Berkeley Unified School District

Garden-Based Learning Curriculum

Second Edition

Fourth – Fifth Grades

September 2017
Curriculum Goals

SCIENCE

Science is essential for understanding our world. Experimenting with the natural and unnatural world informs students and prepares them to be critical thinkers. We ask questions, such as: How do plants use energy from light to make sugars? What happens when the energy from food is transferred from one organism to the next?

ENVIRONMENT

External conditions and factors, living and nonliving, which affect organisms, constitute an environment. Students understand the processes for cultivating food and plants by exploring connections to their environment. We ask questions, such as: What is a food web and what are the different components of a food system?

HEALTH

We encourage students to care for themselves by eating whole food, by connecting with how and where food grows, and by understanding the importance of quality nutrition found in these foods and the role physical exercise plays in keeping us healthy. We ask questions, such as: How do decisions about food affect our health?

LANGUAGE

Students practice speaking and listening, writing comprehension, and building knowledge by investigating a topic within a grade and across grades. We ask questions, such as: How can students integrate and evaluate information presented in diverse formats and an array of texts, including visually, quantitatively, and orally?

STUDENT ENGAGEMENT

The outdoor garden has competing distractions for student focus. We practice harnessing these distractions as teachable moments, allowing students to experience and observe, while still managing their urges and emotions. We ask questions, such as: How can we work together to meet challenges and solve problems as a group?
# Garden-Based Learning Curriculum

## Themes by Month

### Fourth Grade

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Personalizing the 3 Be’s

Objectives/Assessment Targets

Students will:

- Repeat the rules for working in the garden.
- Make a poster identifying how you will practice the 3 Be’s in the garden.
- Plant a mystery plant and plan documentation of its growth.

Activity Preparation

This activity is the first garden lesson of the school year and a useful tool for welcoming new and returning students. Write the 3 Be’s on the whiteboard. Gather samples of garden tools to demonstrate tool safety.

Materials

- 11 x 17 construction paper, colored, and white (if creating a classroom 3 Be’s poster for the garden)
- Collected plants and garden materials for collage
- Drawing materials
- Student workbooks, first page for students to personalize

Activity 1: Respect, Safety, and Responsibility

Introduce students to the garden by taking them on a garden tour and identifying plants and flowers. Get them excited about being in the garden by inviting them to taste what is growing. Introduce the garden tools and practice safety, including but not limited to:

1. Never hold a garden tool, including shovels, above your waist.
2. Ask before you pick.
3. Be careful of where you walk, and do not step on plants.
4. Walk along the paths.
5. Walk, don’t run.
6. Notice the squirrel distractions, but then refocus.

CA Health Standard 7.3.S

Use appropriate protective gear and equipment.
Practice the 3 Be’s that your school follows. Here in Berkeley Unified, each school has its own set of these that help with classroom management and student engagement. Remind students that we follow these same rules and practices in the garden:

1. Be Safe
2. Be Respectful
3. Be Responsible

**Activity 2: Creating a 3 Be’s Poster**

You can create a large poster for the whole class or direct student groups to make their own posters. Distribute poster and collage materials. Invite students to collect their own found garden objects (dead flowers, leaves, pebbles) after touring the garden, and create a poster that is reflective of how they will practice the 3 Be’s in the garden. Hang poster in a visible space to remind students throughout the year.

**CA Health Standard 7.4.N**

Practice how to take personal responsibility for engaging in physical activity.

**Student Reflection**

What are you looking forward to learning more about this year? How will you remind your peers about tool safety throughout the year?

**CA Health Standard 8.1.N**

Support others in making positive food and physical activity choices.

**English Language Learning (ELL) Focus: Abstract Nouns**

- Practice tool **safety**.
- **Respect** the garden and each other.
- You have a **responsibility** for taking care of the garden.
Garden Reflections

Objectives/Assessment Targets

Students will:

● Share a garden experience had in the past with a peer or whole class.
● Write and/or draw garden reflections by themes and concepts.

Activity Preparation

This lesson can be implemented throughout the year as a way to capture student’s understanding of lesson content and garden interests. Students recall key concepts that they learned, and are asked questions about what they would like to learn more about.

Materials

● Select visual aids from past lessons
● Poster making materials for each small student group (if student groups make reflection posters)
● Worksheet, Garden Reflections, page 2 in student workbooks

Activity 1: Sharing What We Learned about the Garden

Display any projects or posters made throughout the year. Distribute poster making materials to student groups. Prompt students to think about what they are most interested in the garden. Direct them to make a poster, write a letter or speech, or create a diagram to share with others.

Common Core State Standard W.4.2

Write informative/explanatory texts to examine a topic in order to write or speak about the subject knowledge.

Student Reflection

What is the most surprising thing you learned this semester? What do you want others to know about the school garden?

English Language Learning (ELL) Focus: Models

● People should know that________.
- People need to know that _______.
- People ought to know that _______.
- People must know that _______.

**Additional Information**

The results from this lesson can be used to make thank-you cards to supporters, funders, and donors who have supported garden-based learning throughout the year. Include a fun activity that allows students to make a snack together, such as smoothies using a bike blender, or making pizzas if you have a pizza oven.

![Figure 1 Students write and draw their garden reflections in the Washington Elementary School Garden](image)

Figure 1 Students write and draw their garden reflections in the Washington Elementary School Garden
Plants Need Light

Objectives/Assessment Targets

Students will:

● Conduct an experiment to demonstrate the importance of sunlight for healthy plant growth.
● Come up with a plan for tracking their experiments over time.
● Make recycled plant containers using newsprint.

Activity Preparation

This lesson introduces students to the concept of photosynthesis, starting with understanding the role light plays in helping plants make food. The activities invite students to experiment with light absorption by plant leaves. Students make seed starts and place them in different light filled spaces to measure light absorption over time.

Materials

● Masking tape and markers
● Leaves for experimenting with light (large and broad are best)
● Newspaper strips and mason jars for making seed starts
● Soil
● Seeds
● Popsicle sticks for seed labels
● Worksheet, Do Plants Need Light, page 3 in student workbooks

Activity 1: Making Plant Containers

Review past lessons on what plants need to grow, focusing on light. Plants are one of the few living things that can make their own food with the help of sunlight. Plants cannot make food without absorbing light.

Ask, How do plants make their own food? (Photosynthesis, starting with absorbing light into their leaves)

Tell students that they will experiment with how plants absorb light.


Plants acquire their material for growth chiefly from air and water.
Direct students to make two recycled plant containers, one for placing in a light filled space and the other for placing in a light absent place, by following these steps:

1. Cut up newspaper in vertical strips.
2. Lay newspaper out so you can roll glass jars neatly along the strips to wrap around the jars.
3. Pull out the glass to leave a newspaper mold.
4. Round the bottom of the newspaper mold by folding newspaper points like a present on the bottom.
5. Fill the mold with soil and place Popsicle sticks with labels of the seeds (suggested seeds are butterfly bushes/milkweed) you will have students plant in them.
6. Have students place seeds and water.

NGSS Disciplinary Core Idea  LS1.A: Structure and Function
Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Activity 2: Experimenting with Light
This activity will demonstrate that a plant cannot make its own food in the absence of sunlight. Students observe the two plants that they just planted over several weeks. Direct them to use the worksheet, Do Plants Need Light, page 3 in their workbooks to record their hypothesis and take notes on their observations:

1. Label half of the plants made in Activity 1 “light” and the others “dark.”
2. Place the plants labeled “dark” in a dark place.
3. Place the other plants outside or by a bright window.
4. Water both sets of plants regularly.
5. Have children sketch pictures of the two plant sets over several weeks and make notes regarding their observations.
6. After two weeks, have students share what they have observed about the “light” and “dark” plants.

NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations
Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
**NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations**
Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

**Common Core State Standard W.4.7**
Conduct short research projects that build knowledge through investigation of different aspects of a topic.

**Student Reflection**
What do you think will happen to the plants that don’t get light? What do you think would happen if a plant didn’t get carbon dioxide?

**English Language Focus: Analogies**
- If plants do not get enough light, they will ________.
- If the plants do not get enough carbon dioxide, they will ________.

**Additional Information**
Plant leaves absorb sunlight differently. There are red and blue light wavelengths that plants absorb. When you see a color, it is actually a color that the object does **not** absorb. For example, green plants do not absorb light from the green range.

**Sources**
Life Cycle of Plants, Utah Education Networks
Do Plants Need Light to Sprout?

**Hypothesis:** (Use complete sentences to explain why your hypothesis is right)

______________________________________________________________________

______________________________________________________________________

**Materials:** 2 pea seeds, 1 wooden pot maker, 1 strip of newspaper, 2 label sticks, 2 pieces of tape

**Group name (garden related and appropriate please) and members:**

______________________________________________________________________

______________________________________________________________________

Each person will be assigned a number in your group. Here are the job assignments by number.
1) Pot maker 2) Label maker 3) Seed planter 4) Soil shovel

**Procedure:**
Create 2 pots using the wooden pot maker, newspaper and tape. Fill the pots to the top with soil. Plant the pea seeds about ½ inch deep. Label one with your group name, teacher name and “light”. Label the other with your group name, teacher name and “dark”.

<table>
<thead>
<tr>
<th>Light</th>
<th>Dark</th>
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<tbody>
<tr>
<td>Week 2</td>
<td>Week 2</td>
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<tr>
<td>Date___________</td>
<td>Date___________</td>
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</table>

| Week 4     | Week 4  |
| Date___________ | Date___________ |

**Conclusions:** ______________________________________________
Leaf Functions

Objectives/Assessment Targets
Students will:
- Observe plant parts and describe each part’s function.
- Record observations.
- Experiment with how plants absorb sunlight.

Activity Preparation
This lesson builds upon past content students learned about how plants needing light. The activities invite students to test a plants’ leaf ability to absorb light in the absence of light. Use the same plant starts that students make in the previous lesson of make new ones with fresh plant starts that have started to sprout and leaf.

Materials
- Variety of large leafs still on plants
- Masking tape
- Clear tape
- Large piece of paper
- Worksheet, Leaf Functions, page 4 in workbooks to draw the plant parts

Activity 1: Reviewing Plant Part
Review plant parts: flower, stems, leaves, roots. Help students create a foldable flower to review the functions of the parts of a plant by demonstrating these steps:

1. Take a 8 ½ x 11 sheet of paper and fold it horizontally.
2. Draw a plant and its parts on the outside of the folded paper. The inside of the sheet will be used for recording the functions of plants.
3. Cut parts of the drawn plant into four sections (flower, stem, leaves, and roots; see sample).
4. Record the function of the leaves for plants.
5. Revisit this foldable flower to complete the function portions for roots, stem, and flower sections, as those concepts are studied in later labs.

NGSS Crosscutting Concept: Structure and Function
Substructures have shapes and parts that serve functions.
Students identify the different parts of the plants (e.g., flower, stem, leaf, and roots). Explain vital functions of each plant part.

**NGSS Disciplinary Core Idea  LS1.A: Structure and Function**
Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

**Ask:**
- What is the main function of a plant’s leaves?
- How do the structures of plants support their roles in food production?

**Activity 2: Observing Leaves and Light**
Review the Plants Need Light worksheet students made. Distribute the leafy plants to each student. Tell students that plants make their own food using light. Students place masking tape in patches on the leaves to experiment with varying degrees of light absorption. Guide students in a light experiment by following these steps (this experiment will need to be set up for five days):

1. Provide cut pieces of masking tape to place on their plant leaf.
2. Be sure that students do not cover all of the leaves. The uncovered leaves should be able to continue to absorb sunlight.
3. Place clear tape over some parts of the leaves.
4. Place small amounts of petroleum jelly on other parts of the leaves.
5. Students record these steps with drawings in their journals.
6. After five days, remove the patches. Have students record their observations in their science notebooks.
7. Students examine the lighter-colored spots on the leaves.

**Ask,** What do you think happened to create lighter-colored spots in the leaves? (The patches prevented the light from reaching the leaves.)

**NGSS Science/Engineering Practice 7: Engaging in Argument from Evidence**
Use data to evaluate claims about cause and effect.

**NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations**
Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

**Student Reflection**
Which part of the plant is vital in order for it to be able to make its own food? (Leaves)
What helps the leaf make food for the plant? (The sun)
NGSS Disciplinary Core Idea PS3.D: Energy in Chemical Processes and Everyday Life
The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

**English Language Learning (ELL) Focus: Adjectives**
- Small
- Slender
- Wide
- Prickly
- Hairy
- Soft
- Hard
- Smooth

**Additional Information**
All leaves change sunlight into energy through photosynthesis, which they learn about in the fifth grade lessons. The leaves are the primary food-making part of the plant. Leaves absorb carbon dioxide from the air, combine it with water that comes through the roots of the plants to make food (a sugar molecule known as glucose), and release oxygen into the air.

**Sources**
Orange County Public Schools, June 2010
Leaf Functions

Fold the page into 3rds. Draw and label the parts of a flower in each section.

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<th>Stems and leaves</th>
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<th>Roots</th>
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Findin g Chlorophyll

Objectives/Assessment Targets

Students will:

- Observe chlorophyll in leaves.
- Experiment finding the chlorophyll in leaves.

Activity Preparation

This lesson builds upon the previous lessons introducing the process of photosynthesis, focusing on light absorption by leaves to make their own food. The activity draws from the Monthly Recipe book for kale salad, which students make by massaging the leaves, breaking down the cells, and releasing the chlorophyll as the color of the leaves darken with pressure.

Wash kale leaves, and gather materials for kale salad dressing found in the Monthly Recipe book.

Materials

- Washed kale leaves
- Whisk and large bowl
- Salad dressing ingredients (oils, vinegars, lemon, salt, pepper)
- Small bowl for each student

Activity 1: Massaged Kale Salad Brings Out the Chlorophyll

Instruct students to wash their hands and review food safety practices they will need to follow when cooking together. There’s a fun glitter activity in third grade that demonstrates how germs transfer from one hand to another that could be helpful for reference here. Students follow the recipe to make kale salad step by step.

Distribute kale salad materials to each student and instruct them how to make kale salad by following these steps:

1. Break up kale leaves away from the spine.
2. Add salt and lemon to break down plant cell walls in the leaves.
3. Mash the leaves with your hands until texture becomes soft and the color becomes dark green.
**Ask,** What do you notice happening to the kale leaves when you massage them? (They get softer, darker green, and watery)

Review the functions of a leaf. Remind students that a leaf’s primary function is to absorb light and turn it into nutrients for the plant.

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**CA Health Standard 7.2.N**

Demonstrate how to prepare a healthy meal or snack using sanitary food preparation and storage practices.

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**NGSS Disciplinary Core Idea PS3.D: Energy in Chemical Processes and Everyday Life**

The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

**Ask,** What do you think makes the leaf green?

**Chloroplast** – it makes food for the whole plant!

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**Chloroplasts** are tiny factories inside the cells of plants. **Chloroplasts** take the energy from the sunlight and use it to make plant food. **Chlorophyll** is the green color in chloroplast, which makes the leaves green. When you squeeze the kale the green liquid that comes out is the chlorophyll.

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**NGSS Disciplinary Core Idea LS1.A: Structure & Function**

Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

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Students work in small groups to make the salad dressing following these steps:

1. Add a small amount of vinegar to the larger bowl.
2. Whisk oil in gradually as you add small amounts of honey and pepper.

**Ask,** What happens to the vinegar as you whisk in the oil?
Distribute small amounts of the salad dressing into the students’ bowls. Students taste the kale salads.

**Student Reflection**

What else needs light to make food? How is this different from how plants use light to make food?

**English Language Learning (ELL) Focus: Scientific Vocab and Figurative Language—Metaphors**

- The *chlorophyll* in leaves **suck up** the sunlight through the *chloroplast*.
- The *chloroplast* is a **sun-harvesting molecule**.

**Additional Information**

We can also see chlorophyll (or a lack thereof) when we make our compost piles. The browns, oranges, and reds of fall leaves are the colors "underneath" that are revealed after the chlorophyll (green) dies in the autumn leaves. We use these brown leaves to help make the perfect compost pile.

**Sources**

Food for Thought: Elementary Lessons on Nutrition and Healthy Living, Nutrition Services Branch of the North Carolina Division of Public Health

Snacking on Sunlight, School of Life Sciences, Arizona State University

K–12 Soil Science Teacher Resource, Soil Science Society of America
Dissecting Flowers

Objectives/Assessment Targets

Students will:

● Dissect flowers.
● Label each part.
● Identify each part’s function.
● Plant edible flowers.

Activity Preparation

This lesson builds on the 2nd grade two-part lesson on flower parts, where students first used their creativity to come up with their own names for each part based on their observations and then learned the scientific names of each part. Like the 2nd grade lesson, these activities could be instructed on different days as follow-up lessons, rather than all at once. They can also be done on rainy days in the classroom.

Collect flowers and place them in jars of water for each small group of students to use during flower dissections.

Materials

● Leaves and flowers such as foxglove, sweet pea, bean, lily, poppy, and apple blossoms (avoid composite flowers, such as daisies and sunflowers)
● Tweezers and magnifying glasses for students to get comfortable using instruments for experiments
● Flower seeds or starts
● Worksheet, Flower Part Diagram, page 5-6 in stent workbooks

Activity 1: Exploring Flower Parts

Review the 6 plant parts, focusing on the flower. This first activity invites students to get creative and look very closely at their flower specimen. Distribute flowers to students groups.

Demonstrate how to dissect the flower by gently
taking their flower apart. Invite them to look at the different pieces of the flower very carefully and explore their imaginations to come up with names for each part they observe based on what they notice (qualities such as size, texture, color, likeness). Using their worksheets, demonstrate how to take apart each piece of the flower, tape it onto their worksheets, describe each part using a key vocabulary word, and then name each part based on what they observe using their five senses. Prompt them to think about what they think each part of the plant is used for.

**NGSS Disciplinary Core Idea LS1.A: Structure & Function**
Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

**Ask:**
- What does this part look like? Does it remind you of anything?
- How would the flower use this part?

Students pair share or group share the names of the parts they came up with and why they named them that.

**Activity 2: Flower Parts and Functions**
Place undisturbed flowers for observation and dissection within each of the student groups. Recall the names of the parts that they had come up with in the previous activity. Review the different flower parts, their features, and their functions:

1. **Sepals:** green leaf-like parts under the petals that hold the petals together.
2. **Petals:** different colors, shapes, and smells designed to attract pollinators (bees and birds).
3. **Stamen:** the male part of the flower that holds the pollen at the very top.
4. **Pollen:** a powder-like grain that travels from flower to flower.
5. **Pistil:** the female part of the flower that holds the seeds.

*Figure 4 Figure 2 Copyright 1997-2017 Journey North (www.learner.org/jnorth).*
**NGSS Disciplinary Core Idea LS1.B: Review of 3rd grade. 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.

Students use the second worksheet for Flower Dissection to then label the parts that they just creatively named with the scientific names.

**Ask,** how are these names similar or dissimilar to the names you came up with for the same parts?

Describe the different leaf parts, their features, and their functions:

1. **Veins:** carry water throughout the leaf.
2. **Mid-rib:** the main vein that runs through the center of the leaf.
3. **Stomata:** very tiny openings, too small to see without a microscope, on the underside of the leaf that take in gas and diffuse it throughout the leaf.


Plants acquire their material for growth chiefly from air and water.

**NGSS Disciplinary Core Idea LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**

Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

**Ask,** how are these functions similar or dissimilar to the functions you imagined when you observed each part?

If some students need more challenge with scientific tools, provide these learners with tweezers and magnifying glasses for identifying the sepal, petal, pistil, and stamen, per the diagram below.

**NGSS Science/Engineering Practice 7: Engaging in Argument from Evidence**

Compare and refine arguments based on an evaluation of the evidence presented.

**Student Reflection**

By now, you may have dissected seeds, leaves, and flowers. What's important to know about dissecting plants? How do scientists learn from these dissections? What can they tell us about the plant? How can we use this information to support plant health?
English Language Learning (ELL) Focus: Contractions

- I'm thinking of __________.
- You're thinking of __________.

Additional Information

Consider planting these edible flowers for pest control:

- **Borage:** deters hornworms and cabbage worms and can help increase plant resistance to disease.
- **Chrysanthemums:** contains a chemical called pyrethrum that's toxic to insects but safe for humans and animals, used for repelling beetles.
- **Lavender:** repels pests, particularly fleas, moths, and mosquitoes, and smells great.
- **Marigolds:** the scented variety repels whiteflies from tomatoes and protects the health of soil under the plants.
- **Calendula:** resembles saffron, and the petals are edible.
- **Dandelions:** the stems and leaves can be salted or tossed in a salad, and the buds are tastier than the flowers.
- **Clover:** sweet and anise-like and can be used for teas.

Sources

Flower Power, The Growing Classroom, Life Lab

Figure 5 Students dissecting flowers and doing pedal smudging to understand the function of the pedals
Seed Dissection

Objectives/Assessment Targets

Students will:

● Dissect a seed/bean.
● Label the parts of a seed/bean.
● Write the function of each part.
● Plant seeds/beans.

Activity Preparation

This lesson builds on past content students’ learned about plant parts and seed dissection. The activity scales up scientific practices for dissecting seeds and explains why seed dissection is important for getting to know the plant parts and functions.

Prepare a whiteboard with the Seed/Bean Parts Diagram (see below). Gather examples of seeds (lentils, rice, coconuts, and sunflower seeds) to demonstrate the variety of seeds. Soak seeds/beans in jars of water for 24 hours. Layout paper towels for dissecting seeds/beans for teaching this lesson inside.

Materials

● Magnifying glasses
● Small paper cups with holes punched out in the bottom for drainage, or newsprint for making quick rolled compostable containers
● Paper towels and plastic baggies
● Soaked and un-soaked fava, pinto, or soybeans (any other large seed)
● Worksheet, Seed /Bean Part Diagram, page 7 in student workbooks

Activity 1: Examining Seeds

Show students the variety of seeds you collected and invite them to examine them carefully.

