Sow and Grow

A Fresh from the Farm
Garden Curriculum

Sow and Grow Table of Contents

Introduction

"How do I start a school garden?" "How do I maintain the garden once it is built?" "How can I use the garden space as an extension to the classroom?" "How do I know I'm doing it right?" Seven Generations Ahead, a non-profit whose mission is to promote the development of healthy and sustainable communities, has compiled a garden-centered curriculum resource, in direct response to questions like these, as well as to help provide answers and methods for garden-based education.

Sow and Grow uses the local environment as a focal point for learning. Place-based education creates a meaningful and culturally relevant framework for learning. By connecting Common Core concept areas and units of study in their classrooms to gardens and local communities, students have a real-world context for learning. Place-based education opportunities are plentiful in the Sow and Grow curriculum.

Most experts agree that a combination of access to and education about healthy food provides the strongest opportunity to influence healthy eating behaviors. The National Association of State Boards of Education (NASBE) Preventing Childhood Obesity School Health Policy Guide concluded that school children need behavior-focused healthy eating education that influences knowledge, attitudes and eating habits and that is coordinated with school meal programs. NASBE also concluded that traditional knowledge-based programs and curricula have not been effective.

Whether wishing to start a school or community garden or seeking to better utilize an existing garden space as part of a classroom, this curriculum provides a range of information and activities to help at every stage of garden education.

Why a Garden?

A garden provides a rich environment for inquiry-based learning where students use academic tools to investigate observations and make discoveries about ecology, agriculture, history, and community. Studies looking at garden based education have shown that students' involvement in these programs can have a positive effect on academic performance, nutrition, and social development. The cooperative learning atmosphere of a garden strengthens interpersonal skills and builds self-reliance in individuals while exposing them to recreation, exercise, and healthy food.

A garden is also an integral piece in accomplishing Fresh from the Farm's goals:

- Providing fresher, healthier, tastier, safer and more nutritious food to school children by linking them directly to the source
- Developing long-term healthy eating habits by exposing them to the benefits
- Educating the school community about food sourcing through involvement of teachers, parents, administrators, and broader school stakeholders
- Supporting local farmers and a local economy by creating an understanding of the importance of these models

Central Concepts

By focusing on several central concepts, this curriculum provides teachers and students with the resources and activities to start, maintain, sustain, and evaluate their school garden:

- A garden can take many forms and requires planning in order to grow
- The needs of a garden change according to season
- In order to maintain a healthy garden, one must understand the role each part plays - from weeds, to bugs, to seasons - and the potential benefits and challenges of each one
- Soil is a living organism, and only healthy soil produces healthy plants and food
- The waste cycle is an important biological process that can be utilized as a positive asset to a garden
- Much of the food we eat is grown on farms, complex ecosystems in which many organisms are dependent on one another to produce healthy plants for food
- All fruits and vegetables can be connected to a part of a plant and can be specifically cultivated and harvested for grocery stores, restaurants, and dinner tables
- Gardens provide a variety of physical, mental, and environmental benefits for students, teachers, and school communities

Target Audience

This curriculum is written to be inclusive for students in grades 1-8. Following the lessons with a target audience of "grades 5-8" are recommended adjustments aimed toward a younger audience - grades 1-4. These adjustments are at the conclusion of the lesson. Each lesson with a younger audience adjustment is marked with an inchworm and the adjustments are at the conclustion of each lesson.

Sow and Grow Curriculum Organization

Sow and Grow is organized along a knowledge continuum that is logical for the growing process. This curriculum is designed to be extremely flexible allowing teachers to customize the content and location of each lesson to suit his or her needs. Therefore, the grid below shows the recommended time and places to teach each of the Sow and Grow lessons. However, this is merely a guideline and teachers should feel free to modify the order as they see fit.

Lesson	Where to teach?		When in the garden process to teach?			What time of year to teach?			
	Indoor	Outdoor	Planning	Growing	Harvesting	Fall	Winter	Spring	Summer
School and Community Gardens	•	•	•			•	•	•	•
Urbs in Horto	•	•	•			•	•	•	•
Harvest Calendar	•	•	•	•	•	•	•	•	•
Garden Transitions	• (Winter)	• (Fall)	•	•		•	•		
Plant Life Cycle	• (Winter)	• (Spring)		•			•	•	
Plant Parts	•	•	•	•	•	•	•	•	•
Plant Parts We Eat	•	•			•	•		•	
Dandelions, Crabgrass, and Burrs, Oh My!	•	•		•	•	•		•	•
Pest or Pollinator?		•		•		•		•	•
What's in Soil?		•	•	•	•	•		•	•
Soil on Earth	•		•			•	•	•	•
Soil Experiment	•		•	•	•	•	•	•	•
From Waste to Resource	•		•	•	•	•	•	•	•
Classroom Composting	•			•	•	•	•	•	•

Mindful Tasting

One of the most appealing pieces of gardening is the promise of the harvest, and one of the best ways to appreciate the season's hard work is through mindful tasting, or tasting using all of one's senses.

On the next page is a chart to help guide students and teachers through the mindful tasting process as well as a list of adjectives corresponding to the 5 senses. When using this method, encourage students to think critically about their experience - use sensory descriptions to describe preference, or use similes and metaphors to compare the food/experience to other things - and challenge them to try new things.

Mindful Tasting

Use your 5 senses! Write an adjective to describe this food in each sense box. You can use the Tasting Words for help.

LOOK	SMELL	SOUND	FEEL	TASTE

My Tasting Words

LOOK	SMELL	SOUND	FEEL	TASTE
Smooth *yogurt*	Bland *white bread*	Crunchy *carrot*	Smooth *yogurt*	Strong/intense *salsa*
Shiny *yogurt*	Fresh *lettuce*	Crisp *apple*	Dry *cracker*	Spicy *jalapeno*
Big *watermelon*	Sweet *berry*	Juicy *berry*	Rough *crusty bread*	Flavorful *pepper*
Small *pea*	Sour *lemon*	Squeaky *cheese*	Soft *peach*	Light/mild *potato*
Long *celery*	Strong/intense *salsa*	Quiet *applesauce*	Hard *nuts*	Bland *white bread*
Bumpy *pineapple skin*	Spicy *jalapeno*	Mushy *banana*	Juicy *berry*	Sweet *berry*
Wrinkly *raisin*	Savory *soup*	Rough *crusty bread*	Heavy *watermelon*	Sour *lemon*

Lesson Objectives

LESSON 1: SCHOOL AND COMMUNITY GARDENS

- Students will maximize garden growth in a limited planning space
- Students will draw parallels between the basic needs of humans and those of plants

LESSON 2: URBS IN HORTO

- Students will observe that gardens take many forms
- Students will consider all of the elements of designing, planting, and maintaining a garden
- Students will design a community garden plan and justify their choices

LESSON 3: HARVEST CALENDAR

- Students will examine the tasks a farmer does on the farm during each month
- Students will differentiate between growing and harvest seasons
- Students will identify the annual cycles of work on a farm

LESSON 4: GARDEN TRANSITIONS

- Students will observe and evaluate the needs of a garden according to the season
- Students will create a list of garden tasks according to season and formulate a plan to implement them
- Students will prepare the garden space for the coming season

LESSON 5: PLANT LIFE CYCLE

- Students will identify the 8 stages of the plant life cycle and the unique characteristics of each stage
- Students will identify at what stage different garden crops are ready for harvest

LESSON 6: PLANT PARTS

- Students will identify the six parts of the plant
- Students will assess how each plant part contributes to the plant's survival
- Students will recognize visual characteristics of each plant part
- Students will categorize different fruits or vegetables based on plant parts.

LESSON 7: PLANT PARTS WE EAT

- Students will identify fruits and vegetables as parts of a plant
- Students will be able to make connections between plant part function and nutritional benefits

LESSON 8: DANDELION, CRABGRASS, AND BURRS, OH MY!

- Students will evaluate which plants are "weeds" in the garden
- Students will name beneficial and/or harmful properties of weeds

LESSON 9: PEST OR POLLINATOR?

- Students will discriminate between helpful vs. harmful bugs
- Students will define four different roles bugs may play in a garden
- Students will examine the value of a diverse presence of organisms in a garden space

LESSON 10: WHAT'S IN SOIL?

- Students will analyze soil samples and identify the five components of soil
- Students will predict how organic matter breaks down to form healthy soil
- Students will assemble "ingredients" and create the beginnings of soil

LESSON 11: SOIL ON EARTH

- Students will appraise the value of soil based on the amount of fertile soil available on Earth
- Students will predict how not having access to healthy soil affects the people who live nearby

LESSON 12: SOIL EXPERIMENT

- Students will differentiate between soil types
- Students connect plant needs to which soil type is best suited for them

LESSON 13: FROM WASTE TO RESOURCE

- Students will identify decomposition and observe how it leads to compost
- Students will link composting to the plant cycle
- Students will use the waste cycle to create a valuable garden resource

LESSON 14: CLASSROOM COMPOSTING

- Students will utilize a natural function to create a valuable garden resource
- Students will build and maintain a classroom worm compost bin

Lesson 1:

School and Community Gardens

Time Allotted
60 Minutes

Target Audience
Grades 1-8

Objectives
- Students will maximize garden growth in a limited planning space
- Students will draw parallels between the basic needs of humans and those of plants

Materials
- Art supplies (crayons, markers, pencils, pens, glue, scrap paper, construction paper, scissors)
- Magazines—specifically gardening, housekeeping, food, and outdoor magazines

Summary

Through discussion and brainstorming, students will consider different factors such as location, type, useful resources, requirements, space, and growing methods associated with a shared garden space and how these concepts will apply to their own garden design and space.

Background

School gardens — whether window, container, or outdoors — can enhance the emotional, social and physical health of its students and school community. The presence of living plants in schools has been shown to increase information retention by both students and staff[1]. Gardens provide teachers of all subject areas with hands-on learning opportunities in an alternative setting and expose students to the joys of growing their own food. Additionally, students working in a garden are able to draw parallels between their own basic needs and those of plants and connect the health of plant life with their own.

Large or small, a garden can be any place a person decides to grow food or ornamental plants. Students will begin to understand that in an urban environment, where space is limited, a garden simply means a space where they take care of plants. Reimaging our definition of what a garden can be can will open possibilities to what it could be. In this lesson, students will begin to relate the needs of their bodies to those of plants and understand that plants are living beings that respond to their environment. Students will also learn different ways to consider space and plant growth and how to use this information to maximize their own garden space.

Method

1. Begin this lesson by facilitating a general garden discussion, using the following questions as a guide:
   - What does a garden look like to you? (Encourage them to use words and images - magazine clippings or drawings - if possible).
   - Are there any gardens around the school or in your neighborhood? What do these gardens look like?
   - What do you think are some important elements and conditions that make a successful garden? A school garden?
   - Who or what would be good resources to consult when trying to create your own garden?
   - What do you think are some basic requirements of creating a garden space? (Have students brainstorm 5 basic requirements—aside from the space and plants—to get a garden started)
   - How are the needs of a garden/plants similar to those of a human?

[1]http://ellisonchair.tamu.edu/health-and-well-being-benefits-of-plants/#.Ux2_gfSwKWg

2. In small groups, have students create a Venn diagram comparing their survival needs to those of a plant. The outer circles will have needs unique to humans or plants and the overlap will show shared needs. Have them share their diagrams. Understanding the fundamental similarities will help them to understand many of the changes that occur in the garden.
3. Often, when gardening, we are working within a limited space. In order to achieve the highest yield or harvest possible within this space, it is important to know a few things. After learning about plant cycles, parts, and parts we eat (see lessons 6 and 7), consider: Where do these plants grow (below ground, above ground, on vines, on trees, etc)? When planning a garden, it is useful to know these things when choosing which plants will work best in the space you are working with.
4. Briefly introduce methods of growing (or have students research different methods) using illustrations, or diagrams. There are many different planting methods used in gardening, dictated by the garden's intention, crops grown, region, intended results, etc. Some gardens are planted directly in the ground — conventional row design — whereas others are built in containers or raised beds; some have single crops grouped, whereas others interplant multiple crops — as with intensive planting.
5. Briefly explain the concept of "intensive planting." Intensive planting broadly means "growing more in a limited space" and can include inter-planting (planting a mix of crops in the same place) and planting in layers. One way to describe the latter method is through a comparison to the natural layers of forest growth: canopy, low-tree, shrub, herbaceous, ground cover, rhizosphere (below ground), and vertical (vines and climbing plants). Within a garden, we also have layers (albeit, on a much smaller scale) and planting crops considering not only surface area, but the space below and above ground is an effective way of maximizing space.

