ▶ Have students plant both the wet and dry seeds. After developing a hypothesis, have students carefully monitor each seed’s germination rate. Record visual observations and theorize how soaking a seed in water may affect its germination.
- ▶ Learn how to identify whether a plant is a monocot or a dicot without dissecting the seed. Characteristics of monocots include parallel veins, stem cross-sections that feature scattered vascular bundles, and flowers in multiples of three. Characteristics of dicots include netted veins, stem cross-sections that feature vascular bundles in a ring, and flowers in multiples of four or five. Take a field trip around the school grounds and predict whether plants are monocots or dicots, then think of a way to test your prediction.

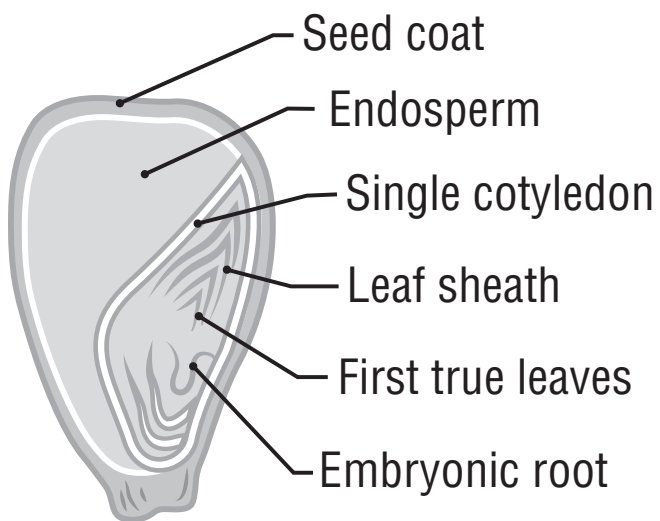
Seed Science

ELL Adaptations

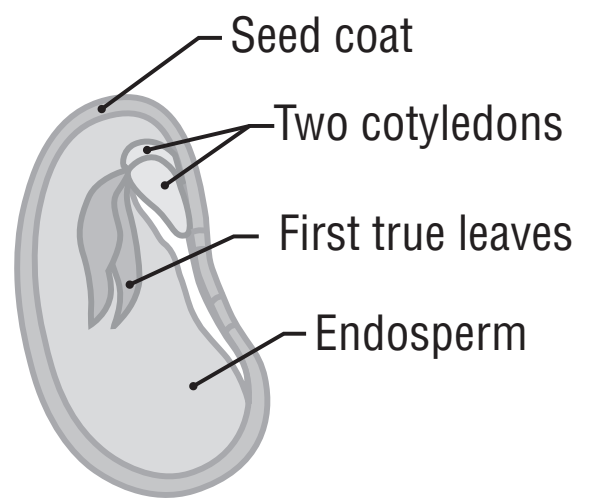
- ▶ Place ELL students in a group with other students who are proficient in English. Cooperative learning provides opportunities for students to illustrate, label, and discuss information.
- ▶ Students can define and draw illustrations of new terms like monocot and dicot in their science journal or on a classroom word wall.

Dicot and Monocot Seed Anatomy

Monocotyledon (corn)



Dicotyledon (bean)



Seed Science

Name: _____

Testable Question: Do lima bean seeds and corn seeds each have a seed coat, cotyledons, and an embryo even though the seeds are structurally different?

Hypothesis: _____

Part I: Lima Bean Seed

Materials

- ▶ Wet lima bean seed
- ▶ Dry lima bean seed
- ▶ Wet corn seed
- ▶ Dry corn seed
- ▶ Hand lens
- ▶ Toothpick

Procedure

1. Observe the dry and wet lima bean. Compare the texture and size. Using the colored pencils draw a picture of each of the seeds in the table below. Use descriptive words to communicate your observations. We will be dissecting the wet lima bean seed.
2. Using your fingernail or a toothpick, gently remove the seed coat. It is helpful to start on the edge of the seed. The seed coat should peel away easily.
3. Look at the seed coat using the hand lens. Draw and describe the seed coat in the table below.
4. Carefully split the lima bean in half. The embryo should be attached to the top of one of the cotyledons. Use your hand lens to observe the embryo. Record your observations.

Lima Bean Results

Draw and label your findings.

Dry seed coat	Wet seed coat	Magnified seed coat

Seed Science *(continued)*

Inside the lima bean seed. Label the seed coat, cotyledon, and embryo.

Write three facts about dicot seeds:

1. _____
2. _____
3. _____

Part II: Corn Seed

Procedure

1. Observe the dry and wet corn seeds. Compare the texture and size. Using the colored pencils draw a picture of each of the seeds in the table below. Use descriptive words to communicate your observations. We will be dissecting the wet corn seed.
2. Using your fingernail or a toothpick, gently remove the seed coat. It is helpful to start on the edge of the seed. The seed coat should peel away easily.
3. Look at the seed coat using the hand lens. Draw and describe the seed coat in the table below.
4. Carefully split the corn seed in half. The embryo should be attached to the top of one of the cotyledons. Use your hand lens to observe the embryo. Record your observations.

Seed Science *(continued)*

Corn Seed Results

Draw and label your findings.

Dry seed coat	Wet seed coat	Magnified seed coat

Inside the corn seed. Label the seed coat, cotyledon, and embryo.

Write three facts about monocot seeds:

1. _____
2. _____
3. _____

Conclusion

Did you prove or disprove your hypothesis? Write a short paragraph restating your hypothesis and how you were able to prove or disprove it based on your findings.

A Seedy Fruit Challenge

Purpose

Students will investigate different types of fruits and learn to categorize fruits into two main groups based on whether they are dry or fleshy.

Time

Teacher Preparation:
40 minutes

Student activity:
60 minutes

Materials

For the teacher demonstration:

- ▶ Seeded orange
- ▶ Apple or pear
- ▶ Peach, plum, apricot or other stone fruit

For the class:

(Three of each or adjust to what is available)

- ▶ Seeded orange
- ▶ Apple
- ▶ Peach
- ▶ Bell pepper
- ▶ Pea pod
- ▶ Tomato
- ▶ Cucumber
- ▶ Berries

Background Information

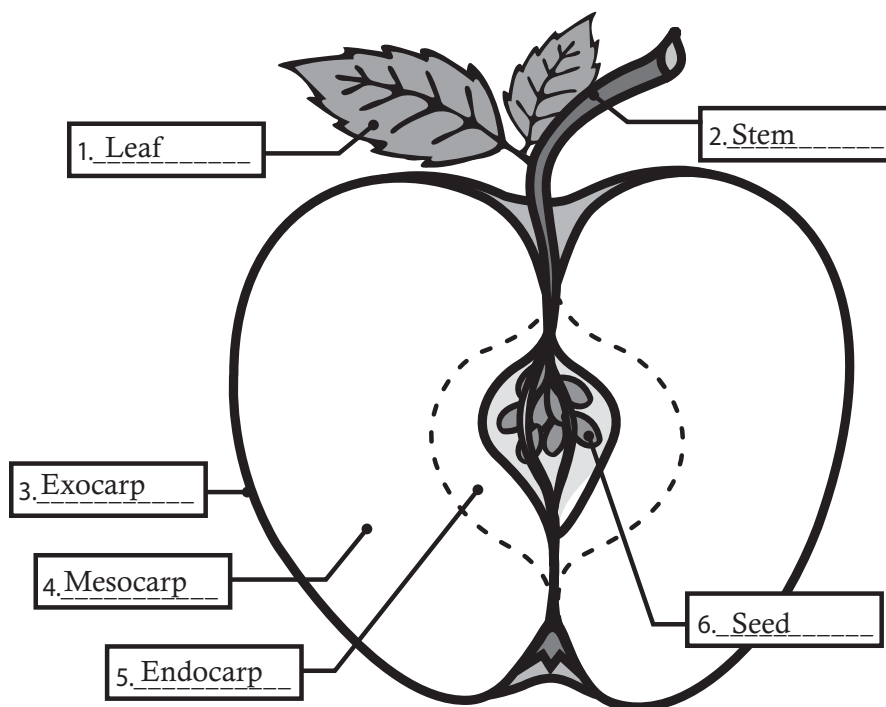
Seeds develop from flowers once the egg cell in the ovary of a flower is fertilized. Generally, the ovary ripens into the fruit and provides a protective structure around the seed. Sometimes, the ripened fruit comes from another part of the flower such as the ovary wall, receptacle of the flower, or the fleshy tissue of the ovary.

Fruit is the ripened ovary and the other structures that surround it at maturity. As the ovary develops into a fruit, its wall often thickens and becomes differentiated into three, more or less distinct layers. These three layers together form the pericarp, which surrounds the seed or seeds.

The three layers are:

- ▶ **Exocarp** – The outer layer consisting of the epidermis (skin)
- ▶ **Mesocarp** – The middle layer consisting of the fleshy portion that we often eat
- ▶ **Endocarp** – The inside layer *varies greatly from one species to another*

Draw the following diagram on the board.



A Seedy Fruit Challenge

- ▶ Peanut
- ▶ One paper plate for each piece of fruit
- ▶ Scales for weighing fruit

For each partnership:

- ▶ An assortment of three different fruits, such as: seeded orange, apple, bell pepper, and a peanut
- ▶ Paper towels
- ▶ Sharp plastic knife
- ▶ One paper plate for each fruit given

For each student:

- ▶ Student lab worksheets (pages 39-41)

Most angiosperms (flowering plants) have simple fruits, which can be categorized as follows:

Fleshy Fruits

These fruits have a pericarp that is soft and fleshy at maturity. Common fleshy fruits can be divided into groups as follows:

- ▶ **Drupe:** a fruit from a single carpel, in which the outer wall of the ovary has become fleshy and the inner part stony at maturity. Often termed a "stone fruit." Examples include peach, plum, apricot, cherry, and almond.
- ▶ **Pome:** Endocarp is papery, forming a core with several seeds, compound pistil; Examples include apple, pear and quince.
- ▶ **Pepo:** an accessory berry, with a relatively hard rind; Examples include watermelon, cucumber, pumpkin, squash, and cantaloupe.
- ▶ **Hesperidium:** a modified berry, in which the outer part of the ovary wall becomes leathery. Examples include orange, tangerine, lemon, lime, grapefruit.
- ▶ **Berry:** Ovary wall becomes fleshy throughout, one to many seeds. Examples: grape, eggplant, tomato, kiwifruit, and persimmon.

Dry Fruits

These fruits have a pericarp that becomes dry and hard at maturity.

- ▶ **Legume (pod):** Splits open along two seams. Examples include pea, green bean, and peanut.
- ▶ **Capsule:** Two or more fused carpels, the fruit splits open at maturity. Examples includes lily.
- ▶ **Indehiscent dry fruit:** Does not split open at maturity. Examples include grains and nuts.

Aggregate Fruits

Clusters of several ripened ovaries produced by a single flower and produced on the same receptacle of a single flower. Examples include raspberry, blackberry, and boysenberry.

Multiple or Compound Fruits

Clusters of several ripened ovaries produced by several flowers in the same inflorescence. Examples include pineapple.

A Seedy Fruit Challenge

California Standards

Grade 2

**Common Core English
Language Arts**
W.2.8

Common Core Mathematics
2.MD.10

**Next Generation Science
Standards**

2-ETS1.A
2-ETS1.B

Grade 3

**Common Core English
Language Arts**
W.3.8

Common Core Mathematics
3.MD.3

**Next Generation Science
Standards**

3-LS1.B
3-LS3.B
3-LS4.C

Grade 4

**Common Core English
Language Arts**
W.4.8

Common Core Mathematics
4.MD.4

**Next Generation Science
Standards**

4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

Most people have a very good understanding of what the difference is between a fruit and a vegetable, but often have difficulty coming up with a clear definition. For a botanist, the definition is much clearer.

A fruit is defined as the reproductive structure of an angiosperm (flowering plant), which develops from the ovary and the accessory tissue, which surrounds and protects the seed. The fruit is also important in seed dispersal. Generally speaking, a vegetable is used to indicate the edible part of a plant that includes the stem, leaves, bulbs, flowers, and roots.

Procedure

1. Facilitate a discussion with students about different fresh foods they eat that have seeds. Make a list of these foods on the board. Ask them if the foods are fruits or vegetables (botanically, fruits have seeds; vegetables come from another part of the plant and don't contain seeds).
2. Tell students that they will dissect fruits to observe and record where the seeds are located, how many seeds they have, and the size, color, texture, and shape of the seeds in each fruit.
3. Distribute student lab, *A Seedy Fruit Challenge* to each student. Explain what is expected of the students with the lab worksheet. Demonstrate how to make a bar graph.
4. Divide students into groups of three or four. Distribute newspaper, paper plates, plastic knife, paper towels, and three to five pieces of fruit to each group.
5. Instruct students to weigh each piece of fruit before cutting into it.
6. Instruct students to place each piece of fruit on a paper plate and carefully dissect it with a plastic knife being careful to keep the fruit's juices on the plate.
7. Upon completion, discuss the results as a class.

Variations

- After dissection, students can gather seeds from one fruit at a time. Ask them to find the mass of the seeds and find out what percentage of the fruit are seeds.

A Seedy Fruit Challenge

- ▶ Have students find the mass of the fruit before dissection. Ask students to separate the inedible parts of the fruit (seeds, skin, core, etc.) from the edible portion. Have students find the mass of the inedible (or edible) portion of the fruit and find what percentage of the fruit is edible.

Extensions

- ▶ Take step two further and find the price of a piece of fruit. After finding the percentage of edible versus inedible parts of the fruit, have students find what piece of fruit gives you the most edible portion for the money.
- ▶ Ask students if they can find similarities between fruits. See if they can come up with other fruits that develop similar characteristics. For example: oranges, limes, and lemons have rinds and peel in sections.

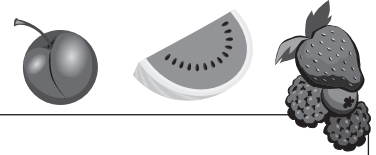
ELL Adaptations

- ▶ This lesson incorporates hands-on activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ Add new vocabulary to a word wall and match photos to the new words.

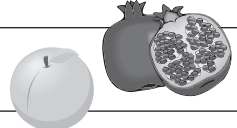
A Seedy Fruit Challenge

Name: _____

Dissect and record the following information for each of your three fruits.