Ask:

● What kind of seed is it?
● Which plant does it come from?
● Is it edible or inedible?
● Are there unusual features that you notice?
• Can these features tell us something about the type of plant it will become?

Explain that seeds and beans come from flowering plants. Given the right amount of water, oxygen, and warmth, most seeds germinate and develop into mature plants. Seeds vary in physical appearance both on the outside and on the inside. Distribute the Bean/Seed Anatomy diagram in the workbook. Review the functions of the six parts of seed/bean anatomy in full germination:

1. **Seed coat**: a thin, protective outer covering of the seed.
2. **Hypocotyl**: becomes the plant’s stem and first root.
3. **Cotyledon**: the largest part of the seed, where the seed’s nutrients are stored.
4. **Epicotyl**: elongates so that cotyledons remain in the soil.
5. **Plumule**: becomes the plants’ leaves.
6. **Embryo**: the growing part of the seed.

**NGSS Crosscutting Concept: Structure and Function**
Substructures have shapes and parts that serve functions.

Demonstrate how to dissect a seed/bean by following these seven steps:

1. Inspect the outside of the beans and identify the seed coat.
2. Use your fingernails to carefully remove the seed coat from one of the beans.
3. With a fingernail, gently pry open the rounded side of the bean like a book.
4. Open the two halves of the bean.
5. Use the magnifying lens to study the inside of each bean half and identify the embryo.
6. Use the magnifying glass and the second diagram to identify the parts of a seed in full germination and identify the cotyledon.
7. Open several beans/seeds and compare their parts for differences in size, shape, and organization.

*Figure 6Science for Kids: Dissecting a Bean*
Students draw and label the different parts they observe

**NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations**

Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

**Activity 2: Germinating Seeds**

Students plant a bean that has been soaked in baggies between wet paper towels. Students place their names and date on the baggie. Keep these in sunny spots for a couple days and invite them to observe the bean’s germination when they come back to the garden. They will notice the radial extending and possibly a small leaf. Students can plant these in containers and watch them grow. Students can also plant non-soaked seeds straight into the soil.

**Student Reflection**

How many parts of the seed were you able to identify with the magnifying lens? What parts did you identify without a magnifying lens?

**English Language Learning (ELL) Focus: Verbs for Dissection**

- Inspect the outside
- Remove the seed coat
- Pry open the bean
- Spread the two halves open
- Examine the parts

Figure 7 Germinating seeds with wet paper towels and enclosed in plastic baggies labeled with dates, classroom teacher or number, and student names
Additional Information

Given the right amount of water, oxygen, and warmth, most seeds germinate and develop into mature plants. Seeds vary in physical appearance both on the outside and on the inside.

Sources

Bean Seed Cycle, National Agriculture in the Classroom
Department of Biology, Miami University
Education.com
Life Lab
Plant Parts and Functions, by Alisa Kowalski, Jessi Spry, and Alyson Wilson

Figure 8 Germinated seeds planted in plastic cups
Compost Pyramid

Objectives/Assessment Targets

Students will:

- Describe the compost pyramid.
- Identify FBI needed for decomposition.
- Document functions of FBI in decomposition.

Activity Preparation

This lesson builds upon the past plant science content students learned when looking more closely at chlorophyll, focusing on how the leaves turn brown when there’s a loss of chlorophyll and moisture. It reintroduces the role fungus, bacteria, and invertebrates (FBI) play in decomposition. The activity invites students to practice building compost piles with layers of browns and greens.

Prepare the whiteboard of the compost pyramid, including the role of fungus, bacteria, and invertebrates (FBI).

Materials

- Compost pyramid diagram
- Composting materials
- Samples in boxes or containers of compost with FBI in them
- Worksheet, FBI, on page 9 in student workbooks

Activity 1: Compost Pyramid

Review the ingredients for a perfect compost pile. Reference the compost pyramid below to show the layering of ingredients. Show examples of each layer: green leaves and food waste, and brown leaves and used napkin paper. Invite students to collect and layer browns and greens, stir it aerate it, and then add water.

NGSS Crosscutting Concept: Scale, Proportion, and Quantity

Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
**Activity 2: Decomposition (FBI)**

Show samples of compost with FBI. Share the role of the FBI: fungus, bacteria, and invertebrates. Review each step in the decomposition cycle:

1. Organic materials are converted to nutrients (FBI).
2. The soil brings the nutrients into the roots and through the plant.

*NGSS Disciplinary Core Idea LS2.A: Interdependent Relationships in Ecosystems*

Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants’ parts and animals) and therefore operate as ‘decomposers’.

*NGSS Disciplinary Core Idea LS2.B: Cycles of Matter and Energy Transfer in Ecosystems*

Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.
Students work in groups to examine the compost pile samples. Direct them to use their worksheets to identify at least one type of each FBI, note their name, write observations in full sentences, and note their key role in decomposition.

**NGSS Disciplinary Core Idea LS1.C: Interdependent Relationships in Ecosystems**
Decomposition eventually restores (recycles) some materials back to the soil.

If students are unsure of how to answer these questions, prompt them to use their imagination to help guide what they think their roles in decomposition might be and reflect on past lessons that may help them infer, or guess.

**Student Reflection**
Would the compost pile decompose over time without FBI, why or why not?

**English Language Learning (ELL) Focus: Figurative Language—Metaphors**
- The FBI **digest** the decomposing material to make food.
- The FBI are the intestines of the earth.

**Sources**
K–12 Soil Science Teacher Resource, Soil Science Society of America
Instructions: Write whether they are an invertebrate, fungus, or bacteria. Write how they help decomposition next to each.

Figure 10 Compost Critters
Digestion

Objectives/Assessment Targets

Students will:

- Identify processes in digestion.
- Compare digestion processes to decomposition processes.

Activity Preparation

This nutrition lesson builds on compost lessons, focusing on the role of decomposers. The activities can be scaled up for 5th grade and compare compost decomposition with human digestion. It may be best timed after the introduction to photosynthesis and chlorophyll lessons, since it references how plants are able to make their own food.

Prepare the whiteboard with a diagram of the digestive system. A 3D model of the human digestive system is a great teaching tool for this lesson, if available. Connect with your physical education teacher to relate this lesson to hydration and digestion when being physically active.

Materials

- Anatomy of body with digestive system (this isn't necessary, but a 3D version is helpful)
- Worksheets, Digestion, page 10 in student workbooks.

Activity 1: Decomposition Is Like Human Digestion

We all need energy to survive. Unlike plants that make their own energy out of sunlight, we eat food to make our energy. Explain that plants rely on decomposition in the same way that we rely on our digestive systems. Review the steps in digestion using the digestive system diagram.

1. Chewing in your mouth
2. Throat
3. Stomach breaks down food
4. Small intestine separates nutrients in foods
5. Nutrients absorbed in large intestine
6. Waste elimination of things you don’t digest

**NGSS Crosscutting Concept: Systems and System Models**
A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

**NGSS Disciplinary Core Idea PS3.D: 5th Grade Energy in Chemical Processes and Everyday Life**
The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

**Ask:**
- What do we eat that are hard to digest? (Ex. fibrous fava bean pods)
- What is the role of fiber in digestion?
- How is our digestion like the FBI’s decomposition?

Students use their worksheet on human digestion to list the six steps it takes for food to get from your mouth to your anus.

**Student Reflection**
What are the steps in the digestion process?

**English Language Learning (ELL) Focus: Figurative Language—Metaphors**
- We **digest** food to create energy.
- Digestions is like decomposition

**Additional Information**
Digestion is breaking up large molecules into smaller ones so that they can be absorbed into the bloodstream and used by the body. Decomposition is also breaking down organic matter from a complex to a simpler form, mainly through bacteria in the FBI.

**NGSS Disciplinary Core Idea LS2.A: Interdependent Relationships in Ecosystems**
Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants’ parts and animals) and therefore operate as ‘decomposers’. 

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Objectives/Assessment Targets

Students will:

- Experiment with how water supports digestion.

Activity Preparation

This lesson builds on the digestion lesson and scales up the concept that we need water for human digestion. It could be planned for a rainy day lesson in the classroom or in combination with a heavy garden watering day. The activities encourage students to drink more water and drink less sweetened beverages. Pair this lesson with a water rich snack from the Monthly Recipes book to teach students how to stay hydrated and eat water heavy fruits and veggies.

Materials

- Metamucil or other fiber supplement and 2 empty clear glasses to model how water helps digestion with an experiment
- Diagram of Water and The Human Body (below)
- Chart of produce high in water (below)

Activity 1: You Need Water For Digestion

We need water to start the digestion process. This is one of the many reasons why drinking water is essential for life. Demonstrate how nutrients and fiber are dissolved in water by adding different amounts of Metamucil fiber in the bottom of a glass and then adding water. Students complete their own experiments and record the results in their workbooks:

1. Put 1 tablespoon of Metamucil fiber into 2 glasses.
2. Fill each with a different glass volume of water (2oz, 8oz).
3. Stir the glasses and have students observe what happens to the fiber in each.

These 2 glasses demonstrate different states of hydration:

1. The first glass represents someone who is dehydrated. This person has had only 1 glass of water today. This person would probably feel constipated (finding it hard to go #2) - all because there isn’t enough water to absorb the fiber in their intestine, and they are probably feeling tired because there’s not enough water to move
nutrients into the cell where energy is made for the body. A major symptom of dehydration is feeling tired.

2. The second glass represents someone who has had enough water, which is about 6-8 glasses over the day and lots of fruits and vegetables that contain a lot of water. There’s enough water to form a gel around the fiber and allow it to pass through digestion, helping the person stay ‘regular’ so they can go #2 easily. There’s enough water to carry nutrients from foods within the bloodstream, so the person has good energy levels all day.

Ask:
- What percent of water is in our brain?
- What percent of water is in our blood?

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*California Health Standard 1.6.N*

Explain the importance of drinking plenty of water, especially during vigorous physical activity.

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**Student Reflection**

What role does water play in digestion? Why is it important to stay hydrated with water and not other drinks, such as energy and sports drinks or sweetened beverages?

**English Language Learning (ELL) Focus: Figurative Language—Metaphors**

- We stay hydrated to maintain energy.
- Water in our body is like other bodies of water, like rivers and streams
**Additional Information**

Water is critical for dissolving nutrients in our blood and transporting them throughout our body. Water helps regulate our body temperature. Water is also necessary to help fiber work properly in our digestive system.

**Sources**

Water You Made Of, Rethink Your Drink
Water Cycle

Objectives/Assessment Targets

Students will:

- Create a microhabitat for observing the water cycle.
- Illustrate the water cycle.

Activity Preparation

This lesson builds upon past lesson on cycles in nature. It scales up what students already learned about water conservation and water use in the school garden. The activities can be scaled up for 5th grade and introduce the water cycle. This lesson can be done inside for rainy days. The activities can be paired with measuring amount of rainfall with the rain gauge.

Materials

- Plastic bag
- Soil
- Small watering can or spray bottle
- Grass seeds
- Extra Credit: Worksheet, Water Cycle Quiz on page 13 in student workbooks

Activity 1: What is a Water Cycle?

Remind students that they already know about two different types of cycles: decomposition and human digestion.

Ask:

- What is a cycle? (a complete series of events)
- How does water travel in a cycle? (Water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow, drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration.)
- What else works in a cycle? (Decomposition and nitrogen)

Explain that:

- All of the water on the planet is all the water that we have forever.
- Water makes up three-fourths of the planet and three-fourths of our bodies.
- Most of the planet’s water is in the ocean.
- All living things need water to survive.
NGSS Disciplinary Core Idea ESS2.C: The Roles of Water in Earth's Surface Processes

Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

Outline each step in the water cycle:

1. A cloud that causes a big rainstorm
2. An arrow from the ocean to the cloud, labeled “evaporation”
3. An arrow from the cloud to the planet, labeled “precipitation”
4. A wiggly line across the board, labeled “rising temperatures”
5. Dashes from the wriggly line to the planet, labeled “evaporation”
6. Gathered dashes in the clouds, labeled “condensation”

Activity 2: Biome in a Baggie

Group students and distribute one of each of the following items to each student group: plastic baggie, bag of soil, grass seeds in a cup, and water in container.

1. Fill the bottom of the plastic baggie half way full with soil.
2. Make a half-inch well in the soil and add the grass seeds.
3. Cover the grass seeds with the soil.

Figure 12 The Water Cycle Quiz, https://www.proprofs.com/quiz-school/story.php?title=water-cycle-quiz_4

Figure 13 Student biome in a baggie experiments at Washington Elementary School Garden
4. Add enough water to seep through the soil.
5. Seal the plastic baggie and hang it up where light can get to it. Leave a small opening in the seal to allow air in.

Baggies can be clipped along a string or fence outside. In about four weeks you will see a plant growing. The plant uses the water cycle to recycle all the water it needs and has enough light from the sun to help regenerate the soil it uses for food.


Plants acquire their material for growth chiefly from air and water.

Review with students that:

1. There will be condensation on the inside of the bag from the water evaporating.
2. That condensation goes back into the soil through precipitation, like rain.
3. The plant’s roots absorb the water through the leaves and roots.
4. The leaves release water back into the biome to cycle all over again.

**Student Reflection**

Take the Water Cycle Quiz on page 13 in student workbooks.

**English Language Learning (ELL) Focus: Nouns to Verbs**

- Transportation > Transport
- Precipitation > Precipitate
- Evaporation > Evaporate
- Condensation > Condense

**Additional Information**

Water is essential to life on Earth. In its three phases (liquid, gaseous, and frozen), water ties together the major parts of the Earth/climate system—air, clouds, ocean, lakes, vegetation, snowpack, and glaciers. It influences the intensity of climate variability and change..

“Show Me The Water” is a short video, derived from the Science on a Sphere film Water Falls, that explores how Earth’s freshwater resources are allocated and used: [http://pmm.nasa.gov/education/videos/show-me-water](http://pmm.nasa.gov/education/videos/show-me-water).

**Sources**

Delaware River Basin Commission

National Aeronautics and Space Administration (NASA) Scientific Visual Studio (SVS)

The National Oceanic and Atmospheric Administration (NOAA) Education Resources
Weather and Clouds

Objectives/Assessment Targets

Students will:

● Define weather as a combination of sunlight, air, temperature, and moisture.
● List the ingredients for making a cloud.
● Observe an experiment that illustrates the formation of a cloud.
● Illustrate the process of cloud formation.

Activity Preparation

This lesson is best taught on a cloudy day. It can be scaled up for 5th grade lessons and be taught inside or outside. The activities experiment with making a cloud where students can observe the water cycle inside a glass jar.

Pour hot water into a thermos. Gather ice in a large Ziploc. Having a dark colored paper for a backdrop behind making a cloud helps students see the cloud in the jar better.

Materials

● Glass jar with a lid
● Hot water (a thermos helps keep it hot)
● Ice
● Dark colored paper for a backdrop

Activity 1: There Are Different Clouds

Review the different types of clouds and their characteristics with students.

Ask, What do various clouds look like? What can this tell us about weather?

Direct students to look up into the sky, or recall a cloudy day recently, and observe the cloud formations. Prompt them to notice the location of the clouds in the sky, if they are low to the ground or high up, etc. Review the different scientific names for common clouds:

1. **Stratus**: low-level cloud characterized by horizontal layering with a uniform base
2. **Cirrus**: generally characterized by thin, wispy strands
3. **Cumulus**: puffy or “cotton-like,” with a flat base
4. **Cumulonimbus**: dense, towering vertical cloud associated with thunderstorms
**NGSS Crosscutting Concept: Patterns**

Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.

**Ask:**

- What are clouds made of?
- How does this relate to the water cycle?

**Activity 2: Weather Experiments - Making a Cloud**

Explain that weather is a combination of sunlight, air, temperature, and moisture. We need moisture, dust particles, and temperature change to make a cloud.

**NGSS Disciplinary Core Idea ESS2.A: Earth Materials and Systems**

Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth’s surface materials and processes.

Demonstrate how to make a cloud in a jar by following these steps:

1. Fill the bottom of the glass jar with an inch of hot water. Moisture and warmth are provided by the hot water.
2. Swirl the hot water on the sides of the jar to warm up the glass.
3. Light a match. The smoke from the match provides a surface for the condensation, which produces tiny cloud drops.
4. Blow it out.
5. Throw the smoking match inside the jar quickly.
6. Replace the lid.
7. Place bag of ice on top of the lid. As this moist, warm air rises in the jar, it gets cooler at the top of the jar near the ice. When the water vapor cools, it turns into liquid through condensation.

*Figure 14 Students observe a cloud formation in a glass jar at Thousand Oaks Elementary School Garden*
8. Hold the jar against a dark backdrop to observe the formation of a cloud.
9. Lift the lid so students can touch the cloud. The cloud swirls inside the jar because of the circulation of warm air rising and cold air sinking.

Students observe cloud patterns, condensation, and how sunlight, air, temperature, and moisture interact with each other. Instruct students to draw illustrations of what they observed in their journals. Students label sunlight, air, temperature, and moisture in their drawings.

**Ask**, What is necessary for a cloud to form?

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**NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations**

Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

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**Figure 15 Basic Cloud Formation diagram, Climate Education for K-12, http://climate.ncsu.edu/edu/k12/.cloudformation**
**Student Reflection**

What do you think happens to the cloud when it is release from the jar into the atmosphere?

**English Language Learning (ELL) Focus: Nouns to Verbs**

- Transportation > Transport
- Precipitation > Precipitate
- Evaporation > Evaporate
- Condensation > Condense

**Additional Information**

Cirrus clouds are the most common of the high clouds. They are composed of ice and are thin, wispy clouds blown in high winds into long streamers. Cirrus clouds are usually white and predict fair to pleasant weather. By watching the movement of cirrus clouds you can tell from which direction weather is approaching.
Mapping Your Watershed

Objectives/Assessment Targets
Students will:

- Make a map of Berkeley's watershed.
- Simulate the effect of pollutants on the watershed.

Activity Preparation
This lesson dives deeper into the concept of water. The activities draw from past lessons on mapping our garden and locating natural resources. This lesson can be extended to two lessons if you have students make their own watershed maps.

Get familiar with the watershed on your campus. Ask the teacher if they are interested in following up on this big idea beyond one lesson in the garden.

Materials
- Large butcher paper
- Cardstock paper
- Permanent markers with multiple colors, one washable in a bright color and one in blue (represents the contaminates and rain water)
- Tape to fasten to a wall if you are hanging the watershed map
- Filled spray bottle with water
- Worksheet, Mapping Your Watershed, page 14 in student workbooks
- A map of Berkeley’s Watershed, page 15 in student workbooks

Activity 1: What Is a Watershed?
Explain to students that everyone lives in a watershed. Watersheds include water that is above and underground and support habitats of all kinds.

Ask:
- Where do you get your water?
- Where do we get water for our garden?
**NGSS Disciplinary Core Idea ESS2.A: Earth Materials and Systems**

Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

There are ten major creeks in Berkeley that make up the Berkeley watershed, including Wildcat Creek, Codornices Creek, Strawberry Creek, Derby Creek, and Hardwood/Temescal Creek.

Prompt students to think about their watershed at their school. Show students a watershed map, below of Berkeley. A watershed map indicates the location of above-ground and below ground water sources.

Watershed maps also indicate where the land is permeable (water seeps up through the surface) and where it is impermeable (water cannot seep up through the surface). Permeable spaces include soils and gravel. Impermeable land is covered with concrete, asphalt, and cement. Water can only be absorbed by permeable soil.

**Ask:**
- Where are some permeable and impermeable surfaces around school?
- How does water get through these permeable surfaces?
- What happens to water if it can’t get through the surfaces?

**Activity 2: Mapping Your Watershed**

We use maps to plan safe locations to grow food, where the water is of good quality, without pollutants, and far away from public drains that may carry pollutant garden water to the ocean. Create a watershed map of the garden together. Demonstrate that the paper represents the land and show how to note cardinal directions. Invite students to come up and draw a feature on the map that is in the garden using the appropriate marker color to represent each feature, such as garden beds, trees, walkways, and water sources. Have students add other bodies of water with a blue marker, such as a creek, or other water source. Note on the map whether a space is permeable (allows water to seep through) and impermeable (doesn’t allow water to seep through) spaces found along our watershed.

Next, students will locate where contaminants could be found, or added by other forces. Invite students to draw on the map the contaminated represented by a dot and label it with a colored marker. Contaminates could include, natural and non-natural pesticides, rain pollution, etc.
**NGSS Disciplinary Core Idea ESS3.B: Natural Hazards**
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.

**NGSS Science/Engineering Practice 2: Developing and Using Models**
Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

Add lines across parts of the map where water cannot be absorbed. Crumple up the paper to represent varying topographies. Tape their paper to a wall or vertical area. Use the spray bottle to lightly mist the paper to represent rain. The brightly colored markers represent pesticide residuals that run into waterways. Students share what they observed when the “rain” fell on their land (permeable and impermeable).

**Ask**, What are other types of contaminants that get into watersheds, and how do they get there?

Prompt students to recall the types of living organisms that live in watersheds. Students share what they think might happen to organisms that live in these watersheds when pesticides end up there.

**Student Reflection**
What happens to pesticides and other contaminants in urban areas when they get washed into the watersheds?

**English Language Learning (ELL) Focus: Prepositions for Water**
- Permeable land allows water to **seep through** to the surface.
- Impermeable land blocks water so it cannot **seep through** to the surface.
- Contaminated water **runs into** waterways.
- Contaminate water **washes into** waterways.

**Additional Information**
You can access a watershed map of Oakland and Berkeley to demonstrate to students here: https://www.museumca.org/creeks/MapOak.html.

**Sources**
Explore Your Watershed, Rangers in the Classroom, National Park Service
University of California, Berkeley, Strawberry Creek Watershed
Figure 16 Historic Creek Maps, Friends of Five Creeks
Soil Sampling

Objectives/Assessment Targets

Students will:

- List the components of soil.
- List the composition of loam.
- Test soil samples from the garden for their loam content.