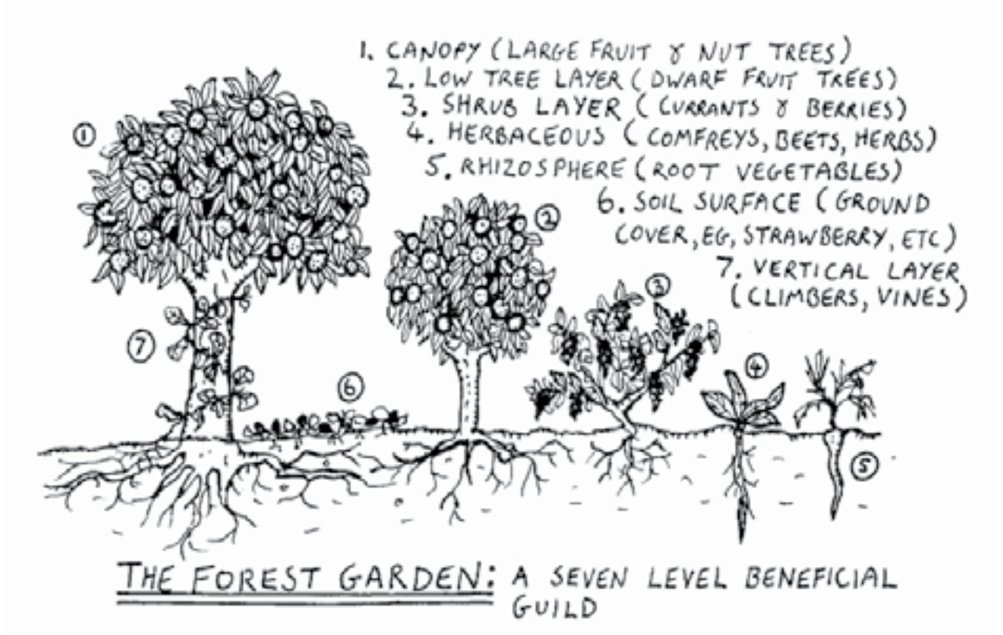


Diagram by Graham Burnett, permaculturalist.

Extensions

- Give students a hypothetical 4'x4' plot and have them research crops based on requirements such as zone, spacing, height, and light. Based on their findings, have students select crops to "plant" in their plot; have them draw and present their findings and final "garden space."
- Have students research alternative growing methods for different climates and regions around the world — terraced gardening in mountainous regions, hydroponics, rooftop gardening, vertical gardening, etc.
- Have students research planting strategies, such as interplanting and companion planting. Interplanting is the practice of planting a fast-growing crop between a slower-growing one in order to make the most of your garden space. An example of this would be sowing lettuce seeds between broccoli plants; the lettuce will grow happily in the space and shade provided by the broccoli plants, and you will be able to harvest it before the broccoli is large enough to totally shade it out. Companion planting is putting plants together for mutual benefit, such as increased yield or bug attraction/repellence. Visit http://www.garden.org/ediblelandscaping/?page=201005-interplanting as a starting place.

Lesson 2:

Urbs in Horto

Time Allotted
60 Minutes

Target Audience
Grades 1-8

Objectives
- Students will observe that gardens take many forms
- Students will consider all of the elements of designing, planting, and maintaining a garden
- Students will design a community garden plan and justify their choices

Materials
- Worksheet
- Pens or pencils
- Clipboards (optional)

Summary
Students plan a community garden.

Background
The official motto of Chicago is Urbs in Horto, Latin for "City in a Garden." The many forms a garden can take are as diverse as the city's population; a garden may be several containers of vegetables on a back porch or rooftop, or a corner lot on community-owned land. A garden might be located at a school, church, community center, food pantry, housing development, empty lot, or in a truck!

When considering planting a community garden, taking the community and its needs into account must be part of the conceptual process. By thinking about their own community's needs, students will be able to use the concept of the garden to improve their community's access to fresh produce, enrich the sense of community, and beautify the space.

Method
1. Introduce the activity by asking the students what "community" means to them. Create a word web on the board with "community" as the center and students' ideas branching out. Then ask the students what some of the needs of a community are and add those to the board.
2. Tell the students they will be creating a community garden. Have them split into groups of 2-5, depending on class size. Give each group a copy of the Plan a Community Garden worksheet.
3. Read the instructions for Plan a Community Garden aloud to the class. Remind students that considering all suggestions and ideas can help a cooperatively built garden succeed.
4. Allow students 35-40 minutes to come up with a garden concept to present to the class.
5. Use the remaining time after project completion for presentation and discussion of ideas and garden concepts.
6. Optional: Present the project as a contest and have the class vote on a favorite garden.

Extensions
- Have students research the pros and cons of conventional farming (ie: fertilizers, herbicides, pesticides), organic methods, sustainable practices (ie: native plants, biodiversity, permaculture), biodynamic agriculture, etc.
- Have students research the history of community garden models through the ages—medieval open field system, tenant farming, allotment farming—and at turning points throughout history--1800s, 1900s, 1930s, 1940s, 1960s, 2000s—both in the U.S. and throughout the world.

PLAN A COMMUNITY GARDEN

The city gives you permission to create a garden in a location of your choice. Keeping in mind the definitions community may have, create a concept for this garden. You may draw or write your concept. Complete the following prompts as a guide through the process:

Garden Name: _____

WHERE: Where will you locate your garden? You might choose a specific neighborhood, or a different public site in your city.

_____

_____

_____

WHO: Who will you involve in your garden planning process? Think of different groups of people, including friends, neighbors, community leaders, and people at your school who can help work and benefit from the harvest.

_____

_____

_____

WHAT: As you conceptualize your garden, consider these three Ps:

What will you plant? (vegetables, fruits, ornamental plants)

_____

_____

_____

What will you produce? (food, health benefits, community benefits)

_____

_____

_____

What will your garden provide? (community gathering space, a safe place, making neighborhood more visually appealing, a place to learn and teach)

WHY: Why did you choose the type of garden you did? Why did you choose to plant the things you did? Why do location and community needs affect your decisions?

HOW: How will your garden benefit the community? Who will maintain your garden and how will they do it?

Lesson 3:

Harvest Calendar

Time Allotted
25 Minutes

Target Audience
Grades 5-8

Objectives

- Students will examine the tasks a farmer does on the farm during each month
- Students will differentiate between growing and harvest seasons
- Students will identify the annual cycles of work on a farm

Materials

- Birthday month signs: name of each month on 8½" x 11" paper with fruits and vegetables harvested and farm tasks conducted in that month listed on back (see appendix)
- Land Connection calendar: http://thelandconnection.org/community/farmer-annotated-calendar
- Images of foods grown in local region during each month (optional)
- Images of farming tasks for each month (optional)
- USDA Hardiness Zone Map: usna.usda.gov/Hardzone/ushzmap.html

Summary

Students explore the work farmers do year-round to grow the foods we eat.

Background

We associate farms with summer bounty and fall harvests, but farmers work year-round to produce the fruits and vegetables we eat. This lesson introduces students to what takes place on farms each month in the growing year. Students will be instructed to form a circle and position themselves in the circle according to their birth months. This arrangement will help demonstrate that the work of a farmer does not end, but is instead a cycle that repeats each year.

This activity requires teachers to make a sign for each month of the year (or use the ones in the appendix) that features the fruits and vegetables that can be harvested that month. Climates vary in each region of the world, and climate determines what foods can grow in each region. In the United States, regions are defined by hardiness zones. Each hardiness zone is identified by a number that indicates climate tendencies and plant needs. To find out your zone, search for your region on the USDA's hardiness zone map (see materials section for URL). Then search for a local harvest calendar for your zone which tells what fruits and vegetables can be grown during particular times of year.

Method

1. Tell students: Food in our area is growing on farms almost year-round. When food is not growing, farmers are still busy working to prepare for the upcoming season. We're going to make a human calendar that displays what is going on at the farm each month.
2. Have students gather in groups according to their birthday month. Assign each group the sign displaying their birthday month. On the back of each sign, list the fruits and vegetables that can be harvested in Illinois during that month. If no fruits and vegetables can be harvested that month (for example, in January, when winter weather prevents food growth), list tasks that farm workers are performing to prepare for the next season. Use the Land Connection calendar listed in the materials section or have the students research.
3. OPTIONAL: Lay images of foods and farming tasks on the table. Have students read the back of their group's sign. Tell students to choose the food that grows or the activity that takes place on the farm in their birthday month.

4. Tell students to arrange themselves in a circle, starting with January and going through December. Next, have the students describe the typical weather in that month, and then share with the class what is happening on the farm, what is growing, and what crops are being harvested.
5. Engage students in conversation by asking the following questions:
   - In what months do most fruits and vegetables grow? Why?
   - Why are we standing in a circle?
   - What are the farmers doing during the winter months?

Extensions

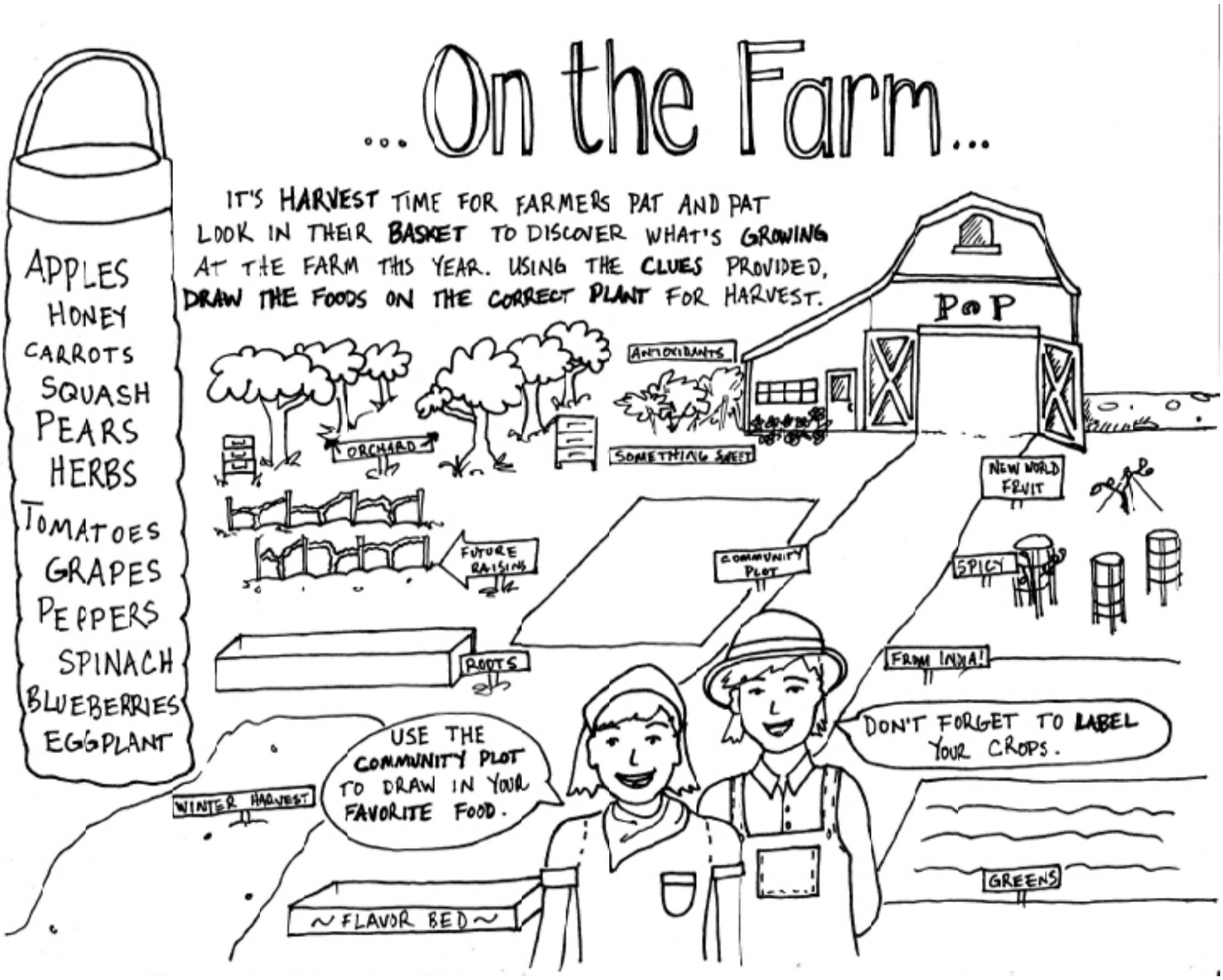
- Invite a farmer to speak to your class. Have students create a list of questions for the farmer prior to the presentation in addition to impromptu questions that may arise during the presentation. Following the visit, have the students complete the On the Farm worksheet (following this lesson). In the "community plot," they can add a new fruit or vegetable they learned about during the visit.
- Discuss seasonality and why tomatoes purchased in January are probably not local to your region. What are the pros and cons to purchasing foods in season?
- Find video clips and images of farm tasks and monthly harvests to help illustrate seasonal farm work.
- Play "Farm Charades". Have students act out farm activities in the form of a game.

Younger Audience Adaptation

For a younger audience, invite a farmer to speak to the class and hand out the On the Farm worksheet (following this lesson) and have students use it to guide questions and discussion.

Sources

Kelly Joslin, Green Earth Institute



Lesson 4:
Garden Transitions

Time Allotted
30-60 Minutes

Target Audience
Grades 1-8

Objectives

- Students will observe and evaluate the needs of a garden according to the season
- Students will create a list of garden tasks according to season and formulate a plan to implement them
- Students will prepare the garden space for the coming season

Materials

- Clipboards
- Writing utensils
- Paper
- Hand tools
- Rakes
- Shovels
- Marker board or chart paper
- Mulch materials, ie: hay, glass-clippings, leaves, newspaper, pine needles (optional)
- Cover crop seed, ie: rye, buckwheat, clover
- Garlic seed
- Cool-weather crop, ie: spinach, lettuce, arugula, beets, radish, carrot
- Native wildflower seed

Summary

Students will apply knowledge from the Harvest Calendar lesson and translate the seasonal changes on a farm to their garden space. Just as on a farm, a garden's needs change with the seasons. In this lesson, students will identify both the season and necessary seasonal tasks required to care for the garden. Note: Students should complete the Harvest Calendar lesson prior to this so they have a better context for discussions during this lesson.