Name of Fruit _____	
Draw dissected half and label the Exocarp , Mesocarp and Endocarp .	Number of seeds _____ Color of seeds _____ Shape of seeds _____ Texture of seeds _____ Mass of fruit _____ Mass of seeds _____ Check the type of fruit: <input type="checkbox"/> Fleshy <input type="checkbox"/> Dry <input type="checkbox"/> Aggregate <input type="checkbox"/> Compound

Name of Fruit _____	
Draw dissected half and label the Exocarp , Mesocarp and Endocarp .	 Number of seeds _____ Color of seeds _____ Shape of seeds _____ Texture of seeds _____ Mass of fruit _____ Mass of seeds _____ Check the type of fruit: <input type="checkbox"/> Fleshy <input type="checkbox"/> Dry <input type="checkbox"/> Aggregate <input type="checkbox"/> Compound

A Seedy Fruit Challenge *(continued)*



Name of Fruit _____	
Draw dissected half and label the Exocarp , Mesocarp and Endocarp .	Number of seeds _____ Color of seeds _____ Shape of seeds _____ Texture of seeds _____ Mass of fruit _____ Mass of seeds _____ Check the type of fruit: <input type="checkbox"/> Fleshy <input type="checkbox"/> Dry <input type="checkbox"/> Aggregate <input type="checkbox"/> Compound

- How are seeds protected? _____

- Name three kinds of seeds that people eat: _____

- In what part of the flower do seeds come from? _____

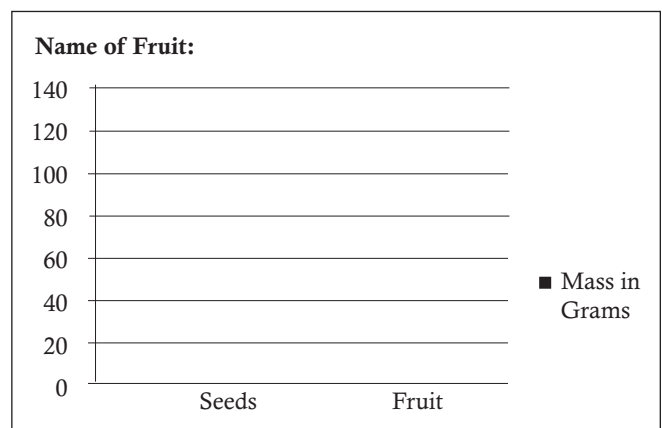
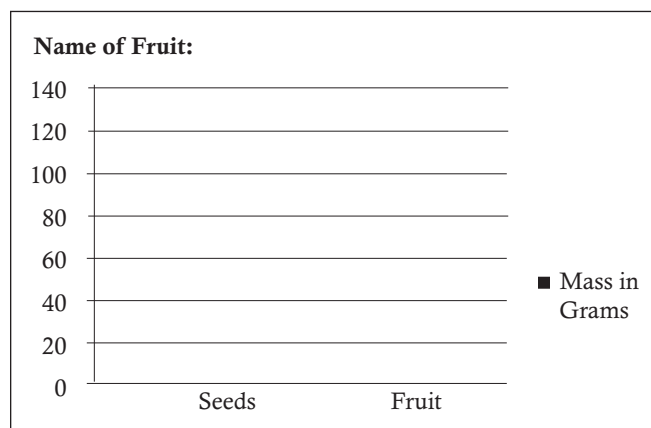
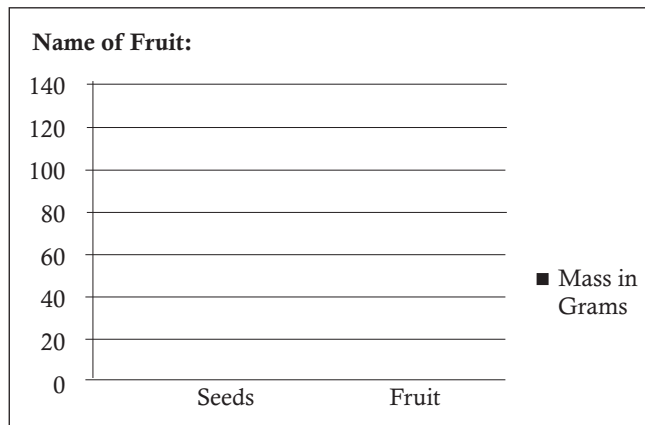
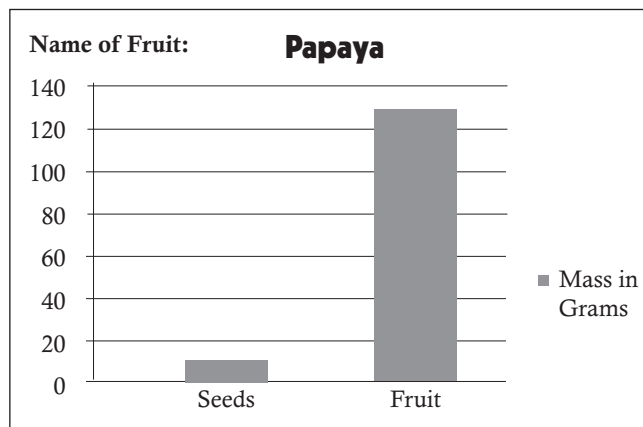
- What is the seed's function? _____

A Seedy Fruit Challenge *(continued)*

5. Name three ways seeds are transported in nature. _____

Use a bar graph to compare the mass of each fruit and the mass of its seeds.

Example:



Knowing Our Needs

Purpose

In this lesson, students will consider the difference between human wants and human needs. Based on these discoveries, students will compare human needs to the needs of plants. By the end of the lesson, students will be able to identify the basic needs of plants.

Time

Teacher Preparation:
30 minutes

Student Activity:
Two 30-minute sessions

Materials

For the class:

- ▶ Butcher or chart paper – *size of small poster*
- ▶ Markers

For each partnership:

- ▶ Set of *Knowing Our Needs* cards (pages 48-49)
- ▶ Envelope or resealable plastic bag

For each student:

- ▶ *Knowing Our Needs* handout (page 47)
- ▶ *Knowing Our Needs* collage template (page 46)

Background Information

All living things have physical needs that must be met in order to sustain life. Depending on the environment and availability of resources, some organisms may be able to survive well, some less well, and some cannot survive at all. Human needs have not changed for centuries. As the world's first explorers set off to discover new lands and map uncharted territories, they had to make sure that basic survival requirements were met. To endure these long voyages, human beings had to make sure they had food, water, air, and adequate shelter on hand. If any one of these basic needs were not met, life would be in jeopardy.

Just like humans, plants require certain elements to develop, reproduce, and survive. Plants need room to grow, the right temperature, light, water, air, and nutrients. When these requirements are limited or aren't provided at all, they can inhibit plant growth or cause the plant to die.

Procedure

1. Prior to the lesson, replicate and cut out a set of *Knowing Our Needs* cards for each student partnership. Organize each set of cards in an envelope or resealable plastic bag.
2. Write the words “need” and “want” on the board. With the help of the class, discuss and form understandable definitions of the words. Write the class determined definitions on sentence strips so they can be referred to throughout the unit.
3. Assign partnerships. Distribute one set of *Knowing Our Needs* cards to each partnership. Instruct students to sort the cards into two categories—human wants and human needs. Explain that students must reach an agreement with their partner as to which category each item belongs. Encourage cooperative discussions between students. Students can create their own need or want on the blank card provided in the set.
4. After students have finished sorting their cards, review each card as a group. If students disagree with each other, encourage them to collaboratively discuss the topic, building on the comments of their peers. Be sure to clarify and highlight these important concepts:
 - ▶ Needs are things people must have to live, and wants are things people would like to have. Needs sustain life, and wants usually enhance living.

Knowing Our Needs

- ▶ Old magazines with a variety of pictures
- ▶ Glue stick
- ▶ Scissors
- ▶ Colored pencils, crayons, or markers

- ▶ Humans require food, water, air and adequate shelter. All other items listed on the cards are human wants.
 - ▶ If humans were denied these needs, human life would cease to exist.
5. Have students summarize their understanding by creating a collage of human needs and wants using images from magazines. Give each student a copy of the *Knowing Our Needs* collage template on page 46. This template shows how students should draw their outlines on their poster papers. Half of the body will represent human wants, and the other half, human needs. Instruct students to make their collage as personal as possible. Display student art in the classroom.
 6. Explain that just like humans, plants require certain elements to develop, reproduce, and survive. Make a Venn diagram on the board. Label one circle “What Humans Need.” Label the other circle “What Plants Need.” If necessary, provide additional information about Venn diagrams. Distribute two sticky notes to each student. Instruct students to write two needs, for either plants or humans, on the sticky notes. Have students place their sticky note in the region that best represents each need. Review responses as a class. Define and clarify the following needs of plants:
 - ▶ **Room to Grow:** The above ground portions of the plant need space so leaves can expand and gather the sun’s energy to carry out the job of making food. Roots also need room to grow.
 - ▶ **Light:** Whether they’re grown inside or outside, plants need light. They use light energy to change carbon dioxide and water into food. This process of food productions is called photosynthesis.
 - ▶ **Water:** Water is essential to all life on earth. No known organism can exist without water. Plants use water for many life processes including moving nutrients throughout the plant.
 - ▶ **Air:** Green plants take in carbon dioxide from air and use it during photosynthesis to make food. Smoke, gases, and other air pollutants can damage plants.
 - ▶ **Nutrients:** Most of the nutrients that a plant needs are taken up by the plant through its roots. The three most important nutrients for plants are nitrogen, phosphorous, and potassium.

Knowing Our Needs

California Standards

Grade 2

**Common Core English
Language Arts**
L.2.5a

**Next Generation Science
Standards**

2-LS2.A
2-ETS1.B

Grade 3

**Common Core English
Language Arts**
L.3.5b

**Next Generation Science
Standards**

3-LS1.B
3-LS4.C

Grade 4

**Common Core English
Language Arts**
L.4.6

Standards descriptions are listed
in the matrix on page 108.

7. Have students record their discoveries in their science journals or on the *Knowing Our Needs* handout on page 47. By the end of the lesson, students should realize that all living things require certain resources to survive. Requirements depend on species, but the basic requirements of food, water, and air are needed by all living things.

Variations

- ▶ Set up a relay in which student teams race to sort the *Knowing Our Needs* cards into categories. Line two teams of students up at the edge of a playing field. Instruct them to select a card, run to the end of the field, and sort the card into bags labeled “needs” and “wants.” Teams can compete with each other or against the clock. At the end of the race, review how each item was sorted and discuss as a class.
- ▶ If magazines are not available, students may illustrate the human wants and needs on the poster paper.
- ▶ Instead of cutting the cards out and distributing in baggies, present them to the class using a document camera. Have a class discussion to develop the definitions of human wants and needs.

Extensions

- ▶ Students write a journal entry describing life without one of the human needs identified in this lesson. Students should address how the resource disappeared, the challenges they now face, and their plan to save the planet.
- ▶ Give students the challenge of growing a plant in outer space. Have students think of the potential challenges and creative ways to meet the plant’s needs. Visit the NASA website, www.nasa.gov, to research real examples of astronauts growing plants in space.

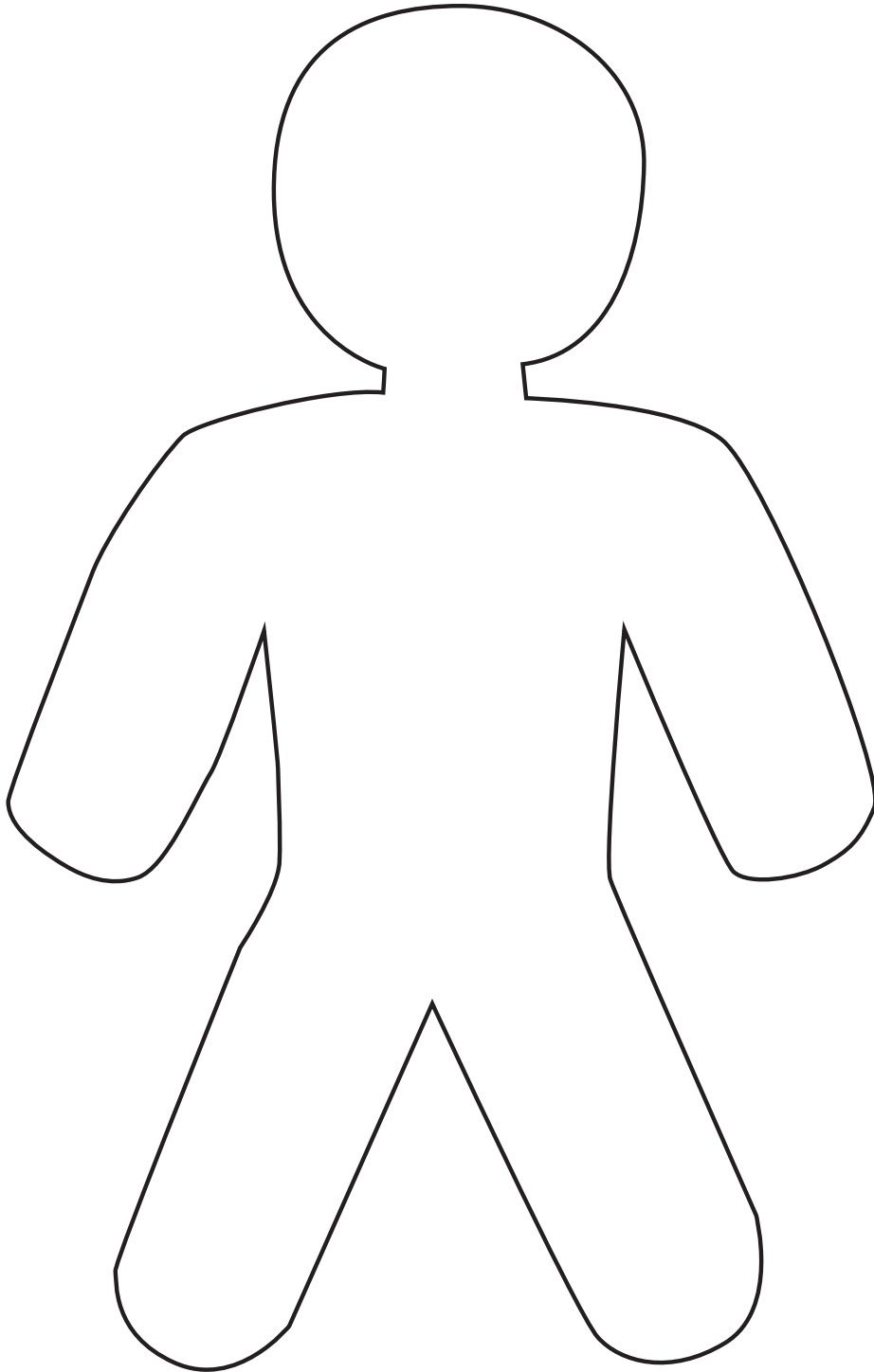
ELL Adaptations

- ▶ This lesson incorporates hands-on art activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ On the student handout, *Knowing Our Needs*, have ELL students draw a picture that represents what plants need to grow next to each word.

Knowing Our Needs

Name: _____

(Template for Human Needs & Wants)



Knowing Our Needs

Name: _____

Definitions

Need: _____

Want: _____

What do plants need to grow?

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

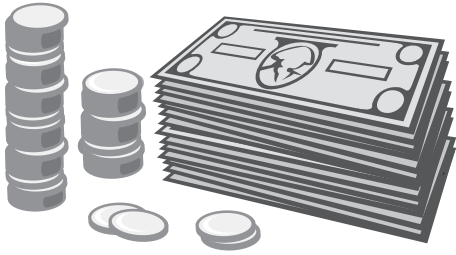
List at least three human needs that are provided by plants.