Activity Preparation

This lesson can be scaled up for 5th grade and uses a pie chart to teach students about soil composition. The activities guide students in experimenting with preparing different soil compositions and identifying the composition that supports plant growth.

Prepare the four soil samples in jars, one with mostly sand, the other mostly silt, the other mostly clay, and then the other a mixed loam. If students are digging for their own soil samples, flag spots in the garden you want them to dig. Draw the Soil Composition pie chart on the whiteboard.

Materials

- Soil samples with gravel, sand, silt, and clay in four separate trays
- Glass jars with lids (one for every three to four students)
Activity 1: Understanding Soil

Inform students that they will make mud pies out of garden soil to determine whether the soil has good composition for growing plants. Direct students to help you dig a hole at least six inches down to get the soil sample. (Scraping the surface will not give you a true sample of the garden soil texture).

Invite them to grab a handful and observe what they notice. Scoop up a soil sample and add it to a glass jar. Mix it well, adding water as needed to create a sticky soil (it should not ooze through your fingers, rather make a good mud ball). Invite students to mimic your soil sampling. Plants need organic matter and minerals to thrive. They get this mainly from soil composition in the form of abiotic and biotic materials.

Abiotic components of soil are the minerals. Explain that gravel, sand, silt, and clay are all tiny rocks of various sizes. Rocks are broken down and eroded over thousands of years to become sand, silt, and clay.

Draw a pie chart on the whiteboard to illustrate that soil is 40% sand, 40% silt, and 20% clay. This is called “loam.”

Biotic components of soil are organic material (FBI). The organic material (plants and leaves) combine with water and air to keep the rocks together.

Students observe similarities and differences between the samples. Invite students to touch the contents and organize them in two groups: abiotic (minerals) or biotic (organic matter). If students need more challenge, have them create a T-Chart that lists the materials by name according to abiotic or biotic.

NGSS Science/Engineering Practice 4: Analyzing and Interpreting Data

Represent data in tables and/or various graphical displays to reveal patterns that indicate relationships.
NGSS Disciplinary Core Idea ESS2.A: Earth Materials and Systems
Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Activity 2: Loam Tests
Divide students into groups with the names Sand, Silt, Clay, and Loam. Direct each group to a section of the garden where they can dig one or two scoops of dirt into plastic containers. Students use masking tape and markers to label their containers according to where in the garden they found the soil and their group name. One student from each group adds water to their container to make a mud pie consistency and close the lids on each jar tightly. Each student takes a turn shaking or mixing the container until the water is mixed in. Students observe what happens to the contents in the jar over time (about a minute).

Ask, Which jar has mostly sand, silt, or clay? How do we know this?

NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations
Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Place masking tape on each jar and label each one “sand,” “silt,” or “clay” according to the answers to questions above.

Prompt them to look for contents that fall to the bottom of the container first. Tell them that sand is the heaviest particle and will reach the bottom the quickest. The top layer will be clay, which includes the smallest, lightest particles. The middle layer will be silt.
Ask, Which one of the soil samples (sand, silt, or clay) is closest to loam?

NGSS Science/Engineering Practice 4: Analyzing and Interpreting Data
Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.

Students compare their initial determination with the results of this soil test.

Ask, Why would loam be the best condition for growing plants? (The consistency holds the most nutrients and allows for roots to dig and stems to grow.)

Student Reflection
Vegetables grow best in loam soil. What happens when the soil gets too much water from rain? What can we do to change the composition of our soil to make the perfect balance of sand, silt, and clay?

English Language Learning (ELL) Focus: Verbs for Science
- Observing soil samples
- Analyzing soil samples
- Comparing soil samples
- Testing soil samples

Additional Information
Gardeners add sand or organic matter to bring the percentages closer to that of loam.

Sources
Nitty Gritty, Life Lab
Health and Nutrition from the Garden, Agricultural Communications, The Texas A&M University
Soil Erosion

Objectives/Assessment Targets

Students will:

- Observe and hypothesize the results of erosion tests.
- Compare the effects of various amounts of organic material on erosion.

Activity Preparation

This lesson can be scaled up for 5th grade or down for 3rd grade. It dives deeper into the concept of soil composition. The activities conduct experiments with the quality of organic matter to affect soil erosion. The second activity invite students to role play the steps in an erosion narrative.

Prepare three trays of soil: one with organic materials (sticks, roots, leaves, dead bugs, and other rotting plants); one with living organisms (worms, roly-poly, and centipedes), and one with various sizes of rocks (pebbles, sand, silt particles). Make sure that each tray has different amounts of organic materials (grasses and roots) so that the erosion experiment demonstrates how water drainage affects erosion with less and more organic material.

Materials

- Three trays of soil with varying amounts of organic matter
- Narrative Cards (laminated so you can re-use these) below in Activity 2.

Activity 1: What Causes Erosion?

Show the trays of soil with different amounts of organic material in them.

Ask:

- What’s the difference between each tray?
- What do you think will happen when I pour water into each one, at the same rate and amount?
Invite them to be scientist testing for erosion. Students hypothesize what they think will happen to each tray.

**NGSS Science/Engineering Practice 1: Asking Questions and Defining Problems**
Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

**NGSS Science/Engineering Practice 2: Developing and Using Models**
Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

Prop the trays up on a slope to demonstrate how erosion occurs when water is added to the trays. At the end of the experiment, lift the plants to show them the roots that are wound around the soil, holding it in place.

**Ask:**
- Were the results different from your hypothesis, why?
- What role did the organic material play and what role did the soil (salt, silt, clay, or loam consistency) play?
- What other ways can soil erode?

**Fun Facts:**
- The three main causes of erosion are wind, water, and glaciers (large masses of frozen water).
- One inch of topsoil can be removed from land by erosion in one year.
- Erosion is a problem because it takes 600 years or more for nature to create one inch of topsoil.

**NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations**
Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

**Activity 2: Erosion - The Story**
Distribute the Narrative Cards (there are three sections, part I, part II, part III). Start with part 1. Invite conversation about which one would go first if there are more than one hands raised.
**Ask**, who thinks they have the first part of the story?

**Part I: Erosion**

1. A mountain stands alone.
2. An earthquake rumbles the Earth.
3. A boulder breaks off of the mountain... we call this EROSION!
4. Erosion breaks down big rocks into smaller rocks.
5. Erosion breaks smaller rocks into pebbles.
6. Erosion breaks pebbles into sand.
7. Erosion breaks down sand to silt.
9. Sand, silt, and clay mix together to make LOAM.
10. Sand and other parts of loam are not alive. We call this ABIOTIC. End of Part I!

**Part II: Organic Material**

1. Animals and plants die...we call their decomposing bodies ORGANIC MATERIAL.
2. A worm eats a dead animal. Fungus and bacteria help, too!
3. The FBI (fungus, bacteria, and invertebrates) digest organic material.
4. The FBI are alive! We call this BIOTIC. End of Part II.

**Part III: SOIL**

1. The sand, pebbles, rocks, abiotic, organic material, and biotic things all mix together.
   - We call this SOIL!
2. Soil is cared for by living things like earthworms, plants, farmers, and gardeners.
3. We plant seeds in the soil.
4. Sunlight, water, and air help the seeds grow.
5. The seed grows roots.
6. The roots grow up into seedlings.
7. Time passes. We wait for seedlings to grow into bigger plants.
8. We harvest the plants.
9. We wash the plants. We eat the plants. Yum!
10. The end? End of Part III.

**Activity 3: Preventing Erosion**

Students turn over the compost pile to aerate and allow for drainage, prepare beds with mulch to retain water and heat, and plant seasonal seeds to reinforce soil with organic matter.
Student Reflection
What can be done to stop erosion on hills and fields nearby? What would happen to our plants if all the topsoil washed away?

English Language Learning (ELL) Focus: Would, Should, Could

- If all the topsoil washed away, our plants would __________.
- To stop erosion on hills and fields nearby, we could ______________
- To stop erosion in our garden, we should _______________

Additional Information
Do you and/or your collaborating teacher want to dive deeper? Conduct further investigations on erosion and have students research and journal about their predictions, findings, and what surprised them: http://www.uen.org/Lessonplan/preview?LPid=9862

Sources
“Slip Sliding Away,” Utah Education Network
**Objectives/Assessment Targets**

Students will:

- Explain mutualism and mutualistic relationships between plants and animals.
- Match animals and plants by their mutualism.

**Activity Preparation**

This lesson builds on previous content about interdependence, scaling up the idea that plants and animals depend on each other to survive. The activities can be scaled up for 5th grade.

**Materials**

- Animal pictures
- Diagram of plant parts and flower parts
- Worksheet, Mutualism on page 19 in student workbooks

**Activity 1: Matching Mutualistic Relationships**

Mutualism is when two organisms of different species (a plant and an animal) exist in a relationship where each individual benefits. Explain that plants and animals have mutualistic relationships, such as plants create habitats for certain animals, which in turn fertilize them.

**NGSS Disciplinary Core Idea LS2.A: Interdependent Relationships in Ecosystems**

Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.

A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.
Students use Mutualism worksheet on page 19 in their workbooks to match the plant with the animal based on how they mutually support each other. Instruct them to fill in the missing information in order to match mutualistic species and plants.

Student Reflection
For example, mutualism supports evolution in flowering plant species that showed up 90–130 million years ago. Approximately 750 species of fig tree are pollinated by approximately 750 species of fig wasps. Are there other examples of relationships like this in nature?

English Language Learning (ELL) Focus: Nouns two Adjectives
- Mutualism
- Mutualistic

Additional Information
An extreme form of mutualism, called an obligate mutualism, occurs when the interdependence between a plant and a pollinator is so specific that no other organism can take its place. In this case, one specific pollinator is required to pollinate one specific plant, and that pollinator needs that specific plant in turn. This is the most precarious kind of mutualism, because if one partner becomes extinct the other can’t survive and goes extinct.

An example of an obligate mutualism is the yucca plant and the yucca moth. The yucca plant is dependent on the yucca moth to pollinate its seeds. The yucca moth larvae cannot survive without yucca seeds to eat. The system works because the larvae eat only some—not all—of the seeds.

Sources
Honey Bee Suite
North American Pollinator Protection Campaign (NAPPC)
Mix and Match Mutualism Worksheet

**Instructions:** Fill in the blanks to match the plant with the animal. Describe how they are mutualistic (help each other out).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Animal/insect</th>
<th>How they are mutualistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>An insect</td>
<td>The insect pollinates the flower to help with reproduction</td>
</tr>
<tr>
<td>A plant with huge leaves that creates a shaded dark area</td>
<td></td>
<td>Protection from herbivores</td>
</tr>
<tr>
<td>A plant with yellow flowers</td>
<td></td>
<td>Retains water</td>
</tr>
<tr>
<td></td>
<td>A mammal with fur</td>
<td></td>
</tr>
</tbody>
</table>
Insect Anatomy

Objectives/Assessment Targets

Students will:

- Label basic anatomy of an insect.
- Name a common garden problem that has to with insects and why (too many bees, not enough butterflies)
- Conduct an investigation on how to solve this common garden problem.

Activity Preparation

This lesson builds on what students know about compost critters. It scales up the concept of interdependence between the garden and the insects that inhabit it.

Gather a selection of different insects in the compost and flag places in the garden that have insect homes, such as caterpillar chrysalis, .

Materials

- Diagram of insect anatomy
- Worksheet, How Do Insects Benefit The Garden?, page 22 in student workbooks

Activity 1: Describing Insects

Invite students to be scientists and practice using scientific vocabulary to conduct an experiment on how insects support or don't support the garden. Explain that entomology is the study of insects and bugs. Entomologists study bees, ants, beetles, termites, and mosquitoes as well as related animals (known as arthropods), such as spiders and scorpions.

Ask, How do we know it's an insect?

Fun Facts:

- All insects have six legs, three body sections (head, thorax, abdomen), and usually two pairs of wings.
- Insects include flies, mosquitoes, bees, crickets, dragonflies, beetles, butterflies, and many others.
- Spiders, ticks, and centipedes are not insects. One feature that sets them apart from insects is the fact that they have more than six legs.
NGSS Crosscutting Concept: Patterns
Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.

Show them the anatomy of insect diagram, also in their workbook.

Ask, Are there similarities to our human bodies?

Show the diagram and prompt students to share out each part.

- Six legs
- Three body parts (head, thorax, and abdomen)
- Hard exoskeleton
- Compound eyes
- Antennae
- Wings

NGSS Disciplinary Core Idea LS1.A: Structure & Function
Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Ask, what are the behaviors of insects that allow them to survive in their environment?

Insects can be herbivores (eat only plants) or carnivores (eat only meat). Some insects are pests to humans: mosquitoes feed on mammalian blood, aphids and scale insects infest our gardens, and wasps produce a nasty sting. Most insects are beneficial: bees, beetles, and butterflies pollinate our gardens and crops, making possible such foods as chocolate, nuts, and most fruits. Some insects are decomposers, helping to break down dead material. Other insects, like ladybugs and praying mantises, feed on pest insects.

Activity 2: How Do Insects Benefit the Garden?

Some insects are beneficial and others are pests, we need to be aware of how insects are affecting our garden. There may be too few insects, because there are not enough flowers turning into fruits (lack of pollination), or a lot of mosquitoes biting kids (too much standing water where mosquito larvae hatch). Prompt students to think about the microhabitats in the garden where insects could thrive in a mutualistic way.
Ask, Can you think of a problem or benefit in the garden that involves insects?

NGSS Science/Engineering Practice 1: Asking Questions and Defining Problems
Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Students use their worksheets, How Do Insects Benefit The Garden, in their workbook to identify a problem they would like to solve. Propose a hypothesis for how the problem could be solved and create an experiment to test their hypothesis. For example: the problem is that we have mosquitoes that bite kids. The solution is that mosquitoes can be avoided by removing standing water. The experiment is removing standing water from one section of the garden and not from another and then comparing which section has more mosquitoes over time.

NGSS Science/Engineering Practice 6: Constructing Explanations and Designing Solutions
Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.

Student Reflection
Why is it important to try to solve problems in the garden using hypotheses and experiments?

Additional Information
Revisit this worksheet with students in the following weeks so they can observe their experiments and record their final observations (what happened, what worked, what didn’t work, how they could do it better).

English Language Learning (ELL) Focus: Conditional Statements
- If there are not enough flowers in the garden, then ____________.
- If there are too many mosquitos in the garden, then ____________.

Sources
Dr. Toby Schuh, an entomologist at the American Museum of Natural History
Honey Bee Suite
North American Pollinator Protection Campaign (NAPPC)
How Do Insects Benefit the Garden?

Definitions:
Identify the Problem: A situation that is bad for the garden.
Create a Hypothesis: A proposed answer to how to solve the problem.
Conduct an Experiment: The act of conducting a controlled test or investigation to test the proposed answer to the question
Make Predictions: Best guesses for what will happen during the experiment.

Problem: ________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Hypothesis: ______________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Experiment: ______________________________________________________________
________________________________________________________________________

Predictions: ______________________________________________________________
________________________________________________________________________
________________________________________________________________________

Final Observations: ________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Pollinators

Objectives/Assessment Targets

Students will:

- Observe pollinators in the garden using a “sit-spot” activity
- Plant pollinator attractors

Activity Preparation

This lesson builds on past pollinator and interdependence lessons.

Prepare 3 (or more) sets of cards with each fun fact/pollinator/follow-up question on a different color cardstock (Facts below; Cards might do well laminated). Card colors correlate with colors that pollinators are attracted to (ex: yellow, pink, blue). Hide them in the garden and have them ready for students to search for at the beginning of each period. Devise a strategy for splitting up students into groups. Print visuals for the Pollinator sit-spot activity.

Materials

- Cards with fun facts/examples of pollinators/follow-up questions written on them in multiple colors (See “Fun Facts section below)
- Worksheet, Citizen Science “Sit Spot” page 22 in the student workbooks
- One-bite garden snack that was made possible via pollination

Activity 1: There Are Many Different Pollinators

Ask:

- What are pollinators?
- Why do we need pollinators?
- What pollinators might be present at our school, and how can we protect them?

Introduce the many different types of pollinators, per the additional information section. Pollinators are attracted to plants and flowers that have particular smells and colors.

NGSS Disciplinary Core Idea LS1.A: Structure & Function

Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.
Invite connections to human civilizations, class content, and daily life connections (inside the classroom). Let students know we will be doing a scavenger hunt to become more familiar with pollinators and then we will do an observation activity to become more familiar with the pollinators in our garden.

Invite students to read a fact from the set below in the additional information and discuss the various implications, such as lack of water, heat, lack of plants and flowers, etc. Direct students to find a quiet place with flowers to observe for pollinators using their Citizen Science “Sit Spot” - Pollinators Worksheet in the student workbooks.

| NGSS Science/Engineering Practice 4: Analyzing and Interpreting Data |
| Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. |

Reference broader citizen science efforts to support healthy pollinator environments, like the great sunflower project.

| NGSS Science/Engineering Practice 8: Obtain, Evaluate, and Communicate Information |
| Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. |

### Student Reflection

Why is it important to try to create safe habitats for bees in our garden? Why is it important to study pollinators in their habitats?

### Additional Information

- Pollinators are responsible for bringing us an estimated 1 out of every 3rd bite of food.
- They assist 90% of the world’s flowering plants to reproduce, and provide an indispensable food source for countless other animals.
- In order for the fruit and seeds of plants to develop, pollen has to be transferred between two flowers of the same species (or sometimes just within a single flower), which fertilizes it and enables the production of viable and healthy seeds on the plant.
- At a very basic level, without sufficient numbers of pollinators, we couldn't grow the crops we need for food, as it's estimated that 1/3 of our food crops require pollination.
- 3/4 of our staple crops rely on pollination.
- Pollinating crops without the aid of insects, bats, and birds, would be virtually impossible, or at least financially unsustainable.
- Honeybees are responsible for the production of over $19 billion in food crops each year (just in the US), but there are a number of other pollinators that are important to plant reproduction, and in turn, our own survival.
Bats, birds, ants, beetles, flies, butterflies, moths, wasps, and even small mammals all play important roles as pollinators, and due to the influence of our actions, habitat loss, irresponsible pesticide use, and diseases are all taking their toll on pollinator populations.

**English Language Learning (ELL) Focus: Conditional Statements**

- If there are not enough flowers in the garden, then ____________.
- If the garden is too hot or cold, then ____________.

**Sources**
Longfellow Middle School Garden Project-Based Learning Lesson, Pollinator Habitat
UC Berkeley Bee Lab
Planet Bee Foundation
Plant Families

Objectives/Assessment Targets
Students will:

- Identify how plants are alike and how they are different
- Group plants according to their plant families

Activity Preparation
This lesson builds on methods for using scientific classification for organizing plants and animals. It scales up 3rd grade lessons about plant families.

Write the classification of plant families on the board.

Materials

- Photo or samples of followers in the same plant families, such as roses, potentillas, and morning glories
- Worksheet, Classification of Plants: Plant Family Chart, page 23 in student workbooks
- Samples of plant starts in different and the same plant families

Activity 1: Tracing Plant Families
Tell students that botanists group seeds/plants into groups called plant families. “Family” is an official botanical classification that is important to gardeners and scientists. Plants in the same family share features and characteristics. In botany, the word “family” has a definite meaning that extends beyond what flowers and plants may look alike. Looks are not always the common denominator. Show and discuss examples of plants that may not look alike, but are in the same family; below are two prominent wildflower families represented in North America

NGSS Crosscutting Concept: Patterns
Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.

Acanthus family (Acanthaceae): These wildflowers are similar to the snapdragon family but are distinguished by having seeds attached to a two-cavity capsule. Many of the species
of this family can be found in rich, moist woods. The Midwestern native wild petunia is a famous member of the Acanthus family.

**Amaranth family (Amaranthaceae):** A weedy family with inconspicuous flowers made up of 71 genera and about 800 species, mostly herbs. “Amarantos” is a Greek word meaning “unfading” referring to the fact that if moistened with water, many of the species in this family will revive. Most members of this family have a sort of plumed flower cluster. Garden cockscomb is a showy member, and one of the world’s most common weeds, pigweed, is an amaranth.

Distribute the plant starts to student groups.

**Ask,** What is different about these plants and what is the same?

**Student Reflection**

How is your family like a plant family?

**English Language Learning (ELL) Focus: Collective Nouns**

- _____ are **members of** the _____ family.
- _____ belongs to the _____ family.

**Additional Information**

Plants are classified in several different ways. The further away from the garden we get, the more the name indicates a plant’s relationship to other plants. Usually, only the family, genus, and species names are of concern to the gardener, but we sometimes include subspecies, variety, or cultivar to identify a particular plant.

**Sources**

Getting to Know Plant Families, Eat Think Grow, Portland Partners for School Food and Garden Education

Plants (Botany), Teacher Vision
Classification of Plants

Objectives/Assessment Targets

Students will:

- Describe various features of common plants grown in the garden.
- Group different plants into plant families.
- Make seed saving packets by plant family.

Activity Preparation

This lesson builds on past content students learned about categorizing plants and animals. It focuses on using scientific terms for organizing plants by their Family. Students practice organizing plants into Families through seed saving activities.

This lesson can be taught inside. Prepare the whiteboard with a list of the plant families below and create seed cards for each family (you can create seed cards with students instead with the steps 1-5 below in Activity 2).

Materials

- Dried plants for students to harvest seeds from.
- Making Seed Cards
  a. Heavy paper stock for seed cards
  b. Scissors and glue
  c. Markers and tape
  d. Colored pencils
- Plant Family chart
- Seed packets (variety with pictures and descriptions) for students to use for organizing plants by Families.
- Worksheet, Classification of Plants, page 24 in student workbooks.