Background

Following the method section are Recommended Seasonal Task and Activities lists corresponding with the following two seasons of transition.

Putting the Garden to Bed (Fall):

As the weather cools, days shorten, and the gardening season comes to a close, there are a number of things that must be done to help prepare the space for winter. Fall is a great time to get in the last plantings (September - October) of cool season crops with short maturation time such as lettuces, spinach, or radishes, as well as planting garlic for spring. For any crops planted in cool weather, be sure to heavily mulch with straw to protect plants from temperature change.

Prepare for the Growing Season (Winter):

During the winter months, while the garden is dormant, a gardener must begin preparing for the coming spring. Winter is a great time for planning next year's plantings, ordering seed, new equipment and materials, and, in late winter, starting indoor planting.

Method

1. Ask: What season is it? What changes are associated with this season (temperature, precipitation, sunlight)? How might these changes affect our garden?
2. Ask: What were some tasks farmers performed during this season? Are there any tasks on this list that we may need to perform in our garden to prepare for the season change?
3. Students should survey their garden space to see if there are additional tasks needed. Divide the class into small groups and assign each group a section of the garden for which they will provide care and make observations.
   - Have the students draw a physical garden plan. This illustration will not only help show where different tasks are needed, but is invaluable when planning for future seasons.

   - Fall: Make note of any perennial plants that will return as well as any observations regarding growth - were there certain areas where plants did not grow as well? Pests? These notes will be helpful for spring planning.
   - Spring: Have the students decide what to plant and estimate how much seed they will need. This will be determined by what they decide to plant, how large the plants get, and how many plants will fit in their space. Use the Seed It! Plant It! Grow It! Sow It! Worksheet following this lesson to help guide and track the process.

     Ask: Will they need more soil? New materials for new beds? Pots? Trees?
4. Have the students come up with a list of 2-3 tasks each month for the season for these transition times:
   - September, October, November -> preparing for winter
   - December, January, February, March ->preparing for spring
5. Gather the students back together and have them organize their proposed tasks by month to come up with a seasonal work-plan.
6. Finalize the work-plan making any necessary adjustments/additions and assign tasks and responsibilities.

Task List and Activities by Season:

Putting the Garden to Bed

Fall for preparations for Winter (September/October/November)

- Weed — This is often a time when late season weeds have gone to seed. Pulling them now will help reduce the chance of new weeds next year.
- Bulbs — Dig up and store any summer bulbs (if applicable).
- Reduce water — Encourage hardier species, such as fuzzy herbs (savory, thyme, rosemary, oregano, lavender, etc.), to enter dormancy by reducing watering.
- Save seeds — When seeds are thoroughly dry, and seem ready to fall off the plant, cut seed heads and lay them out flat or upside down in a paper bag in a warm, dry place, until seed heads are completely dry. Separate individual seeds from debris and chaff (leaves, stems). Lay out cleaned seeds and continue drying for another week before storing, picking out any seeds that seem lighter.

  NOTE: Do not save seeds from hybrid varieties as many will not breed true the following year; try to source non-hybrid varieties for a school garden to save money and allow for seed saving practices.
- Garlic — Now is the time to get a head start on spring by planting garlic. Be sure to choose cloves from a nursery, seed catalog, or another gardener; most garlic found in grocery stores is not suitable for growing in cooler climates. After the first killing frost, plant the cloves with the pointed side up, 2-4" deep, about 6" apart. Water. After 3-5 weeks, heavily mulch the soil using straw or chopped dried leaves to help protect the cloves from temperature fluctuations.
- Plant — September and October before the first killing frost are good times to get a last planting in for harvest. Choose cool-season crops with shorter maturation such as spinach, lettuce, or arugula and leafy root crops such as carrots, radish, beets, or turnips. The greens of root crops are edible and can be lightly harvested while the root is maturing.
- Plant — Begin planting cover crops and wildflower seeds 4-6 weeks before the first killing frost to help suppress weeds, build your soil, and help control pests and diseases. Some suitable cover crops are clover, buckwheat, and rye (most cold-tolerant).

- Compost — Rake leaves and dead disease-free garden plants and add them to your compost pile.
- Mulch —Be sure to mulch any bare soil to help with moisture retention, suppress weeds and regulate temperature. Appropriate mulch materials are a mix of (weed free) leaves, hay, grass clippings, pine needles, or newspaper (color-free).
- Test your soil — Take a pH test of the soil in different areas of the garden; continue this practice throughout the year to determine which plants prefer or achieve certain pH levels and how this affects growth. Knowing the pH of different areas in your garden may also factor in to your choice of cover crop and next years crops (as certain plants can "fix" certain deficiencies or surpluses in the soil).
- Inventory — Take note of all remaining seeds, plants (potted and perennial), and tools; have the students create a garden tool guide with illustrations of the tools used in the garden and what they are used for. This will be useful for future gardeners and can be updated as more tools are added to the library/inventory.
- Care and repair — Clean and oil all tools before storing for the winter. Make any repairs to tools, beds, fences, etc. as needed (this is also a great activity for Winter, especially for older students with access to a "shop" classroom).

Preparing for Spring: Winter preparations for Spring (December, January, February)

Before the first thaw:

- Clean up — Clean up any debris that has collected in the garden over the winter.
- Plan — Using notes and inventory from the fall, order seed catalogs and begin mapping the season's planting and seed orders. For continuous harvest throughout the season, plan plantings based on germination and maturation of seeds. Once plants reach maturation, they can be harvested and the plot can be replanted with the same or a different crop. Another consideration is "companion planting" - pairing complementary plants to aide in pest control and maintain balance.
- Order — Place seed orders and materials orders for tool and bed and fence repair (if necessary).
- Plant — Begin planting cool season crops such as spinach, radishes, beans and peas indoors.

After the first thaw:

- Till cover crop — After the ground has thawed, begin tilling under cover crops as needed, allowing them to decompose and replenish the soil with nutrients.
- Plant — Begin sowing warmer season crops such as tomatoes, peppers, eggplant, cucumbers and herbs indoors.
- Beds — Repair and refill beds with soil/mulch as needed.
- Transplant — When danger of frost has passed, begin transplanting seedlings into the garden. In Illinois, the official last freeze typically occurs in May, so be sure to choose hardy varieties and mulch for protection.
- Weed — Keep an eye on weeds as the season warms up and pull weeds to keep them under control.

Extensions

- Bird feeders — Build bird feeders for the winter and keep them stocked—have students observe which birds come to the garden during the winter. Perhaps compare this to spring/summer and discuss migration (some birds do not migrate).

- Bird guide — Create a garden bird guide complete with how to attract certain birds (or not). Birds can be incredibly useful for organic pest control and plant pollination.
- Scarecrow — Build a scarecrow and either read a fiction book related to scarecrows or have older students research the history of scarecrows and other methods for keeping certain "pests" from a garden.
- Tree guide — Try to identify trees in the neighborhood or schoolyard and have students create a schoolyard/neighborhood fall tree guide, describing the colors, shapes, and seed pods each tree may form during each season.
- Butterflies and bugs — Hatch butterflies and/or ladybugs. You can order butterflies and ladybugs online from sources including: http://educationalscience.com/butterflycultures.htm, https://www.insectlore.com/, and http://www.thebutterflysite.com/rearing.shtml

Seed it! Plant it! Grow it! Sow it!

Your name:

Plant:
Date Started:

Plant Information:

Read the plant packet or conduct brief research to discover the following information about when and in what conditions your plant grows best.

Season: ______________________ **Light:** _______________________________
Soil type: _____________________ **Temperature:** ________________________
Sprouts in: _____________ **days** **Matures in:** _____________ **days**

Track the growth of your plant using the following chart. Be sure to fill in all the areas for each day.

Date	Growth (cm)	Light (cloudy, partly cloudy, sunny, etc.)	Temperature	Notes

Lesson 5:

Plant Life Cycle

Time Allotted
30 Minutes

Target Audience
Grades 1-8

Objectives

- Students will identify the 8 stages of the plant life cycle and the unique characteristics of each stage
- Students will identify at what stage different garden crops are ready for harvest

Summary

Students will learn the 8 stages of the plant life cycle and how those stages connect to a garden's life cycle.

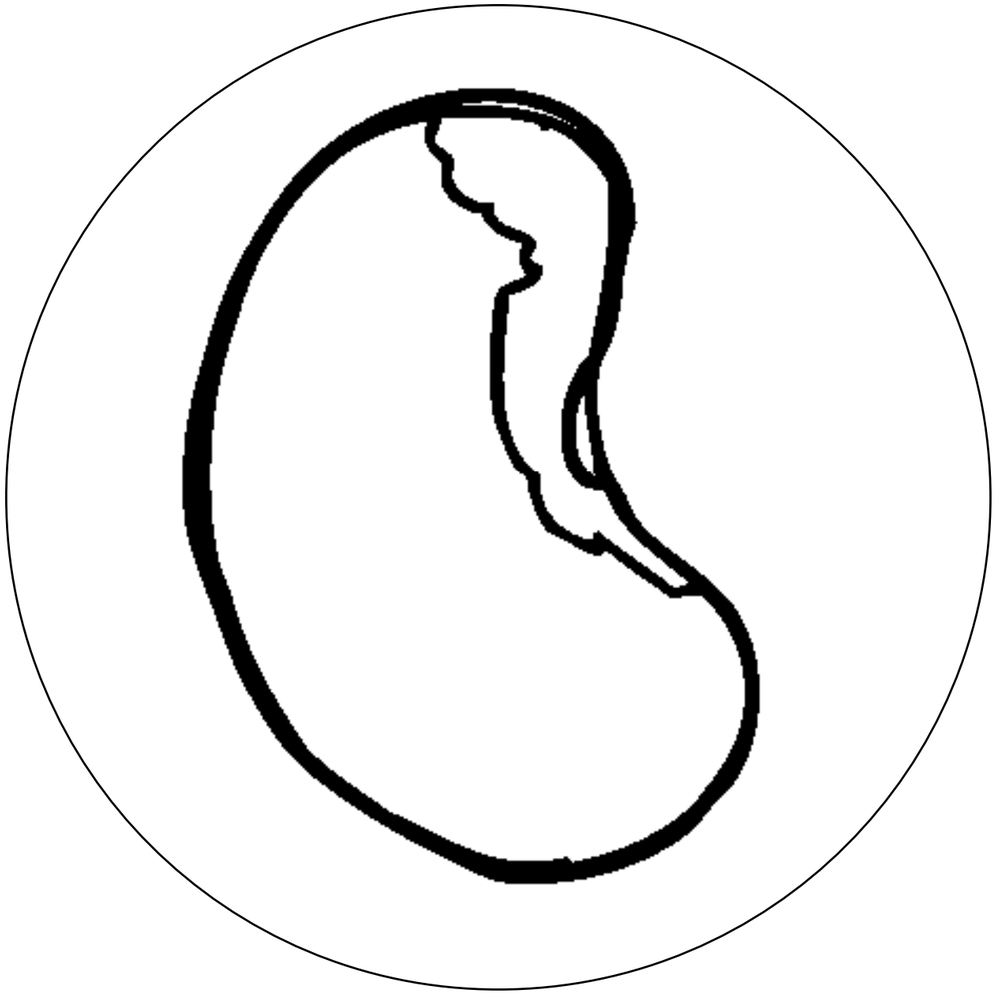
Background

Plant growth can be tracked and divided into 8 stages. The ability to recognize these stages and the changes that the plant undergoes during each stage will help students to understand how to determine germination, maturity, and harvest readiness of plants in the garden.