1. _____

2. _____

3. _____

Knowing Our Needs Cards



Money



Computer



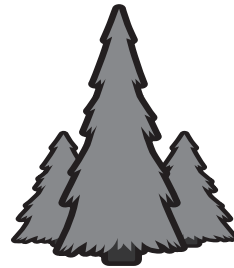
Clothing



Car



Shelter



Plants



Water



Refrigerator



Electricity



Food

Knowing Our Needs Cards



Cell Phone



Off Highway Vehicles



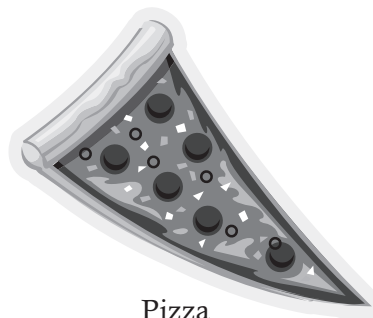
Toys



Shoes



Air



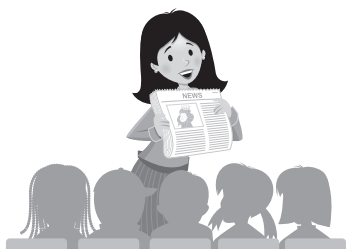
Pizza



Medical Care



Pets



Education

Create Your Own _____

Room to Grow

Purpose

Students will plant 5-6 different seeds of different sizes to investigate if seed size directly corresponds to the size of the plant the seed produces over time. Students will learn the importance of seed spacing in order to give the germinating plant the room it needs to grow and be healthy.

Time

Teacher preparation:
30 minutes

Student activities:
One 50-minute session for introduction and planting seeds.

One 10-minute session for three weeks to observe and care for seedlings.

Materials

For each student group:

- ▶ Shoebox (or long planter box or outdoor garden space)
- ▶ Plastic shopping bag for shoebox liners
- ▶ Centimeter ruler
- ▶ Potting soil
- ▶ Craft sticks
- ▶ Permanent marker

Background Information

Farmers must consider many factors when planning which crops to grow, including when to plant, demand for their product, and what nutrients the crop will need. Some factors are out of farmers' control such as lack of rain, hot or cool weather, and wind. The factors that farmers can control include, amending soil with appropriate nutrients, the type of seeds planted, and the spacing given to each seed. The objective in ideal spacing of crop plants is to obtain the maximum harvest for an area without decreasing the quality of the crop.

For the most part, farmers plant crops in rows or straight lines for convenience and optimum harvest. When crops are planted in rows, light absorption is maximized and wind passage between rows is enhanced, which increases air circulation and lessens the chance of wind damage to plants. Rows also provide convenient pathways for farm equipment and farmers tending to the plants.

Different factors come into play when farmers decide how many seeds to plant in each crop row. If there are too many plants in a row, the seedlings must compete for sunlight, water, and nutrients. The plants will not grow to their full potential and could become diseased and die, resulting in a failed crop. Farmers also need to make sure they don't plant seeds too far apart because this wastes space. Proper seed placement is very important for healthy plants and a good harvest that allows the farmer to make a living.

Procedure

1. Invite five students to stand near each other, with their shoulders touching, in the front of the classroom. Tell students to stretch their arms out to their sides, being careful not to hurt their neighbors. Share with students that their arms are like plant roots that cannot spread enough to get the proper nutrients they need.
2. Ask students to spread out really far and spread their arms. Walk between the students. Look at all that wasted space. Tell students there is so much extra room that more seeds could have been planted to fill in this wasted space.
3. Have students come together so that when their arms are spread their fingers are touching. Tell students that this represents perfect planting of a seed row, where no space is wasted and no crowding occurs.



California Foundation for
Agriculture in the Classroom

Room to Grow

- ▶ A variety of seeds, such as: carrots, radish, large lima beans, zucchini, corn, pea, basil, pumpkin, tomato, cucumber, and sunflower

- ▶ *Room to Grow* student worksheet (pages 54-56)

California Standards

Grade 2

Common Core English

Language Arts

RI.2.1
W.2.2
W.2.7
W.2.8
SL.2.1a
SL.2.1c

Common Core Mathematics

MD.2.1

Next Generation Science Standards

2-LS2.A
2-ETS1.A
2-ETS1.B

Grade 3

Common Core English

Language Arts

RI.3.1
W.3.2d
W.3.7
W.3.8
SL.3.1b
SL.3.1c

4. Ask students if they think seed size is related to the size of the plant that will grow from that seed. In other words, do large seeds produce large plants and do small seeds produce small plants? Write responses on the board.
5. Tell students that they are going to carry out an experiment to find out if seed size and plant size are positively related. Show students the shoeboxes and show them how the seeds will be planted in rows (*this can also be done outside if you have a garden space*).
6. Divide students into groups of 3-4 and distribute a worksheet to each student. Instruct student groups to line their shoeboxes with plastic bags and to fill their shoebox $\frac{3}{4}$ full with potting soil. Have students moisten the soil using a spray bottle (*this prevents over watering*).
7. Have student groups choose 4 different seed types, making sure they choose small and large seed types. Students may select 4-8 seeds from each group to plant depending on the seed's size.
8. Instruct students to use the millimeter scale on their rulers to measure the length of one of each type of seed that will be planted. Record the measurement on the worksheet chart.
9. Instruct students to make seed labels on craft sticks and correctly label each seed row. Have students record each seed type and number of seeds planted in their boxes on their worksheet.
10. Instruct students to use the spray bottles to keep soil moist, but not too wet. Seed boxes should be placed in a sunny classroom window.
11. Have students keep a log of when seeds germinated and the height of each seed type.
12. After three weeks, have student groups report and share their results. Record and compare results on the board.

Variations

- ▶ Instead of having each group do a variety of seeds, assign one seed type to each group and compile class results to find out if seed size is related to plant size.

Room to Grow

California Standards (cont.)

Grade 3 (cont.)

Common Core Mathematics

3.OA.1
3.OA.3
3.MD.4

Next Generation Science Standards

3-LS4.C

Grade 4

Common Core English Language Arts

RI.4.3
W.4.2d
W.4.2e
W.4.7
SL.4.1b
SL.4.1c

Common Core Mathematics

4.MD.1

Standards descriptions are listed
in the matrix on page 108.

Extensions

- ▶ Invite a Master Gardener in to plan a small vegetable garden area for your class. The Master Gardener can instruct students on seed placement during planting.
- ▶ Take a field trip to a local flower or vegetable farm to learn how farmers plant crops.
- ▶ Compare seeds from various trees and research the sizes of the trees. Is there a relationship between seed size in trees and their size?

ELL Adaptations

- ▶ Model math problems on the board by showing students how to find the average weight of a group of seeds and the average height of a group of plants.
- ▶ Place ELL students in a group with other students who are proficient in English. Cooperative learning provides opportunities for students to illustrate, label, and discuss information.



California Foundation for
Agriculture in the Classroom

Room to Grow Data Sheet

Name: _____

Testable Question: Do plants with larger seeds need more room to grow than plants with smaller seeds?

Hypothesis: _____

Procedure

1. Take your shoebox and carefully line it with a plastic bag.
2. Fill shoebox $\frac{3}{4}$ full with potting soil.
3. Using a spray bottle filled with water, lightly spray the soil to make it damp.
4. With your lab partners, select 4 different kinds of seeds to plant. Make sure to choose seeds of different sizes.
5. Measure the length of 3 seeds of the same seed type in millimeters and record the results. Calculate the average seed size for each seed type.
6. Follow step 5 for each seed you will be using in your experiment.
7. Make seed labels on craft sticks and correctly label each row.
8. Plant seeds according to package instructions. Make sure to count the exact number of seeds you are planting and record in table below.
9. Place seed box in a sunny spot and make sure to keep soil moist using the spray bottle for watering.
10. Keep a record of the number of seeds that germinated and the average height of each seedling type.
11. Share results with the class after three weeks of observations and recordings.

Seed Measurements in Millimeters

Type of Seed	Seed 1 Length	Seed 2 Length	Seed 3 Length	Average Length

Room to Grow Data Sheet *(continued)*

List Seed Types from Smallest to Largest in Size

--	--	--	--

Smallest

Largest

Results

Seedling Growth

Find the height of the three largest seedlings from each plant type and find the average plant height.

Week One

Type of Seedling	Seedling 1	Seedling 2	Seedling 3	Average Height

Week Two

Type of Seedling	Seedling 1	Seedling 2	Seedling 3	Average Height

Week Three

Type of Seedling	Seedling 1	Seedling 2	Seedling 3	Average Height

Room to Grow Data Sheet *(continued)*

List the order of seedlings from smallest type to largest type.

1. _____
2. _____
3. _____
4. _____
5. _____

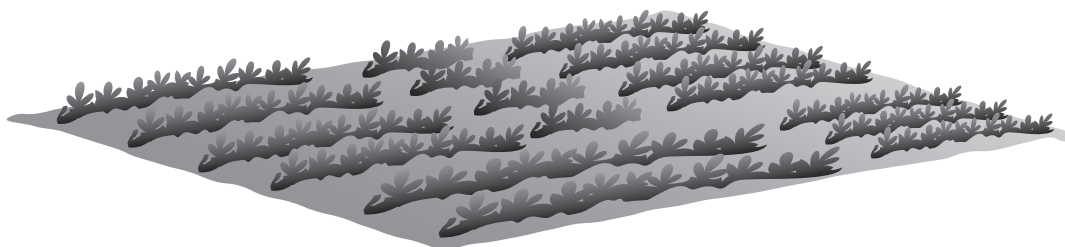
Conclusion

Write a few sentences that address the following topics:

- ▶ Did my experiment support my hypothesis? _____

- ▶ What did I learn from this experiment? _____

- ▶ What changes could I make to the procedure to make it a better test? _____



I'm Superb Soil, Not Dirty Dirt!

Purpose

This activity will help students understand the basics of soil composition and the important role soil plays in our lives.

Time

Teacher preparation:
20 minutes

Students activities:

- ▶ One 50-minute session for introduction and activity,
- ▶ One 20-minute session for soil model and conclusion.

Materials

For the class:

- ▶ 1 large clean jar with a lid
- ▶ Plastic glove or snack bag for serving soil snack
- ▶ Variety of snack foods – *see chart on page 59*

For each pair of students:

- ▶ 1 shovel or trowel
- ▶ 1 clean school milk carton
- ▶ 1 hand lens
- ▶ 3-4 sheets of newspaper
- ▶ Paste or glue
- ▶ Tweezers, strainer (optional)
- ▶ Crayons or markers

Background Information

Soil is generally defined as the top layer of Earth's surface. Soil is formed from the weathering of rocks and the decomposition of dead organisms. Soil is made up of minerals, organic material (decayed plant and animal remains), water, and air.

The Ingredients for Soil

Mineral Matter 45%

Water 25%

Air 25%

Organic Matter 5%

These percentages are approximate

In addition to water, air, mineral, and organic matter, you will also find decomposers in your soil. These are organisms that recycle nutrients by breaking down dead plant and animal material.

So what is the difference between soil and dirt? Dirt is something you get under your fingernails and soil is the ground you stand on. You can think of soil as Earth's "living skin," it makes life on Earth possible. Soils are needed for plant growth and provide habitat for many organisms including bacteria, fungi, and animals like earthworms and prairie dogs. Soils absorb, store, and filter water and also emit and absorb gases like methane, carbon dioxide, and water vapor. Soils are formed very slowly, sometimes only 1 cm of thickness in as many as 500 years. Farmers who grow our food know how important it is to take good care of our soil. They carefully study and monitor their soil, replacing nutrients and organic matter as needed. They also use farming techniques to keep soil in the fields so it doesn't erode away. One way soil can be described is by its texture. Soil texture is the size of particles that make up the soil. From smallest to largest, the particles are clay, silt, and sand. Most soils are a combination of all three.

Soils can also be described by their color. Color is a result of the parent materials or bedrock that the soils originated from. Soils that are deep orange or reddish in color are usually high in iron. Dark brown or black soils are high in organic matter. Organic matter is important in soils because it helps soil resist compaction and allows for more air spaces which is good for growing plant roots. Organic particles also absorb and store water.

I'm Superb Soil, Not Dirty Dirt!

For each student:

- ▶ *Superb Soil* handout (page 61)
- ▶ *What is Soil Made Of?* handout (page 62)
- ▶ *What Superb Soil Has* handout (page 63)
- ▶ 1 toothpick
- ▶ 1 pair of scissors

California Standards

Grade 2

Common Core English Language Arts

- RI.2.1
- RI.2.7
- W.2.8
- SL.2.1a

Next Generation Science Standards

- 2-ETS1.A

Grade 3

Common Core English Language Arts

- RI.3.1
- RI.3.7
- W.3.8
- SL.3.1b

Grade 4

Common Core English Language Arts

- RI.4.1
- RI.4.7
- W.4.8
- SL.4.1b

Standards descriptions are listed in the matrix on page 108.

Procedure

1. Distribute the *Superb Soil* handout to each student. Tell students to close their eyes and imagine that they are outside digging a hole in the soil. What would they find as they dig? In the space for Jar #1, have students draw and label a detailed picture of what the soil would look like and what it would contain.
2. Divide students into pairs. Using shovels and small milk containers, take students outside and spread them out so each pair can dig up a small sample of soil from different areas. Students should dig at least 4 inches down. Tell students that they will be returning the soil to the place where they dug it up after the experiment. Monitor students to avoid digging in inappropriate areas.
3. Have students spread newspaper out on their desks or the ground outside. Soil samples should be dumped out on the newspaper for inspection. Students should use the hand lens to find as many different things as they can. Tell them that the little rock-like pieces of sand are the mineral content of the soil. Little bits of twigs and decomposing leaves are organic matter. Some students may find decomposers in their soil. Instruct students to draw and write a description of their soil samples in the space for Jar #2.
4. Make a list on the board of every different thing that has been found by the student groups. Examples:
 - ▶ Small mineral particles: clay or silt
 - ▶ Larger mineral particles: sand
 - ▶ Rocks
 - ▶ Dead plant parts: leaves, twigs, etc.
 - ▶ Live plants
 - ▶ Seeds
 - ▶ Humus: a soft type of dirt of decomposed material, organic matter
 - ▶ Water
 - ▶ Garbage
 - ▶ Air
5. Have students fill in the holes they dug by returning their soil samples.
6. Discuss the actual components of soil. Have students build a soil model by coloring and cutting out the pictures provided then gluing them onto *What Superb Soil Has* handout.

I'm Superb Soil, Not Dirty Dirt!