Figure 21 Diagram or origami seed saving packets adapted from Seeds of Diversity Canada’s "How to Save Your Own Seeds"
Activity 1: Matching Seeds to their Plant Families

Describe how botanists organize plants into groups they call “Plant Families.” Present the plant Family chart below and discuss the characteristics of the plants in each family. Distribute different seed packets. Students study the seed cards you have been given. Prompt them to think about the features they observe, without getting too focused on whether they are in the same Family. Direct students to share-out the common features of the plants in the different packets. For example, the squash plant has similar leaves as the cucumber plant.

Students use their worksheet, Classification of Plants, on page 24 in student workbooks to list the features in each seed packet to sort into Families. Direct students to compare the seeds according to color, shape, size, and other features they notice.

NGSS Disciplinary Core Idea LS3.B: Variation of Traits 3rd Grade Review
Different organisms vary in how they look and function because they have different inherited information.

NGSS Science/Engineering Practice 4: Analyzing and Interpreting Data
Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.

Activity 2: Making Seed Cards

Demonstrate how to harvest seeds from dried plant pods. Invite students to do the same and collect their seeds in their seed cards. Students use the seed cards they made to harvest seeds from dried plants of the same family.

Demonstrate how to make origami seed packets using the steps 1-5 in Figure
Students write their name and date on the packets. Invite them to get creative with the name of their seed packets using descriptive words that relate to the types of seeds inside. Students place the seeds collected into these packets and label them by the plant seeds inside.

**Student Reflection**

What Family does your favorite vegetable belong to?

**English Language Learning (ELL) Focus: Collective Nouns**

- X are **members of** the X family.
- X **belongs to** the X family.

**Sources**

Variations in Families/Populations of Plants, The Science Behind Our Food.
**Plant Family Chart**

**Instructions:** Study the seed cards you have been given. List the features and characteristics you observe or have learned about each seed.

<table>
<thead>
<tr>
<th>Plant family</th>
<th>Their plants</th>
<th>Shared features and characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apiaceae</td>
<td>Carrots, celery, celery root, cilantro, dill, fennel, parsley, parsnip</td>
<td></td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Artichoke, chicory, dandelion, endive, lettuce, sunflower, tarragon</td>
<td></td>
</tr>
<tr>
<td>Brassicaceae</td>
<td>Arugula, broccoli, Brussels sprouts, cabbage, cauliflower, collards, cress, kale, kohlrabi, mizuna, mustard, radish, rutabaga, tatsoi, turnip, watercress</td>
<td></td>
</tr>
<tr>
<td>Chenopodiaceae</td>
<td>Beet, orach, spinach, Swiss chard</td>
<td></td>
</tr>
<tr>
<td>Convolvulaceae</td>
<td>Sweet potato, morning glory</td>
<td></td>
</tr>
<tr>
<td>Cucurbitaceae</td>
<td>Cantaloupe, cucumber, gourd, loofah, melon, pumpkin, summer squash, winter squash</td>
<td></td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Beans, peas, peanuts, soybeans</td>
<td></td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>Basil, lavender, marjoram, mint, oregano, sage, savory, thyme</td>
<td></td>
</tr>
<tr>
<td>Liliaceae</td>
<td>Asparagus, chives, garlic, green onions, leeks, onions, shallots</td>
<td></td>
</tr>
<tr>
<td>Malvaceae</td>
<td>Okra, hollyhock, hibiscus</td>
<td></td>
</tr>
<tr>
<td>Poaceae</td>
<td>Corn, wheat, barley, rice</td>
<td></td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Eggplant, sweet pepper, hot pepper, potato, tomato</td>
<td></td>
</tr>
</tbody>
</table>
Count It Up

Objectives/Assessment Targets

Students will:

- Read nutrition fact labels to identify sugar.
- Convert sugar grams into sugar teaspoons.
- Measure different amounts of sugar found in sweetened beverages.

Activity Preparation

This nutrition lesson reveals the hidden sugars in sweetened beverages. The hands-on sugar demonstration makes amounts of sugar in each beverage tangible. The goal of this lesson is to encourage students to reduce the amount of sugar they consume.

The lesson can be scaled up or down for all grades and can be taught inside. Cut out the Count The Sugar Cards, laminate, and distribute one for each student during the counting activity.

Materials

1. Worksheet, Count It Up, on page 25 in student workbooks.
2. Sugar packets or cubes (1 packet or 1 cube = 1 teaspoon)
3. 1 spoon per each pair of students.
4. Samples of soda cans, cereal boxes available for students to read labels and count out teaspoons of sugar
5. 1 sugar cane, if available from the garden, to demonstrate what sugar looks like before it’s processed.

Activity 1: How Do We Digest Sugars?

Review past lessons about added and natural sugars found in commonly eaten foods and beverages. Sugars are either natural or added. Natural sugars are found in whole foods, like fruits and veggies. Added sugars are those found in processed foods, like soda and candy. Regardless of the type of sugar, it goes straight to our guts and brains, making us SPEED up and then...
SLOW down. The sugars we find in, say an apple, are natural occurring sugars. An apple has fiber that helps us digest the sugars at a much slower rate, thus not giving us a “sugar rush.”

**NGSS Disciplinary Core Idea LS1.C: Organization for Matter and Energy Flow in Organisms 5th Grade Review**

Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.

Sugar that is processed to refined sugars from sugar cane (sample sugar cubes), like the sugar you add to baked goods, like cupcakes, are called added sugars. They are different from natural sugars, because there is no fiber to help us digest it slowly. Added sugars are rushed through our bodies (hence sugar rush), which elevates our blood sugar levels and gives us a fast high and a fast come down. It’s important for us to know the difference between these sugars. We often have to search for them in our packaged foods.

Distribute the sample sugar sweetened beverage containers to student groups. Demonstrate how to read a nutrition label using a sugar sweetened beverage container. Show a soda can and calculate teaspoons of sugar from grams (4 grams = 1 teaspoon). If there are 39 grams of sugar in a soda, then there are 9.7 teaspoons of sugar.

**NGSS Science/Engineering Practice 5: Using Mathematics and Computational Thinking**

Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.

Next, use an example of an empty smoothie container to demonstrate this one more time (Tell them that they will be practicing this with their groups, so pay close attention). Use age appropriate containers (no energy drinks, and more juice boxes).

Students use their worksheets, Count It Up, on page 25 in student workbooks to read the labels and use teaspoons to measure out 1 gram in their sample beverage containers. Students can either work alone or in pairs. Have them either pour out 1 packet of sugar per teaspoon, stack 1 sugar cube per teaspoon, or measure teaspoons directly from a bowl of sugar onto the plate.

Ask:
- How many servings are in the beverage?
- How many grams of sugar per serving are there per serving?

Alternatively, invite two students to count it up in front of the class, one adding the teaspoons and the other reading the nutrition facts label on the sugary drink container.
**NGSS Science/Engineering Practice 4: Analyzing and Interpreting Data**
Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.

---

**Activity 2: Processing Sugar Cane**

This activity is best paired with the recipe for Beet Smoothies found in the Monthly Recipes book. Make beet smoothies with students to model the different types of processed sugar and to teach students how to make a healthy alternative to the processed sweetened beverages they may commonly drink.

Show a whole sugar cane. Slice it for kids to try and chew on (Don’t swallow all the fibers. It’s too many and may be hard to digest) The same process can be done to turn beets into sugar by removing the fibers. Beet sugar is processed as a carbohydrate without any nutrients. We can also use beets, like the ones you have in front of you, to sweeten things, like smoothies. Hand out slices of the raw beet you will add to the smoothie to compare to the sugar cane they just tried. We’ll be making beet smoothies with these beets. We don’t need to add as much sugar to our smoothies, because we’re using fruits, and we’ll be experimenting with our own taste for sugars.

**Student Reflection**

How do you feel after you eat a lot of processed sugars? What is difference between natural and added sugars?

**English Language Learning (ELL) Focus: Series**

- Whole foods contain natural sugars.
- Many processed foods contain added sugars.

**Sources**

President and Fellows of Harvard College and YMCA of the USA Unit 3, Page 14 of 4
# Count It Up

**Instructions:** Read the nutrition facts on each beverage container. Write the name of the beverage and list the sugar amount per serving. Convert sugar grams into teaspoons.

## Beverage #1 Name:

1. Calculate the Total Sugar (in teaspoons) for each drink:
   
a. Sugar per serving × Number of servings in drink = Grams of Total Sugar
      
      _______ gm  _______  _______ gm

   b. Grams of Total Sugar ÷ 4 gm per teaspoon = Teaspoons of Total Sugar per drink
      
      _______ gm  of sugar  _______ tsps

2. Using sugar cubes, count the number of teaspoons of sugar per drink container and place sugar cubes in a plastic bag.

3. Label the bag with the name of your drink.

4. Review the Ingredients List and write down forms of added sugar:

## Beverage #2 Name:

1. Calculate the Total Sugar (in teaspoons) for each drink:
   
a. Sugar per serving × Number of servings in drink = Grams of Total Sugar
      
      _______ gm  _______  _______ gm

   b. Grams of Total Sugar ÷ 4 gm per teaspoon = Teaspoons of Total Sugar per drink
      
      _______ gm  of sugar  _______ tsps

2. Using sugar cubes, count the number of teaspoons of sugar per drink container and place sugar cubes in a plastic bag.

3. Label the bag with the name of your drink.

4. Review the Ingredients List and write down forms of added sugar:
## Whole Food Nutrition Facts Labels

### Apple

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
<th>Serving Size 1 large apple (154g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
<td>Calories: 105, Calories from Fat: 3</td>
</tr>
<tr>
<td>Calories</td>
<td>105</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>3</td>
</tr>
<tr>
<td>% Daily Value*</td>
<td>2%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>0mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>25g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>4g</td>
</tr>
<tr>
<td>Sugars</td>
<td>5g</td>
</tr>
<tr>
<td>Protein</td>
<td>1g</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>4%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>0%</td>
</tr>
<tr>
<td>Calcium</td>
<td>2%</td>
</tr>
<tr>
<td>Iron</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

### Orange

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
<th>Serving Size 1 medium orange (91g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
<td>Calories: 60, Calories from Fat: 0</td>
</tr>
<tr>
<td>Calories</td>
<td>60</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>0</td>
</tr>
<tr>
<td>% Daily Value*</td>
<td>0%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>0mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>14g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>3g</td>
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<tr>
<td>Sugars</td>
<td>9g</td>
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<tr>
<td>Protein</td>
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<tr>
<td>Vitamin A</td>
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<td>Calcium</td>
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<tr>
<td>Iron</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

### Corn

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
<th>Serving Size 1 medium ear (96g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
<td>Calories: 50, Calories from Fat: 0</td>
</tr>
<tr>
<td>Calories</td>
<td>50</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>0</td>
</tr>
<tr>
<td>% Daily Value*</td>
<td>0%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>0mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>10g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>3g</td>
</tr>
<tr>
<td>Sugars</td>
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<tr>
<td>Protein</td>
<td>1g</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>2%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>10%</td>
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<tr>
<td>Calcium</td>
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</tr>
<tr>
<td>Iron</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

### Tomato

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
<th>Serving Size 1 medium tomato (94g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
<td>Calories: 23, Calories from Fat: 0</td>
</tr>
<tr>
<td>Calories</td>
<td>23</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>0</td>
</tr>
<tr>
<td>% Daily Value*</td>
<td>0%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
</tr>
<tr>
<td>Sodium</td>
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</tr>
<tr>
<td>Total Carbohydrate</td>
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</tr>
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<td>Dietary Fiber</td>
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</tr>
<tr>
<td>Sugars</td>
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<tr>
<td>Protein</td>
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</tr>
<tr>
<td>Vitamin A</td>
<td>20%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>40%</td>
</tr>
<tr>
<td>Calcium</td>
<td>2%</td>
</tr>
<tr>
<td>Iron</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

### Potato

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
<th>Serving Size 1 medium potato (108g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
<td>Calories: 23, Calories from Fat: 0</td>
</tr>
<tr>
<td>Calories</td>
<td>23</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>0</td>
</tr>
<tr>
<td>% Daily Value*</td>
<td>0%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
</tr>
<tr>
<td>Sodium</td>
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</tr>
<tr>
<td>Total Carbohydrate</td>
<td>5g</td>
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<tr>
<td>Dietary Fiber</td>
<td>1g</td>
</tr>
<tr>
<td>Sugars</td>
<td>4g</td>
</tr>
<tr>
<td>Protein</td>
<td>1g</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>2%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>40%</td>
</tr>
<tr>
<td>Calcium</td>
<td>2%</td>
</tr>
<tr>
<td>Iron</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

*Your daily values may be higher or lower depending on your calorie needs.
Fourth Grade
Nutrition

Whole or Processed

Objectives/Assessment Targets
Students will:
- Read nutrition facts labels.
- Compare and sort processed and unprocessed foods based on nutritional value.

Activity Preparation
This extended nutrition lesson can be scaled up or down for all grades. It can be taught inside. You will not have time to do all these activities in one class. Break up the activities into several days for rainy day lessons. Review the materials and activities best suited for your audience and prepare accordingly.

Having hands-on materials, like empty cartons and packages, rather than print outs of nutritional facts, engage kids with real-life experiences. Most kids have seen popular snack foods and can identify their marketing and packaging. Analyzing packaged chips students may have eaten at school, invite them to connect the lesson content with everyday practices.

Materials
- Samples of processed food containers.
- Food cards with nutrition facts
- Ingredients for a healthy snack from a recipe found in the Monthly Recipe book
- Worksheet, Whole of Processed, on page 27-28 in student workbooks
- Example of seasonal whole foods (Apples or oranges)

Activity 1: Comparing Processed and Unprocessed Foods
Review the difference between whole and processed foods. Reference the Nutrition Facts labels in the previous Count It Up lesson. Hold up an example of a whole food, like an apple. An apple, an orange, and a tomato are considered whole foods, because they are unprocessed. Apple pie, orange soda, and tomato soup are processed foods, because they contain one or more foods and/or changed form, such as drying, cooking, canning, and freezing.

Distribute processed food samples (make sure these are empty and have nutrition facts labels). Instruct them to read the labels, identifying serving sizes and the amount of fat, sodium, sugar, and carbohydrates.
Carbohydrates and fat are measured in grams and sodium is measured in milligrams. Calories are the unit for measuring energy in foods. A calorie is a unit of energy. Our bodies need energy to survive, and plants produce energy from the sun. Different nutrients provide different amounts of energy.

**Ask:**
- What is surprising about your sample, based on the nutrition facts?
- Which samples have the highest amount of calories, fat, carbohydrates, sugar, and sodium?
- What is a similar snack that would be healthier and why?

**Activity 2: Charting Nutrition Data**

This activity has two worksheets found in student workbooks. Review the different nutrients found in the nutrition facts labels. Distribute food packages to each group to study, if they don’t have them already. Direct students to share-out the type and amount of nutrients per serving. Students use their worksheet, Whole or Processed, on page 27 and 28 in student workbooks to record data and answer questions in groups. Direct them to make predictions and record the results of their experiments. This can also be done as a whole class with nominated students to record data and predictions on white boards in front of the class.

**Ask:**
- What is the serving size?
- Is it a whole or processed foot?
- Which one has the most calories, carbohydrates, total fat, and sodium?
Common Core State Standard 4.MD.A.1
Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr., min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.

NGSS Science/Engineering Practice 7: Engaging in Argument from Evidence
Use data to evaluate claims about cause and effect.

Students groups first make predictions about the food packages based on which one they think will have the most calories, carbs, fat, and sodium. They then read the nutrition facts to record actual data.

Ask:

- How many nutrients are there per serving?
- How many nutrients would you consumer if you ate the whole package?
- How does this compare to the recommended daily amount of each nutrient?
**Whole or Processed**

**CLASS PREDICTIONS AND RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Class prediction</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most calories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most carbohydrates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most total fat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most sodium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DATA SUMMARY**

<table>
<thead>
<tr>
<th>Food item</th>
<th>Energy (calories)</th>
<th>Total fat (grams)</th>
<th>Carbohydrates (grams)</th>
<th>Sodium (milligrams)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**INVESTIGATE WHOLE AND PROCESSED FOODS**

Read the food fact labels distributed to your group. Record the data from the food label for the two food items you are investigating.

1. Which food is whole? ________________________________
2. Which food is processed? ____________________________
3. Which food has more calories? _______________________
4. Which has more total fat? ___________________________
5. Which has more sodium? _____________________________
6. How does processing change the whole food you investigated? ______________
7. Which group (whole or processed) does the team think is healthier? ______________
Activity 3: Sorting Packaging by Ingredients

Students read labels on food packaging. Display assortment of packaging items commonly found and uncommonly found in typical grocery stores on one table. Students work in groups of no more than 5 (wheat group and corn group) to sort product containers (corn and wheat) by less to more ingredients. Each group lines up the containers in order from the least processed to most processed, based on reading the lists of ingredients.

Discuss the difference between ingredients. **Ask**, Why did you sort your packaging containers this way?

Students count the ingredients and consider how do we process each ingredient in our bodies (slow or fast based on whether they are SLOW-sugar, GROW, GO, or GLOW foods).

**NGSS Science/Engineering Practice 4: Analyzing and Interpreting Data**

Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.

Activity 3: Marketing Foods with Advertisements

Distributed laminated ads to each group. Explain that ads do a lot to convince us to buy their products. Discuss the tactics advertisements use to pull your attention. Surprising facts, health foods have ad campaigns, as well (Not all ads sell you something that is bad for you, they are just selling).

**Ask:**

- Why would it be important to consider where information comes from?
- What does the term valid information mean? (Valid information is well-founded and justifiable information).
NGSS Science/Engineering Practice 8: Obtain, Evaluate, and Communicate Information
Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.

Invite students to share out their favorite ads and why.

Ask:
- Did anyone name a healthy food or drink?
- Can anyone recall seeing advertisements for healthy drinks such as milk, water, or 100% fruit juice?
- Can anyone recall seeing advertisements for healthy foods such as fruit or whole grain cereal?

Students practice being advertisers (use absurdity). Each table analyzes a common fruit and veggie, using fruit and veggie cards from Harvest of the Month. Instruct them to make a real ad to promote fruits and veggies with different slogans and ideas (Use drawings, jingles, etc.). Students present their ads to the group.

Student Reflection
How will you choose foods to eat next time you're at the market?

English Language Learning (ELL) Focus: Measurements
- Grams
- Milligrams
- Servings
- Calories

Additional Information
Most unprocessed foods are highly perishable and cannot be stored for a long time. They often require some preparation, including seasoning, mixing with other foods, or cooking to be palatable, and sometimes even more digestible. Food processing entails a series of steps that convert unprocessed foods into foodstuffs, which prolong their duration, enable storage, and reduce some time/effort in culinary procedures.

Sources
Making Healthy Choices

Objectives/Assessment Targets
Students will:

- Design and make a snack using ingredients from each food group.
- Identify how each food group keeps us healthy.
- Identify vitamins, minerals, and fiber in each food group using nutrition facts.

Activity Preparation
This nutrition lesson builds on past content students learned about the difference between whole foods and processed foods, identifying sugar content in processed foods, and reading nutrition facts to make healthy choices.

This lesson can be taught inside and scale up and down for grades 3-5. You will not have time to teach all activities. Select an activity to teach or extend this lesson over a couple days. Prepare a nutrition chart that illustrates the vitamins, minerals, and fiber in whole foods. These activities are best paired with a healthy snack make with students from out Monthly Recipe book.

Materials

- Bowls for tasting and mixing
- Ingredients for a garden snack: lemon, oil, vinegar, tamari or soy sauce
- Worksheets, Healthy Recipe and Making Healthy Choices, and on pages 29-31 in student workbooks
- Monthly Recipe book and ingredients depending on the recipe you choose

Activity 1: Making Healthy Choices
Review what is currently growing in the school garden. Invite students to share out their favorites that they have tasted over the school year. Explain that fruits and vegetables are excellent sources of healthy...
nutrients: vitamins, minerals, and fiber. Most fruits and vegetables are naturally low in fat and cholesterol. Present the Different Colors that help different parts of our body to illustrate the nutrients found in common fruits and vegetables.

One way to ensure that we get the nutrients we need is to eat the colors of the rainbow every day. Distribute food cards. Invite a student or teacher to have their body outline traced on butcher paper. Tape this outline on the wall. Direct students to share out the food cards they have, making sure they note benefit they have. Students tape their food card to the outline, placing them on the body part that they support the most (Example, fish helps brain function and red beets keep our hearts strong).

**Ask:**
- Why is your color important for healthy?
- What other food has this color?

Invite students to make a snack with all five food groups, such as: rainbow crackers, edible art with sliced veggies on crackers layered on top of cream cheese or healthy dips. Match plants grown in the garden with the nutrition chart by using trays with compartments to collect foods grown in the garden to make a rainbow snack.

**Helpful tip:** bring a flip chart of all the colors and nutrition facts for reference throughout the year.

---

**California Health Standard 7.3.N**
Identify ways to establish and maintain healthy eating practices consistent with current research-based guidelines for a nutritionally balanced diet.

---

**Nutrition Chart**

<table>
<thead>
<tr>
<th>Vitamin/Mineral /Fiber</th>
<th>Benefits</th>
<th>Occurs in these fruits and vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Keeps eyes and skin healthy and helps to protect against infections.</td>
<td>Dark leafy greens (like spinach and kale) and orange fruits and vegetables (like sweet potatoes, carrots, and mango).</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Helps heal cuts and wounds and keeps teeth and gums healthy.</td>
<td>Citrus fruits like oranges and vegetables like broccoli and bell peppers.</td>
</tr>
<tr>
<td>Potassium</td>
<td>Keeping fluids in balance in your body</td>
<td>High sources of potassium include bananas, melons, and avocados.</td>
</tr>
<tr>
<td>Fiber</td>
<td>Keeps food moving through the digestive tract.</td>
<td>Some of the highest sources of fiber include apples, berries, pumpkins, and beans.</td>
</tr>
</tbody>
</table>
Activity 2: Making Healthy Choices

Invite students to put on their chef hats and use their imaginations to create the most tasty and healthy snack. Students work in small groups to create healthy recipes based on what is growing in the garden. Direct them to create recipes based on what they learned about eating the rainbow and the parts of the body each fruit and veggie supports the most.