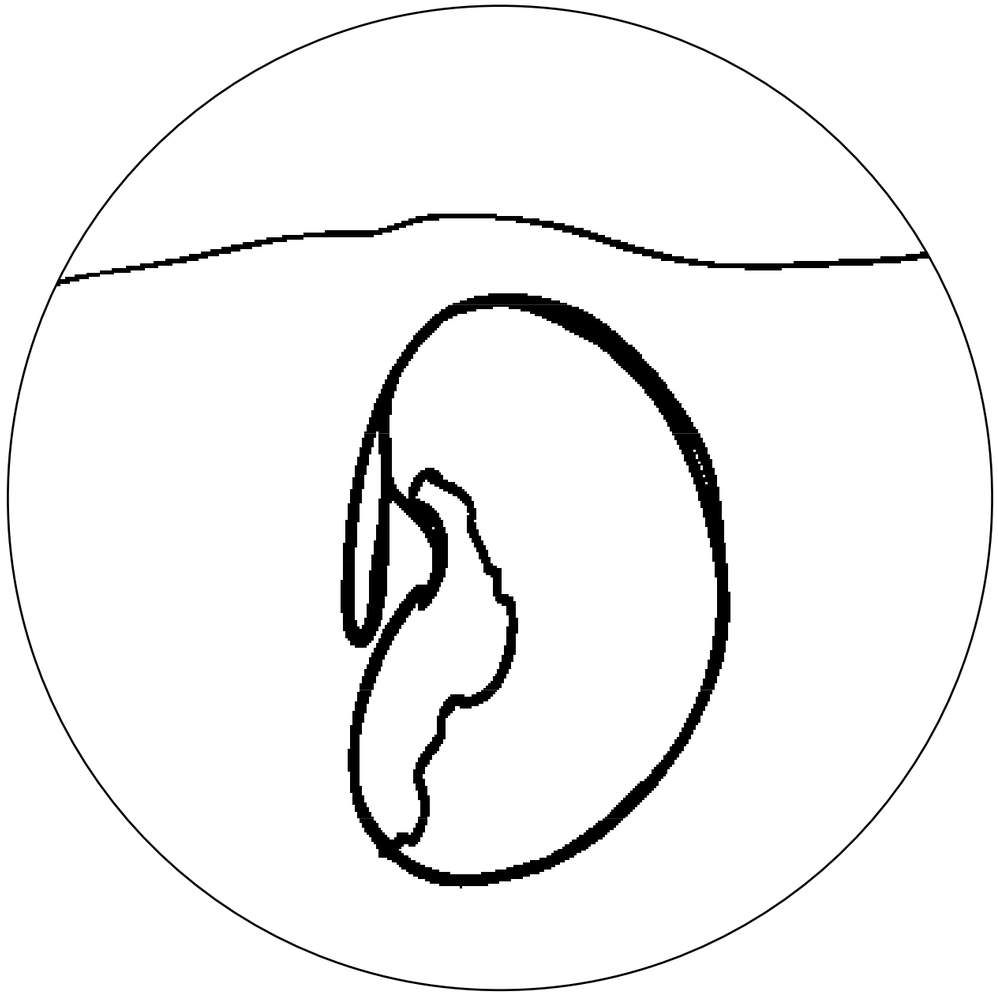
Method

1. Cut out the following images and descriptions (separately) of the eight stages of a plant's life cycle.
2. Either in groups or independently, have students arrange the images and descriptions chronologically.
3. As a class, review the correct order and discuss the process. Are there any plants that we eat as a seed? A shoot? Before the buds/flowers/fruit form? Are there plants that we grow only for their fruit? Do all plants begin growing at the same time? Do all plants mature at the same time? Do all plants like the same weather — water, temperature, sunlight? How might this affect how our garden grows?
4. Have the students choose and research the life cycle of a food item (grain/fruit/vegetable). Have students draw a diagram of their findings, indicating the stage and at what time of year the food item is harvested.

Instructions: Cut out the following images and descriptions of the eight stages of a plant's life cycle. Arrange them in the correct order on the board. Images should be arranged in a circle.

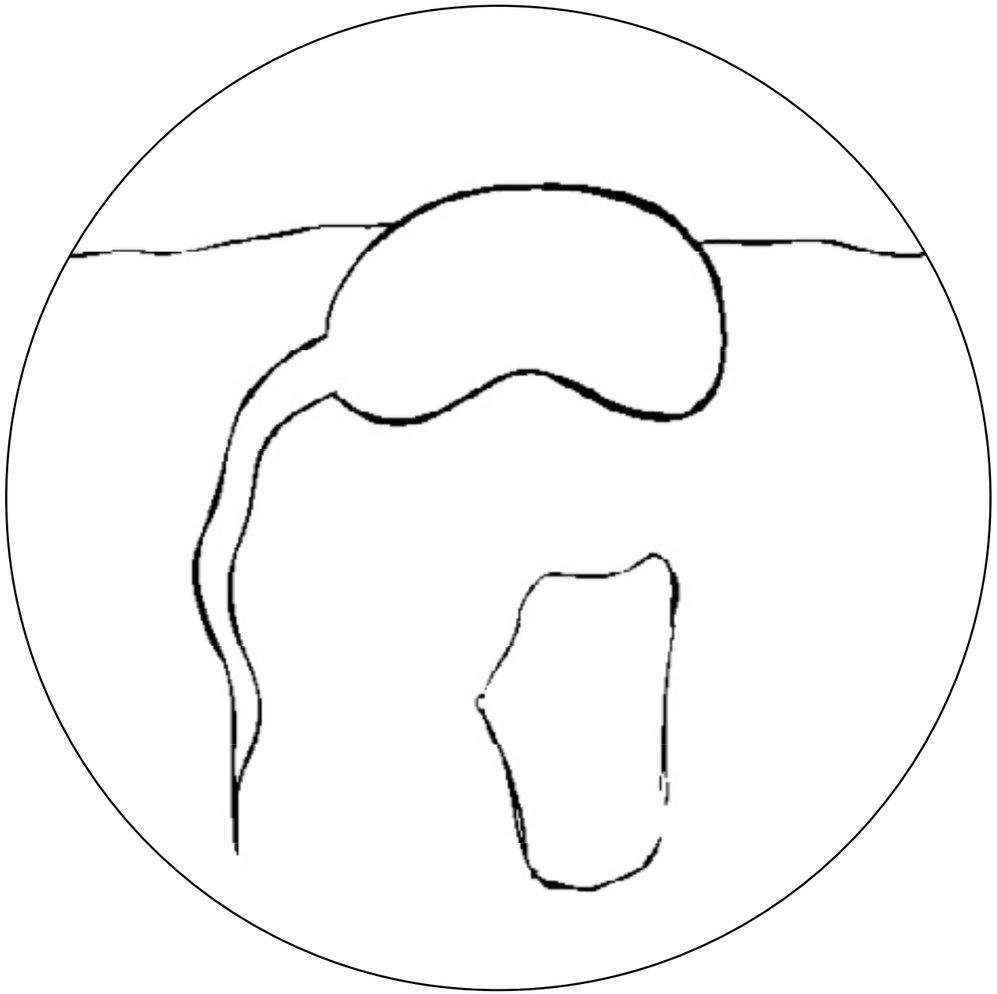


STAGE 1: Seed
Seeds are mature and distributed.



STAGE 2: Seed Germination

Seed absorbs water and begins to swell, root emerges.



STAGE 3: Shoot

Shoot penetrates the soil toward the light,
root continues to grow downward.

STAGE 4: Leaf

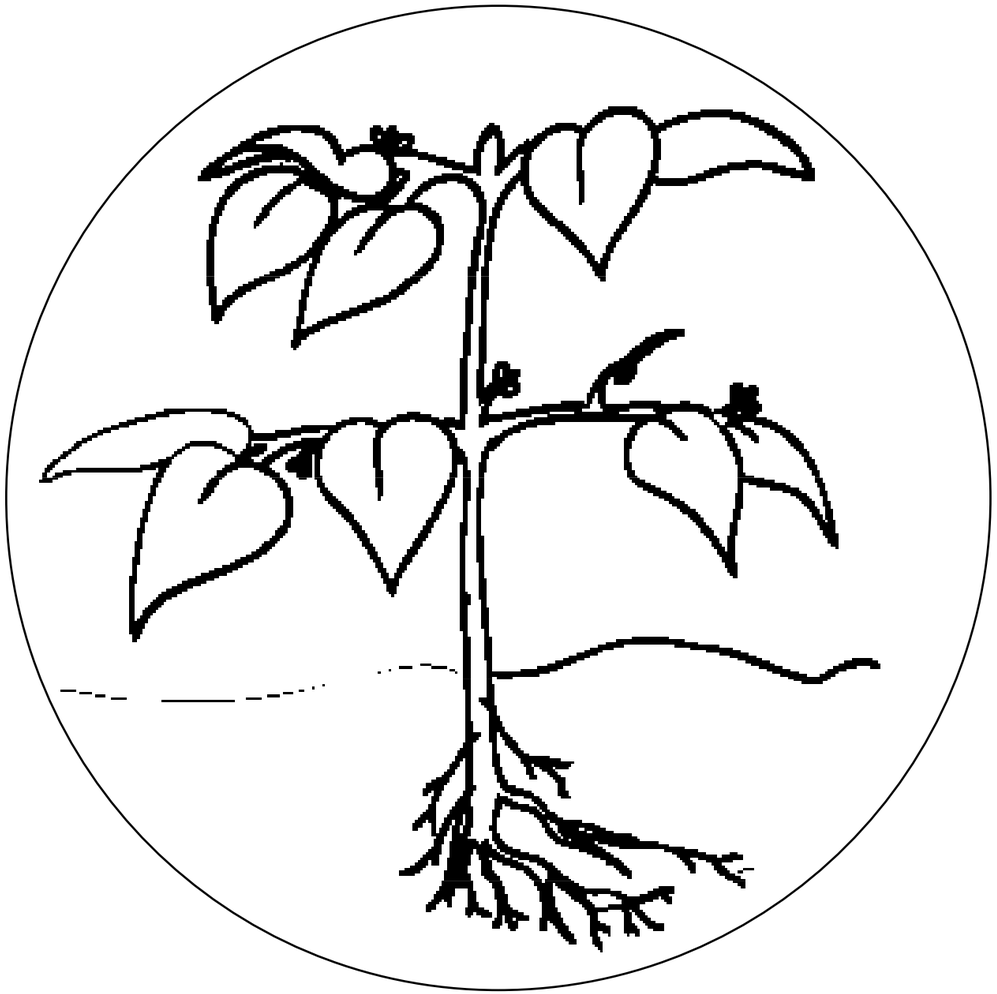
Mature leaves develop, taproot and main roots develop.

STAGE 5: Stem

Stem and true leaves develop, roots continue to penetrate the soil in search of nutrients.

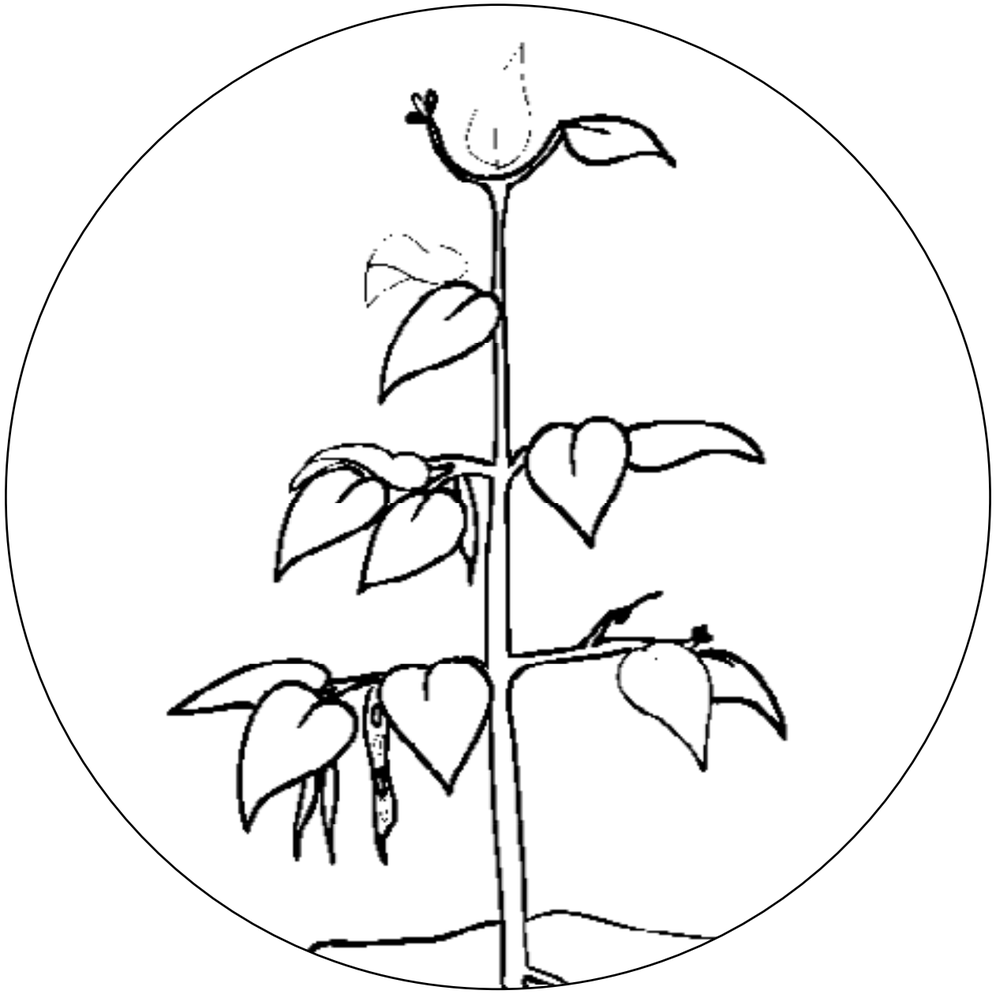
STAGE 6: Bud

Leaves grow outward, roots extend outward to support the plant's growth, rhizo-sphere or bud develops.



STAGE 7: Flower

Flowers pollinate, roots take up more nutrients from soil.



STAGE 8: Fruit

Fruit and seeds develop.

Extensions

- Have students research the process their food item undergoes after harvest. What does this item become? Ex: wheat->processed to separate grain from chaff->milled for flour, groats, or whole grain->packaged and sold as flour/groats/grain->flour sold to become baked item, grain for feed, groats as bulgur.

  Discuss: Why is it important to understand this process? Understanding this cycle begins to reveal the moving parts and players in our food system, how a garden fits in, and the benefits/ drawbacks of different system models such as scale, agricultural methods (conventional, organic, sustainable), local vs. non-local foods, and highly vs. minimally processed foods.

Lesson 6:

Plant Parts

Time Allotted
60 Minutes

Target Audience
Grades 1-8

Objectives

- Students will identify the six parts of the plant
- Students will assess how each plant part contributes to the plant's survival
- Students will recognize visual characteristics of each plant part
- Students will categorize different fruits or vegetables based on plant parts.