7. Ask students to think about what would happen if all decomposers disappeared from Earth. What would happen with waste materials? Would plants be able to get the nutrients they need to grow? Discuss ideas as a class.
8. **Edible Soil Demonstration** – reinforce student knowledge of soil components by making a delicious edible soil model. Place the clean, large jar at the front of the class. Ask students to list, one at a time, an item that is part of soil. As they list the item, choose one snack to represent that item and pour it into the jar. As you fill the jar, discuss with students that soil is made of many components, many of which cannot be seen with the unaided eye. What are some examples of things the students could not see in their soil without a microscope? Make a list on the board. After all the items have been listed and the jar is full, seal it and place it on display. Serve the snack to students at an appropriate time.

Edible Soil Demonstration (possible ingredients)

Soil Component	Candy	Other Snack Item
Air	Pop Rocks	Coconut flakes
Rocks	Large jawbreakers	Dried pears
Pebbles	Gumballs	Dried apricots
Sand	Jelly Beans	Chocolate covered peanuts
Clay/silt	Red Hots	Sunflower seeds
Animals	Animal cookies	Goldfish crackers
Decomposers (worms, fungi, bacteria, etc.)	Gummy Worms, gum drops, Nerds	Yogurt covered raisins
Water	Blue candy	Fruit roll-ups bits
Seeds	Peanut M&Ms	Peanuts
Organic matter	Crushed chocolate cookies	Raisins
Plants	Orange slices, candy corns	Spearmint leaves

I'm Superb Soil, Not Dirty Dirt!

9. On the back of one of their handouts, have students write down five things that they did to get ready for school today. Use a flow chart to describe and illustrate how those things can be traced back to the soil. Examples:

- ▶ Rode skateboard to school ⇒ wood deck of skateboard ⇒ trees ⇒ forest soil
- ▶ Drank milk at breakfast ⇒ cow ⇒ ate alfalfa/grass ⇒ grew in soil
- ▶ Remember... even oil and gas originate from organic materials that were once the remains of dead plants from ages ago: plastic ⇒ oil extraction ⇒ decay of plants ⇒ oil under layers of rock and soil

Variation

- ▶ If digging outside is not an option, bring in a few containers of various soil samples for students to investigate.

Extensions

- ▶ Write a paragraph about how one of the following organisms depends upon the soil: apple tree, earthworm, mushroom, you, farmer, ant, etc.
- ▶ Have students fill baby food jars half full with soil. Fill the jars with water and secure lids. Shake the jars vigorously for five minutes. Let the jars sit overnight and observe the soil profile over the next couple of days. For more information, see “Shake, Rattle, and Roll” from WE Garden lesson packet at www.LearnAboutAg.org/wegarden.

ELL Adaptations

- ▶ This lesson incorporates hands-on activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ Demonstrate how student groups should dig and inspect their soil samples. Pair ELL students with other students who will model instructions.
- ▶ Add new vocabulary to a word wall and match photos to the new words.

Superb Soil

Name: _____



Jar #1

I think soil is made of:

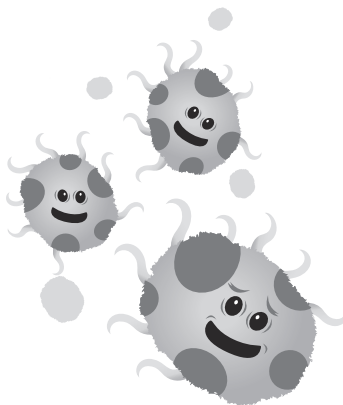
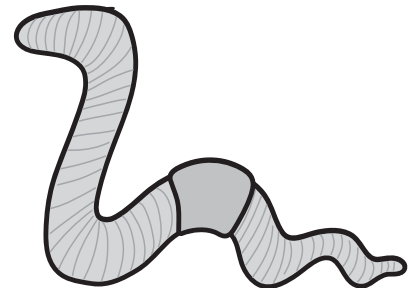
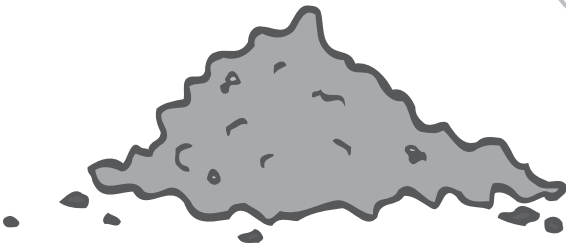
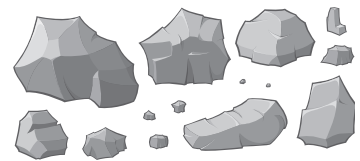
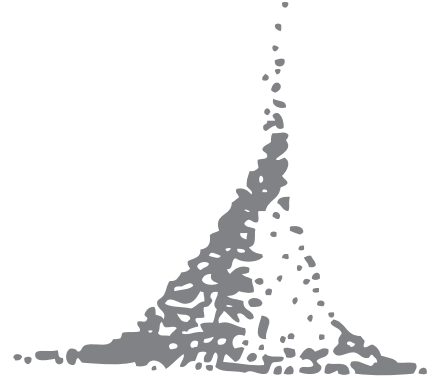


Jar #2

I found the following things in my soil sample:

What is Soil Made Of?

Directions: Color and cut out the pictures and glue them in onto Jar 3.



What Superb Soil Has

Name: _____



Tropism Twist

Purpose

Students will investigate how light affects plant growth by observing changes in a plant's growth and movement as light availability is altered through an experiment.

Time

Teacher Preparation:

60 minutes

Student Activity:

- ▶ One 50-minute session
- ▶ Three 10-minute observation sessions over 10 days

Materials

For the teacher:

- ▶ Build an example of the phototropism box according to directions
- ▶ Utility knife

For each group:

- ▶ Shoebox and/or cardboard milk cartons (have students bring these from home)
- ▶ Thick cardboard sections
- ▶ Duct tape
- ▶ Scissors
- ▶ Clear plastic cup (6 oz.)
- ▶ Potting soil or peat pots
- ▶ Two bean seeds

Background Information

Although plants don't have the ability to move from their rooted position, they do have the ability to respond to stimuli such as temperature, animals, moisture, gravity, and light. Tropisms are plant growth movements toward or away from a specific stimulus in nature. They help plants achieve optimal growth. Tropism comes from the Greek word, "to turn."

Phototropism, photo meaning light, is the growth of a plant toward light. For plants, this light source is the sun, but artificial alternatives can also stimulate phototropism. This ability is very useful for plants, enabling them to position their leaves and flowers to efficiently receive the light energy they need for photosynthesis.

Plants have special receptors made of chemical pigments known as phytochromes. When phytochromes absorb visible wavelengths of light they emit a chemical signal that produces a hormone known as auxin. Auxins cause the cells on the shaded side of a plant to elongate more than cells on the sunny side. The growth of cells on the light-receiving side of the plant is inhibited. As a result, plants bend and twist towards the light.

In this lesson, we will focus on phototropism. However, there are a couple of other types of tropisms displayed by plants that are also important. Gravitropism causes stems of plants to grow up and roots to grow down. Hydrotropism causes plant roots to grow towards water.

Procedure

1. Ask students, "Once a seedling or plant is rooted in the soil, can it move?" Facilitate a discussion on different types of plant movement. Introduce the word phototropism. Break the word down into smaller pieces, explaining that "photo" means "light" and "tropism" means "to turn." Have students give examples of phototropism they have observed.
2. Tell students that in this lesson, they will design an experiment so they can observe phototropism in action.
3. Distribute the *Tropism Twist* worksheet to each student. Ask students to write a hypothesis for the testable question, "Does light affect the direction that a seedling will grow?" in the appropriate place on their worksheet.

Tropism Twist

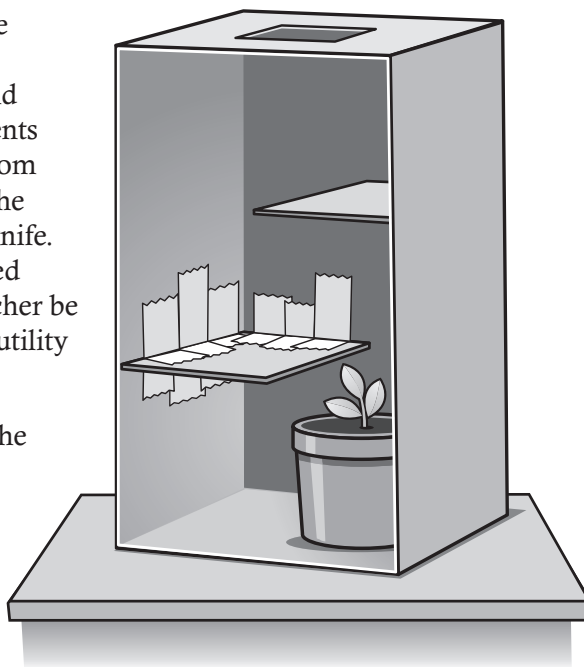
For each student:

- ▶ *Tropism Twist* worksheet
(pages 69-71)

4. Divide students into lab groups consisting of 3-4 students. Distribute shoebox, scissors, duct tape, and cardboard. Instruct students to write their names on the bottom of the shoebox.
5. Show students a completed tropism testing box and guide them through the steps of creating their own boxes. Use the diagrams to guide students through the construction process.

- ▶ Carefully draw and cut out a two-inch square from the middle section of one end of the box. Students may need help from the teacher and the teacher's utility knife. It is recommended that only the teacher be equipped with a utility knife.

- ▶ Place the lid on the front of the box. Hold the box up to the light. Look through your two-inch hole and make certain that this hole is the only source for light to get into the box. Carefully duct tape over any other cracks or crevices that may be letting light in. *Do not tape the box shut.*



- ▶ Using paper to create a pattern, cut two pieces the height of the inside of the shoebox and half the width. Trace the pattern on stiff cardboard and cut them out. Tape them into the box as shown.

6. After tropism boxes are complete, instruct students to use the designated planting station to plant two bean seeds for their group experiment. The planting station should be supplied with newspaper, 6-ounce plastic cups, potting soil, bean seeds, water spray bottles, craft sticks, masking tape, and markers for labeling.

Tropism Twist

California Standards

Grade 2

Common Core English Language Arts

RI.2.1
RI.2.7
W.2.2
W.2.7
W.2.8
SL.2.1a
SL.2.1c

Next Generation Science Standards

2-LS2.A
2-ETS1.A
2-ETS1.B

Grade 3

Common Core English Language Arts

RI.3.1
RI.3.7
W.3.2d
W.3.7
W.3.8
SL.3.1b
SL.3.1c

Next Generation Science Standards

3-LS4.C

Grade 4

Common Core English Language Arts

RI.4.3
RI.4.7
W.4.2d
W.4.2e

7. Place planted seeds in a lighted area and wait for the seeds to germinate. When the seedlings are approximately two inches tall, place the watered seedlings into the shoebox as shown.
8. Close the box, tape it, and place it by a sunny window so the square hole on the top can be exposed to the light.
9. After five days, carefully shine a flashlight through the square hole to observe the plant growth. It is best not to disturb plants during this testing period. It can alter the final outcome.
10. In another 3-5 days, check to see if the plant has grown enough to reach the top of the box. Remove the shoebox lid once the plant has reached the top of the shoebox. Have students record their observations and answer the questions on their *Tropism Twist* worksheet.

Variations

- ▶ Have students plant the bean seeds, then build the tropism boxes on another day while you are waiting for seeds to germinate.
- ▶ Using different kinds of seeds, test to see if different kinds of seedlings display phototropism more than others. Do some seedlings bend and twist the moment they germinate? Do other seedlings show no sign of phototropism? Compare and contrast growth rate and angle of growth rate between seedlings.

Extensions

- ▶ Plant sunflower plants in large pots or outside. Once the sunflower plants begin to flower have students observe the flowers throughout the day. Explain to students that sunflower plants display heliotropism. Heliotropism is a plant behavior where the flower of the plant will follow the sun throughout the course of the day. Plants do this to maximize the light they receive during daylight hours.
- ▶ Have students plant bean seeds as described above. Place nylon netting over the cup and tie it closed so the cup's contents cannot be displaced. Tell students that they are going to study a different kind of tropism called gravitropism, or (geotropism). Gravitropism is a plant's movement in response to gravity. It causes roots to grow down and the shoots to grow up towards the sky. By using a clear cup, students will be able to observe the growth pattern of both the roots and shoots.



California Foundation for
Agriculture in the Classroom

Tropism Twist

California Standards (cont.)

Grade 4 (cont.)

Common Core English Language Arts (cont.)

W.4.7

SL.4.1b

SL.4.1c

Next Generation Science Standards

4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

- ▶ Plant bean seeds as described above. Create cone shaped covers made from different colors of cellophane. Research wavelengths and how colors are absorbed at different wavelengths. Test to see if color affects plant growth.

Tropism Twist

Name: _____

Testable Question: Does light affect the direction that a seedling will grow? Write your hypothesis for the testable question below. Remember, a hypothesis is an intelligent guess and is usually written as one complete sentence.

Hypothesis: _____

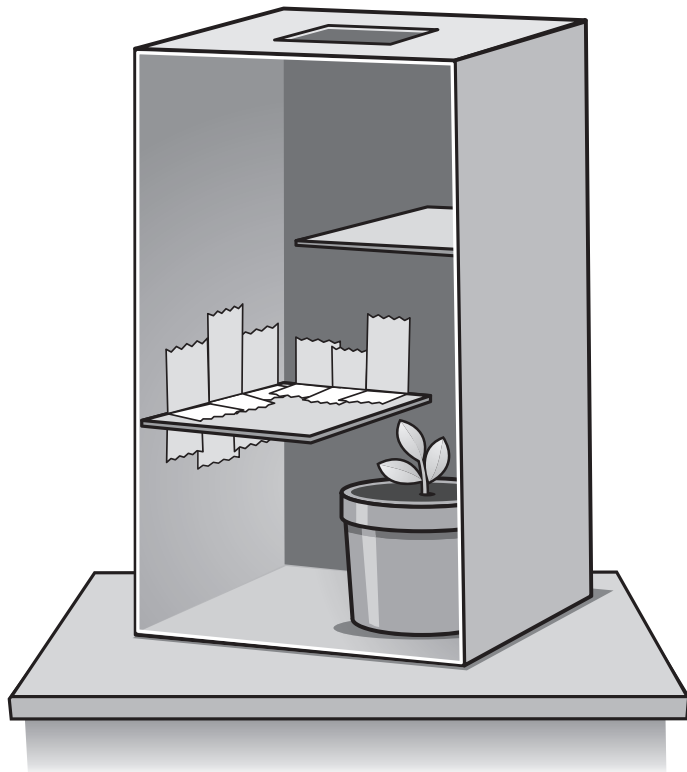
Materials

For your group:

- | | | |
|---------------------------|----------------------|--------------------|
| ▶ 6 oz. clear plastic cup | ▶ Potting soil | ▶ Scissors |
| ▶ Shoebox or milk carton | ▶ Water spray bottle | ▶ Craft stick |
| ▶ Duct tape | ▶ 2 bean seeds | ▶ Permanent marker |
| | ▶ Thick cardboard | |

Procedure

Follow the directions to make a phototropism box like the one pictured:

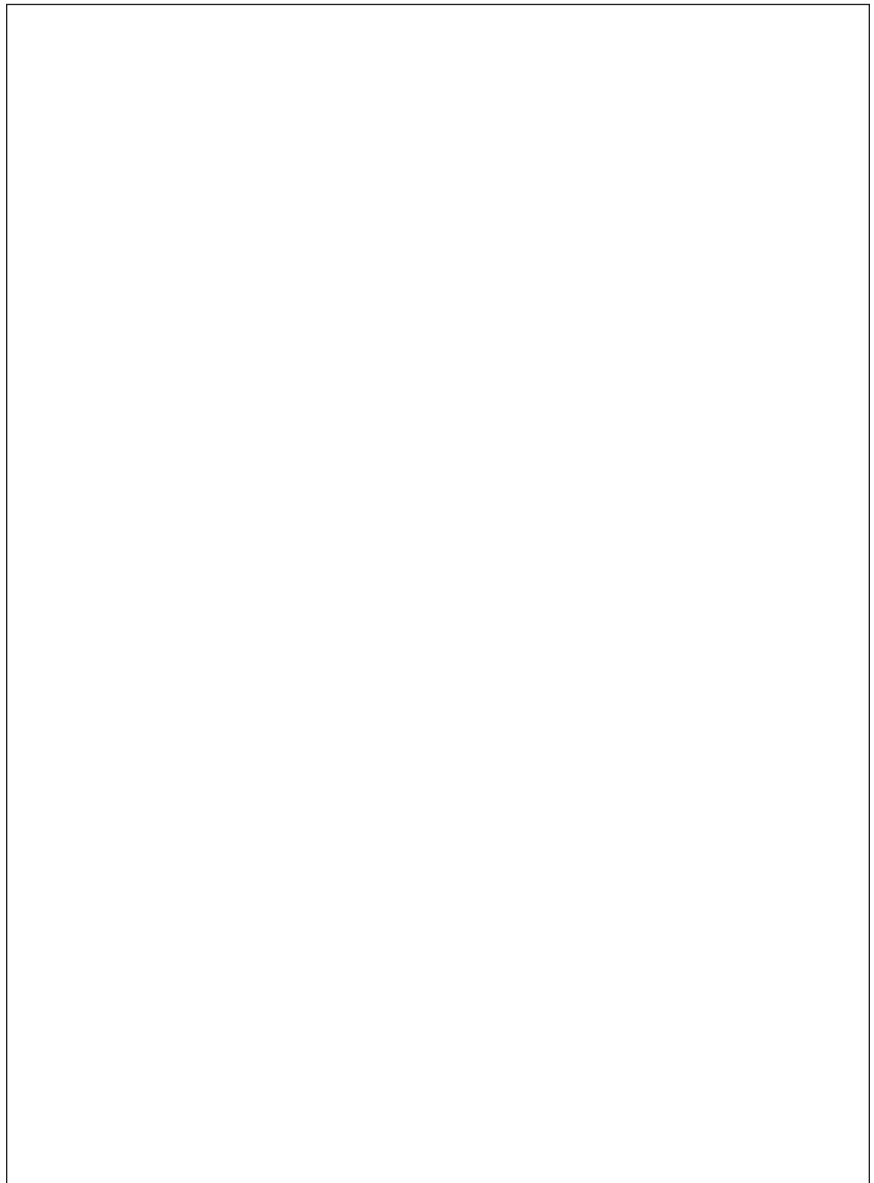


Tropism Twist *(continued)*

1. Carefully draw and cut out a two-inch square from the middle section of one end of the shoe box.
2. Place the lid on the front of the box. Hold the box up to the light. Look through your two-inch hole and make certain that this hole is the only source for light to get into the box. Carefully duct tape over any other cracks or crevices that may be letting light in. *Do not tape the box shut.*
3. Using paper to create a pattern, cut two pieces the height of the inside of the shoebox and half the width. Trace the pattern on stiff cardboard and cut them out. Tape them into the box as shown.
4. After tropism boxes are complete, use the designated planting station to plant two bean seeds for your group experiment.
5. Place planted seeds in a lighted area and wait for the seeds to germinate. When the seedlings are approximately two inches tall, place the watered seedlings into the shoebox as shown.
6. Close the box, tape it, and place it by a sunny window so the square hole on the top can be exposed to the light.
7. After five days, carefully shine a flashlight through the square hole to observe the plant growth. It is best not to disturb plants during this testing period. It can alter the final outcome.
8. In another 3-5 days, check to see if the plant has grown enough to reach the top of the box. Remove the shoebox lid once the plant has reached the top of the shoebox. Record your observations and answer the questions on your worksheet.

Results and Conclusion

1. With the lid removed, draw the inside of your tropism box along with the bean plants' growth progress in the shoebox.



Tropism Twist *(continued)*

2. Did the experiment prove or disprove your hypothesis? _____

3. Explain how your plant grew in the phototropism box. _____

4. Why is phototropism important for plants? _____

Troubled Waters

Purpose

Through this experiment, students will understand that water is essential for plant growth and survival. By experimenting with water of varying qualities, students will learn how water quality affects plant health.

Time

Teacher Preparation:
30 minutes

Student Activity:

- ▶ **Part I:** 20-minute introduction
- ▶ **Part II:** Four 10-minute sessions (spaced over 2 weeks) for observation and watering
- ▶ **Part III:** 20-minute conclusion

Materials

For the class:

- ▶ Distilled water (five gallons)
- ▶ Saline water (one gallon)
- ▶ Acidic water (one gallon)
- ▶ Alkaline water (one gallon)
- ▶ pH test strips
- ▶ pH Up and pH Down
(available in the aquarium section of pet store for approximately \$3)

Background Information

We know that plants need fertile soil, ample sunlight, and water to grow. In addition to watering frequency and amount, farmers also pay close attention to the quality of the water they use to irrigate their crops. Poor water quality can lead to soil conditions that are harmful to crops. In this lab, we will look at the effects of saline, alkaline, and acidic irrigation water.

In some areas, groundwater used for irrigation can be high in salts or saline. Saline irrigation water can raise the salt content in the soil, which will inhibit plants' ability to uptake water. This happens because water moves from areas of low salt concentration in the roots of plants to higher salt concentrations in the soil. Plants growing in saline soils may appear wilted even if they are being watered regularly. Plants don't germinate well in saline soils and if they do, they usually have stunted growth. One remedy for saline soils is to leach the salts out of the plant root zone by periodically over-watering the area.

The pH level of water is also important. Water with a pH above 7 is called alkaline and water with a pH below 7 is called acidic. Some areas of the United States experience acid rain, which can harm plants.

If plants are irrigated with acidic water, soils may become acidic, reducing the availability of nutrients like iron, zinc, and phosphorus. Symptoms of these nutrient deficiencies can include yellow stripes on leaves or purplish coloring of the lower leaves of the plant.

Alkaline irrigation water can lead to plant deficiencies in calcium and magnesium. Plants growing in Alkaline conditions can become yellowed in appearance or "chlorotic."

A pH level between 6.0 and 7.2 is best for most plants. It can be difficult and expensive to change the pH of soil. If soils are slightly alkaline it may be best to plant crops that are tolerant of alkaline soil. If the soil is too alkaline, a couple of methods that can lower pH include adding organic matter like peat moss or adding acidifying fertilizers to the soil. If the soil is too acidic, pH can be raised by adding ground limestone.

Water quality is a critical issue around the world. Earth's supply of fresh water is limited and it is often treated before it is consumed by people or used for agricultural purposes. This lesson will help students relate their classroom experiment to the importance of good water quality for producing the crops that provide food for us.

Troubled Waters

- ▶ Four clear, plastic milk jugs with lids (to mix above solutions)
- ▶ 20 plants, all of same type (purchase six packs of marigolds, beans, or squash)

For each group:

(You will have 5 groups of students)

- ▶ Four plants
- ▶ Four labels
- ▶ Measuring cup
- ▶ Tray to set seedlings in
- ▶ Ruler with cm

For each student:

- ▶ *Troubled Waters* handout (pages 76-78)

California Standards

Grade 2

Common Core English Language Arts

RI.2.1
W.2.7
W.2.8
SL.2.1a

Common Core Mathematics

2.MD.1
2.MD.4

Procedure

1. Prior to the lesson, prepare the water solutions needed for the experiment.
 - ▶ **To make saline water:** Add ½ cup salt to one gallon of distilled water.
 - ▶ **To make acidic water:** Add pH Down to one gallon of distilled water until the pH is between 3 and 4. You can also use white vinegar if you don't have pH Down.
 - ▶ **To make alkaline water:** Add pH Up to one gallon of distilled water until pH is between 10 and 11. You can also use baking soda if you don't have pH Up.
 - ▶ For your control: Fill one gallon jug with distilled water.
 - ▶ Appropriately label each gallon jug.
2. Temporarily cover up the labels and ask students to consider what is in each of the containers. After they've made their predictions, reveal the actual contents. Discuss that clear liquids are not always pure water. Even regular tap water has various dissolved substances, such as chlorine, fluorine, and various minerals.
3. Distribute a copy of the *Troubled Waters* handout to each student. Provide an overview of the lab procedures and a demonstration of the plant experiment set up.
4. Divide students into five equal groups. Distribute four plants and four labels to each group.
5. Instruct students to label each seedling with one of the four water types (Acidic, Alkaline, Saline, Control). Ask groups to predict what will happen to the plants when watered with each of the four watering solutions. Students should complete the "My Hypothesis" section of the handout. Provide guidance in writing a hypothesis.
6. Instruct each group to decide which group member will be in charge of watering each plant with the appropriate type of water. *Stress the importance of making sure that each student waters their assigned plant with the correct type and amount of water every time.* Demonstrate the watering technique and amount.
 - ▶ Students should use a measuring cup to deliver a set amount of liquid to each plant. Measuring cups should be rinsed out between watering with each different type of water. Start out

Troubled Waters

California Standards (cont.)

Grade 2 (cont.)

Next Generation Science Standards

2-ETS1.A

Grade 3

Common Core English Language Arts

RI.3.1

W.3.7

W.3.8

SL.3.1b

Grade 4

Common Core English Language Arts

RI.4.3

W.4.7

SL.4.1b

Common Core Mathematics

4.MD.1

Standards descriptions are listed
in the matrix on page 108.

by having students water each plant with $\frac{1}{2}$ cup of liquid, this should be enough to moisten but not saturate the soil. Check the plants in a couple of days and repeat the watering procedure when the soil appears to be drying.

7. Show groups how to measure the height of their plants and how to make visual observations of their plants.
8. Over the next two weeks, set aside four, 10-minute session for groups to water, measure, and observe their seedlings.
9. After two weeks, have students complete the *Troubled Waters* handout. As a class, discuss how this experiment and the results relate to agriculture, pollution, and plant health. Emphasize that water quality is essential for plant health. Poor water quality will affect how much food is available for humans and other animals.

Variations

- ▶ Perform the same experiment with seeds, rather than seedlings.
- ▶ Make a mystery out of the lesson. Ask students to water the plants, but do not reveal what the liquids are. Ask them to guess what is in the liquids as the week passes and the plants become noticeably different.

Extensions

- ▶ Test the effects of hot water, cold water, and pond water on plant growth.
- ▶ Invite a farmer or sewage treatment employee to your class to discuss what is being done to maintain or improve water quality.
- ▶ Contact Project WET (Water Education for Teachers) for additional materials to teach about water:
www.watereducation.org.

ELL Adaptations

- ▶ Model the lab procedures so all students have a visual example of how to set up and carry out their experiments.
- ▶ Place ELL students in groups with other students who are proficient in reading and writing.
- ▶ Draw a step-by-step instructional diagram on the board.

Troubled Waters

Name: _____

Our team will water each of our plants with a different watering solution.

Circle one watering solution for each plant and write it in the correct columns in all three charts:

- ▶ We will water plant #1 with: Control Basic Saline Acidic
- ▶ We will water plant #2 with: Control Basic Saline Acidic
- ▶ We will water plant #3 with: Control Basic Saline Acidic
- ▶ We will water plant #4 with: Control Basic Saline Acidic

	Plant #1 _____	Plant #2 _____	Plant #3 _____	Plant #4 _____
My Hypothesis <i>(for each plant)</i>				

Procedure

1. Label each of your plants with the type of water you will use to water them: Saline, Alkaline, Acidic or Control.
2. Predict what will happen to each of your four plants during the experiment. Write down your hypothesis for each plant.
3. Write down your Day 1 visual observations of each of your plants and measure the height of each plant in cm.
4. Designate which group member will be in charge of watering plant #1, #2, #3 and #4. Use your measuring cup to deliver _____ amount of watering solution to each plant. Your teacher will tell you how much water to put in your measuring cup. Rinse out your measuring cup between watering each different plant to eliminate cross contamination.
5. Your teacher will have you repeat this process during specified times over the next two weeks. Record data each time.
6. At the end of the experiment, complete the results section and questions on your *Troubled Waters* handout.

Troubled Waters *(continued)*

Observations

	Plant #1 _____	Plant #2 _____	Plant #3 _____	Plant #4 _____
Day 1 Plant Height (cm) Visual Observations				
Day _____ Plant Height (cm) Visual Observations				
Day _____ Plant Height (cm) Visual Observations				
Day _____ Plant Height (cm) Visual Observations				

Troubled Waters *(continued)*

Results

	Plant #1 _____	Plant #2 _____	Plant #3 _____	Plant #4 _____
Results Was your hypothesis proved or disproved?				

1. After viewing your results, do you think crops would grow well if watered with ocean salt (saline) water? Yes/No

a. Why or Why Not? _____

b. Based on your results, what type of water would be best for watering corn? _____

2. Many parts of the world are affected by acid rain. Acid rain is formed when pollution in the air mixes with rain. Do you think acid rain (acidic water) could be a problem for plants? Yes/No

a. Why or Why Not? _____

3. Explain why farmers must be concerned about the quality of water they use on their crops. _____

4. How can the quality of water available for watering crops impact your life? _____

Is There Ever Too Much of a Good Thing?

Purpose

The purpose of this lesson is for students to understand that plants require certain nutrients for successful growth. If these nutrients are not available in the appropriate levels, the plant will not grow and may possibly die. Students must also recognize that excessive exposure to nutrients may also be unhealthy for the plant. A healthy balance of proper nutrients is essential to plant health.

Time

Teacher Preparation:
30 minutes

Student Activity:

- ▶ **Part I:** 20-minute introduction
- ▶ **Part II:** Five 10-minute sessions (every other day for two weeks) for observation and watering
- ▶ **Part III:** 20-minute conclusion

Materials

For the class:

- ▶ Houseplant fertilizer: enough for 2-3 gallons
- ▶ Distilled water: 3-4 gallons
- ▶ Three, one-gallon plastic containers with lids to mix

Background Information

As our population grows, so does the need to grow more food to feed all the people. Farmers must grow food on the same land over and over again. It is easy to think of soil as a “grocery store” for plants. The plants go “shopping” in the soil to retrieve what they need. When plants grow, they remove nutrients from the soil. What happens if our grocery stores don’t restock their shelves after people buy food? What happens to nutrients in the soil after plants grow and are harvested year after year?