Ask, Which ingredient is most healthy for our bodies and minds?

Instruct students to tour the garden and survey what is growing and what is ready to be harvested. Students use the worksheet, Healthy Recipe, on page 29 to describe the recipes they will create, identify the ingredients and the nutrition facts.

California Health Standard 6.1.N
Make a plan to choose healthy foods and beverages.

Students share out their recipes.

Student Reflection

What were the ingredients? What are some minerals and vitamins in your ingredients? Which ingredients have the most minerals and vitamins? (hint. winter greens grown in the garden)?

English Language Learning (ELL) Focus: Cause and Effect

● _________ is important to eat because ____________.

Additional Information

These activities can be extended to the cafeteria and the science classroom. Invite teacher collaborate and/or have students present their healthy snack recipe to the cafeteria team.

Sources

California Department of Public Health, Network for a Healthy California. Tips, Lessons, and Resources for Integrated Instruction, Linking Science and Nutrition
Healthy Recipe

Instructions: You made a garden-fresh recipe today. What were the ingredients and step by step process to making it? What are some macro-minerals, vitamins found in it and where do they come from (hint.. winter greens grown in the garden)?

- What did you make and what did you think of the taste?

- List the ingredients in the recipe and the steps to making the recipe.

- What were some of the minerals and vitamins in this recipe and what part of the plant could they be found in?
Welcome to the Garden

Objectives/Assessment Targets

Students will:

- Repeat the rules, practices, and guidelines for working in the garden.
- Write 2–3 questions you hope to answer during the year.

Activity Preparation

This lesson is the first lesson of the school year. The activities introduce, or reintroduce students to the garden. It reinforces the school practices for being safe, respectful, and responsible. Students get their workbooks that they will use throughout the year and personalize them with drawings, rubbings, etc. To demonstrate how they will be learning and what they want to learn in the garden.

Write the school’s 3 Be’s on the whiteboard.

Materials

- Garden tools for demonstrating tool safety
- Workbooks and drawing materials

Activity 1: Welcome to the Garden

Explain that behavior expectations in the garden are the same as in the classroom. Review the 3 Be’s.

Ask:

- How can we interpret the classroom Be’s into garden Be’s?
- How will you practice the 3 Be’s in the classroom, garden, and cafeteria?
- What is different about each practice space?

Introduce key elements of the garden with a garden tour, focusing on tool safety best harvesting practices. Call and response each garden rule. Direct students to model tool safety for the whole group.

CA Health Standard 7.3.S

Use appropriate protective gear and equipment.
Activity 2: What Will We Learn In The Garden?

Invite students to share what is special about having class in the garden. Students use their workbooks to personalize the cover. Direct them to write two to four sentences stating what they would like to learn in the garden and why. Prompt them to consider specifics about what they would like to learn.

Ask, Would you like to learn more about dirt, flowers, bees, roots, etc.

CA Health Standard 5.1.P
Use a decision-making process to determine personal choices that promote personal, environmental, and community health.

Student Reflection

What are you most interested in learning about in the garden this year and why?

English Language Learning (ELL) Focus: Asking Questions

● Who, what, when, where, why, and how.

Addition Information

Prompt students to revisit their first workbook entry at the end of the year. Ask them the same questions at the last lesson and invite them to compare their answers to see if there is any change in response, expectations, or assumptions.

Sources

Students Learning Through Urban Gardening (SLUG)
What Role Will I Play?

Objectives/Assessment Targets
Students will:
- List the different roles of a gardener.
- Identify their responsibilities in the garden.
- Make a plan for how to carry out these responsibilities.

Activity Preparation
This lesson reinforces the importance of being responsible in the garden. The activities invite student leadership. They ask for their commitment to carry out roles for caring for the garden throughout the year.

Prepare the whiteboard outlining the roles and responsibilities required for the garden throughout the year. List tasks for each responsibility. This lesson can be paired with reading a book with students. Highlight sections in the book, “The Gardener,” that you would like students to read during group reading and discussion.

Materials
- Worksheet, What Role Will I Play, on page 2 in student workbooks
- “The Gardener,” by Sarah Stewart (or a similar book)
- Create your own list of Gardener Responsibilities to review with students (Watering, Weeding, Collecting workbooks, Distributing and collecting tools, Washing produce, etc.)

Activity 1: Reviewing Roles and Responsibilities of a Gardener
Lead a reading and discussion of “The Gardener” with students. Allow students to compare roles a gardener plays in the garden.

CA Health Standard 7.4.N
Practice how to take personal responsibility for engaging in physical activity.

Ask, What did you learn about garden responsibility in your garden tour and after reading “The Gardener?”

Present the five main responsibilities of a gardener. Explain that each responsibility involves several steps and will need to be completed according to seasonality. Students make a commitment to take on a responsibility as an individual, pair, or small group.
Ask, Is there a responsibility or task that you think is important that is not on the whiteboard?

Students use their worksheet, What Role Will I Play, page 2 in their workbooks to write down their responsibility. Prompt them to consider the details of each task, the schedule and timing for each task, and if other students or adults will help. Students pair-share their responsibility and what they are looking forward to doing most.

**Activity 2: Getting the Garden Started**

Review student roles. Create a task chart for student role to do each time they visit.

Assist students as they prepare garden beds for planting: turning soil, collecting items for compost, and/or adding ripe compost to the beds. Demonstrate how to plant a plant start with the roots down in the earth, such as tomatoes or cucumbers. Help students plant starts. As they work, prompt students to consider how each plant part uses the sun, soil, water, and air.

*NGSS Disciplinary Core Idea LS1.C: Organization for Matter and Energy Flow in Organisms*

Plants acquire their material for growth chiefly from air and water.

**Student Reflection**

If you were going to a store that sells supplies for a gardener, what would you buy? What happens in the garden during each season?

**English Language Learning (ELL) Focus: Noun and Verb Form**

- In the garden, I am responsible for ________.
- In the garden my responsibility is ____________.

**Sources**

Clare Friend, Curriculum Consultant, Learning to Give
Drawing from Experience

Objectives/Assessment Targets

Students will:

- Identify one theme, idea, or concept learned.
- Use nature journaling to describe what was learned.

Activity Preparation

This garden community lesson is a reflection and can be implemented throughout the year as a check in or at the end of the year. Print out garden bingo cards for each student. Invite students to bring or find a nature object that is meaningful to them.

Materials

- Examples of fruits and vegetables or Fruit and Vegetable Cards
- Garden bingo cards and markers in their workbooks
- Garden harvest and healthy dips or green or pink smoothies recipes and ingredients in the Monthly Recipe book
- Worksheet, Drawing from Experience, on page 3 in student workbooks

Activity 1: The Most Important Thing about the Garden

Display projects or posters made throughout the year for students to recall and reflect on. Students review their workbook entries and take a quick tour of the garden, reflecting on what will change next time they see it.

NGSS Crosscutting Concept: Stability and Change

Some systems appear stable, but over long periods of time will eventually change.

Students use their worksheet, Drawing from Experience, on page 3 in student workbooks to practice journaling. Prompt them to write the most important idea, concept, or theme covered in the garden and why this was the most important to them.

Common Core State Standard W.4.1

Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
Is this activity is taught at the end of the year, prompt students to write about how they will practice garden and nutrition lessons learned throughout the summer. Some ideas: eat a rainbow; notice the fruits and veggies that they eat and think about why they look this way; visit a farmer at the farm or farmers market.

**CA Health Standard 6.1.N**
Make a plan to choose healthy foods and beverages.

**CA Health Standard 5.1.P**
Use a decision-making process to determine personal choices that promote personal, environmental, and community health.

**Activity 2: Test Your Nutrition Knowledge and Garden Jeopardy**
Distribute the bingo cards below to each student. Hold up a picture of each food sample, including fruit and veggie cards if needed. Students fill in their bingo cards until a few bingos have been won.

**Student Reflection**
What would you like to learn more about next year?

**English Language Learning (ELL) Focus: Models**
- I will share that I learned ______ with Community leaders.
- I will share that I learned ______ with Teachers.
- I will share that I learned ______ with Parents.
- I will share that I learned ______ with fellow Students.

**Sources**
Healthy Living for Life, Alameda County Public Health Department, Nutrition Services
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<th>B</th>
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<td>Fruit</td>
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<td>minerals</td>
<td>nutrition</td>
<td>obesity</td>
<td>oranges</td>
<td>protein</td>
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Flowering Seeds: Winnowing

Objectives/Assessment Targets

Students will:

● Identify cultures that used winnowing.
● Compare methods of winnowing.
● Experiment with two winnowing methods.

Activity Preparation

This food system lesson introduces the concept that there are processes for getting food to the fork. It can be paired with a science and/or humanities lesson on ancient culture’s methods for processing grains. The activities experiment with different winnowing methods and reflect on how they compare to modern agriculture. You may want to invite students to create a timeline on the history of seed saving in farming.

Collect samples of seeding flowers from the garden. Prepare different stations for winnowing.

Materials

● Sieve, screens, or strainers
● Metal bowls
● Small containers (paper boats used in the cafeteria work well)
● Cloth sacks
● Wooden boards
● Wheat stalk with weed berries

Activity 1: Why and When for Winnowing?

Show students a plant with the seeds and the flower intact. Review flower anatomy, focusing on the seeds found in wheat flowers particularly. Review the 4th grade seed saving lesson. Discuss a brief history of seed saving in farming:

● European settlers and Native Americans established an important agriculture seed saving base.
● The wealthy formed agricultural societies to save and trade seeds during the colonial era.
● The society of the treasury initiated a seed saving program in the early 1800s.
● The USDA established a budget for collecting and distributing seeds to farmers across the country in 1862.
● Today, roughly 10 top companies control 65% of the seed property.

NGSS Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems
Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments.

Activity 2: Methods for Winnowing

Ask:

● Why do we need wheat seeds?
● How do we process the seeds?

Review the different methods for winnowing seeds:

1. **Threshing:** Perhaps the most common method. Place seed pods in a pillowcase or cloth sack and thrash (“thresh”) it against a hard surface to break the seeds from their coverings.
2. **Pressure:** Apply gentle pressure to crack open the pods with boards. Take care not to press so hard you split the seeds.
3. **Screening:** Separate dirt from seeds with screens or strainers. Screens with meshes of varying sizes provide a quick way to separate debris from seeds. A single screen is a vast improvement over hand picking. Screens work especially well for seeds (such as lettuce) that do not have pods. A set of graduated screens will cut out about 80% of the hand work. You can build screens yourself or order seed cleaning screens from sources like Horizon Herbs.
4. **Wind power:** Outside on a breezy day, drop seeds from one container into another and let the wind blow away the unwanted chaff. Use your breath to slightly blow on the seeds at an angle to separate them from the chaff. This method works particularly well for amaranth.
5. **Gravity:** This works well for round seeds. Use gravity to help roll seeds down a newspaper into a container. The heavier seeds roll down, while the chaff remains behind.

Once the grain has been separated it can be milled into flour, which is used to make bread.

Activity 3: Practice Winnowing
Review past content on whole foods and processed foods. Tell students that whole grains are whole foods, which means they have fiber. Demonstrate how to collect amaranth or wheat flowers that are seeding in the garden. Students work in small groups to practice winnowing flowers using two of the methods discussed for amaranth, hollyhock, wheat, and/or cosmos.

Students compare the chaff of seeds from different plants. Direct them to pair-share with their small groups or use their worksheet to explain the differences in detail.

**Student Reflection**

What are the benefits of modern processing for separating seeds? What are the benefits of ancient winnowing seeds?

**English Language Learning (ELL) Focus: Phrasal Verbs**

- Separate from
- Blow away
- Roll down
- Blow on
- Crack open

**Sources**

History of US Seed Development and Patent Regimes, Center for Food Safety

Northwest Farm and Food
Plant Traits

Objectives/Assessment Targets

Students will:

- Compare and contrast different plants in different families.
- Plant two plants from different plant families.

Activity Preparation

This lesson reviews 4th grade content on how and scientists organize the natural environment according to specific plant features and Plant Families.

Prepare the whiteboard with a list of the Plant Families. Gather seed packets from each of these Plant Families.

Materials

- Plant families chart
- Examples of two plants from different families, ex Brassica (broccoli and kale) and the Lamiaceae (mint and oregano)
- Seed packets
- Worksheet, Plant Families and Their Traits, on page 5 in student workbooks

Activity 1: Matching Seeds to Plant Families

Distribute seed cards. Students observe the seeds and compare their features.

Ask, What do you already know about the plants on the seed packets?

Prompt students to recall lessons on companion planting and plant traits. Review the Plant Family chart. The Brassica (broccoli and kale) and the Lamiaceae (mint and oregano) are two common Plant Families that grow well in school gardens. Show students examples of both. Highlight one (ex. kale) and ask them to identify the traits they notice.

Ask:
- What plant family do they belong in?
- What are the characteristics of the plants on the seed cards that you have?

Student Reflection
How do the plant traits support their growth? What traits does ____ have to support its growth? What traits does the ___ and do____ have to support its growth? How are these two plants similar in traits? How are these two plants differing in traits?

English Language Learning (ELL) Focus: Similarities and Differences

- A ____ is like a _______ because it has ______
- A ____ is not like a _______ because it has ______

Additional Information

There are seven main taxonomic ranks: kingdom, phylum or division, class, order, family, genus, species. Most fifth grade lessons review Family → Genus → Species.

Sources


Plant Families and Their Plants

<table>
<thead>
<tr>
<th>Family</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apiaceae</td>
<td>Carrots, celery, celery root, cilantro, dill, fennel, parsley, parsnip</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Artichoke, chicory, dandelion, endive, lettuce, sunflower, tarragon</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td>Arugula, broccoli, Brussels sprouts, cabbage, cauliflower, collards, cress, kale, kohlrabi, mizuna, mustard, radish, rutabaga, tat soi, turnip, watercress</td>
</tr>
<tr>
<td>Chenopodiaceae</td>
<td>Beet, orach, spinach, Swiss chard</td>
</tr>
<tr>
<td>Convolvulaceae</td>
<td>Potato, morning glory</td>
</tr>
<tr>
<td>Cucurbitaceae</td>
<td>Cantaloupe, cucumber, gourd, loofa, melon, pumpkin, summer squash, winter squash</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Beans, peas, peanuts, soybeans</td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>Basil, lavender, marjoram, mint, oregano, sage, savory, thyme</td>
</tr>
<tr>
<td>Liliaceae</td>
<td>Asparagus, chives, garlic, green onions, leeks, onions, shallots</td>
</tr>
<tr>
<td>Malvaceae</td>
<td>Okra, hollyhock, hibiscus</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Corn, wheat, barley, rice</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Eggplant, sweet pepper, hot pepper, potato, tomato</td>
</tr>
</tbody>
</table>
Botany on Your Plate

Objectives/Assessment Targets

Students will:

- Name and label the functions of each part of a plant.
- Harvest produce and assemble ingredients for a one-bite garden tasting.

Activity Preparation

This lesson builds on past content students learned about plant parts and functions. The activities review each part and then invite students to taste a new vegetable or fruit growing in the garden.

Draw the six plant parts on the whiteboard or prepare a laminated diagram that is large enough to show a full class (this is helpful preparation for future lessons and will save on time). Gather the plant parts from all six categories and prepare them in bowls (this can also be done as part of the activity).

For snack preparation, draw from the Monthly Recipe book or prepare additional ingredients for students to add to their one-bite tasting to make a version of a garden burrito. If doing the latter, boil beans and sauté leafy green stems, and prepare tortillas to wrap the plant part ingredients in. Alternatively, the leaf can act as the tortilla.

Materials

- Edible seasonal plant parts from each category: roots, stems, leaves, flowers, fruits, and seeds
  - Lettuce leaf (Leaves), shredded carrots (Roots), chopped celery or sautéed leafy green stems (Stems), basil and fennel flowers (Flowers), chopped tomatoes (Fruit), and hummus or sunflower butter or beans (Seeds).
- Knives and chopping boards for students
- Collecting and mixing bowls

Figure 31 Sarah Winer, Garden Instructor, reviews plant parts with students at Oxford Elementary School Garden
Activity 1: Reviewing Plant Parts and Their Functions

Review plant parts and functions. Show students a plant with all six parts: roots, stems, leaves, flowers, fruits, and seeds (bonus if it is a legume with nitrogen nodules which will be covered in another 5th grade lesson). Invite students to observe closely and dissect with their fingernails the different flowing parts of the samples. Students share descriptions of the parts of the plants. Students answer each question as a group or in their worksheet, Botany on Your Plate, page 6 in their workbooks.

<table>
<thead>
<tr>
<th>Ask</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the purpose of roots?</td>
<td>Roots hold the plant in the ground and take in water.</td>
</tr>
<tr>
<td>What is the purpose of stems?</td>
<td>Stems move water up the plant and move sugar down the plant. They also hold the plant upright.</td>
</tr>
<tr>
<td>What is the purpose of leaves?</td>
<td>Leaves turn the sugar into plant food through their stomata, which get energy from the sun and absorb carbon dioxide. They then breathe out the energy in the form of oxygen.</td>
</tr>
<tr>
<td>What is the purpose of flowers?</td>
<td>Flowers attract pollinators with their pollen. The flowers also turn into a fruit.</td>
</tr>
<tr>
<td>What is the purpose of fruits?</td>
<td>Fruits hold the seeds and often taste sweet, which attracts animals. The animals eat the fruits and disperse the seeds through defecation.</td>
</tr>
<tr>
<td>What is the purpose of seeds?</td>
<td>Seeds are the offspring of the plant that can be planted to grow new plants.</td>
</tr>
<tr>
<td>What is the purpose of nitrogen nodules?</td>
<td>Nitrogen nodules store the nitrogen that, with the help of bacteria, the plant draws from the air. Not all plants store nitrogen in this way. Peas, alfalfa, and beans are especially good at this.</td>
</tr>
</tbody>
</table>

NGSS Disciplinary Core Idea LS1.A: Structure & Function

Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Activity 2: Harvesting Plant Parts for Burritos

Review appropriate techniques for harvesting from the garden. Students pair up to receive containers/bowls to harvest produce according to the four groups:
1. Green leaves from lettuces
2. Edible flowers
3. Carrots
4. Fruits

Set up the garden burrito ingredients like an assembly line. Demonstrate how to make garden burritos with the items they harvested and the items you had prepared: begin with a lettuce leaf (Leaves), fill the leaf with shredded carrots (Roots), chopped celery or sautéed leafy green stems (Stems), basil and fennel flowers (Flowers), chopped tomatoes (Fruit), and hummus or sunflower butter (Seeds).

Ask:
- What did you pick and why?
- What’s one nutritional value or each?

**CA Health Standard 8.1.N**
Support others in making positive food and physical activity choices.

**Activity 3: Planting for Next Season**

It’s not quite time to start warm-weather seeds outside, but it’s time to start seeds in the greenhouse for plants that like to grow in warm weather.

Ask:
- What kind of plants do we plant in cool weather? (Plants that tend to grow well in cool weather are plants that we eat the leaves and roots of, although root crops will grow faster in the warmer months.)
- What kind of plants do we plant in warm weather, and why? (Plants that grow in the summer tend to be more colorful, and we eat their seeds or fruits.)

Students share some plants that like cool weather:
- Lettuce
- Kale
- Collard greens
- Swiss chard
- Cabbage
- Spinach
- Celery

A couple of exceptions to the leaf rule:
- Broccoli and cauliflower (We eat the closed flowers.)
- Fava beans (This is the only bean that grows well in winter!)
• Sweet peas
• Roots and bulbs, like carrots, beets, onions, and turnips (Although most will grow faster in warmer months.)

**NGSS Crosscutting Concept: Patterns**
Patterns can be used as evidence to support an explanation.

**Student Reflection**

What are other traits that roots, stems, leaves, flowers, fruits, and seeds have?

**English Language Learning (ELL) Focus: Verbs**

- Plants *store* nitrogen. This plant is *storing* nitrogen.
- Flowers *house* seeds. These flowers are *housing* seeds.
- We *plant* foods in our garden. We are *planting* foods in our garden.

**Sources**

“Garden Burritos,” Jennifer Bedrosian, science teacher, Edible Schoolyard, Greensboro Children’s Museum, Greensboro, NC.

“Morphology of Flowering Plants,” Dr. Aarif Kanadia, biology teacher in Mumbai, India.
Nitrogen in Plants and Soil

Objectives/Assessment Targets

Students will:

- Explain the importance of nitrogen.
- Identify the nitrogen nodules.
- Take soil temperatures

Activity Preparation

This lesson reviews previous content students learned about the importance of nitrogen in soil for healthy plants. The activities can be taught indoors with sample nitrogen fixing plants, such as fava beans with noticeable nodules on their roots.

Materials

- Butcher paper for each student group to examine soil (if being done inside a classroom)
- Fava beans or other legumes with nodules on their roots
- Thermometers for taking soil temperatures

Activity 1: Finding and Testing Nitrogen

Review the perfect compost pile, focusing on why gardeners use compost to help support nitrogen fixing in soil. Lift up the compost bins and invite students to dig through it to see the layers of the compost.

Ask, What is happening in there? (Decomposition)

A key ingredient in decomposition is nitrogen. Explain that nitrogen is essential for plant growth. To absorb nitrogen, a plant must form a mutual relationship (also called a symbiotic relationship when studying mutualism) with bacteria in the soil. These bacteria are “nitrogen-fixing bacteria.” Compost alone can’t fix nitrogen into the soil.