Materials

- Plant part worksheet
- Physical examples of each plant part - see teacher key (optional)

  Roots: carrot, radish, jicama, beets

  Stems: celery, asparagus

  Leaves: spinach, lettuce, kale, basil

  Flowers: broccoli, cauliflower

  Fruits: cucumber, tomato, pepper

  Seeds: sunflower, pumpkin, cooked garbanzo beans

Summary

Students learn the six parts of a plant and their functions.

Background

Almost all fruits and vegetables we eat come from plants. Mushrooms, a fungus, are one of the only types of food that does not come from plants. Even the snacks and non-plant foods we eat have ingredients that originate from plants. Corn and soy, for example, are major ingredients in snacks, baked goods, prepared meals, and packaged goods we consume. Comparing the foods we eat to the plant parts from which they originate can help to understand the nutritional value of these foods, when we harvest them, and how we may need to process them for consumption.

Plants consist of six parts: roots, stems, leaves, flowers, fruits, and seeds. Each of the fruits and vegetables we eat can be categorized as one of these parts. This lesson requires teachers to provide at least one example of each plant part we eat. Some examples include carrots, the roots; celery, the stem; and spinach, the leaf. Each of these plant parts has a different function for helping plants grow and survive.

See the list below for definitions of each plant part function and the suggested corresponding symbols to represent each function.

- Roots absorb nutrients and water from the soil, anchor the plant in the soil, and provide storage for food and nutrients. (symbol: refrigerator, anchor)
- Stems carry nutrients and water from the roots to other parts of the plant (symbol: veins, straw)
- Leaves absorb sunlight and transform it into food through a process called photosynthesis. (symbol: sponge, skin)
- Flowers enable sexual reproduction by attracting pollinators to help produce seeds. (symbol: showy costume/clothes)
- Fruits store and protect seeds and attract animals to eat and disperse seeds (symbol: lunchbox, Tupperware)
- Seeds provide materials for new growth. (symbol: baby)

Fruit: The definition of "fruit" can often be confusing. Botanical scientists consider fruits to be the ripened, seed bearing parts of plants. Thus, any food that contains seeds is considered a fruit—apples, pears, oranges—including foods commonly referred to as vegetables—tomatoes, cucumbers, squash. In the culinary world, the term "fruit" is used to describe a plant food with high levels of sugar whereas "vegetable" is used to describe a plant food containing lower levels of sugar. This curriculum uses the botanic definition of fruit.

Method

1. Using the plant part worksheet, lead a short discussion on the parts that compose a plant. Ask students to consider the role each plant part plays in the plant's survival. How does this plant part help the plant survive? Have students brainstorm an object that functions similarly to each part of the plant. Ex: the stem delivers nutrients and waters from the roots to other parts of the plants: straw
2. Discuss visual characteristics that each plant part displays. Leaves are often green, broad, and flat; fruits contain seeds; flowers are bunched with petals and are often brightly colored; stems are long and skinny, roots have leaves or other greens attached at the top; seeds are often small and numerous. Ask students to brainstorm foods that match these characteristics.
3. Tell students that of the six different parts of a plant we are discussing, we eat each one. Ask them if they can name any of the parts of the plant/food we eat.

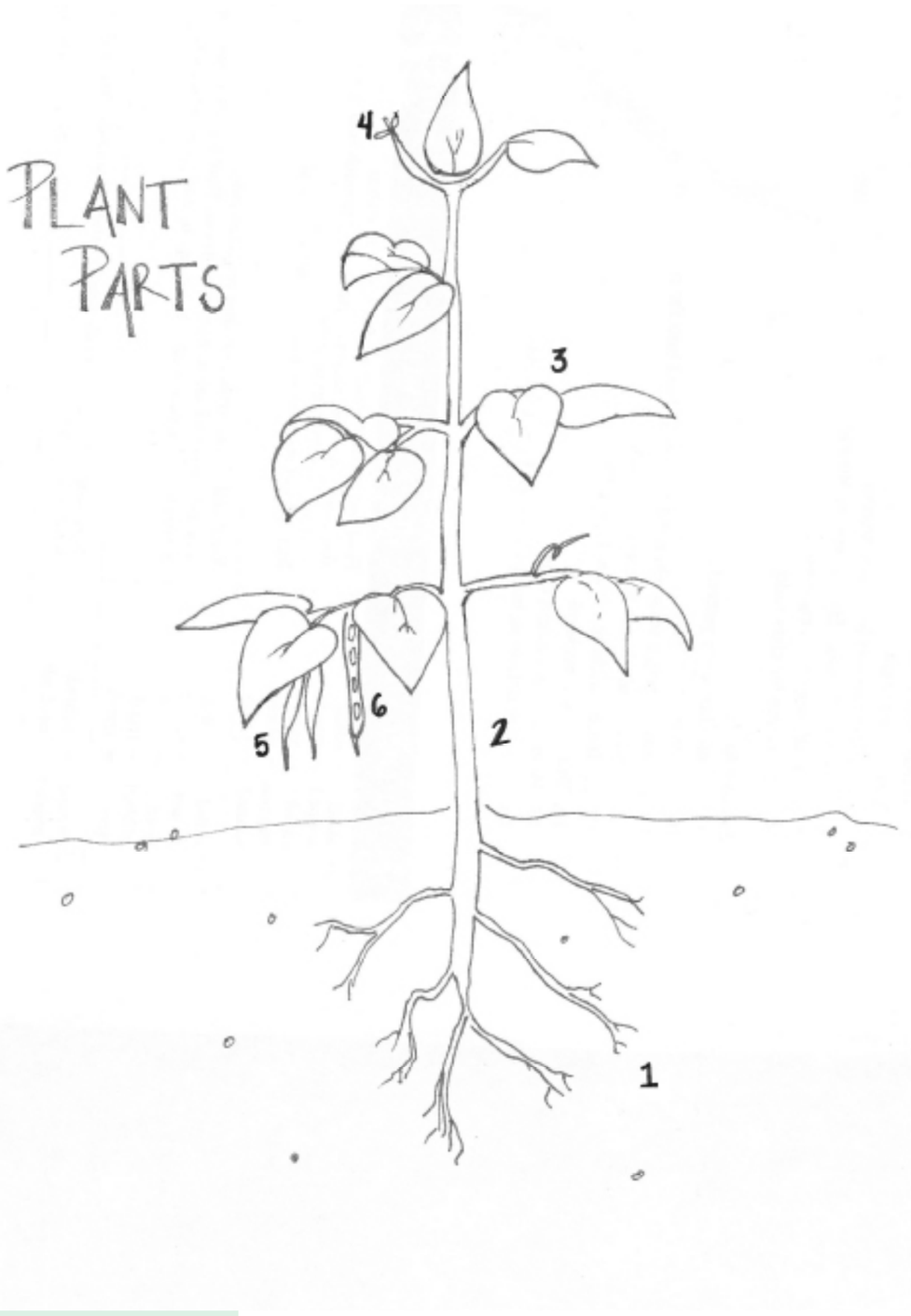
Extensions

- Research and compare different types of modified stems and roots.

  Root crops are simply an edible underground plant structure, such as parsnip, carrot, yam, horseradish, or beets, but some "root crops" are actually part of the stem.

  Modified stems are often mistaken for roots as they are part of the edible underground plant structure. There are 4 types of modified stems:

  - Bulbs grow in layers connected by a round, flat, hairy base with the beginnings of roots they reproduce by creating offshoots connected to the larger bulb. Ex: onion, garlic
  - Corms appear to be the same as bulbs but do not grow in layers. As the plant grows, all the energy is used up and the corm shrivels producing new corms alongside the original corm. Ex: taro
  - Tubers have leathery skin and lots of eyes, which appear as tiny buds which are growing points where new plants will emerge. Ex: potatoes, sweet potatoes, yucca, yam, water chestnuts
  - Rhizomes are underground stems that grow horizontally just below the soil's surface with lots of growing points. Ex: hops, asparagus, ginger, calla lilies.
- Gather a variety of seeds and physical examples or images of their corresponding fruits and plants and have students attempt to match them.
- Research: "Why is fungus not a plant?" Have students research distinguishable differences between plants and fungi—appearance, growth, needs, reproduction. What are some other examples of fungi we eat?
- Choose a variety of root crops listed above and provide the students with definitions for each type pointing out that they are actually modified stems. Have the students dissect and determine what type of root/stem each is.
- Introduce students to the parts of a flower and their functions to help illustrate how some plants reproduce (http://www.chicagogreenteachers.com/documents/Parts-of-a-Flower.jpg).
- Introduce students to monocots vs. dicots and discuss how to identify each and how their life cycles differ.
- Research different methods (animals, wind, self-dispersal) of seed dispersal and ways that plants are adapted to ensure their seeds are spread. Have students report their findings.



Plant Part Functions

1. Roots _____

2. Stems _____

3. Leaves _____

4. Flowers _____

5. Fruits _____

6. Seeds _____

TEACHER KEY

1. Roots

The roots are the foundation that holds a plant in the ground. Roots also have tiny hairs that soak up water and minerals, and some plants have enlarged roots that serve as storage for the plant's food or sugar. Examples: carrot, radish, jicama, beet.

2. Stems

The stem acts as a support for the plant and contains the plant's vascular system, which transports food or sugar, minerals, and water. The system has two parts: xylem and phloem. The xylem carries the water and minerals up from the roots to the rest of the plant, while the phloem carries food or sugars from the leaves down through the rest of the plant. Examples: celery, asparagus.

3. Leaves

The primary purpose of leaves is to absorb sunlight for making food or sugar in a process called photosynthesis. During photosynthesis, carbon dioxide is also absorbed by the leaves and turned into oxygen, a by-product or waste of the process. Examples: spinach, lettuce, kale, basil.

4. Flowers

The primary purpose of flowers is reproduction. The flower contains the plant's reproductive organs. Their showy appearance is intended to attract insects and other animals to them as part of the seed-producing pollination process. Examples: broccoli, cauliflower.

5. Fruits

The fruit of the plant is the part that holds and protects the seeds. Animals often eat the fruit, helping the plant spread its seed to other areas through waste elimination. Examples: cucumber, tomato, pepper.

6. Seeds

Seeds are composed of three parts: the embryo (a miniature, dormant plant); the endosperm (the built-in food supply); and the seed coat (a protective layer). Examples: sunflower seeds, pumpkin seeds, beans

Sources

"Arizona Master Gardener Manual: Plant Parts and Functions." College of Agriculture and Life Sciences. 14 Mar. 2012. http://ag.arizona.edu/pubs/garden/mg/botany/plantparts.html

Lesson 7:

Plant Parts We Eat

Time Allotted
45 Minutes

Target Audience
Grades 1-8

Objectives

- Students will identify fruits and vegetables as parts of a plant
- Students will be able to make connections between plant part function and nutritional benefits

Materials

- Plant part manipulatives from Plant Part Key (next page)
- Pita bread or pockets (one per student)
- Salad dressing, one bottle
- Plates (one per student)
- One package of shredded or crumbled cheese (optional)
- Vegetables representing different plant parts (at least one plant per part plus enough for all students to eat in a snack pita)

Summary

Using ingredients harvested from the garden (or purchased if necessary), students classify the items and build a Plant Part Pita.

Background

Each fruit and vegetable we eat can be categorized into one of the six plant part categories. This lesson requires teachers to provide at least one example of each part we eat (see suggested materials list).

Method

1. Using the crops listed in the Plant Part Key, create Harvest Word Bank manipulatives. Cut out the words by following the dotted lines to easily create the manipulatives or have students create their own.
2. Write the column titles (plant parts) of the Mystery Harvest chart on the board or a large piece of paper. Introduce the students to the activity by telling them:

   Farmer Pat has mixed up his harvests, help him to organize his crops into the correct plant part category.

   As a class or in small groups, have students match the crops (see key) to the correct category.
3. To help remind students of the different plant part characteristics, pass around different fruits and vegetables for students to observe. Make sure samples are cut to display any seeds.
4. Review student answers to the Mystery Harvest chart. Explain that we will be using plant parts to make a snack.
5. If appropriate, pass out knives or graters and cutting boards for the students to assist with preparing ingredients. Assign one plant part/vegetable per student and demonstrate how to use a knife to safely cut them up.
6. Set up a "plant part buffet" with all the chopped vegetables, pita pockets, dressing, cheese, and plates. Have students assemble their "plant part pita," identifying the plant's parts as they add them.

Extensions

- Have students explore the crops growing in the garden. For each crop, identify the parts of the plant represented.

Mystery Harvest Key

ROOTS	STEMS	LEAVES	FLOWERS	FRUIT	SEEDS
Parsnips	Asparagus	Radicchio	Artichoke	Squash	Sunflower Seeds
Radishes	Celery	Turnip Greens	Broccoli	Bell Pepper	Pumpkin Seeds
Carrots	Rhubarb	Spinach	Cauliflower	Eggplant	Fava Beans
Beets	Hearts of Palm	Lettuce	Calendula	Cucumber	French Beans
Daikon	Bamboo Shoots	Cabbage	Squash Blossoms	Tomato	Pigeon Peas
Turnips	Broccoli Stems	Swiss Chard	Nasturtium	Tomatillo	Snow Peas
Celeriac	Ginger	Bok Choy		Zucchini	Lentils
Rutabaga	Potato	Kale		Sweet Corn	Almonds
Jicama	Taro	Collard Greens		Chili Pepper	Walnuts
		Leeks		Melon	Pecans
		Beet Greens		Citrus Fruits	Peanuts
		Nopales		Berries	
				Apples	
				Cherries	

Lesson 8:

Dandelions, Crabgrass and Burrs, Oh My!