To maintain healthy soil, farmers must replace the nutrients that plants remove from the soil. There are many ways to do this. A fertilizer is a substance added to the soil or water to make sure necessary nutrients are available to plants. Fertilizers can be man-made or natural substances. Manure, fish emulsion, composted plant materials, and store-bought products are all types of fertilizers.

Plants require 17 chemical elements for successful growth and reproduction. Of these elements, Nitrogen (N), Phosphorus (P), and Potassium (K) are the most likely to be deficient in the soil, as plants take up a lot of N, P, and K as they grow.

- ▶ Nitrogen (N) is important for plants to grow strong stems and healthy green leaves. It also is involved in making important proteins and is found in chlorophyll, the pigment that helps plants capture sunlight energy
- ▶ Phosphorus (P) is known as the energizer because it helps the plant store and transfer energy. Phosphorus stimulates root growth and helps flowers bloom.
- ▶ Potassium (K) protects plants against diseases and hot and cold weather.

If plants don’t get enough of the required nutrients, they will not grow well, and may become diseased and die. If plants get too many nutrients, the plants get poisoned, just as a vitamin overdose is unhealthy for humans. Many fertilizers draw water out of the roots of plants. If too much fertilizer is added to the soil, too much water is pulled from plants, which will dehydrate and die. This is often referred to as plants being “burned” by fertilizer. Overuse of a fertilizer of any type is not only harmful to the plants, but if used improperly, can contaminate waterways, streams, and oceans. Ongoing research and new farming techniques help farmers precisely monitor and amend soil

Is There Ever Too Much of a Good Thing?

the following solutions. Once these solutions are made, pour them into the spray bottles, which students will use to water their plants (*prevents over watering*).

- One containing distilled water only
- One containing the recommended mixture of distilled water + fertilizer, mixed according to fertilizer package directions
- One containing distilled water + 5 times the recommended amount of fertilizer
- ▶ Large bucket containing a mixture of 1 part vermiculite to 1 part soil. Soil should be obtained from an area that has not been amended with fertilizers, compost, etc.
- ▶ Six labeled spray bottles (two each of the three liquids described above)
- ▶ Light source

For each of your 3 class groups:

- ▶ Nine bean seeds (use garden seeds, dried grocery store beans are not recommended)
- ▶ Three plastic or wax-lined paper cups (9 oz. size)
- ▶ Three write-on labels

nutrients to save on the cost of fertilizers, produce healthy crops, and protect the environment.

Procedure

To ensure positive results, please note the following:

1. Prior to this activity you will label and fill the spray bottles with each of the three pre-mixed liquids from the one gallon containers, allowing for easier student application.
2. Use an equal mixture of clean vermiculite and soil. Obtain soil from an area that has not been amended with fertilizers, compost, etc. Do not use potting mix—it contains fertilizer and compost materials. A poor quality soil is ideal for this experiment. Mix the vermiculite and soil very well.
3. Use distilled water. The minerals in tap water may lead to poor results. The soil and vermiculite mixture will dry out quickly. Instruct students to carefully monitor their cups to ensure they stay moist throughout the experiment.
4. Plant at least three beans in each cup.
5. Expected results are as follows:
 - ▶ **Distilled water only:** some growth
 - ▶ **Distilled water + fertilizer:** best growth
 - ▶ **Distilled water + extra fertilizer:** poor or no growth
6. As a class, discuss the reasons why some people may take vitamins. Explain that often, people take vitamins when they may not be receiving all of the nutritional benefits their body needs from eating regular meals.
7. Ask the class how plants get nutrients from the soil. As a class, discuss whether plants need vitamins (fertilizers). Explain that plants do need certain nutrients to remain healthy. If all of the required nutrients are already available in the soil, plants do not need additional vitamins (fertilizers). Fertilizers should be used to improve plant health when soils do not contain the essential nutrients for plant growth.

Is There Ever Too Much of a Good Thing?

- ▶ Colored pencils, crayons, or markers
- ▶ *Is There Ever Too Much of A Good Thing?* handout (page 83)
- ▶ Pie tin or other container to hold plants for each group.

California Standards

Grade 2

Common Core English Language Arts

RI.2.1
RI.2.4
W.2.7

Next Generation Science Standards

2-ETS1.A

Grade 3

Common Core English Language Arts

RI.3.1
RI.3.4
W.3.7

Grade 4

Common Core English Language Arts

RI.4.1
RI.4.4
W.4.7

Standards descriptions are listed in the matrix on page 108.

8. Tell students that they will be conducting an experiment to find out what happens to plants if they get too few or too many nutrients.
9. Assign groups and distribute the *Is There Ever Too Much of A Good Thing?* handout and necessary materials. Model the instructions before letting the students begin, giving special attention to the number of sprays you would like student to use when watering their plants.
10. Guide students as they collect their experimental data. Compare and discuss class results at the end of the experiment.

Variations

- ▶ Perform this lesson as a class project rather than in partnerships.
- ▶ Take a class or school-wide poll. Ask students to predict what will happen to the plant watered with extra fertilizer. After the experiment concludes, make graphs to show the results of the poll.
- ▶ Use young plants rather than seeds for the experiment: the results will be faster.

Extensions

- ▶ Students may experiment with other types of fertilizers (coffee grounds, manure, fish emulsion, etc.)
- ▶ Ask students to design experiments that would explore what happens to plants when they get too much sunlight or water.

ELL Adaptations

- ▶ This lesson incorporates hands-on activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ Demonstrate how student groups need to set up their experiments and pair ELL students with other students who will model instructions.
- ▶ Add new vocabulary to a word wall and match photos to the new words.

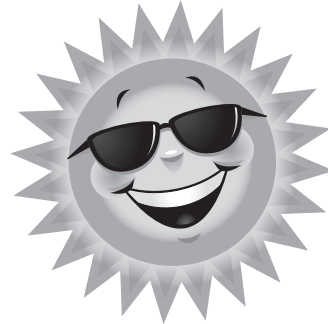
Is There Ever Too Much of a Good Thing?

Name: _____

Materials

Obtain the following materials for your group:

- ▶ 9 bean seeds
- ▶ 3 cups
- ▶ 3 labels
- ▶ 1 marker



Procedure

1. Create three labels, and place one on each of your three cups, as follows:
 - ▶ **Distilled water only**
 - ▶ **Distilled water + fertilizer**
 - ▶ **Distilled water + extra fertilizer**
2. Poke three small drain holes in the bottom of the cups using a pen or similar pointed object.
3. Fill each cup nearly to the surface with the soil and vermiculite mixture, leaving a two-finger width space at the top.
4. Plant three beans in each cup, one inch below the soil surface.
5. Water each cup with the correct liquid as demonstrated by your teacher and place in the pie tin or container on the windowsill.
6. Fill in the “My Hypothesis” section of the worksheet.
7. Water and observe plants every other day for two weeks and fill in the “My Results” section of the worksheet at the end of the experiment. *Make certain that you water each plant with the correct liquid every time you water and pay close attention that your soil stays moist between watering.*



Is There Ever Too Much of a Good Thing? *(continued)*

	Cup #1 Water Only	Cup #2 Water + Fertilizer	Cup #3 Water + Extra Fertilizer
My Hypothesis			
My Results			

- What do your results show you about plant growth using different amounts of fertilizer?

- Why are Nitrogen, Phosphorus, and Potassium so important to plants?

- Some people may think that adding extra fertilizer would help their plants grow even better. What would you say to this person based on your experiment results?

- What are some different types of fertilizer?

What Do Plants Need to Grow?

Purpose

The purpose of this lesson is for students to review the fundamentals required for plants to survive. Students will understand that healthy plants need water, air, light, and nutrients. The lesson will also demonstrate the many ways that humans rely on plants in everyday life.

Time

Teacher Preparation:
30 minutes

Student Activity:
45 minutes

Materials

For each pair of students:

- ▶ *What Do Plants Need to Grow* Grid handout (page 88)
- ▶ *What Do Plants Need to Grow* Cards/*Plant Hunt* double-sided handout (page 89-90)
- ▶ Crayons, markers, or colored pencils
- ▶ Tape
- ▶ Envelope or resealable plastic bag

Background Information

After completing the previous lessons in this unit, it is beneficial for students to review some of the key points learned from these experiments, including plants' basic necessities: water, air, light, and nutrients. Students should also revisit the connection between plants and humans, and their interdependence. Emphasize that humans and animals need oxygen produced by plants and that all of the food we eat can be traced back to plants. For example, the milk we have in our cereal at breakfast came from a cow that ate plants. People also use types of plants for their shelter and clothing. Trees make lumber for our homes, furniture, and paper products. The fabric in your cotton shirt was grown by a cotton farmer.

Procedure

1. Before the lesson, replicate and cut out one set of *What Do Plants Need To Grow?* cards for each pair of students. Organize each set of cards in an envelope or resealable plastic bag.
2. As a class, discuss the four basic things plants need to grow: water, air, light, and nutrients and write these on the board. In the space below each of these plant needs, ask the class to help you fill in details. Discussion topics for each plant need could include:

Water	Air	Light	Nutrients
How do plants take up water?	Plants take in carbon dioxide.	Why do plants need light?	N, P, and K are important plant nutrients.
What's the difference between a tap root and a fibrous root?	Plants release oxygen. Stomata are...	What plant structures capture energy from the sun?	Farmers can test their soil to determine if there are enough nutrients for crops.
How does water quality affect plants?	What's in air? Oxygen, carbon dioxide, water vapor, nitrogen gas, and other gases.	What is phototropism? How do plants make their own food?	If needed, fertilizer can be added to replace soil nutrients. What are some types of fertilizer and where do they come from?

What Do Plants Need to Grow?

California Standards

Grade 2

**Common Core English
Language Arts**
SL.2.1a

**Next Generation Science
Standards**
2-LS2.A
2-ETS1.B

Grade 3

**Common Core English
Language Arts**
SL.3.1b

**Next Generation Science
Standards**
3-LS1.B

Grade 4

English Language Arts
SL.4.1b

**Next Generation Science
Standards**
4-LS1.A

Standards descriptions are listed
in the matrix on page 108.

Ask students to think about the ways that humans use or depend on plants. Ask students how plants might depend on people? Make a list of responses on the board. Emphasize that plants are the primary source of matter and energy entering most food chains. Plants are producers.

3. Divide students into pairs. Distribute one *What Do Plants Need to Grow?* grid and one set of *What Do Plants Need to Grow?* cards to each pair of students. Point out to students that each of the columns on the puzzle grid is labeled with one of the plant necessities. Also point out that each puzzle piece is labeled with a row number, one through four.
4. Instruct pairs to read the clues on the cards and decide which plant need is being described on the card. Students will place each card in the correct grid column and row number indicated until all the pieces are placed on the grid. Do one card together as a class.
5. Students may compare their answers with other groups and discuss their results. Allow students to rearrange pieces to make corrections if they choose.
6. Once students are satisfied with the arrangement of their cards on the grid, instruct them to tape the cards together, being careful not to tape them to the grid below.
7. When all the card pieces have been taped together, ask students to turn the cards over to reveal an illustration and activity, Plant Hunt.
8. Ask students to perform the activity by circling all of the objects in the illustration that come from plants. Discuss possible answers as a class. Students may then color the illustration.

Extensions

- Make a bulletin board or wall chart titled *Why People Need Plants*. Fill this bulletin board with magazine cutouts or actual samples of plants or plant by-products used by humans. Examples may include clothing, such as cotton and wool, rope, food, cosmetics, furniture, homes, etc. It may also include a few plastic items and synthetic fabrics, after you discuss how fossil fuels (dead plants and animals millions of years old) are used in these plastic or synthetic items.

What Do Plants Need to Grow?

- ▶ Do the *Link 'Ems* activity found on the CFAITC website: www.LearnAboutAg.org/linkems. This is a fun activity that will help students make an agricultural connection to many things they consume or use throughout the day.

ELL Adaptations

- ▶ This lesson incorporates hands-on art activities. Kinesthetic learning events provide an excellent learning environment for English language learners.
- ▶ In part two of the procedure, incorporate illustrations for the list of discussion topics on the board.

What Do Plants Need to Grow?

Grid

	Water	Air	Nutrients	Light
1				
2				
3				
4				

What Do Plants Need to Grow?

Cards

<p>Row 1</p> <p>I am made of hydrogen and oxygen</p>	<p>Row 1</p> <p>I am made of carbon dioxide, nitrogen, water vapor and other gases</p>	<p>Row 1</p> <p>Plants absorb these through their roots</p>	<p>Row 1</p> <p>I am energy</p>
<p>Row 2</p> <p>I appear blue and cover most of the Earth's surface</p>	<p>Row 2</p> <p>You can rarely see me</p>	<p>Row 2</p> <p>We are the vitamins for plants</p>	<p>Row 2</p> <p>I am the opposite of dark</p>
<p>Row 3</p> <p>Plants absorb me through their roots</p>	<p>Row 3</p> <p>I may once have been in a person's lungs</p>	<p>Row 3</p> <p>We come from the decomposition of rocks, dead plants, and animals</p>	<p>Row 3</p> <p>Plants are special because they can capture me</p>
<p>Row 4</p> <p>Farmers irrigate their fields with me</p>	<p>Row 4</p> <p>Special openings in plant leaves allow me to enter</p>	<p>Row 4</p> <p>We are sometimes called fertilizers</p>	<p>Row 4</p> <p>I make plants green and help plants make their own food</p>

Plant Hunt



Circle the objects that come from plants

Answers to Commonly Asked Questions

What is botany?

Botany is the study of plants. There are many different careers available to people who enjoy working with plants. Plant lovers can enjoy careers as nursery workers, gardeners, farmers, or landscape designers. Specialized studies are also available in areas such as plant anatomy, plant history, fertilizer manufacturing, pest management, genetic engineering, wood science, natural plant preservation, and much more.

Why has composting become so popular?

Compost is a mixture of decayed organic matter. With an increase in public concern over environmental issues such as overflowing landfills, an increasing human population, and finite resources, we are constantly searching for ways to re-use and recycle materials we consume. Composting allows farmers, gardeners, and the general public to turn everyday organic waste, such as kitchen scraps and lawn clippings, into organic matter that can be used to fertilize plants. Composting not only provides plants with nutrients but also improves soil quality. Adding organic matter to the soil increases the amount of air available to plant roots and improves the soil's ability to absorb water. Compost bins can be constructed from scratch, and pre-made containers are widely available in home improvement stores and nurseries. Composting is an interesting and responsible way to reduce waste and fertilize plants.

Why do plants die if they get too much water?

With the help of light, plants are able to convert water and carbon dioxide into food for themselves. The process of converting food energy into actual plant growth is known as respiration, which requires the intake of oxygen into the root of the plant. If the soil is too wet, it becomes waterlogged and does not provide enough oxygen to the roots for plants to grow. Therefore, the plants cannot respire and will die. You could say plant roots “suffocate” without oxygen, the same way humans and animals will die from a lack of oxygen.