NGSS Disciplinary Core Idea LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.
There are a few plants (legumes) that are able to store it in their roots, with the help of bacteria to fix nitrogen into the soil. Show the fava bean plant and invite students to examine it. Explain that when a plant stores nitrogen in its roots, it produces a lump on the root called a nitrogen nodule; this is where bacteria is stored. These nodules are harmless to the plant and very beneficial to your garden.

**Ask**, How do legumes in our garden affect rising heat levels in our compost or soil?

Legumes or alfalfa, our favorite winter crop, naturally add nitrogen to the soil. As these plants decompose, they will raise the total nitrogen in the soil and will make it available for plants that are unable to get nitrogen from the air (gas form).

**NGSS Disciplinary Core Idea LS2.A: Interdependent Relationships in Ecosystems**

Decomposition eventually restores (recycles) some materials back to the soil.

Compost heats up when legumes turn the nitrogen gas into a solid. Provide students thermometers to take the temperature of the soil. Students use the worksheet, Nitrogen in Soil, on page 8 in their workbooks to write down the temperatures, dates, and times. Prompt students to consider what is growing around it and why. They can track the different temperatures over time as the legumes mature and release nitrogen from their nodules.

**NGSS Science/Engineering Practice 3: Planning and Carrying out Investigations**

Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

**Activity 2: Nitrogen Cycle**
Ask, Where do these legumes get the nitrogen from?

The nitrogen cycle is the biogeochemical cycle by which nitrogen is converted into various chemical forms as it circulates among the atmosphere and terrestrial and marine ecosystems. The conversion of nitrogen can be carried out through both biological and physical processes.

The majority of Earth's atmosphere (78%) is nitrogen, making it the largest source of nitrogen. However, atmospheric nitrogen has limited availability for biological use, leading to a scarcity of usable nitrogen in many types of ecosystems. The conversion of nitrogen can be carried out through both biological and physical processes. Atmospheric nitrogen must be processed, or "fixed", in a usable form to be taken up by plants. Legumes fix nitrogen from the air and distribute it to the soil for other plants.

Student Reflection

What are other ways that nitrogen can be brought to our soil? How can too much nitrogen damage our garden and our environment?

**English Language Learning (ELL) Focus: Vocabulary of the Nitrogen Cycle**

- Bacteria
- Nodules
- Nitrogen
- Legumes

**Additional Information**

Plants and soil absorb less than half of the nitrogen added to them. Too much nitrogen can create additional heat trapping gases, which goes into our air and water. Fertilizers are often used to add nitrogen to gardens.
**Sources**

“Closing the Loop,” California Academy of Sciences

What a Waste: K–6 Waste Management Education Curriculum, Minnesota Office of Environmental Assistance:

The Climate Friendly Gardener, Union of Concerned Scientists

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**Nitrogen in Soil**

**Instructions:** Write down the compost temperatures, dates, and times, as well as what is growing around it. You can track the different temperatures over time as the legumes mature and release nitrogen from their nodules.

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<thead>
<tr>
<th>Date/Time</th>
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The Carbon:Nitrogen Ratio

Objectives/Assessment Targets

Students will:

● Make models of the C:N ratio using compost.
● Test organic material for content, temperature, and weight.

Activity Preparation

This lesson dives deeper into the role nitrogen plays in the garden. It introduces carbon to the mix. The activities invite students to better understand the role of carbon and nitrogen by modeling ratios needed for decomposition using the compost piles as the test grounds.

Write the different C:N ratios for healthy compost piles on the whiteboard. Review the perfect compost pile pyramid.

Materials

● Compost pile pyramid
● Scale for weighing compost materials (A homemade scale is outlined in the 3rd grade lesson, Weighing Our Harvest)
● Thermometer for taking the temperature of each compost pile
● Worksheet, Carbon:Nitrogen Ratio, page 10 in student workbooks

Activity 1: Carbon and Nitrogen in Compost

Review the Nitrogen Cycle taught in the previous lesson. Relate the nitrogen cycle to the decomposition cycle.

Ask:

● What are the key ingredients for a perfect compost pile? (greens, browns, air, water, FBI)
● Why do these ingredients make it perfect? (greens contain nitrogen, mixing aerates with oxygen, and browns release carbon)
● What role does the fungus, bacteria, and invertebrates (FBI) play? (digestion)
NGSS Crosscutting Concept: Systems and System Models
A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

Invite students to work in the compost piles. Clarify the difference between organic and non-organic materials as they break down compost layers.

- **Organic materials** will decompose more efficiently if the compost pile is made with the proper balance between carbon-rich and nitrogen-rich materials.
- **Carbon and nitrogen** provide the necessary environments for microorganisms (FBI) to live.
- Generally, **carbon-rich materials are brown**, although we can find carbon in many colored organic materials.
- Generally, **nitrogen-rich materials are green**, but there is nitrogen in many kinds of organic material. Red meat and brown walnuts, for example, are rich in nitrogen. Nitrogen comes from nitrogen fixing plants, like legumes, fertilizers, as well as lightning from the sky.
- Browns (carbon) can be identified as being dry and greens (nitrogen) can be defined as fresh and moist.

NGSS Disciplinary Core Idea LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

The balance between these two types of materials is referred to as the carbon:nitrogen ratio and shown as C:N. The ideal C:N ratio is around 25 to 30 parts carbon to one part nitrogen, or 25-30:1.

This ratio describes the chemical composition of a material and does not mean that you need a volume of brown materials that is thirty times greater than the amount of green matter.

**Ask**, What do you think will happen if there is too much carbon or too much nitrogen in our compost? (If the C:N ratio is too high (excess carbon), decomposition slows down. If the C:N ratio is too low (excess nitrogen), you will end up with a stinky pile.)

NGSS Science/Engineering Practice 1: Asking Questions and Defining Problems
Ask a question about what would happen if a variable is changed.
**Student Reflection**

How does adding compost to our garden reduce the use of fertilizers and other chemicals?

**English Language Learning (ELL) Focus: Prepositions**

Ratio of C:N means the ratio amounts of C to N.

**Additional Information**

Our knowledge about the science of composting comes from research conducted during the past 50 years – relatively recent compared to the 2000 plus years that humans have been composting. Microorganisms that digest compost need about 30 parts of carbon for every part of nitrogen they consume. If there’s too much nitrogen, the microorganisms can’t use it all, and the excess is lost in the form of smelly ammonia gas. Nitrogen loss due to excess nitrogen in the pile (a low C:N ratio) can be over 60%. At a C:N ratio of 30 or 35 to 1, only one half of 1% of the nitrogen will be lost. That’s why you don’t want too much nitrogen (fresh manure, for example) in your compost.

Most fresh plant material contains 40% carbon. The C:N ratio varies because of differences in nitrogen content, not carbon content. (Note: dry materials are generally in the range of 40% to 50% carbon, and sloppy, wet materials are generally 10% to 20% carbon. Therefore, the most important factor in estimating the C:N ratio of plant or food waste is how much water is present).

**Sources**


Home Composting Made Easy
Whole Grains and Fiber

Objectives/Assessment Targets

Students will:

- Compare ingredients in packaged foods to whole foods.
- Identify that fiber helps you digest fats and sugars in foods.
- Identify 3 nutrients that are removed when a grain product is refined (protein, fat, fiber)
- Experiment with fiber content in whole and processed grains

Activity Preparation

This lesson builds on the 4th grade lesson on whole and processed foods and digestion. This lesson focuses on the role fiber plays in digestion, and the differences between whole grains and refined grains in foods. The activities can be taught inside and scaled up or down for different grades.

Gather two different types of bread, one whole-wheat and one white bread, for the orange juice experiment testing fiber content. If modeling the layers of a whole grain, then you will want to gather a couple different jackets, which you will put on and take off as you describe the different layers in a whole grain.

Materials

- 2 personal jackets or sweaters for whole grain demo
- Small sandwich baggies containing white rice and brown rice, separated
- Worksheet, Fiber Keeps Us Healthy, page 11 and Healthy Recipe, page 12 in student workbooks

Activity 1: What is Fiber?

Ask, What is fiber?

Show the model of a whole grain and review each layer. Whole grains contain all three parts. Fiber only comes from plant-based foods; animal foods like meat and milk do not contain fiber. Fiber adds structure and form to the plant.

Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

In your intestines, fiber absorbs water, adds bulk, and slows digestion and helps maintain blood sugar and energy level. Some high fiber plant foods include: fruits, vegetables, grains, beans, and seeds. Use jackets to demonstrate that whole grains have layers. Each layer contains different nutrients and amount of fiber:

1. Standing without a jacket on and referencing poster: Demo how the germ is like a baby seed inside of every whole grain, which has the potential to sprout into a new plant. It contains many B-vitamins (which our body uses to make energy from foods), but the germ also has protein and healthy fats. Both protein and fat help to fill us up and satisfy our hunger longer.

2. The next layer in a whole grain is the endosperm (put on a jacket and reference poster). The endosperm is the baby germ’s food supply, providing a starchy sugar and protein for energy so the plant can send roots down into the ground for water and nutrients, and send sprouts up for sunlight.

3. The bran is the outer layer- or shell- of the whole grain (put on a second jacket and reference poster) and the part that has all the fiber in it.
Ask, Who can help me name the parts?

Hold up the bags of rice side by side. Whole grains (such as brown rice) contain healthy fat, and have more protein, more fiber, vitamins and minerals compared to refined grains, like white rice. When a whole grain is processed, the fiber is removed (take off one jacket), but the protein and fat is also stripped out (take off the last jacket). All we’re left with is the endosperm, the starchy sugar.

CA Health Standard 1.6.N
Differentiate between more nutritious and less nutritious beverages and snacks.

Students use the Fiber worksheet in their student workbooks to identify the main use of fiber and why we need it in our diets.

CA Health Standard 6.1.N
Make a plan to choose healthy foods and beverages.

Activity 2: Refined Grains Won’t Hold Up

Let’s see now how our food choices affect our body. Demonstrate how refined grains, like this bleached flour in wonder bread, digest more rapidly than whole grains, like 100% whole wheat bread.

Show them the two bowls with orange juice. The orange juice is acidic and represents the acid in your stomach. The acid in your stomach starts digestion so nutrients in the foods can be absorbed as they go down into the small intestine.

Invite a student to place a whole grain slice of bread in one bowl and another student to place a white bread slice in the other. Time the bread for no more than 2-3 minutes. Direct students to hypothesize what they think will happen and why. Students share out the results (the white bread disintegrates and the whole wheat bread stays more solid). Show them the results. Review why this happens:

- All you are left with in the processed grain (white bread) is the endosperm - the starchy sugar. While this would give you a quick boost of energy, it will also make you feel sleepy and sluggish within the hour. This is a result of the rapid digestion.
• Your body responds the same way when you drink soda - you get a rush of sugar because there is no fiber to slow down its absorption
• The whole grain bread still has all 3 parts, along with the protein, fiber, and healthy fat - all which sit in the stomach longer and are more slowly digested and absorbed. Whole grains give you time-released energy so you don’t have a high or a crash.

**NGSS Disciplinary Core Idea PS3.D: Energy in Chemical Processes and Everyday Life**

The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

**Student Reflection**

Prepare a whole grains recipe from the Monthly Recipe book and ask students to reflect on the grain they are eating, the part of the grain, and invite them to name the nutrients and fiber in that part. Use the Healthy Recipe worksheet on page 12 in student workbooks to describe the ingredients they would use in creating their recipe. Prompt them to choose ingredients with the most fiber.

**CA Health Standard 7.3.N**

Identify ways to establish and maintain healthy eating practices consistent with current research-based guidelines for a nutritionally balanced diet.

**English Language Learning (ELL) Focus: Verbs with Prepositions**

- Fiber is **made up of** nutrients that help us digest food.
- Whole grains **contain** more fiber than processed grain.

**Sources**

Plant It, Grow It, Eat It, Lesson for Garden – Enhanced Nutrition Education form Life Lab
Finding the Whole Grains, Cooking Matters, Share Our Strength
Fiber Worksheet

Name one health benefit of fiber: ____________________________

List the 3 layers of a whole grain

• __________________
• __________________
• __________________

Draw a picture of a whole grain. Label each part.
Objectives/Assessment Targets

Students will:

● Identify vitamins and minerals found in foods that make us healthy.
● Locate specific vitamins and minerals on the periodic table of elements.
● Prepare a nutritious seasonal snack using produce found in garden.

Activity Preparation

This lesson may be best taught in partnership with your science teacher. Students can search the answers to many questions about vitamins and minerals that are healthy for our bodies using the periodic table of elements, below in the student worksheet.

Materials

● Bowls and utensils for mixing and tasting
● Large pan and burner for sautéing
● Nutrition facts for the healthy snack, identifying the vitamins and minerals
● Healthy Choices worksheet and recipe found in Monthly Recipe book
● Worksheet, Vitamins and Minerals, on page 13 in student workbooks
● Science teachers can bring additional periodic table tools (school science textbooks or tech tools like Chromebooks)

Activity 1: Making a Garden-Fresh Recipe Using the Periodic Table

Present the ingredients for the seasonal healthy snack (garden fresh kale, cucumbers, etc). Reference the nutrition facts for these on the whiteboard.

Ask, What are these vitamins for? What are these minerals for? What part of our body do they support?

*NGSS Disciplinary Core Idea LS1.C: Organization for Matter and Energy Flow in Organisms*

Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
Review the periodic table by asking students to find the vitamins and minerals found in the ingredients in your healthy snack, such as: vitamin A, C, magnesium, K (potassium, and folate). These are commonly found in harvests, such as kale, kohlrabi, broccoli, cauliflower, and cabbage.

Ask:

- What does macro mean? (very large in scale, scope, or capability)
- What are macro-minerals made of? (any mineral required in the diet in relatively large amounts, especially calcium, iron, magnesium, phosphorus, potassium, and zinc.)
- What is a food that has a lot of each of the macro-minerals? (ex. milk and cheese have a lot of calcium)

NGSS Crosscutting Concept: Scale, Proportion, and Quantity

Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.

Students harvest the ingredients for the snack. Review what is available in the garden to harvest, how to harvest safely, and where to harvest (markers in the garden for this activity are helpful). Describe the recipe they will cook, noting the different vitamins and minerals found in the ingredients.

Ask:

- What vitamins and minerals does this have?
- What is the abbreviation for them in the periodic table?
- Where is it located on the periodic table?

An example of a common seasonal harvest is the brassica family (broccoli), which has the following qualities:

- Broccoli is high in calcium for your bones, teeth, and muscles. It is also high in iron, which helps your blood carry oxygen.
● A head of broccoli is actually just a bunch of closed flowers—if you leave them on the plant, they open into yellow flowers that are also edible. These have a sour smell, a sweet taste, and fibrous stalks. The leaves are also edible and equally good for you.

Each student adds an ingredient and participates in stirring, serving, and tasting.

**CA Health Standard 8.1.N**
Support others in making positive food and physical activity choices.

**CA Health Standard 7.2.N**
Demonstrate how to prepare a healthy meal or snack using sanitary food preparation and storage practices.

**Sample Recipe Ingredients and Directions**

- Broccoli (or other any other brassica family veggie you have growing in the garden)
- 1 Tbsp. olive oil
- Tamari
- 1 Tbsp. broth (optional)
- Lemon pepper to taste (optional)
- Lemon for zest (optional)

**Steps**

1. Sauté the ingredients until the broccoli is tender.
2. You can make your own lemon pepper dressing by zesting a lemon and mixing the zest with pepper and whisking in some olive oil.

**Student Reflection**
How can you identify a plant in the brassica family? What are the nutrition facts about brassicas? What part of the brassica plant do we eat?
English Language Learning (ELL) Focus: Verbs with Prepositions

- Vegetables in the Brassica family contain magnesium.
- Magnesium helps our bones grow strong.

Additional Information

Vitamins and minerals are called micronutrient. For further investigation, teachers can dive deeper using kidshealth.org.

Sources

Bay Farm Alameda Unified School District
Dynamic Periodic Table, http://www.ptable.com/
Kidshealth.org
Vitamins and Minerals

**Instructions:** Find the vitamins and minerals in the healthy snack you prepared today. List the ingredients in the recipe and note the element found in it below.

List the Ingredients and the Element found in it.

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Herbs in History

Objectives/Assessment Targets

Students will:

● Read about how herbs were used historically by different cultures.
● Identify herbs growing in the garden.
● Make herbal tea.

Activity Preparation

This lesson builds on previous content students learned about herb and plant use by ancient cultures and Native Americans. The activities invite students to more closely observe the herbs in the garden and identify their ancient use.

There are several library books on herb use in history, Latin folklore and medicine, and Native American cultures. These are helpful for referencing and making available during this lesson for students that need additional challenges or tasks.

Prepare laminated sheets with names of herbs and their health benefits. Note the culture and the time in history, if available. Place these sheets in the garden next to the herbs they delineate. Students will use these to fill in the worksheets for the herb hunt. This lesson ends with a warm tea, which would be great on a cold garden day.

Materials

● Worksheet, Herb Hunt, page 14 in student workbooks
● Hot water container
● Recommended readings listed in Additional Information
● Herbs, lemon, etc.
● Tasting cups

Activity 1: Identify Ancient Herbs in History

Preface the lesson by inviting students to brainstorm different medicines they use at home and their purpose. Describe how herbs have been used in many
different cultures throughout history to heal. Many herbs have a unique smell, feel, and taste that enhance their medicinal properties.

Long before the Europeans arrived on the North American continent indigenous people were practicing herbal medicine and curing diseases that were not curable by Europeans.

**NGSS Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems**

Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments.

Some of their knowledge of how plants could be used for healing came from their keen observation of the wildlife around them. They observed that deer, elk and bear sought out plants to eat when they were sick. They saw the animals recover and knew to experiment with these herbs and plants to heal themselves.

**NGSS Crosscutting Concept: Cause and Effect**

Cause and effect relationships are routinely identified, tested, and used to explain change

Invite students to explore the garden to find the herb markers and information about how they were used. Students use their worksheets, Herbal Hunt, on page 14 in their workbook noting the marked herbs, their use, and their observational qualities. Prompt students to come up with verbs or adjectives to describe the herbs without using the herb name, like minty.

**Ask,** What could (herb) be used for and why?

If students need additional activity or challenge, invite them to read through the books you have available on medicinal uses of herbs in different cultures. Instruct them to find more information on the herbs they noted and observed in their herb hunt worksheet and write down these facts to share with the group during closing circle.

**NGSS Science/Engineering Practice 8: Obtain, Evaluate, and Communicate Information**

Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.

**Ask:**

- Why is it useful to identify an herb?
- What culture used the herbs for medicinal use?
- How is this herb similar to medicines we use today at home?
CDE 5th History Standard 5.1.2 Human Impacts on Earth Systems
Describe ... varied customs and folklore traditions [of major pre-Columbian settlements].

Activity 2: Make Herbal Tea

Native Americans studied plants, particularly herbs, and identified over 500 herbal plants and their many uses. Most of this knowledge was passed down orally; however, many herbs that were discovered and used by Native Americans are used today. Below, in the Additional Information Section, is a sample list of herbs that were used by the earliest inhabitants of the North American continent, many of which can be found in our Bay Area gardens.

Prepare herb tea using many of these herbs, if available in your garden. Invite students to collect herbs they found on their worksheets and place them in a simmering pot of water. Add lemon and/or honey for taste. Distribute to students in tasting cups meant for heat. If this lesson is provided on a warmer day, you can pre-make the tea and add ice.

CA Health Standard 2.2.N
Recognize that family and cultural influences affect food choices.

Student Reflection
What is an herb? Why do we spend time learning about herbal medicine?

English Language Learning (ELL) Focus: Medicinal Verbs

The list below is minimal and contains herbs used by many Native American tribes, their plant family name, and some common medicinal uses. These herbs/plants can often be found in our school gardens.

- Aloe (Aloe vera) leaves are used topically to reduce redness and sting from burns.
and can be used after sunburn on the skin.

- Dandelion (Taraxacum officinale) leaves and flowers **stimulate** appetite and improves upset stomach.
- Echinacea (Echinacea angustifolia) leaves, flowers, and roots are used in traditional herbal remedies by the Great Plains Indian tribes to **fight** infections.
- Licorice (Glycyrrhiza glabra) root and leaves **relieve** digestive problems, including stomach ulcers, and heartburn.
- Nettle (Urtica dioica) leaves can be used to **reduce** joint pain and stiffness, while the root can **relieve** urinary tract infections and hay fever.
- (Mentha piperita) leaves **relieve** stomach aches and flatulence.
- Purslane (Portulaca) is loaded with good fatty omega-3s and **moderates** the effects of depressive brain chemicals.
- Sage (Salvia officinalis) is a savory leaf used in cooking and **improves** liver function.
- Yarrow (Achillea millefolium) flowers are used the Cherokee, Gosiute, Iroquois, and Mohegan peoples as a digestive **aid**.

**Additional Information**

Recommended reading on this topic are available at your school library, which are: Healing Herbal Remedies from Ancient Traditions and Secrets of Native American Herbal Remedies, A Comprehensive Guide.

**Sources**

The Herbal Academy, The Herbal Healing Practices of Native Americans, Marlene Adelmann
**Herb Hunt**

**Instructions:** Take a tour of the garden. Find the herbs that are marked. Write the name of the herb. Use your five senses to observe the herbs. Sketch a drawing of the herb plant, paying close attention to detail. Read the health benefits or the herbs. Write at least one fact or use.

<table>
<thead>
<tr>
<th>Herb Name</th>
<th>Herb Sketch</th>
<th>Health Fact or Use</th>
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Photosynthesis: Part I

Objectives/Assessment Targets
Students will:

● Describe the steps in photosynthesis.
● Identify the plant parts and functions.
● Identify the roles each plant part plays in processing light for food

Activity Preparation
This lesson is the first of a 2 part lesson. It builds on content learned by students in 4th grade on light absorption by leaves to help plants make food. This lesson is best taught in collaboration with your science teacher.