Time Allotted
60 Minutes

Target Audience
Grades 5-8

Objectives

- Students will evaluate which plants are "weeds" in the garden
- Students will name beneficial and/or harmful properties of weeds

Materials

- Magnifying glasses
- Notebooks and writing utensils for note taking
- Weed identification book (region specific if possible) and/or printout of Organic Gardening's "12 Most Common Weeds" article: http://www.organicgardening.com/learn-and-grow/12-most-common-weeds

Summary

Students will become "weed experts" through library and field research.

Background

What is a weed? "Weed" is a general term used to describe any unwanted wild plant, especially when it is in competition with cultivated plants. Ralph Waldo Emerson said of weeds that they are merely "plant(s) whose virtues have never been discovered." Students will discover properties of weeds, their history, and which weeds can be useful versus which weeds are truly a nuisance.

Method

Ask students the question, "What is a weed?" As a class, discuss and hypothesize how to define a weed. Using the responses students come up with, go into the garden and have the students, either in pairs or on their own, choose a plant/weed to research. Acceptable plants are any that weren't intentionally planted.

Discussion/Verbal Exploration

Following the scientific method, have students conduct their research using any available resources (books, articles, internet, experts, etc.).

Question: Why is this a weed?

Hypothesis: Make observations about the way the plant looks and grows to determine why it may be a weed (field study).

Research: Identify and research your weed, including its origins, history, uses, and indentifying characteristics.

Analyze: Compare your findings with your original hypothesis.

Conclusion: Do you still think this plant is a weed?

Report: Share your findings with the class.

Following student presentations, go back to the original definition of "weed." Are there any adjustments to their definition? What were some common characteristics of the weeds that students found? Without knowing something is a weed, what are some things we can look for to determine whether or not it might be considered one?

Extensions

- Students create a weed identification guide for their garden
- Students create "Wanted" signs for unwanted plants in the garden
- Students create an "Edible Weeds" guide complete with recipes

Younger Audience Adaptation

Have printouts and physical examples of weeds they may find in the garden and go on a weed hunt. Using the images and teacher assistance, students will find and identify at least 5 examples of weeds. When students find a weed, they may collect their specimens for the classroom, but be sure to have them confirm their findings as weeds before removing. Show the students how to properly remove weeds by pulling at the part closest to the soil, using gloves or a trowel when needed (spiny leaves or deep roots). When the students have collected set number of specimens, have them record their findings through a combination of illustration and writing (dictation where needed).

Lesson 9:

Pest or Pollinator?

Time Allotted
60 Minutes

Target Audience
Grades 1-8

Objectives

- Students will discriminate between helpful vs. harmful bugs
- Students will define four different roles bugs may play in a garden
- Students will examine the value of a diverse presence of organisms in a garden space

Materials

- Whiteboard
- Writing utensils
- Paper
- Magnifying glasses

Summary

Students will become acquainted with different bugs and their roles — be it harmful or helpful — in the garden.

Background

A garden can provide a home for a wide variety of creatures, playing various roles, performing tasks both welcome and unwelcome. There are roughly 1 million known species of insects on the planet, making up nearly 75% of the animal kingdom. Often, these tiny creatures have a negative association, being called things such as "creepy," "crawly," "slimy," or "pests" with little credit being given to their necessary role in a balanced ecosystem. Much can be discovered about these bugs simply by observing them in their environment. Through observation, students will be able to determine the roles the bugs play in the garden.

Pests, like weeds, are merely an unwanted presence often considered detrimental to a space. Pests flourish in simpler environments, therefore encouraging diversity of plants and creatures in a garden can aide in maintaining balance and keeping pests in check. Even "helpful" bugs can become "harmful" if their population is not kept in check, and "harmful" bugs can play a useful role. For instance, caterpillars become food for birds who also may help with pollinating our plants or help keep other bug populations in check.

Method

1. Create a KWL (Know-Want to Know-Learned) chart on the board to begin a "bug brainstorm." Have students copy the chart to fill in for themselves beginning with what they already know and want to know about bugs.

K	W	L
•		

2. Ask:

   What is a bug?

   What do bugs eat?

   Where do bugs live?

   What is their life cycle like?

   How do we know if a bug is "good" or "bad"?

   Are all bugs "bad"?

3. Have the students list as many bugs as they can. Based on what they know about the insects, have them determine if each is a "good/helpful" or "bad/harmful" bug in a garden. (ie: ladybug, butterfly, grasshopper, snail, spider, aphid, praying mantis, worm, beetle, fly).

4. Introduce students to the following roles a bug may play in the garden:
   - Pest — harmful to food supply, homes, or bodies (hornworms, cabbage loopers (inchworms), aphids, termites, ticks)
   - Pollinator — help with pollination of plants, especially important for food crops (butterflies, bees)
   - Predator — prey on pests (can help keep "pest" populations down) but may also eat "good" insects, such as ladybugs, praying mantis, lacewings, spiders
   - Decomposer/recycler — responsible for the decomposition of dead organic materials (worms, flies, beetles*).
5. Give students magnifying glasses and have them explore the garden to find out what bugs live in the garden, drawing pictures and writing descriptions of their appearance (color, legs, wings, etc.), where they found the bug, and whether they think the bug they found is beneficial/harmful.
6. Have the students present their findings and as a group come up with answers to the following questions for the 'L' (learned) section or their KWL chart:
   - What is a bug?
   - How do we determine whether a bug is beneficial? Harmful?
   - Were the bugs we discovered in the garden harmful or helpful?

Extensions

- Read The Magic School Bus in a Beehive and invite a beekeeper to visit the class. Have students complete the Honeybees worksheet following this lesson.
- Research the different bugs identified in the garden and create a "Garden Bug Guide" or have students create informative signs for the garden.
- Research the life cycles of different bugs and create drawings or diagrams to illustrate each.
- Research different methods of pest control in agriculture/garden space. Compare the pros and cons of each.
- Research methods of attracting "good" bugs to the garden. Figure out which methods would be suited to your garden space, implement them and record the results.

Sources

Garden Buddies: Making Friends with Beneficial Insects http://www.kidsgardening.org/node/11528

*Some beetles and their larvae can be pests; research specific varieties to distinguish between them.

For more information on decomposers and the process of decomposition, see the composting lesson.

Honeybees

BEES COLLECT _____ AND _____ FROM FLOWERS.

BEES CARRY _____ FROM PLANT TO PLANT IN A PROCESS CALLED _____.

THIS PROCESS IS ESSENTIAL FOR PLANT REPRODUCTION (FRUIT PRODUCTION).

BEES LIVE IN A: (CIRCLE ONE)

CONDO · HIVE · TREEHOUSE

COLOR THE BEE'S HOME:

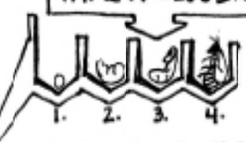
A COMMUNITY OF BEES IS CALLED A _____. IN A _____, EVERYONE PLAYS AN IMPORTANT ROLE.

...DID YOU KNOW...

HONEY CONTAINS BENEFICIAL NUTRIENTS SUCH AS _____ AND _____.

THIS IS BEEKEEPER PAT. BEEKEEPERS MUST WEAR SPECIAL CLOTHING TO PROTECT BOTH THEMSELVES AND THE BEES. WHILE THEY ARE HARVESTING HONEY.

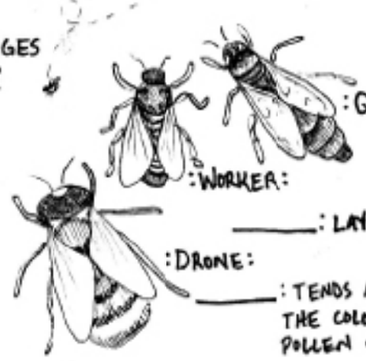
TAKE A CLOSER LOOK!



CAN YOU NAME THE STAGES OF METAMORPHOSIS?

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

CAN YOU MATCH THE BEES TO THEIR ROLE?



:QUEEN:

:WORKER:

_____: LAYS EGGS

:DRONE:

_____: TENDS AND DEFENDS THE COLONY. COLLECTS POLLEN & NECTAR.

_____: FERTILIZES EGGS

Busy Bees... bees must visit 2 million flowers to make 1 pound of honey! *PHEW.

Lesson 10:

What's in Soil?

Time Allotted
60 Minutes

Target Audience
Grades 1-8

Objectives

- Students will analyze soil samples and identify the five components of soil
- Students will predict how organic matter breaks down to form healthy soil
- Students will assemble "ingredients" and create the beginnings of soil

Materials

- Pie tins, small bowls or plastic gallon sized bags (one per every 3-5 students)
- Hand lenses or magnifying glasses
- Soil samples from garden or schoolyard (about 1/2-1 cup per every 3-5 students)
- Hand trowels or shovels
- White paper
- Large mixing bowl
- Cloth or cover for large mixing bowl

Summary

Students will examine soil samples to determine the components of soil and attempt to make their own soil using their findings.

Background

The word "soil" is often used interchangeably with the word "dirt," but the two do not actually refer to the same thing. Dirt is simply the small, brown pile of mud or dust particles we may hold in our hand. Soil, however, is a complex material composed of organic matter (decaying remains of plants and animals), minerals (sand, silt, clay), water, and air. Earthworms, beetles, and other small animals are often found in the soil. Lastly, soil contains many microorganisms (organisms too small to see with the naked eye alone) such as bacteria that help break down organic matter. Students will explore the components of soil using a soil sample from the garden or schoolyard.

Soil is formed through a complicated process involving multiple factors. Soil begins with parent material—various types of sediment left by glaciers or volcanoes—which is then broken into finer particles through a combination of temperature, water, and wind over a long period of time. As plants and animals die, their remains are added to this material, and as they decay, their nutrients are added. Water and air infiltrate the soil as it is moved by wind and living organisms. Eventually, healthy subsoil and topsoil are formed, but this process takes hundreds of years. This lesson asks students to consider the processes that form soil, paying special attention to the length of time required for those processes to be complete.

Many human practices damage the soil that requires so much time to form. For example, housing development and urban expansion have caused significant erosion of our topsoil since the roots of trees and other plants have been removed or disturbed and can no longer hold the soil in place. Unsustainable agricultural practices, including pesticide-based farming and the use of monoculture crops, has added harmful chemicals to and depleted much of our land's topsoil of valuable nutrients. Farmers, who cannot always afford to remediate their soil by replenishing lost nutrients may simply move to another plot of land, or spray more chemicals to help their plants grow. Because soil is an invaluable resource that cannot be quickly replaced, these harmful practices decrease the amount of fertile soil available for safe and healthful food production.

Method

1. Divide students into small groups of 3-5. Pass out magnifying glasses, a tin/bowl/bag, and a hand trowel to each group. Instruct the students to collect a cup of soil, taking care not to disturb surrounding plants or creatures when doing so. Go outside and collect soil from the schoolyard or garden space, placing the soil sample into the containers.

2. Have students dump their samples onto white paper to examine it with their hand lenses. Have students separate the different materials they find: rocks, leaves, roots, insects, etc. Have each group come up with a label for the different categories of materials they found. As a class, come up with a master list of ingredients that make up soil. Be sure to include such items as: rocks, sticks, dirt or sand, grass and worms.
3. Announce to the students that they will now be making their own soil. Assign the ingredients from their "soil ingredient list" to different groups. Have groups collect their assigned ingredient(s).
4. Double check the list to be sure all items are present. One-by-one, have each group add their ingredient to the bowl, when all ingredients are inside, cover it with the cover or cloth. Either have the students repeat the following chant: "alla-kazaam…alla-ka-zoil…turn this mixture…into soil!" or gently agitate the bowl while they count down from ten.
5. Pull the cloth off and ask the students whether they've created soil or not (they have not). Ask them what ingredients may be missing—think of other natural elements that may be present in nature and what they may contribute to the creation of soil (sun, water, nutrients, bacteria).

   Ask: If we added these ingredients, would the resulting mixture be soil?
6. Have the students compare their soil samples to the contents in the bowl.

   Ask: What did the soil from the garden have that our mixture did not? Think of other processes of transformation (plant life cycle, human life cycle, seasons, cooking, transport, etc.). Are there any similarities that may help us discover the missing ingredient(s)?

   Students should conclude that the missing ingredient is time. It takes a long time for bacteria and other decomposers such as earthworms to break down all these ingredients and to create rich, healthy soil. In fact, it takes 50-100 years to develop one inch of topsoil.

Extensions

- Have students begin a discussion on the damage that is being done to topsoil throughout the world because of harmful agricultural practices and urban/suburban development (such as the use of pesticides and chemical fertilizers that kill both harmful and helpful microorganisms and contribute to erosion). Ask students to think about the effects of harmful agricultural practices and their relation to the production of new topsoil. How do you think this affects overall soil health? Quality of things grown in the soil? Health of those consuming products grown in "damaged" soil?
- Have students research decomposers such as earthworms. Have them create posters or diagrams of different decomposers and describe how their form (size and shape) is suited to their function (breaking down organic matter).
- Take a field trip to Chicago's Field Museum to see its permanent exhibit "Underground Advernture". Get a bug's-eye view of the world when you magically "shrink" to 1/100th of your actual size — smaller than a penny — to explore an immersive environment of worm tunnels and soil chambers. This exhibition reveals soil to be home to an incredible diversity of living things, and shows how not a single plant or animal could survive without it. After regaining your regular size, become a soil scientist to investigate how life above ground connects to life below. http://fieldmuseum.org/happening/exhibits/underground-adventure

Sources

Parella, Deborah. Project Seasons: Hands-On Activities for Discovering the Wonders of the World. Shelburne Farms. 1995.