Why do plants grow towards the light?

Plants are phototropic, which means they are attracted to light sources because they need it for energy. Plants contain a growth hormone called auxin that only functions in the dark. Plant cells on the shady side of the plant tend to elongate due to the presence of auxin, allowing plants to reach and bend in the direction of the light source. Essentially,

Answers to Commonly Asked Questions

the shady side of the plant grows faster than the sunny side of the plant, thus causing the plant to lean over and face the sun.

Why do plants yellow if they do not have enough nutrients?

Yellowing is a sign of an unhealthy plant. There are many causes of yellowing, but generally it means that the process of chlorophyll formation is interrupted. This can be due to over watering, under watering, or too little exposure to light. Chlorophyll is the green substance in plants that is able to absorb energy from the sun and convert carbon dioxide and water into sugars and starches. The chemical formula for chlorophyll is $C_{55}H_{72}O_5N_4Mg$. As the chemical formula illustrates, specific elements are needed to build the molecule. If the required nutrients cannot be produced, the plant turns yellow and eventually dies.

Why do plants need fertilizer?

Just like humans, plants need certain nutrients to grow and thrive. The most important of these nutrients are the chemical elements carbon, hydrogen and oxygen, which are used to produce sugars and starches that serve as plant food. Other essential elements are nitrogen, phosphorus, and potassium (potash), which can be found in most packaged fertilizers. Nitrogen, phosphorus, and potassium are important because they are necessary to sustain a plant's basic building blocks, such as chlorophyll, plant proteins, amino acids, and cell membranes. It is commonly believed that healthy plants require 17 chemical elements. If all of these elements are available to the plants, fertilizers do not need to be added to soils. However, if these nutrients are not present in the soil, fertilizers can be used as a supplement. As plants grow they take up nutrients from the soil. When plants are harvested the nutrients that they have taken up are removed from the soil. If we continue the cycle of growing and harvesting plants without replacing nutrients, the soil becomes depleted of essential nutrients. Farmers and home gardeners have various methods for replacing soil nutrients. Fertilizers include manures as well as store-bought concentrated fertilizers.

How are fertilizers made?

The elements found in fertilizers come from above, below, or on the Earth's surface. They are natural resources, therefore, we must

Answers to Commonly Asked Questions

manage them properly. The three key fertilizer ingredients, nitrogen, phosphorus, and potassium, are manufactured in factories using materials from the earth and atmosphere. Through a complex factory process, bacteria converts nitrogen from the air, known as atmospheric nitrogen, into ammonia or nitrates that can be absorbed by plants. The phosphorus found in fertilizer comes from mining phosphate rock and combining it with sulfuric acid from fossil fuels. Potassium is obtained from salt deposits throughout the world like those of the Great Salt Lake in Utah.

How does manure benefit plant growth?

Manure is another word for animal excrement, and is often used as organic fertilizer in agriculture. Manure contains nutrients that contribute to the health of plants, such as nitrogen, and components that can improve the fertility and aeration of the soil. Animal manures vary in nutrient composition, depending on the type of animal and the diet of the animal.

Why does manure smell?

Bacteria and other organisms decompose manure, converting it to organic matter. During this process the bacteria release odorous gas as a waste product. Ammonia and methane are often by-products of the decomposition process. Another interesting fact about manure is that the more odorous it is, the less efficient the bacteria are in decomposing matter. The ammonia is released into the atmosphere rather than converted into the organic matter that can be used by plants.

What do the three numbers on a fertilizer label mean?

Most commercial fertilizers have three numbers on the front label, separated by dashes. For example: 5-10-5. The series of numbers stand for the percentages of nitrogen, phosphorus, and potassium in that particular fertilizer. These are abbreviated as N-P-K, always in this order. These three elements are the major nutrients required by plants for growth and reproduction. When buying a fertilizer, consider whether the plant requires higher levels of a specific nutrient(s) and purchase a fertilizer with higher levels of the required nutrient(s). The example above, purchased as a ten pound bag, would contain 5% nitrogen, 10% phosphorus and 5% potassium. The remaining 80% could be comprised of other nutrients and filler.

Answers to Commonly Asked Questions

Why do plants die if they get too much fertilizer?

Most fertilizers are applied as salts. Any type of salt will draw out and absorb any available water supply. Fertilizers draw water from plant cells. If too much fertilizer is applied to a plant, the plant cells will dehydrate and may become brittle and discolored. This drying out of plants is often referred to as plants being “burned” by fertilizer.

Why do some fertilizers require people to wear protective clothing such as masks or gloves?

Most commercial fertilizers are more concentrated than natural manures and composts. They are also applied in salt form. Large quantities of salt can draw water out from not only plant, but also human and animal cells and cause them to dehydrate. This can cause irritation to skin cells, eyes, and lungs. For most household fertilizers, rinsing exposed areas with generous amounts of water will prevent damage. Manufacturer’s application instructions are designed to keep people and the environment safe.

What is hydroponics?

Hydroponics is a process in which plants are grown in water instead of soil. The word is derived from Latin and means “working water.” Hydroponics is possible when the nutrients required for plant growth are made available in the water and when there is a support system available to keep the plants stable. Using hydroponics, farmers and gardeners can maximize small spaces and grow a wide variety of plants year-round, as the process is conducted indoors.

Agricultural Organizations

General

American Farm Bureau Foundation for Agriculture

600 Maryland Avenue SW, Suite 1000W

Washington, DC 20024

Phone: (202) 406-3700

Toll free: (800) 443-8456

E-mail: curtism@fb.org

Website: www.agfoundation.org

Website: www.myamericanfarm.org

California Foundation for Agriculture in the Classroom

2300 River Plaza Drive

Sacramento, CA 95833-3293

Phone: (916) 561-5625

Toll free: (800) 700-AITC

E-mail: info@LearnAboutAg.org

Website: www.LearnAboutAg.org

National 4-H Cooperative Curriculum System, Inc.

405 Coffey Hall, 1420 Eckles Avenue

St. Paul, MN 55108-6068

Phone: (612) 624-4900

Toll free: (800) 876-8636

E-mail: shopext@umn.edu

Website: www.n4hccs.org

Website: www.4-hmall.org

University of California

Agriculture & Natural Resources Communication

Services Publications

1301 South 46th Street, Building 478

Richmond, CA 94804

Toll-free: (800) 994-8849

E-mail: anrcatalog@ucdavis.edu

Website: anrcatalog.ucdavis.edu

Teacher Resources and References

Botany

PlantingScience.org

A learning and research resource bringing together students, plant scientists, and teachers from across the nation. Students engage in hands-on plant investigations, working with peers and scientist mentors to build collaborations and to improve their understanding of science.

Grades 6-12

Free online

Botanical Society of America Business Office

Post Office Box 299

St. Louis, MO 63166-0299

Phone: (314) 577-9566

Website: www.botany.org/bsa/careers

Website: www.PlantingScience.org

The Budding Botanist: Investigations With Plants

Investigate how the structure and function of flowers, leaves, roots, and stems help plants live, grow, and reproduce. Students develop content knowledge along with process skills such as observing, measuring and organizing data, and communicating results. Includes 26 activities over 122 pages and a CD with printable student pages.

Grades 3-6

\$21.95 plus s/h; request item #1213

AIMS Education Foundation

Post Office Box 8120

Fresno, CA 93747-8120

Phone: (559) 255-4094

Toll-free: (888) 733-2467

E-mail: aimsed@aimsedu.org

Website: www.aimsedu.org

Teacher Resources and References

Gardening

Common Ground Garden Program

Information on many gardening topics, including tips, school and community gardens, composting, container gardening, saving water, and recycling.

Adult

Free; available online only

University of California Cooperative Extension

4800 East Cesar E. Chavez Avenue

Los Angeles, CA 90022

Phone: (323) 260-3407

E-mail: ydsavio@ucdavis.edu

Website: celosangeles.ucdavis.edu/Common_Ground_Garden_Program

Create from Waste!

This activity guide has 20 hands-on activities designed to educate students to find ways to reduce the amount of waste they send to the landfills. Some activities include investigating food, exploring soil, and worm composting.

Grades K-3

\$19.95

Life Lab Science Program

1156 High Street

Santa Cruz, CA 95064

Phone: (831) 459-2001

Fax: (831) 459-3483

E-mail: admin@lifelab.org

Website: www.lifelab.org

Teacher Resources and References

Math in the Garden

This engaging curriculum uses a mathematical lens to take children on an education-filled exploration of the garden. Dozens of hands-on activities hone math skills and promote inquiry, language arts, and nutrition. All were developed to support mathematics and science standards and were extensively trial-tested by educators and youth leaders nationwide. Developed by the University of California Botanical Garden and Lawrence Hall of Science in Berkeley, California.

Grades K-8

\$29.95

National Gardening Association

1100 Dorset Street

South Burlington, VT 05403

Phone: (802) 863-5251

Fax: (802) 864-6889

E-mail: customerservice@garden.org

Website: www.kidsgardening.org

Operation WATER: Dr. Thistle Goes Underground

This Junior Master Gardening curriculum combines the teacher/leader guide with reproducible pages. Through dozens of engaging and fun activities, students can investigate important soils and water concepts, take part in service learning projects, and earn Junior Master Gardener certification—all while undertaking an urgent mission to foil the newest plans of Dr. Thistle! Aligned with National Content Standards.

Grades 6-8

\$35

Junior Master Gardener

225 Horticulture/Forest Building, MS 2134

College Station, TX 77843-2134

Phone: (979) 845-8565

Toll-free: (888) 900-2577

E-mail: programinfo@jmgkids.us

Teacher Resources and References

WE Garden Lesson Packet

California Foundation for Agriculture in the Classroom (CFAITC) worked side-by-side with First Lady Maria Shriver and staff to plan and install an edible garden at the state capitol. As a capstone to the project, CFAITC collaborated with other agriculture literacy organizations to provide 11 garden-related lesson plans aligned to content standards for grades 1-6. These downloadable lesson plans highlight activities that complement garden-related education and can be performed inside or outside the classroom. Lesson plans include California Crops, Read the Roots, Eat Your Plants, Frozen Canned or Fresh, and more.

Grades 1-6

Free; available online only

California Foundation for Agriculture in the Classroom

2300 River Plaza Drive

Sacramento, CA 95833-3293

Phone: (916) 561-5625

Fax: (916) 561-5697

Toll-free: (800) 700-AITC

E-mail: info@LearnAboutAg.org

Website: www.LearnAboutAg.org

Worms Eat My Garbage

This 176-page book, written by Mary Appelhof, is a guide to vermicomposting, a process using redworms to recycle food waste into nutrient-rich food for plants. ISBN 978-0-9778045-1-1

Grades K-adult

\$12.95 plus \$3.50 s/h

Flowerfield Enterprises, LLC

10332 Shaver Road

Portage, MI 49024

Phone: (269) 327-0108

E-mail: nancy@wormwoman.com

Website: www.wormwoman.com

Teacher Resources and References

Soil

A Slice of Soil

An apple is used to model the earth. Students learn that just $\frac{1}{32}$ of its surface is devoted to farmland. Discuss in class what sacrifices may be needed to feed a larger population.

Grades 2-4

Free

Growing the Next Generation

Agrium

13131 Lake Fraser Drive SE

Calgary, AB

T2J 7E8

Toll-Free: 1-877-247-4861

Website: www.growingthenextgeneration.com

California Fertilizer Foundation

The California Fertilizer Foundation provides information about plant nutrients and agriculture in California. School garden grants are also available.

Grades K-12

Free online information

California Fertilizer Foundation

4460 Duckhorn Drive, Suite A

Sacramento, CA 95834

E-mail: corriep@healthyplants.org

Website: www.calfertilizer.org

Teacher Resources and References

Healthy Foods from Healthy Soils

Healthy Foods from Healthy Soils invites you and your students to discover where your food comes from, how our bodies use food, and what happens to food waste. You'll participate in the ecological cycle of food production and compost formation, while helping children understand how their food choices affect not only their own health, but farmers, the environment, and your local community. Includes over 45 hands-on activities. ISBN 978-0-88448-242-0

Grades K-6

\$19.95, paperback

Tilbury House Publishers

103 Brunswick Avenue

Gardiner, ME 04345

Phone: (207) 582-1899

Fax: (207) 582-8227

Toll-free: (800) 582-1899

E-mail: tilbury@tilburyhouse.com

Website: www.tilburyhouse.com

Soil Biology Primer

The Soil Biology Primer introduces the living component of soil and how it contributes to agricultural productivity and to air and water quality. The primer includes information on the soil food web and how the web relates to soil health. Chapter topics include bacteria, fungi, protozoa, nematodes, arthropods, and earthworms.

Grades 8-Adult

\$18 plus s/h

Soil and Water Conservation Society

945 SW Ankeny Road

Ankeny, IA 50023

Phone: (515) 289-2331 ext. 126

Toll-free: (800) THE-SOIL

E-mail: pubs@swcs.org

Website: www.swcs.org

Teacher Resources and References

Soil Stories—Second Grade Science Exploration

This grouping of six lesson plans, taken from the Life Lab Science Curriculum, focuses on soil studies and meets the second grade California Content Standards for California Public Schools in science. Packet includes recommended literature, a master materials list, and a blackline science journal.

Grade 2

Free; available online

Life Lab Science Program
1156 High Street
Santa Cruz, CA 95064
Phone: (831) 459-2001
E-mail: admin@lifelab.org
Website: www.lifelab.org

Soils Sustain Life

Soil science is the study of Earth's land and water resources as they relate to agriculture, forestry, rangeland, ecosystems, urban uses, and mining and reclamation. This brochure defines soil science and its importance, identifies soil scientists and what they do, and provides information about career opportunities.

Grades 7-12

Free; online

Soil Science Society of America
677 South Segoe Road
Madison, WI 53711
Phone: (608) 268-4949
E-mail: lmalison@soils.org
Website: www.soils.org

Teacher Resources and References

Field Trips

The Center for Land-Based Learning

Two programs: the FARMS Leadership Program (statewide) and the SLEWS Program (Northstate, Sacramento Valley, Napa, and San Joaquin). Both are hands-on, experiential learning programs that take students out of the classroom and onto farms, ranches, wildlife areas, and post-secondary institutions to teach them about sustainable agriculture, conservation, and the environment. The headquarters in Winters is also an educational farm, which can host school classes for outdoor activities and field days.

Center for Land-Based Learning
5265 Putah Creek Road
Winters, CA 95694
Phone: (530) 795-9569
Website: www.landbasedlearning.org

Ten Things Kids Want to Know About Farming

This 22-minute educational video or DVD takes students on a series of field trips to farm and ranch locations throughout the United States, offering them a firsthand view of how the food and clothing we use every day is produced.