Get familiar with the diagram of photosynthesis below. Prepare cheat sheet cards that outline the steps in photosynthesis that you can use repetitively over the years: Cut strips of paper or note cards, write the name of each of photosynthesis process and draw the plant parts involved in each one on the front side of the card, write the description of each step on the back. Laminate the cheat sheet cards for continual use. Place tape on the back of each cheat sheet card when using them on the whiteboard. These cheat sheet cards will come in handy throughout the year and will continually save you time.

Materials

● Worksheet, Photosynthesis Part I, page 15 in student workbooks
● Photosynthesis cheat sheet cards explained above.

Activity 1: Diagramming Photosynthesis: Sun + Water + CO₂
Review that Plants Need Light. Explain how plants make their own food by absorbing sunlight and carbon dioxide (CO₂) through the surface of their leaves, more specifically the stomata in their leaves. The stomata turns the light into sugar, or food for the plant.


Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

This process is called *photosynthesis*. Write the “recipe” for photosynthesis on the whiteboard = Sun + Water + CO₂.

Plants acquire their material for growth chiefly from air and water.

Show the diagram of a flower with the sun above it found on page 15 in student workbooks. Use this diagram to place the photosynthesis cheat sheet cards in the right order, next to the right plant part.

Photosynthesis happens when:

1. Sunlight hits the leaf.
2. Plants absorb energy from light through stomata in their leaves and turn it into food.
3. Sugar travels down the stem roots. Specific nutrients are turned into plant sugars that the plant uses as energy.
4. The stomata in the leaf absorb carbon dioxide (CO$_2$). This is how plants breathe IN what we breathe Out.
5. The stomata turn carbon dioxide into oxygen released into the air. This is how we breathe IN what plants breathe OUT.
6. Water travels up from the roots to the stem through the ribs into all parts of the leaf.

**NGSS Disciplinary Core Idea PS3.D: Energy in Chemical Processes and Everyday Life**

The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

Students use their worksheet, Photosynthesis Part 1, on page 15 in student workbooks to explain how photosynthesis works, first by studying the diagrams of a plant, labeling the plant parts and their function, and then describing how sunlight is absorbed by leaves and turned into plant food through photosynthesis. Students will use their diagram that they just drew for the next lesson, Photosynthesis: Part II.
**Student Reflection**

What role does the (sun, leaf, roots) play in photosynthesis?

**English Language Learning (ELL) Focus: Vocabulary of Photosynthesis**

- Carbon dioxide is what we **breathe** out.
- Oxygen what we **breathe** in.
- Carbon dioxide is what plants **absorb**.
- Oxygen and sugar is what plants **produce**.

**Additional Information**

Plants are the only living things on Earth that can make their own food. Thus, they are able to live almost everywhere on earth in a wide range of habitats. This is one of the special adaptations they've developed to help them survive.

**Sources**

Life Cycle of Plants, Utah Education Network

Ph-ocusing on Photosynthesis In and Out of the Garden, Yale-New Haven Teachers Institute
Photosynthesis: Part II

Objectives/Assessment Targets

Students will:

- Review the steps in photosynthesis.
- Experiment and document light absorption in leaves
- Compare the results of the sunlight experiment
- Observe how water travels through the vascular system of a plant.

Activity Preparation

This lesson builds on the first part, Photosynthesis: Part I. It dives deeper into the details of the plant parts roles in absorbing water into the vascular system, absorbing sunlight into the stomata by trapping light in the chlorophyll, and converting the light into carbon dioxide and sugar starches.

Prepare glass jars with celery stalks for every pair of students to study how water travels up the vascular system. Draw the diagram of photosynthesis using the diagram and cheat sheets from the previous lesson, Photosynthesis: Part I.

Materials

- Photosynthesis diagram and cheat sheets
- Worksheet, Photosynthesis Part II: How Does Chlorophyll Work?, page 16 in student workbooks
- Samples of plants with large, green leaves
- Tall, clear glass jars filled with water
- Red food coloring
- Celery stalks with leaves

Activity 1: Reviewing Photosynthesis


NGSS Science/Engineering Practice 8: Obtain, Evaluate, and Communicate Information

Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.
Ask, How do plants use water and sunlight?

Use your laminated photosynthesis cheat sheet cards to describe the steps each plant part. Photosynthesis happens when:

1. Sunlight hits the leaf.
2. The stomata in the leaf absorb carbon dioxide (CO₂). This is how plants breathe in what we breathe out.
3. The stomata turn carbon dioxide into oxygen. This is how we breathe IN what plants breathe OUT.
4. New focus: The chlorophyll is found in the stomata. It’s the green color in the leaves. It absorbs the sun’s light and turns it into sugar.
5. Sugar travels down the stem and roots. Specific nutrients are turned into plant sugars that the plant uses as energy.
6. Water travels up from the roots to the stem through the ribs into all parts of the leaf.

Activity 2: Testing Chlorophyll

Show a plant with large, green leaves. Photosynthesis happens with the help of chlorophyll that is found in the green leaves of plants. Chlorophyll absorbs the sun’s light and turns it into sugars that plants use for food.

Fun fact: Plants are the only living thing that can make its own food.


Plants acquire their material for growth chiefly from air and water.

Ask, How is this similar/different from how we get our food?

Show students the water in jars with food coloring.

Ask, What will happen when we place a leaf with a stem in this water?

Students experiment with leaves and stems to see the chlorophyll in action. Students collect leaves with stems no larger than their hand. Direct them to observe the process of
the roots “sucking up water” and moving through their vascular system and into their leaves, which will highlight the chlorophyll, by following these steps:

1. Fill a tall, clear glass jar half full with water.
2. Add a few drops of red food coloring and mix well.
3. Trim the bottom edge of the large stalk of celery, keeping the leaves on.
4. Put the celery stalk in the glass jar and leave it overnight.
5. Observe what has happened the next morning.
6. Students identify that the water has been absorbed into the celery stalk, tinting the stem and leaves red.
7. Prompt students to think about how the whole plant got water and why the color moves to the leaves.
8. Students journal what they observe.

NGSS Crosscutting Concept: Structure and Function
Substructures have shapes and parts that serve functions.

NGSS Crosscutting Concept: Systems and System Models
A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

Student Reflection
How does a plant’s vascular system help it get the nutrients (food) it needs?

English Language Learning (ELL) Focus: Comparative Adjectives
- Plants are similar to humans because __________.
- Humans are different than plants because _____________.
- Plants are the same as humans because _____________.

Sources
Phocusing on Photosynthesis In and Out of the Garden, Yale-New Haven Teachers Institute
Photosynthesis Part II: How Does Chlorophyll Work?

Instructions: You learned today that chlorophyll turns sunlight into food in a process called photosynthesis. Below is a diagram that describes where chlorophyll is in the leaves. You conducted an experiment that lets you observe the chlorophyll in plants. Answer the questions below to explain the experiment you did.

What was your experiment called?

What were the materials you used and why?

What steps did you take in order to complete your experiment?

What were the results of your experiment?

Figure 42 Schematic of photosynthesis in plants. The chlorophyll absorbs the light and carbon dioxide in the leaf stomata. It turns light energy into sugar and releases oxygen.
Pollution Soup

Objectives/Assessment Targets

Students will:

- Identify the types of pollutants created by human and natural activities.
- Experiment with why watershed contamination is harmful for plants, animals, and humans.
- Model what happens when several pollutants are introduced into a clean “watershed.”

Activity Preparation

This lesson builds on content students have learned about watersheds and animal and plant habitats. It introduces the topic of pollution, natural and man-made, and how contaminates affect our garden’s habitat. The activity can be done as a larger group or smaller groups with adult supervision.

Label seven containers and fill them with the following materials to represent different types of pollutants. These will eventually be added to a larger bucket, representing a watershed.

1. **Weather:** rocks and dirt
2. **Trash:** wrappers and crumpled paper
3. **Car owner:** metal, pennies, rubber bands
4. **Homeowner:** paint chips, soap
5. **Pet owner:** Tootsie roll or chocolate-covered raisins to represent pet waste
6. **Gardener:** water and food coloring to represent fertilizers and pesticides
7. **Heavy industry:** soy sauce and water to represent industrial discharges

Materials

- Seven containers with the above labels and contents
- Larger bucket to hold these “contaminants”
- Container of water and spray bottle
- Samples of pollutants from each groups, garden trash, etc.
- Photo example of how polluted watersheds affect animals
- Worksheet, Pollution Soup, page 17 in student workbooks
Activity 1: Polluting Our Watersheds and Habitats

Review what a watershed is. Explain that a watershed is an area of land where all water drains off and goes into a common body of water, such as a storm drain, a creek, or the Berkeley Bay. A watershed can be thought of as a large bathtub. When a drop of water hits the edge of a bathtub, it eventually finds its way into the drain (the lowest point).

Ask:
- Where is our watershed?
- Where do we get water for our garden?
- Where does the water that we add to our garden go?

Review what a habitat is. Prompt students to consider all the plants and animals that call the garden home.

Ask, How might our garden habitats be affected by water that comes in and water that comes out?
Tell students they will experiment with contaminants effect on our watershed. Direct students to share out all the contaminants they can think of.

**Ask**, How does the contaminate get into our watershed? (Rain, carwash, garden water runoff)

Review the seven containers that represent different types of pollutants. Direct students to identify the source of the contaminate. Write the source and the type on the whiteboard in a grid. Explain that the objects in the containers represent the type of pollutant.

<table>
<thead>
<tr>
<th>Source</th>
<th>Contamination Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>Heavy rainstorms push dirt from construction sites onto streets, into storm drains, and into the bay. Sediment in the water can decrease the amount of light available to plants in the water, increasing temperatures and smothering aquatic life.</td>
</tr>
<tr>
<td>Trash:</td>
<td>Litter is tossed on the streets and creeks, which is washed down the storm drains or directly into our watersheds when it rains or during street cleaning. Plastics, aluminum, and other trash do not degrade and contain toxic materials.</td>
</tr>
<tr>
<td>Cars</td>
<td>All vehicles contribute to urban runoff that goes down our storm drains and into our watersheds. They are major sources of metals, such as copper, lead, cadmium, and chromium that are toxic to all life.</td>
</tr>
<tr>
<td>Homeowner</td>
<td>Repairs and home upkeep may contain paints that have heavy metals, fungicides to inhibit mold, and dyes. When paint is poured down the storm drain or brushes and rollers are cleaned outside, our watershed becomes polluted.</td>
</tr>
<tr>
<td>Pet owner</td>
<td>Pet waste that is not picked up collects bacteria and parasites that are carried into the watershed when they are washed down the streets or seep into creeks.</td>
</tr>
<tr>
<td>Gardeners</td>
<td>When pesticides, fertilizers, herbicides, and weed killers are used on our landscapes and gardens, they leave remaining contaminates that sit on the surface of the earth. These are washed into our storm drains and creeks more quickly when these landscapes are overwatered.</td>
</tr>
<tr>
<td>Heavy industry</td>
<td>There are more regulations for industrial pollution than home pollution; however, some industries illegally dump toxic waste or discharge hot water into rivers and bays.</td>
</tr>
</tbody>
</table>

**NGSS Disciplinary Core Idea ESS2.E: Biogeology 4th Grade Review**

Living things affect the physical characteristics of their regions.

Demonstrate how a watershed can be contaminated by inviting each student to add one of the “contaminants” to a large container of water, which represents the watershed. Students
share the contents of their “contaminant” and how it could get into our watershed and how it can harm the environment.

**Ask,** How might these pollutants affect animals, humans, and plants?

**NGSS Science/Engineering Practice 1: Asking Questions and Defining Problems**
Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Students use the worksheet, Pollution Soup, page 17 in their workbooks to document the model they just made. Review examples of how these pollutants get into our watershed by writing down examples that students share on the whiteboard next to each of the seven activities. Add more details as the activity proceeds.

**Student Reflection**
What can you do to help keep the watershed clean and free of pollutants?

**English Language Learning (ELL) Focus: Noun, Collective Noun, and Verb**
- **Pollutants are** individual material that contaminates water, air, or land.
- **Pollution** is a collection of materials that contaminates water, air, and land.
- Gardeners **pollute** the watershed when they use pesticides, fertilizers, and herbicides.

**Sources**
Kids in the Garden
Pollution Soup

Instructions: Below are examples of the perils of plastics. You modeled how pollutants get into our watershed and the affects they have on our natural environment. Answer the questions about the model you created on how pollutants affect watersheds.

What pollutants did you add to the watershed bucket?


How did they get there?


How do they affect our natural environment?


Weather and Climate

Objectives/Assessment Targets
Students will:

- Review why farmers need to know the weather and climate
- List some of the consequences of drought.
- Explain the cause-and-effect relationships between weather and climate.

Activity Preparation
This lesson builds on content students learned about sources that affect our habitats. It adds new ideas about how we influence our food system. The activity focuses on man-made influences and weather’s effect on our environments. The lesson is adapted from the Teacher’s College, Growing Food Curriculum, Crops and Weather. Students use their worksheet, Weather and Climate, to describe how weather and climate affect farmers’ ability to get the food to the fork. This lesson can be scaled up or down for 3rd and 5th grades. It can be taught inside on rainy or cold days, referencing the weather and season.

Materials
- Worksheet, Weather and Climate on page 18 in student workbooks

Activity 1: Weather and Climate
Review seasonality with students, focusing on the weather of the current season and day. Weather tells us what is happening right now, such as hot, cold, or dry, and affects our daily activities. Climate is the average weather of a region over time and determines if we can grow food and need particular shelter.

NGSS Disciplinary Core Idea ESS2.A: Earth Materials and Systems 4th Grade Review
Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

Farmers rely on the climate to produce an abundance of crops. Without an understanding of climate, farmers wouldn’t know what kinds of crops to grow or when they could plant them. In any given season, the weather can help farmers have an abundance harvest or cause them to have no harvest at all.

Ask:
• What can weather tell us about how and when to plant in our garden? (The Farmers’ Almanac offers farmers different climate reports and tips for how to pick the right site, figure out how “big” to go, and how to select which vegetables to grow.)
• How can we learn from our climate to plan for planting in our garden? (Sow seeds after the last frost, plant cover crops in the winter to keep soil warm, water less in rainy seasons, practice companion planting)

Activity 2: Farming Stories

Direct students to put on their farmer hats and brainstorm how farmers would use information about climate to plan their farms. Then ask them to think about climate scenarios that could harm the farm and how farmers could respond. Students use their worksheet, Weather and Climate, on page 17 to respond to the different climate scenarios they may face as farmers. Prompt them to think about all they have learned about farming and garden planning in past lessons and years. They may only want to choose one or two to expand on.

Scenario 1: You live in a colder climate with winter snow. It’s the end of summer and fall is approaching. The weather is cooling down to 50 degrees during the day. The soil is getting cold. How will you plan for your farm? What will you plant? Where will you plant it?

Scenario 2: You live in a desert where it doesn’t rain often and it’s hard to get water to your farm. How will you plan for your farm? What will you plant? Where will you plant it?

Scenario 3: You live in an urban environment without a lot of room for a big farm. You have to pay a lot for water, which you get from the City. You have to bring in a lot of soil amendments and compost to make sure your plants get enough nutrients. You are close to markets and retail. How will you plan for your farm? What will you plant? Where will you plant it?

Common Core State Standard W.4.1

Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

Student Reflections

How does the weather affect you? How does the weather affect what you’re able to eat? How does the climate affect what you’re able to buy at the stores, particularly veggies and fruits?
English Language Learning (ELL) Focus: Auxiliary Can and Do Questions

- Why do we study weather?
- What do you think causes climate change?
- What can policy do to conserve natural resources?
- How can gardeners conserve natural resources?

Additional Information

“There are many possible environmental changes as a result of global warming. There are many scientists currently studying what these consequences might be. No one knows exactly what these consequences will be. Many scientists recommend what is called the “precautionary principle.” That is, since we don't know what the consequences could be, we should make every attempt we can to decrease global warming through decreasing fossil fuel use.” – 2005, LIFE: Linking Food and the Environment, Lesson 22: Fossil Fuels and the Environment, Farm to Table and Beyond, and inquiry-based science and nutrition program, Teachers College, Columbia University.

Sources

Drought beyond Borders, Bilingual Lesson Plans for the Binational Santa Cruz Watershed Project WET Discovering Drought, Project EAT
Objectives/Assessment Targets

Students will:

● Model the effects of salt and fresh water on earth.
● Document the many water uses, home, gardens, etc.
● Brainstorm ways to conserve water.

Activity Preparation

This lesson builds on content students learned about the water cycle and water use. The activity invites them to model the small amount of fresh usable water we have available on Earth and encourages them to conserve and be water-wise.

Cut sponges into twelve pieces. Fill a pitcher with one quart of water. Draw the Water Use Chart on the whiteboard, which represents the planet’s water percentages of fresh (usable water) and salt water.

Materials

● Pitchers of water (one for each student group)
● Eye dropper
● Three cups
● Small plastic cups (one for each student)
● Two sponges cut into 12 pieces (one piece per student)
● Worksheet, Water Use Chart, page 19 in student workbooks

Activity 1: Drop in the Bucket

Review the Water Cycle they learned about in 4th grade. Outline each step in the water cycle:

1. A Cloud that causes a big rainstorm
2. An arrow from the ocean to the cloud, labeled “evaporation”
3. An arrow from the cloud to the planet, labeled “precipitation”
4. A wiggly line across the board, labeled “rising temperatures”
5. Dashes from the wriggly line to the planet, labeled “evaporation”
6. Gathered dashes in the clouds, labeled “condensation”
Remind students that our planet’s water is finite (it has limits). Explain the difference between fresh and saltwater is that fresh water comes from rain, wells, rivers, lakes, and can be used for human use. Salt water is found in oceans and seas and is the majority of the water available on Earth. Demonstrate how much of the planet’s water is salt water (invite student participation):

1. Hold up the pitcher and fill it with water, which represents all of the water on the planet, 97% of which is salt water.
2. Pour six teaspoons from the pitcher into a cup, which represents the 3% of the planet’s water that is fresh.

**NGSS Disciplinary Core Idea ESS2.C: The Roles of Water in Earth’s Surface Processes**

Nearly all of Earth’s available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

**Ask,** What portion of the Earth’s water is drinkable?

Demonstrate how much of the planet’s water is fresh water (invite student participation):

1. Pour one teaspoon into another cup to demonstrate the amount of freshwater that is liquid.
2. Hold up the remaining water left in the pitcher.

**Ask,** Where do you think the remaining freshwater is found? (Most of the remaining fresh water is deep underground).

3. Use an eyedropper to pull out a single drop of water from the small cup of “fresh water” and place it on your finger, representing the freshwater on the planet that is drinkable.
80% of the freshwater is solid.

**Common Core State Standard M.P.4**
Reason abstractly and quantitatively.

**Activity 2: Observing Our Water Footprint**

Explain that our water footprint is the amount of water we, as individuals, consume and the impact that our use has on the planet. Students use their worksheet, Water Use Chart, on page 19 in their workbooks to brainstorm all the ways that they use the 3% of drinkable water, other than for drinking. This may be a great opportunity to pair-work.

**NGSS Science/Engineering Practice 1: Asking Questions and Defining Problems**
Use prior knowledge to describe problems that can be solved.

Tell students that they will make a model that represents all the water they use. Distribute small cups and small pieces of sponge to each student. Students model their water consumption by following these steps:

1. Dip your sponge into the pitcher of water each time you think of an activity that you do that uses water.
2. Retain as much water in the sponge as possible without wringing it out in between actions.
3. Squeeze your sponge into the small cup, which represents your water footprint.
Students compare the amount of water in their water footprint with the amount of water that represented all of the drinkable water on earth.

Ask:
- What is conservation?
- How can you conserve water?

Student Reflection
How will you conserve the 3% of available drinking water?

English Language Learning (ELL) Focus: Verb to Noun
- Conserve water
- Water conservation

Additional Information
The reservoir that Berkeley gets its water from is located on the Mokelumne River in the Sierra Nevada Mountains. We share this reservoir with other living organisms that relies on consistent amounts of water.

Sources
Project EAT
**Water Use Chart**

**Instructions:** Below is a pie chart of all the water we have on the Planet (Earth). Brainstorm all the ways that you use the 3% of drinkable water, other than for drinking. The, brainstorm all the ways you can conserve the 3% of water.
Food Chains

Objectives/Assessment Targets

Students will:

- Simulate a food chain by role playing different animals, plants, and the sun.
- Draw the relationship between the different members of a food chain.
- Discuss the implications if any one of the members of the food chains were to die.

Activity Preparation

This interdependence lesson expands on what students learned about food systems, focusing on food webs and food chains.

This can be taught in the classroom using the whiteboard or overhead projectors.

Materials

- Examples of different animal cards and food cards
- Worksheets, Food Chains, page 23 in student workbooks

Activity 1: Food Chain

Unlike plants, animals can’t make their own food. Some animals eat plants. Some animals eat other animals. Energy passes from one animal to another as they eat plants or one another. The lives of these plants and animals are interconnected. They depend upon one another for survival. Science calls that a food chain.


Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.


Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.
A food chain follows one path from the sunlight to the plant to the animals. There are many steps and interconnections along the way.

Ask:
- What are examples of animals that eat plants?
- Do they also eat other animals?
- What are examples of animals that eat other animals?
- Do other animals then eat them?

Draw these steps on the whiteboard. Invite students to create a story together about a food chain. For example:
- Grass grows using the energy from the sun.
- A grasshopper eats the grass.
- A frog eats the grasshopper, which has eaten the grass.
- A snake eats the frog, which has eaten the grasshopper, which has eaten the grass.
- A hawk eats a snake, which has eaten a frog, which has eaten a grasshopper, which has eaten grass.

Ask:
- What if there were no more plants?
- Who would survive in this example of a food chain if there were no plants?
- Who would survive in this example of a food chain if there were no more? (name the animal that was listed in the example)

Students use their worksheet, Food Chains, on page 23 in their workbooks to draw their own food chains. Direct them to start with the sun, make sure it’s linear, and label the type of producer of consumer.