Lesson 11:

Soil on Earth

Time Allotted
20 Minutes

Target Audience
Grades 5-8

Objectives

- Students will appraise the value of soil based on the amount of fertile soil available on Earth
- Students will predict how not having access to healthy soil affects the people who live nearby

Materials

- Apple
- Slicing knife (small)

Summary

Students will learn about the percentage of fertile soil on Earth and how this relates to agriculture and conservation.

Background

Growing healthy food begins with healthy soil. Soil is the foundation of human nourishment and of life, making it one of the most valuable natural resources the earth has to offer. Unfortunately, soil is not a limitless natural resource and is used at a much faster rate than the earth can create and replenish it. With water covering 75% of the Earth's surface, fertile, tillable soil only makes up slightly greater than 6%. Deserts, high altitude mountain ranges, barren land, and areas covered with ice make up the remaining 19% of Earth's surface. Human practices have a significant impact on the little available fertile soil, many of which can be detrimental to the quality and usability of the soil available for growing food. This lesson provides students with a powerful visual illustrating just how little soil is available for food production.

Method

1. Begin this lesson with a brief discussion about soil using the following questions as prompts:

   What is the difference between soil and dirt? What is soil made of?

   What are some examples of things that may make soil unsuitable for growing food?

   What are some ways soil could be improved for food growth?

   Why do some regions in the world have "better" soil than others? Does this make them more or less capable of growing food? How might this affect other regions in the world?

   Why, if at all, is soil important?

2. Tell the students that in this lesson, they will discover how much soil on Earth is available on our planet to grow food. Instruct students to partner with another student and together answer the question: How much of Earth's surface is suitable for growing food? Each pair should make a prediction—encourage students to use fractions, percentages, and decimals to describe their estimates. After students have had three to five minutes to talk, ask the students to share their predictions, recording the results on the board for them to see.
3. Next, show the students the apple, and explain that the whole apple represents Earth. Follow the prompts below for the demonstration to illustrate how much of the Earth's surface is suitable for growing food:

   - Cut the apple into four equal parts. One slice (¼ or 25%) represents the land on Earth, and the remaining three slices (¾ or 75%) represent the water present on Earth.
   - Next, cut the land section in half. One of these pieces (1/8 or 12.5%) represents mountains, deserts, or land covered with ice or soil in which we cannot grow food. The other piece represents land we can live on.
   - Cut the piece representing land we can live on into fourths. On Earth, three of these pieces are too rocky, wet, hot, infertile or are covered with cities and roads. There is now 1/32 or ~3% of the apple left.
   - Slice the skin off the remaining piece. This sliver of skin represents the topsoil which is suitable for growing food, and which must produce enough food to feed everyone on Earth!
4. Engage the students in a discussion about what they have just learned.

   Why is it important to know how much soil is available for growing food on Earth?

   What does this help us understand about the value of soil?

   What are some measures we can take to conserve the little soil we have?

Extensions

- Have students create a pie chart representing fertile soil on earth based on information gathered from the activity.
- Create a world map, indicating different types of terrain and types of soil they typically have. What types of terrain typicaly have the most fertile or infertile soils?
- Have students research different regions/terrains and the types of food suitable for growing in those areas. Do the foods grown in certain regions always reflect the food predominantly consumed in those regions? Why/why not? How might this affect other regions supplying the foods consumed?
- Explore the soil types around your planning site, neighborhood, city, state, etc. How do you think soil type affects the crops grown in different areas/regions, if at all? What are some ways someone might change the composition of the soil? Why might they choose to do this?

Younger Audience Adaptation

Use the above method, with the following change to step 2: have students make their predictions on a circle by coloring in portions of the circle—have them imagine how one divides a pizza or pie to help illustrate.

Lesson 12:

Soil Experiment

Time Allotted
60 Minutes

(requires additional weeks to observe growth)

Target Audience
Grades 5-8

Objectives

- Students will differentiate between soil types
- Students connect plant needs to which soil type is best suited for them

Materials

- Plastic bags or jars, numbered, and filled with one of five different soils: potting soil, cactus soil or sandy soil, construction site soil or clay-heavy soil, compost, and schoolyard soil. If using jars, fill with one-third soil and two-thirds water to separate the particles. (Note: Make a key that tells which soil is in which container.)
- Enough extra soil (of each type) to fill cups for planting
- Writing utensils
- Scrap paper
- Copies of Soil Experiment report (one per student)
- Small cups (poke holes in bottom) or pots
- Small plates (to place under cups to collect water)

Summary

Through a hands-on planting activity and use of the scientific method, students explore different planting mediums and soil types and their affect on growing healthy plants. Note: The What's in Soil? lesson should be taught prior to this lesson.

Background

Scientists describe soil based on the type and amount of particles in it. The three types of particles present are clay, sand, and silt. Clay soils are tightly packed with little space between particles; sand soils have larger particles, allowing for more space between grains; silt soils have particles bigger than clay, yet smaller than sand. Different types of plants require different types of soil to grow robustly. For example, cactus and other desert plants grow in sandier soils that allow for more drainage of water, while tropical plants require soil higher in clay, since the particles are closer together and retain more moisture. This activity asks students to consider soil types as important factors in the successful cultivation of healthy plants.

Soil Type	Aeration & Water Infiltration	Nutrient & Water Capacity	Ability to Work Soil
Sand	Excellent	Poor	Excellent
Silt	Average	Average	Average
Clay	Poor	Excellent	Poor

Kidsgardening.org, http://www.kidsgardening.org/node/61046

Method

1. On the board, draw the following chart (below), altering names and locations to match those you use.

Number	Name or Location	Description	Good for Growing? Why or why not?
1	Potting Soil		
2	Cactus Soil		
3	Compost		
4	Construction Site		
5	School Yard		

Here are some good adjectives for the description section:

Chalky, heavy, light, pebbly, rocky, sandy, stony, wet, dry, damp, loose, packed, clay-like, lumpy, clumpy, smooth, grainy, colors.

Materials (cont.)

- Vessel for watering plants (spray bottle or large plastic cup will work)
- Masking tape
- Radish seeds
- Blank sheet of paper (optional)

2. Divide the class into five groups. Have the students copy the chart on a piece of paper (or hand out a printed copy) for each group to use.
3. Pass out one soil sample to each group and allow two minutes for the students to make and record observations about it. Rotate the soil samples, allowing two minutes for each sample (10 minutes total), until each group has had a chance to write observations for each type.
4. Ask students to identify what they see. Which of these samples would be considered "dirt"? "Soil"? If they struggle, refer to previous soil lessons and review what they know about the differences between the two.
5. Holding up one soil sample at a time, ask groups to volunteer their observations or descriptions about each sample. Complete the chart on the board as you record student observations. Would this soil be good for growing? Why or why not? Encourage students to think about the plants' roots and water's ability to pass through different types of soil.
6. Have students remain in their groups and tell them they will now test their theories about the soils. Give each group one Soil Experiment worksheet, one cup, one of the soil samples, a piece of masking tape, and two to four radish seeds.
7. Have the students fill their cup with the given soil and label them with the date and soil type used (number and name). Tell the students to make an indentation in the soil up to the first knuckle of their index finger and drop the seeds into the hole. Gently cover the seeds with soil. When the students have finished planting their seeds, have them bring their cups to the designated location, place them on plates, and water their seeds (just enough to moisten the soil).
8. Once the students have finished planting, have them complete their Soil Experiment report. Encourage them to discuss their observations about their soil sample and what plants need to grow.

Extensions

- Investigate the permeability of each type of soil by performing a brief science experiment. Materials needed: 10 plastic cups, soil samples, 5 stop-watches.

  1. Take 10 clear plastic cups, measure, and mark 1 inch from the bottom; label each cup with numbers 1-5, leaving the remaining 5 as your measuring cups.

  2. Use your measuring cup to place a small amount each type of soil in a coffee filter, using a rubber band to secure them into place over the cup with their corresponding number — this is easier to observe with a dry sample.

3. Pass out one soil sample, a measuring cup, and a stop-watch to each of the five groups.

4. Have one student from each group measure 1" of water in their measuring cup and designate one student as the "timer." Instruct the students to simultaneously begin pouring and start timing the water as it passes through the sample into the cup, stop the timer when the water level in the sample cup reaches the line.

5. Ask the students to discuss their results first within their group, then amongst the class. How does the time the water took to pass through the soil relate to a plant's ability to obtain the proper amount of water? Ask them to keep their conclusions in mind for the Soil Experiment.

- Acquire a soil testing kit to examine the nutrient composition, contaminant level, and acidity level of all five soil samples; compare this to a sample of soil from the garden.

Younger Audience Adaptation

Follow the method as laid out above, but have the class work on observations collectively, rather than in the individual groups. Fill out the Soil Experiment worksheet as a class, asking questions, making hypotheses, and tracking growth weekly or daily (the Seed it! Plant it! Grow it! Sow it! worksheet may be helpful here as well). The total length of the experiment can be either until a sprout emerges (roughly 21 days with radishes) or a month (to observe the emergence of the true leaves, stem, etc.). Once the experiment is done, as a class, discuss the data, results and conclusions about the different types of soil.

SOIL EXPERIMENT

Title: _____

Group Members: _____

Materials Used: _____

_____

_____

Questions: _____

_____

_____

Hypothesis: What I think will happen...

_____

_____

_____

_____

_____

Method: What I did... (To help explain your method, you may use a blank sheet of paper to make a sketch.)

_____

_____

_____

_____

_____

SOIL EXPERIMENT

Data: What I observed...

Results:

Was my hypothesis correct? (circle your answer and explain in your conclusion)

YES NO

Conclusion: What I learned...

Lesson 13:

From Waste to Resource

Time Allotted
60 Minutes

Target Audience
Grades 5-8

Objectives

- Students will identify decomposition and observe how it leads to compost
- Students will link composting to the plant cycle
- Students will use the waste cycle to create a valuable garden resource

Materials

- Empty water or soda bottles, including bottle caps, two per student (Note: To save time, cut the upper half of the bottle until it is almost removed. Students can then access the inside of the bottle for filling, but still close it later.)
- Scissors
- Spray bottle filled with water
- Soil from a garden or lawn, enough to fill one bottle per student. It is recommended that you consult someone at your local garden supply store to procure soil.

(Continued on next page)

Summary

Students learn that food waste, through composting, can be transformed into a valuable resource by observing the decomposition process in their own decomposition chambers.

Background

Food waste is a major issue in the United States — 32 million tons of food are thrown into the garbage each year. This amounts to 14% of all trash, and represents the largest component of garbage reaching landfills. In addition to increasing our overall garbage production, food waste can have large economic and environmental impacts.

Food waste impacts people economically. Individuals, families, and businesses spend large amounts of money on food, and much of this food ends up in the trash. Making wise food purchases and avoiding needless waste helps save money. Food waste also impacts the environment. When food decomposes in landfills, it emits methane, a powerful greenhouse gas that contributes to global warming. Landfills account for 20% of all human-produced methane. Reducing food waste reduces the environmental impact of landfills.

An easy and effective way to reduce food waste is through composting. Compost is produced when food waste and other organic materials such as yard waste and manure decompose. In the act of decomposition, tiny bacteria and fungi break down the waste and form humus, a dark brown, soil-like material. This material, also known as compost, can be added to the garden's soil to improve structure by adding valuable nutrients that help plants grow. By creating your own nutrient rich compost, you reduce the need for purchasing fertilizers or pesticides, which can harm us and contaminate local rivers, lakes and groundwater.

Method

On the board, or a large piece of paper, create a Waste KWL (Know - Want to know - Learned) chart.

K	W	L
•		

1. Ask: What is food waste?
   - Discuss with students their reactions to this food waste. Add their reactions to the Waste KWL chart.
   - Explain to students that approximately 14% of the country's garbage is food scraps, which amounts to 32 million tons per year. Use the image at the top of the New York Times article, "One Country's Table Scraps, Another Country's Meal," to prompt discussion about wasting food. Have the students brainstorm possible negative effects of wasting food.

Materials (cont.)

Depending on where you live, and what your existing soil is like (clay heavy, sandy, rocky, or even unusable due to contamination), the garden soil or combination of soils you will need may vary (see Soil 101 in appendix for further resources).

- Small pieces of food (one per student)
- Small pieces of trash (one per student)
- Small pieces of "brown matter" (dead leaves, sticks, newspaper)
- Soil collected from the garden
- New York Times article and image, "One Country's Table Scraps, Another Country's Meal," http://www.nytimes.com/2008/05/18/weekinreview/18martin.html?_r=2&pagewanted=1&ref=dining&oref=slogin.