Grades 3-6

VHS \$18.50; DVD \$17; quantity discounts available

American Farm Bureau Foundation for Agriculture
600 Maryland Avenue SW, Suite 1000 W
Washington, DC 20024
Phone: (202) 406-3700
Fax: (202) 314-5121
Toll-free: (800) 443-8456
E-mail: curtism@fb.org
Website: www.agfoundation.org
Website: www.myamericanfarm.org
Website: www.myamericanfarm.org

Related Websites

Agripedia

www.ca.uky.edu/agripedia

Alltech

www.alltech.com/kidzone

California Department of Food and Agriculture, Kids' Page

www.cdfa.ca.gov/kids

California Foundation for Agriculture in the Classroom

www.LearnAboutAg.org

California School Garden Network

www.csgn.org

Fertilizer 101

www.fertilizer101.org

Growing the Next Generation

www.growingthenextgeneration.com

Sci4Kids

www.ars.usda.gov/is/kids

Master Gardeners School Gardens: Resource Guide

www.mastergardeners.org/school-gardens-resource-guide

Natural Resources & Conservation Service Soils Website

soils.usda.gov

Plants Database

www.plants.usda.gov

Wisconsin Fast Plants/Bottle Biology Notes

www.fastplants.org

Related Literature

Berger, Melvin. *The Vegetable Garden*. Newbridge Educational Publishing, 2007. Basic book on gardening for the early science reader. ISBN 978-1-4007-6283-5

Bodach, Vijaya Khisty. *Seeds*. Capstone Press, 2007. Describes how seeds are spread, what they need to grow into plants, and some that are good to eat. ISBN 978-0-7368-9623-8

Gariand, Sarah. *Eddie's Garden and How to Make Things Grow*. Frances Lincoln Children's Books, 2004. Learn how plants need soil, sun, and water to make plants in Eddie's garden grow, and learn some specifics about garden pests and flowers. ISBN 978-1-84507-015-1

Gibbons, Gail. *From Seed to Plant*. Holiday House, 1993. Learn the science of seeds and how they grow into flowers, trees, and other plants. ISBN 978-0-8234-1025-5

Grigsby, Susan. *In the Garden with Dr. Carver*. Albert Whitman & Company, 2010. A story about how George Washington Carver comes to Alabama and teaches school kids about plants. ISBN 978-0-8075-3630-8

Guillain, Charlotte. *Spot the Difference: Flowers*. Heinemann Library, 2008. This book introduces children to the parts of a flower using intriguing photos of a variety of plants to provide child-friendly examples. ISBN 978-1-4329-0952-9

Guillain, Charlotte. *Spot the Difference: Leaves*. Heinemann Library, 2008. This book introduces children to the anatomy and function of leaves using intriguing photos of a variety of plants to provide child-friendly examples. ISBN 978-1-4329-0951-2

Kalman, Bobbie. *How a Plant Grows*. Crabtree Publishing Company, 1996. Through nonfiction text and colorful photographs, learn how plants grow, and then try a couple of experiments that are listed. ISBN 978-0-86505-728-9

Koontz, Robin. *Composting: Nature's Recyclers*. Picture Window Books, 2007. Dead leaves, food scraps, and grass clippings for lunch? Small animals, fungi, and bacteria, called decomposers, turn trash into a tasty compost treat. Learn more about compost and how you can use it in your garden or yard. ISBN 978-1-4048-2194-1

Related Literature

Kite, Patricia L. *Gardening Wizardry for Kids*. Barron's Educational Services, 1995. History and folklore associated with common fruits and vegetables and the methods for raising, eating, and crafting with them. ISBN 978-0-8120-8362-0

Lauber, Patricia. *Earthworms: Underground Farmers*. Henry Holt and Company, 1994. Take a look at the world of earthworms and learn how important these creatures are to a healthy ecology. ISBN 978-0-8050-1910-0

Peterson, Cris. *Seed Soil Sun: Earth's Recipe for Food*. Boyds Mills Press, 2010. Seed, soil, and sun are three ingredients for growing food. ISBN 978-1-59078-713-7

Rosenbaum, Judith. *Looking at Soil*. Newbridge Educational Publishing, 2007. A book that explains the components of soil in an easy to understand format. ISBN 978-1-4007-5213-3

Rosinsky, Natalie M. *Dirt: The Scoop on Soil*. Picture Window Books, 2002. Vivid illustrations and clear, fact-filled text explore the amazing science of soil. ISBN 978-1-4048-0012-0

Royston, Angela. *Flowers, Fruits and Seeds*. Heinemann Library, 1999. Discover why plants have flowers, how some animals help make new plants, and what pollen is. ISBN 978-1-58810-449-6

Schaefer, Lola M. *We Need Farmers*. Capstone Press, 1999. This emerging reader shows the many types of farmers that grow the products we consume. ISBN 978-0-7368-4827-5

Schomp, Virginia. *If You Were a Farmer*. Benchmark Books, 2000. This descriptive simple text, with colorful photographs, describes many different kinds of farmers and what they do. ISBN 978-0-7614-1001-0

Tunkin, David. *How Does My Garden Grow?* National Geographic, 2003. Learn that plants in the garden need sunlight, water, and soil to grow. ISBN 978-0-7922-4264-2

Yu, Norman. *Cotton Comes from Plants*. National Geographic, 2003. Learn how cotton is grown and made into the clothes we wear. ISBN 978-0-7922-4331-1

Related Literature

The Teacher Resource Guide (TRG), compiled by the Foundation, is a must-have tool for professionals and volunteers searching for resources to improve the agricultural literacy of California's youth.

The TRG lists numerous agriculture education lessons, websites, books and field trips. The TRG is available in hardcopy and on our website. The online bookshelf search www.LearnAboutAg.org/books allows users to search the database for literature related to your lesson topics.

Matrix of Standards

2nd Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Common Core English Language Arts													
RI.2.1 Reading Informational Text	Ask and answer such questions such as who, what, where, when, why, and how to demonstrate understanding of key details in a text.							x	x	x	x	x	
RI.2.4 Reading Informational Text	Determine the meaning of words and phrases in a text relevant to a grade 2 topic or subject area.				x							x	
RI.2.7 Reading Informational Text	Explain how specific images contribute to and clarify a text.								x	x			
W.2.2 Writing	Write informative/explanatory text in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.							x		x			
W.2.7 Writing	Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).	x			x			x		x	x	x	
W.2.8 Writing	Recall information from experiences or gather information from provided sources to answer a question.		x	x	x	x		x	x	x	x		
SL.2.1a Speaking and Listening	Follow agreed-upon rules for discussions.	x						x	x	x	x		x
SL.2.1c Speaking and Listening	Ask for clarification and further explanation as needed about the topics and texts under discussion.	x						x		x			

Matrix of Standards

2nd Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Common Core English Language Arts (cont.)													
L.2.5a Language	Identify real-life connections between words and their use.						x						
L.2.6 Language	Use words and phrases acquired through conversations, reading and being read to, and responding to texts, including using adjectives and adverbs to describe.				x								
Common Core Mathematics													
2.MD.1 Measurements & Data	Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.		x	x				x			x		
2.MD.4 Measurements & Data	Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.		x	x							x		
2.MD.10 Measurements & Data	Draw a picture graph and a bar graph to represent a data set with up to four categories.					x							
Next Generation Science Standards													
2-LS2.A Interdependent Relationships in Ecosystems	Plants depend on water and light to grow. Plants depend on animals for pollination or to move their seeds around.	x	x	x			x	x		x			x

Matrix of Standards

2nd Grade

California Standards	Description	Next Generation Science Standards (cont.)											
		Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
2-ETS1.A Defining and Delimiting Engineering Problems	Asking questions, making observations, and gathering information are helpful in thinking about problems.	x	x	x	x	x		x	x	x	x	x	
2-ETS1.B Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem.	x	x	x	x	x	x	x		x			x

Matrix of Standards

3rd Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Common Core English Language Arts													
RI.3.1 Reading Informational Text	By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text complexity band independently and proficiently.							x	x	x	x	x	
RI.3.4 Reading Informational Text	Determine the meaning of general academic and domain specific words and phrases in a text relevant to a grade 3 topic or subject area.				x							x	
RI.3.7 Reading Informational Text	Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).								x	x			
W.3.2d Writing	Provide a concluding statement or section.							x		x			
W.3.7 Writing	Conduct short research projects that build knowledge about a topic.				x			x		x	x	x	
W.3.8 Writing	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.	x	x	x		x		x	x	x	x		
SL.3.1b Speaking and Listening	Follow agreed-upon rules for discussion.	x						x	x	x	x		x
SL.3.1c Speaking and Listening	Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.	x						x		x			

Matrix of Standards

3rd Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Common Core English Language Arts (cont.)													
L.3.5b Language	Identify real-life connections between words and their use.						x						
L.3.6 Language	Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships.				x								
Common Core Mathematics													
3.OA.1 Operations & Algebra	Interpret products of whole numbers, e.g., interpret 5x7 as the total number of objects in 5 groups of 7 objects each.							x					
3.OA.3 Operations & Algebra	Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities.							x					
3.MD.3 Measurements & Data	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.					x							
3.MD.4 Measurements & Data	Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.		x	x				x					

Matrix of Standards

3rd Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Next Generation Science Standards													
3-LS1.B Growth and Development of Organisms	Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	x		x	x	x	x						x
3-LS3.A Inheritance of Traits	Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.			x									
3-LS3.B Variation of Traits	Different organisms vary in how they look and function because they have different inherited information. The environment also affects the traits that an organism develops.		x	x		x							
3-LS4.C Adaptation	For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	x				x	x	x		x			

Matrix of Standards

4th Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Common Core English Language Arts													
RI.4.1 Reading Informational Text	Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences form the text.								x			x	
RI.4.3 Reading Informational Text	Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.						x			x	x		
RI.4.4 Reading Informational Text	Determine the meaning of general academic and domain specific words or phrases in a text relevant to a grade 4 topic or subject area.				x							x	
RI.4.7 Reading Informational Text	Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.								x	x			
W.4.2d Writing	Use precise language and domain-specific vocabulary to inform about or explain the topic.							x		x			
W.4.2e Writing	Provide a concluding statement or section related to the information or explanation presented.							x		x			
W.4.7 Writing	Conduct short research projects that build knowledge through investigation or different aspects of a topic.							x		x	x	x	
W.4.8 Writing	Recall relevant information from experiences or gather relevant information from print and digital sources; take notes, paraphrase, and categorize information, and provide a list of sources.	x	x			x			x				

Matrix of Standards

4th Grade

California Standards	Description	Plant Parts	Role of the Roots	Flower Hour	Seed Science	Seedy Fruit Challenge	Knowing Our Needs	Room to Grow	I'm Superb Soil!	Tropism Twist	Troubled Waters	Is There Too Much?	What Do Plants Need?
Common Core English Language Arts (cont.)													
SL.4.1b Speaking and Listening	Follow agreed-upon rules for discussions and carry out assigned roles.	x						x	x	x	x		x
SL.4.1c Speaking and Listening	Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.	x						x		x			
L.4.6 Language	Acquire and use accurately grade-appropriate general academic and domain - specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., wildlife, conservation, and endangered, when discussing animal preservation.)				x		x						
Common Core Mathematics													
4.MD.1 Measurements & Data	Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz; l, ml; hr, min, sec.							x			x		
4.MD.4 Measurements & Data	Make a line plot to display a data set of measurements in fractions of a unit.		x			x							
Next Generation Science Standards													
4-LS1.A Structure and Function	Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	x	x	x	x	x				x			x

Glossary

Acidic: pH less than 7.

Alkaline: pH greater than 7, also known as basic.

Amendment: any material added to soil to make it more productive. Examples include fertilizer and mulch.

Anther: male part of flower that holds the pollen.

Bacteria: one celled, microscopic organism.

Carbon dioxide: a gas in the air used by plants to make their own food.

Carpel: the female reproductive part of a flower.

Cell: the basic unit of life.

Chlorophyll: the green colored substance in plants that absorbs energy from sunlight.

Compost: a mixture made of decaying organic material used to fertilize plants.

Consumer: an organism that eats plants or other animals.

Control: a standard of comparison.

Cotyledon: the part of the seed that stores food for the young plant.

Decomposer: an organism that recycles nutrients by breaking down waste and the remains of dead plants and animals.

Dicot: type of flowering plant that has two cotyledons to store food for the young plant. Dicots have leaves with netted veins and tap roots.

Embryo: the tiny plant within the seed.

Endocarp: inner woody layer of the fruit, covering the seed.

Exocarp: outer most layer of a fruit, the skin.

Fertilizer: any substance added to the soil or water that increases the nutrients available to plants.

Glossary

Filament: the thin stalk that supports the anther.

Flower: the part of the plant that contains reproductive parts and attracts pollinators.

Fruit: the part of the plant that holds seeds.

Fungi: organisms that feed on dead and decaying matter, such as mushrooms and molds.

Germination: the first growth of a seed when it puts out shoots.

Hypothesis: an educated guess to explain why something happens. For example: If you do *this* then *this* will happen. A hypothesis must be testable.

Leaf: the flat or needlelike part of a plant where photosynthesis happens.

Legume: usually a plant that has pods whose seeds split in two, often help with nitrogen fixation. Examples include beans and alfalfa.

Mesocarp: the fleshy part of a fruit that we often eat.

Manure: animal waste, often used as fertilizer.

Monocot: type of flowering plant that has one cotyledon to store food for the young plant. Monocots have leaves with parallel veins and fibrous roots.

Nitrogen: an element that naturally exists in air and is needed by plants to produce proteins, chlorophyll, and genetic material.

Nutrients: any element taken in by a plant that is essential to its growth.

Organic matter: material in soil made from the decomposition of plants or animals. It increases the soil's ability to hold water and air and resist compaction.

Organism: another name for a living thing.

Ovule: plant part that contains embryo.

Glossary

Oxygen: a gas in the air used by humans to breathe. Plants give off oxygen through the process of photosynthesis.

Petal: the colored segments of a flower.

Phosphorus: an element required by plants that promotes root growth.

Photosynthesis: the process by which plants make their own food from carbon dioxide, water, and sunlight.

Phototropism: a plant's bending and growing towards a light source.

Plant: an organism that produces its own food through photosynthesis. Plants have rigid cell walls and structures to transport nutrients and water.

Pollen: fine powdery material produced by anthers of flowers containing male sex cells of plants.

Pollination: the transfer of male pollen from the male part of a plant to the female reproductive part of a plant.

Potassium: an element required by all plants for carbohydrate production and the hardening of tissues such as tree trunks.

Producer: organism that makes its own food using energy from the sun. Plants are producers.

Reproduction: the process by which new living organisms are created.

Root: the part of the plant that grows into the soil to anchor the plant and collect water and nutrients.

Saline: salty.

Seed: the small object that will grow into another plant.

Sepal: an individual leaf that makes up the calyx of a flower.

Soil: the top portion of the Earth's surface that is used to grow plants.

Stamen: the male part of the plant containing the pollen, anther, and filament.

Glossary

Stem: the part of the plant that supports the upper part of the plant and transports nutrients and water.

Stigma: female part of the flower that receives the pollen.

Xylem: the specialized cells of plants that transport water and nutrients from the roots to the leaves.