Student Reflection
Where do you fit into the food chain? What do you eat most? English Language Learning (ELL) Focus: conditional

- What would happen if ________
- If ________ then humans would _________.

Additional Information
The ultimate source of energy for most living organisms is the sun. A simple food chain shows how energy is transferred from the sun through living organisms. A food chain has
many different **producers** and **consumers**. Most animals eat more than one kind of food, or energy source.

**Sources**

Critters, AIMS Education Foundation, 1989

Hands on Nature, Vermont Institute of Natural Science, 1986

Kaleidoscope, Aid for Primary School Science Ed. Feb 92 Vol. 7 #5

Science on the Go! The Chicago Academy of Sciences

Urban Ecosystems, Field Studies Council, Feeding Relationships
**Food Webs**

**Instructions:** A FOOD CHAIN shows the transfer of energy from the sun through living organisms. Use the examples below to draw your own food web. Label the type of producer or consumer: producer, primary consumer, secondary consumer or tertiary consumer.

```
energy producer primary consumer secondary consumer tertiary consumer

sun → grass → grasshopper → shrew → owl
```
Food Webs

Objectives/Assessment Targets

Students will:

- Roleplay different animals and plants in a food web.
- Explain the relationship between the different animals and plants in a food web.
- Discuss the implications if any one of the members of the food chains were to die.

Activity Preparation

This lesson directly builds on the Food Chain lesson. They should be taught together so students fully understand the interconnectedness of plants and animals, that they rely on each other for survival, and that their relationships can be mapped out to better understand their role in the natural environments.

Materials

- Food web and food chain worksheet in student workbooks, page 30.
- Journals and pencils

Activity 1: Animals and Plants Make Up a Food Web

Some animals eat plants. Some animals eat other animals. The lives of these plants and animals are interconnected. Energy passes from one animal to another as they eat plants or one another. They depend upon one another for survival.

NGSS Disciplinary Core Idea PS3.D: Energy in Chemical Processes and Everyday Life

The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

Review what a Food Chain is. The ultimate source of energy for most living organisms is the sun. A simple food chain shows how energy is transferred from the sun through living organisms. A food chain has many different producers and consumers. Most animals eat more than one kind of food, or energy source, so an ecosystem has different food chains that connect to each other to form a Food Web, which involves the following:

- **Producers** use energy from the sun, like plants.
- **Primary consumers** eat the producers, which makes them herbivores in most communities.
- **Secondary consumers** eat the primary consumers, which makes them carnivores. Some eat producers and consumers; these are omnivores.
- **Tertiary consumers** eat the secondary consumers; these are usually carnivores.

**NGSS Disciplinary Core Idea LS2.A: Interdependent Relationships in Ecosystems**

Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.

Students use their worksheet, Food Webs, on page 24 in their workbooks to review the food web diagram to create their own food web. Students may work best brainstorming in pairs. Direct them to label the name of the plant and animal and whether they are a producer, primary consumer, secondary consumer, or tertiary consumer.

**Student Reflection**

Where do you fit into the food web?

**English Language Learning (ELL) Focus: conditional**

- What **would** happen if ________
- If __________ then humans **would** ____________.

**Additional Information**

Show students the PBS Learning Media video “Food Web”:

You can also share the Food Myth Busters video, “The Real Story About What We Eat,” by Anna Lappé: http://foodmyths.org/myths/hunger-food-security/

**Sources**

Critters, AIMS Education Foundation, 1989
Hands on Nature, Vermont Institute of Natural Science, 1986
Kaleidoscope, Aid for Primary School Science Ed. Feb 92 Vol. 7 #5
Science on the Go! The Chicago Academy of Sciences
Urban Ecosystems, Field Studies Council, Feeding Relationships
Food Webs

Instructions: Most animals eat more than one kind of food in a Food Web. The food webs point to many different animals and plants. Use the examples of a food web below to draw your own food web. Label the type of producer or consumer: producer, primary consumer, secondary consumer or tertiary consumer.
Tomato Seed to Market

Objectives/Assessment Target

Students will:

- Role play different positions in the food system (producer, distributor, consumer)
- Create posters tracing a particular food they like from farm to fork.

Activity Preparation

This lesson summarizes content learned by students about the many factors of a food system. It builds on past lessons about food miles and the effect on produce taste and environmental externalities. The activities invite students to tell their own food system story, mapping their favorite food from farm to fork. They also act out each of the roles as they complete garden tasks.

Prepare (tomato) seedlings for planting. Gather large poster boards of butcher paper for students to make food system posters. This activity may be paired with a garden fresh snack or a recipe found in the Monthly Recipes.

Materials

- Tomato seedlings
- Food system diagram
- Poster making materials
- Worksheet, Tomato Seed to market, page 25-26 in student workbooks

Activity 1: What is A Food System?

Review Food Chains and Webs. Highlight the interdependence we have on plants and animals. Direct students to focus on the big picture. Think of a system that incorporates both food chains and webs.

Ask:

- What is your favorite food? (Break it down to a farm product, such as wheat for bread)
- How do you get your favorite food? (Market or garden)
- Who was involved in getting you that food? (Parents, market, trucks, farms)
Present the five main steps in a regional food system below. Write them on the board. Invite students to use their worksheet, Tomato Seed to Market, on page 25 in their workbooks to come up with a symbol that represents each of the steps.

1. **Agricultural production:** Planting, tending, and harvesting
2. **Processing:** Harvesting and packing
3. **Distribution:** Loading, delivering, and unloading
4. **Retail:** Displaying, selling, cooking, and eating
5. **Composting/Recycling:** Collecting food scraps and digesting

**NGSS Crosscutting Concept: Systems and System Models**
A system can be described in terms of its components and their interactions.

Students share a food that they like to eat and trace it back from their plate to the farm. Now direct students to use the second page of their worksheet, or use the poster materials, to map out their food going through the food system.

![Figure 45 Food system maps created by students with guidance from Ellen McClure, Garden Instructor](image)

**Ask:**
- What are some consequences of buying and eating _____ that are grown very far from your home?
- What would happen to our ability to buy and eat ____ if a farm couldn’t get access to water?
CA Health Standard 2.1.N
Describe internal and external influences that affect food choices and physical activity.

NGSS Science/Engineering Practice 6: Constructing Explanations and Designing Solutions
Identify the evidence that supports particular points in an explanation.

Activity 2: Planting Seeds

Tell students that they will now put on a food system play and get garden work done. Students act out the four main roles of a food system as they prep beds and plant seedlings.

1. **Producer**: As a farmer, they prep the beds and plant the seedlings.
2. **Distributor**: As a distributor, they harvest the fruits and bring them to a table to be processed.
3. **Processed**: As a processor, they wash, slice, and make the fruit available to consumers.
4. **Consumers**: As a consumer, they choose which fruit to buy based on consumer preferences and price.

As they are acting out each role, prompt them to consider their responsibilities.

**Ask:**

- If you enacted the role of producer/farmer, were you able to afford the fruit as a consumer?
- If you enacted the role of distributor/market, were you able to get the fruit to the table fast enough so it didn't spoil? The fruit as a consumer?
- If you enacted the role of processor/cafe, were you be able to market the fruit so your consumers bought it and you could get a profit?
- In the role of consumer, were you able to afford the fruit, did you care about how it was grown or processed, and did you enjoy the taste?
Students Reflect on the Lesson

Direct them to imagine the effects of the following scenarios:

1. The farmers picked tomatoes at their very ripest
2. Farmers needed to pay more for the people that worked in the fields (agricultural labor).
3. There was a drought and farmers were required to cut back their water use by 30%.
4. There was a big rise in demand for tomatoes at the grocery store.

English Language Learning (ELL) Focus: would

• The first, second, third,... steps in the process are__________.
• If the farmers needed to pay more for the agricultural labor, they would ________.
• If the farmers picked their tomatoes at their ripest, the tomatoes would ________.

Sources

Bean Seed Cycle, National Agriculture in the Classroom

Diagram by Carsten Rodin, SPUR: Ideas and Actions for a Better City

Education.com
Vocabulary

Abiotic: Nonliving, inanimate, characterized by the absence of life; of inorganic matter.

Adaptation: A change in an organism or its parts that make it more fit for the conditions of its environment.

Agriculture: The active production of useful plants or animals in ecosystems that have been created by people.

Agroecology: An ecological approach to agriculture that views agricultural areas as ecosystems and is concerned with the ecological impact of agricultural practices.

Agroecosystem: An ecosystem created when people actively plant flora in order to increase the diversity of available plant resources.

Anatomy: The parts that form a living thing (such as an animal or plant).

Angiosperm: A vascular seed plant in which the ovule (egg) is fertilized and develops into a seed in an enclosed hollow ovary.

Annual: Happening once a year; having a life cycle that is one year or one season long.

Anther: The part of a flower that contains pollen.

Bacteria (singular bacterium): Any of a group of microscopic single-celled organisms that live in enormous numbers in almost every environment on Earth, from deep-sea vents to deep below Earth's surface to the digestive tracts of humans.

Bean: A seed or pod of certain leguminous plants of the family Fabaceae. Rich in protein and providing moderate amounts of iron, thiamin, and riboflavin, beans are used worldwide for cooking in either fresh or dried form.

Biodiversity: The diversity (number and variety of species) of plant and animal life within a region.

Biology: The study of living things and their vital processes. The field deals with all the physicochemical aspects of life.

Biotic: Of, pertaining to, or produced by life or living organisms.

Carbon: The chemical element that forms diamonds and coal and that is found in petroleum and in all living plants and animals.

Carbon Dioxide: A gas that is produced when people and animals breathe out or when certain fuels are burned and that is used by plants for energy.
**Carpel:** One of the individual female reproductive organs in a flower. A carpel is composed of an ovary, a style, and a stigma, although some flowers have carpels without a distinct style.

**Cell:** The basic unit of a living organism.

**Chlorophyll:** The green coloring matter of plants that is found in chloroplasts and is necessary for photosynthesis.

**Chloroplast:** A cellular part that contains chlorophyll and is the location of photosynthesis.

**Climate:** The average course or condition of the weather at a place, usually over a period of years, as exhibited by temperature, wind velocity, and precipitation.

**Climate Change:** Changes in the Earth’s climate, especially those said to be produced by global warming.

**Climatology:** The science that deals with climates and investigates their phenomena and causes.

**Community:** A group of interdependent organisms inhabiting the same region and interacting with each other.

**Compost:** The decayed remains of organic matter that has rotted into a natural fertilizer.

**Conservation:** The discipline concerned with the protection of biodiversity, the environment, and natural resources.

**Consumer:** An organism that uses other organisms for food in order to gain energy.

**Cortex:** Tissue of unspecialized cells lying between the epidermis (surface cells) and the vascular, or conducting, tissues of stems and roots.

**Cotyledon:** The first leaf or one of the first pair of leaves developed by the embryo of a seed plant.

**Cultivate:** To prepare or use for the raising of crops; also: to loosen or break up the soil about (growing plants); to foster growth.

**Cycle:** A set of events or actions that happens again and again in the same order.

**Decompose:** To separate or break down something into its components; to disintegrate or fragment.

**Design:** To plan and make decisions about (something that is being built or created): to create the plans, drawings, etc., that show how (something) will be made.

**Dicot:** A plant whose seedlings have two cotyledons.
Dicotyledon (byname dicot): Any member of the flowering plants, or angiosperms that has a pair of leaves, or cotyledons, in the embryo of the seed. There are about 175,000 known species of dicots. Most common garden plants, shrubs, trees, and broad-leafed flowering plants, such as magnolias, roses, geraniums, and hollyhocks, are dicots.

Dicotyledonous: Having two cotyledons.

Disperse: To scatter in different directions.

Disseminating: Spreading widely.

Diversity: The quality or state of having many different forms, types, ideas, etc.

Dormant: Not active but able to become active.

Drought: A long period of time during which there is very little or no rain.

Earth: The planet on which we live; land as opposed to the sea, the air, etc.; the material in which plants grow.

Ecology: The science that deals with the relationships between groups of living things and their environments.

Ecosystem: Everything that exists in a particular environment.

Embryo: A rudimentary plant contained in the seed.

Endosperm: Tissue surrounding the embryo of flowering plant seeds which provides nutrition to the developing embryo.

Energy: The physical or mental strength that allows you to do things; natural enthusiasm and effort; usable power that comes from heat, electricity, metabolism, etc.

Environment: The conditions that surround someone or something; the conditions and influences that affect the growth, health, progress, etc., of someone or something.

Epidermis: The outer, protective layer of a plant.

Equinox: A 24-hour period when day and night are the same length.

Erosion: The gradual destruction of something by natural forces (such as water, wind, or ice).

Farmer: A person who cultivates land or crops or raises animals (as livestock or fish).

Fauna: All the animals that live in a particular areas, time period, or environment.

Fertile: Producing many plants or crops.

Fertilize: To make (soil, land, etc.) richer and better able to support plant growth by adding chemicals or a natural substance (such as manure).
**Filament:** The stalk of a stamen in a flower, supporting the anther.

**Flora:** All the plants that live in a particular area, time period, or environment.

**Flower:** The reproductive portion of any plant in the division Magnoliophyta (Angiospermae), commonly called “flowering plants” or “angiosperms.” As popularly used, the term “flower” especially applies when part or all of the reproductive structure is distinctive in color and form.

**Food Chain:** A series of types of living things in which each one uses the next-lower member of the series as a source of food.

**Food System:** A network that integrates food production, processing, distribution, consumption, and waste management, affecting the environmental, economic, and social health of a particular place.

**Food Web:** The totality of interacting food chains in an ecological community.

**Fungus:** A single-celled or multinucleate organisms that decompose and absorb the organic material that they grow (such as molds, mushrooms, or yeasts) and classified in the kingdom Fungi.

**Gamete:** A mature sexual reproductive cell, as a sperm or egg, that unites with another cell to form a new organism.

**Genetic Diversity:** Refers to both the vast numbers of different species as well as the diversity within a species. The greater the genetic diversity within a species, the greater that species’ chances of long-term survival. This is because negative traits (such as inherited diseases) become widespread within a population when that population is left to reproduce only with its own members.

**Germinate:** To develop into a plant or individual, as a seed, spore, or bulb.

**Heredity:** The sum of all biological processes by which particular characteristics are transmitted from parents to their offspring.

**Humus:** The dark organic material in soils that is produced by the decomposition of vegetable or animal matter and is essential to the fertility of the earth.

**Hypothesis:** A proposition, or set of propositions, set forth as an explanation for the occurrence of some specified group of phenomena, either asserted merely as a provisional conjecture to guide investigation (working hypothesis) or accepted as highly probable in the light of established facts.

**Inorganic:** Not having the structure or organization characteristic of living bodies.

**Interdependence:** The quality or condition of being mutually reliant on each other.
**Invertebrate:** Not vertebrate; without a backbone. More than 90% of all living animal species are invertebrates.

**Investigate:** To try to find out the facts about and learn more about an object, person, place, thing, situation, etc.

**Leaf:** One of the expanded, usually green organs borne by the stem of a plant.

**Legume:** Also called “pod,” a fruit of plants of the order Fabales (peas and beans). The dry fruit releases its seeds by splitting open along two seams.

**Life:** Living matter and, as such, matter that shows certain attributes, including responsiveness, growth, metabolism, energy transformation, and reproduction.

**Metabolism:** The chemical processes by which a plant or an animal uses food, water, etc., to grow, heal, and make energy.

**Monocot:** Any of a group of flowering plants (as palms and grasses) having an embryo with a single cotyledon and usually leaves with parallel veins and flower parts in groups of three.

**Monoculture:** The use of land for growing only one type of crop.

**Mulch:** A covering (as of woodchips or sawdust) spread over the ground to protect the roots of plants from heat, cold, or evaporation, prevent soil loss, control weeds, enrich the soil, or keep fruit (as strawberries) clean.

**Natural Resource:** Something (as a mineral, waterpower source, forest, or kind of animal) that is found in nature and is valuable to humans (as in providing a source of energy, recreation, or scenic beauty).

**Nitrogen:** A colorless, odorless, tasteless gas that is the most plentiful element in Earth's atmosphere and is a constituent of all living matter.

**Nitrogen-Fixing Bacteria:** Microorganisms capable of transforming atmospheric nitrogen into fixed nitrogen (inorganic compounds usable by plants). More than 90% of all nitrogen fixation is affected by these organisms, which thus play an important role in the nitrogen cycle.

**Nutrient:** A substance that an organism must obtain from its surroundings for growth and the sustenance of life. In most living organisms, nutrients provide not only the energy necessary for certain vital processes but also the various materials from which all structural and functional components can be assembled.

**Nutrition:** The assimilation by living organisms of food materials that enable them to grow, maintain themselves, and reproduce.
**Observation:** The act of careful watching and listening; the activity of paying close attention to someone or something in order to get information.

**Opinion:** A personal view, attitude, or appraisal.

**Organic:** Of, relating to, or obtained from living things; of, relating to, or containing carbon compounds.

**Organism:** A form of life considered as an entity; an animal, plant, or fungus.

**Oxygen:** A reactive element that is found in water, rocks, and free as a colorless, tasteless, odorless gas that forms about 21% of the atmosphere, that is capable of combining with almost all elements, and that is necessary for life.

**Petal:** One of the often brightly colored modified leaves that make up the corolla of a flower.

**Perennial:** Living for several years, usually with new leafy growth produced from the base each year.

**Pest:** A plant or animal harmful to human beings or human concerns (as agriculture).

**Pesticide:** A substance used to destroy pests.

**Photosynthesis:** The process by which plants that contain chlorophyll make carbohydrates from water and from carbon dioxide in the air in the presence of light.

**Pistil:** The seed-producing part of a flower, consisting usually of stigma, style, and ovary.

**Pollen:** A mass of tiny particles in the anthers of a flower that fertilize the seeds and usually appear as fine yellow dust.

**Pollinator:** The biotic agent (vector) that moves pollen from the male anthers of a flower to the female stigma of a flower to accomplish fertilization of the female gametes in the ovule of the flower by the male gametes from the pollen grain. Examples include birds, bats, bees, butterflies, beetles, and other small mammals. Creatures that pollinate plants are responsible for bringing us one out of every three bites of food.

**Pollination:** Transfer of pollen grains from the stamens, the flower parts that produce them, to the ovule-bearing organs or to the ovules (seed precursors) themselves.

**Pollution:** The action or process of making land, water, air, etc., dirty and not safe or suitable to use; substances that make land, water, air, etc., dirty and not safe or suitable to use.

**Polyculture:** The raising at the same time and place of more than one species of plant or animal.
**Producer:** A living thing (as a green plant) that makes its food from simple inorganic substances (as carbon dioxide and nitrogen) and many of which are food sources for other organisms.

**Propagate:** To cause (an organism) to multiply by any process of natural reproduction from the parent stock.

**Propagation:** The controlled perpetuation of plants, the most basic of horticultural practices. Its two objectives are to achieve an increase in numbers and to preserve the essential characteristics of the plant. Propagation can be achieved sexually by seed, asexually by utilizing specialized vegetative structures of the plant (tubers and corms), or by employing such techniques as cutting, layering, grafting, and tissue culture.

**Protein:** Any of numerous substances that consist of chains of amino acids, contain the elements carbon, hydrogen, nitrogen, oxygen, and often sulfur, include many compounds (as enzymes and hormones) essential for life, and are supplied by various foods (as meat, milk, eggs, nuts, and beans).

**Reflect:** To cast back (light, heat, sound, etc.) from a surface. Also, to think, ponder, or meditate; to reflect on a topic or one’s opinion.

**Renewable:** Capable of being replaced by natural ecological cycles or sound management procedures.

**Respect:** Esteem for or a sense of the worth or excellence of a person, a personal quality or ability, or something considered as a manifestation of a personal quality or ability.

**Responsible:** Having the job or duty of dealing with or taking care of something or someone; able to be trusted to do what is right or to do the things that are expected or required.

**Root:** The leafless, usually underground part of a plant that absorbs water and minerals, stores food, and holds the plant in place.

**Season:** One of the four periods of the year (spring, summer, autumn, and winter), beginning astronomically at an equinox or solstice but geographically at different dates in different climates.

**Seasonality:** A pattern, variation, or fluctuation that correlates with a season, day of the week, or other period of time.

**Seed:** A fertilized, ripened ovule of a flowering plant that contains an embryo and is capable of producing a new plant.

**Sepal:** One of the specialized leaves that form the calyx of a flower.
Solstice: The point in the apparent path of the sun at which the sun is farthest north or south of the equator.

Stamen: An organ of a flower that consists of an anther and a filament and produces the pollen.

Stele: The central cylinder or cylinders of vascular and related tissue in the stem, root, petiole, leaf, etc., of the higher plants.

Stem: The stalk that supports a leaf, flower, or fruit.

Sustainable: Pertaining to a system that maintains its own viability by using techniques that allow for continual reuse.

Symbiosis: The living together in close association of two different kinds of organisms (as a fungus and an alga making up a lichen), especially when such an association is of benefit to both.

System: A group of related parts that move or work together; a body of a person or animal thought of as an entire group of parts that work together.

Topsoil: The fertile, upper part of the soil.

Trait: A quality that makes one person or thing different from another.

Transplant: To remove (a plant) from one place and plant it in another.


Vertebrate: Having a backbone or spinal column.

Weather: State of the atmosphere at a particular place during a short period of time. It involves such atmospheric phenomena as temperature, humidity, precipitation (type and amount), air pressure, wind, and cloud cover.

Weed: A plant that is not valued where it is growing and is usually of vigorous growth; especially, one that tends to overgrow or choke out more desirable plants.

Xylem: A tissue of higher plants that carries water and dissolved materials upward, functions also in support and storage, lies deeper inside the plant than the phloem, and usually makes up the woody parts (as of a plant stem).

Sources

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