2. Ask: How do we reduce food waste?
   - Ask if anyone has heard of composting. Composting is the act of breaking down food into healthy soil that can later be used to help plants grow and reduce food waste.
   - Ask for a volunteer to draw a plant's life cycle on the board. Guide the student so that the final diagram includes some variation of the following diagram:

     seed sprout full-grown plant
     dead decomposing plant soil seed
   - Explain decomposition if students are not familiar with the concept. Tiny bacteria and fungi act quickly to break down dead plants, transforming them into nutrient-rich soil that will help other plants grow.
   - Remind students that most of the foods we eat come from plants. Consequently, the foods we eat decompose in the same way that plants do.
3. Help students create their own decomposition chambers.
   - Give each student two empty bottles with the tops cut almost off. Tell them that one bottle will be for decomposing food waste, and the other for decomposing a trash item of their choice (small enough to fit in the bottle).
   - Have students fill each bottle halfway with soil from the garden. Tell them that this soil from the garen, as opposed to store-bought potting soil, already contains decomposers such as bacteria, fungi, and possibly worms. Students can add "brown matter" of their choice.
   - Spray water in each bottle until the soil is moist. Replace the lid.
   - Display bottles where students can access them. Tell students to observe the bottles over the next month for signs of decomposition. Examples of decomposition include mold, color change, and strong odors. Tell them to notice which items are decomposing more quickly. Most likely, food items will be breaking down rapidly.
   - Have students write down their observations individually or as a class regarding the appearance of the bottles' contents to track the decomposition process.

Extensions

- Have the students keep a tally of how much food is thrown away in their households for one week. Ask them to come up with ways their family could reduce the amount of food waste.

Younger Audience Adaptation

For a younger audience, draw the plant life cycle on the board. Have students recall the turning leaves of fall. When the dead leaves fall and are then covered with snow in winter, do we see them again, in the same place, looking the same in the spring? How do those leaves look different? During the winter, those leaves are decomposing, or being eaten by tiny bacteria and fungi. They are turned into soil filled with nutrients that help new plants grow.

Sources

"Wastes—Resource Conservation." US Environmental Protection Agency. 2012. Web. 14 Mar. 2012. http://www.epa.gov/osw/conserve

Shreeves, Robin. "Compost vs. Landfill: Does it Really Make a Difference?" Sustainablog. N.p., 2 Dec. 2008. Web. 14 Mar. 2012. http://blog.sustainablog.org/2008/12/compost-vs-landfill-does-it-really-make-a-difference/

Lesson 14:

Classroom Composting

Time Allotted
60 Minutes

Target Audience
Grades 5-8

Objectives

- Students will utilize a natural function to create a valuable garden resource
- Students will build and maintain a classroom worm compost bin

Materials

- Large plastic bin with holes drilled in bottom and two lids
- Shredded newspaper
- Spray bottle filled with water
- One pound of red wiggler worms, available from bait shops, garden centers, or online

  -windycityworms.com

  -redworms.com

  -urbanwormgirl.com

  -unclejimswormfarm.com
- Food waste, broken into small pieces

Summary

Students create a worm compost bin for their classroom. Lesson 13, From Waste to a Resource, should be completed prior to this activity.

Background

Composting is the controlled decay of plant and animal matter to create a rich material that can then be added to existing soil to improve structure and nutrient content.

Check with your principal to make sure worm composting is allowed in the classroom. Some school districts have regulations regarding food storage and whether or not food may leave the lunchroom. If you are able to implement a larger, school-wide composting system, see the Extensions section for more information.

This lesson helps teachers and students create a worm compost bin for their classroom. By composting food scraps, organic material that would otherwise be dumped into a landfill can be used in gardens instead. In a landfill, organic material has difficulty breaking down naturally due to a lack of oxygen. Deterioration in a landfill is an anaerobic (without oxygen) process, whereas composting in a worm bin is an aerobic (with oxygen) process.

Method

1. Before this lesson, review the following process for creating your own worm compost bin and complete any steps necessary prior to class.
   - Drainage — optional, drill 20-25 evenly spaced 1/4 " holes in the bottom of plastic bin and place on top of second lid to collect compost tea.
   - Ventilation — near the top of the box, drill 2 rows of 1/16" holes. In one lid, drill 30 or so evenly spaced 1/16" holes.
   - Bedding — shred newspaper or office paper, moisten it with a spray bottle, and fill the plastic bin about 2/3 full.
   - Worms — add worms to moist bedding, being sure to cover them with additional bedding if needed. Bedding is used to soak up the moisture from decomposing food scraps. If the contents are too wet, add more bedding.
   - Feeding — place kitchen scraps in bedding, chopping it into smaller pieces if necessary to aid in the break-down process. Do not give worms meat, fish, or dairy, avoid oils and salt, and go easy on citrus as it contains a compound toxic to worms. As worms multiply, they will consume scraps faster; check your bin every few days to monitor the process.
   - Location — choose a well-ventilated spot with easy access and temperatures between 55-77*F year round.
   - Monitoring — here are some tips for troubleshooting and monitoring your bin:
     - o Moisture — if contents seem too dry, add a little water with a spray bottle; if too wet, add a little dry, shredded newspaper.
     - o Smell — the worm composter can become anaerobic if more food than the worms can eat is added. If this happens, don't add any food scrap for a few weeks to allow the worms time to catch up. When cared for correctly, compost bins should not smell foul.
     - o Fruit flies — Make sure food is buried and covered with bedding to avoid attraction of fruit flies.
     - o Dying or escaping worms — check moisture and adjust if necessary. If contents are brown all over, it may be time to harvest.
     - o Tea tray — if the tray has a lot of brown sludge in it, put into watering can and top with water, allowing the mixture to steep. Water plants with this highly nutritious compost tea fertilizer.
   - Harvest — when all bedding is gone (usually 3-5 months), it is time to harvest.

     To harvest, don't add new food for two weeks and push the contents to one half of the bin, placing any large undecomposed scraps to the empty side of the bin with fresh bedding. Continue burying the food scraps only in the "empty" side of the bin. Over the next 2-3 weeks, the worms will move over to the new side (where the food is).

     Dump the entire contents of the worm bin onto a sheet of plastic and divide into several piles. As the piles are exposed to light, the worms will move to the bottom of the pile, allowing you to harvest the top most layer. After removing the top layer, allow the pile to sit in the light for 2-3 minutes before harvesting the next layer. Repeat this process until the worms are left at the bottom. Any leftover food scraps can be added to the next composter.
2. Remind students that food put into a landfill does not break down as quickly as the food in their worm bin. When food in landfills does break down, it emits a harmful gas called methane (a by-product of anaerobic decomposition) that contributes to global warming.

   Ask: What are some other reasons why food waste may be harmful?
3. Have students explain what organisms are breaking down the food in their worm bin. When they mention worms, explain that there is a special species of worm that people often use for indoor composting. Red wigglers process food waste efficiently, speeding up the process of decomposition. The worms digest the food waste and bedding, leaving behind a nutrient-rich material called castings (worm poop) that can be used when planting a garden. Red wiggler worms also reproduce quickly, which allows for more worms to eat more food.
4. Create a classroom compost bin according to the above process. Explain to students that worms' bodies are light sensitive, meaning the worms should be buried under layers of food scraps and newspaper to avoid the light. Remember to keep the bin closed to avoid letting in light or attracting flies.
5. Have students research and create a poster of food items that are appropriate for the red wigglers to eat. Post the results near the compost bin.

Extensions

- Have students research uses for anaerobic bacteria, especially in waste water treatment plants and as a source for renewable energy. Have them report and share their findings.
- Have students create a composting guide for other classes. Help them to create a composting system for the school. Explain to the students the value of multiple worm bins in the reduction of the school's food waste. For assistance in this process, visit compost.css.cornell.edu, or contact Seven Generations Ahead at act@sevengenerationsahead.org.
- Have students conduct a research project to discover more about worms. Earthworms are beneficial organisms for growing food on farms and in gardens. In many parts of the country, however, earthworms are an invasive species that damage forest floors. Students can present their findings, written or visually, on the benefits and drawbacks of worms in an ecosystem.
- Have students research different composting methods.
- Invite a local "compost professional" (master gardener, vermiculturist, composter) to discuss what they do and why.
- Visit a local compost facility (small scale or commercial) or wastewater treatment plant to find out how our waste is processed and diverted (treated and reused vs. wasted) on a large scale.

Younger Audience Adaptations

1. Have all the materials assembled in advance — holes drilled, newspaper collected, food scraps chopped - and have students shred paper for bedding and assemble the bin.
2. Read Earl the Earthworm Digs for His Life by Tim Magner and have students create posters with tips about the worms and how to use the bins — do's and don'ts, appropriate food items, fun worm facts.
3. Observe which food items break down fastest or how long different items take to decompose by keeping a "worm food log."

Sources

Cornell University: http://compost.css.cornell.edu/worms/basics.html#Harvesting

Glossary

Aerobic: Organisms requiring oxygen to live; also refers to the most common decomposition process that takes place in nature, producing a stable humus.

Anaerobic: Organisms living in the absence of oxygen; also called fermentation, through which no oxygen and much less heat is required and methane is produced.

Bulbs: A type of modified stem that grows in layers connected by a round, flat, hairy base with the beginnings of roots. They reproduce by creating offshoots connected to the larger bulb, ie: onion, garlic

Corms: A type of modified stem that appears to be the same as bulbs, but do not grow in layers. As the plant grows, all energy is used up and the corm shrivels, producing new corms alongside the original (now shriveled) corm, ie: taro, crocus.

Companion Planting is putting plants together for mutual benefit, such as increased yield or bug attraction/repellence.

Compost: Rich material produced when food waste and other organic materials such as yard waste and manure decompose.

Compost Tea: A liquid produced by extracting bacteria, fungi, protozoa and nematodes from compost that provides an enormous amount and diversity of beneficial organisms for gardens. It is made by steeping active compost in water and can be applied as an organic fertilizer.

Composting: The controlled decay of plant and animal matter to create a rich material that can then be added to existing soil to improve structure and nutrient content.

Cultivation: To raise and assist the growth of crops through labor and care.

Decomposer/Recycler: An organism, such as a bacterium or a fungus, that feeds on and breaks down dead plant or animal matter.

Decomposition: The act of an organism, such as a bacterium or a fungus, when feeding on and breaking down dead plant or animal matter.

Deterioration: The breaking down or decomposition of something into smaller matter.

Dicots (dicotyledon): A flowering plant with an embryo with two cotyledons, leaves with veins that usually branch and interlace to form a network, and flower parts that occur in groups of four or five.

Dirt: A brown pile of mud or dust particles; this term is generally used to refer to non-functioning soil.

Flowers: A part of a plant that enables sexual reproduction by attracting pollinators to help produce seeds.

Fruit: Part of a plant that stores and protects seeds and attracts animals to eat and disperse seeds. The definition of "fruit" can often be confusing, with botanical scientists considering fruit to be the ripened, seed bearing parts of plants. Thus, any food containing seeds would be considered a fruit, including foods commonly referred to as vegetables such as tomatoes, cucumbers, and squash. In the culinary world, the term "fruit" is used to describe a plant food with high levels of sugar whereas "vegetable" is used to describe a plant food containing lower levels of sugar.

Fungus: Any living organism (ie: molds, mildews, mushrooms) lacking chlorophyll, living on dead or decaying organic matter.

Intensive Planting: Growing more in a limited space. Can include interplanting and planting in layers.

Interplanting: The practice of planting a fast-growing crop between a slower-growing one in order to make the most of your garden space.

Leaves: Parts of a plant that absorb sunlight and transform it into food through photosynthesis.

Methane: A colorless, odorless gas produced through anaerobic bacteria.

Modified Stems: Part of the edible underground plant structure, often mistaken for roots. They fall into one of four categories: bulbs, corms, tubers, and rhizomes.

Monocots (monocotyledon): A flowering plant with an embryo with a single cotyledon and usually leaves with parallel veins and flower parts in groups of three.

Mulch: Material added to the soil in layers to conserve moisture, reduce weed growth, improve fertility, and/or enhance visual appeal. Mulch usually consists of organic material such as bark, leaves, grass clippings, peat moss, straw and/or wood chips. "Mulching" is the act of adding a layer of mulch to soil or a garden space.

Pest: A plant, animal, or bug that is unwanted.

Planting in layers: Planting with consideration for the spaces in which things grow - roots, vines, stalks, trees - and planning a garden to utilize all "layers" of a garden space.

Pollinator: Something (often animal or insect) that pollinates flowers, or assists in the reproductive cycle of plants.

Predator: An animal or bug that survives by preying—killing and eating—on other animals.

Rhizomes: A type of modified stem that is grown underground horizontally just below the soil's surface with lots of growing points, ie: asparagus, ginger, calla lilies.

Roots: Part of a plant that absorbs nutrients and water from the soil, anchor the plant in the soil, and provide storage for food and nutrients.

Root Crops: An edible underground plant structure; some "root crops" are actually part of the stem. See "modified stems".

Seeds: Parts of a plant that provide the material for new growth.

Soil: A complex material composed of organic matter (decaying remains of plants and animals), minerals (sand, silt, clay), water, and air.

Stems: Part of a plant that carries nutrients and water from the roots to other parts of the plant.

Tubers: A type of modified stem that has leathery skin and lots of eyes, which appear as tiny buds, which are growing points where new plants will emerge, ie: potatoes, sweet potatoes, yucca, yam, water chestnuts, and dahlias.

Vegetable: In culinary terms, a vegetable is an edible plant or its part, intended for cooking or eating raw. Botanical scientists consider vegetables to be edible parts of a plant that do not contain seeds.

Weed: A plant that grows quickly and thickly, especially where it is not wanted and chokes out more desirable plants.

Zone: Areas that are used to compare climate regions and where a plant is known to grow well; also referred to as a "planting zone" or "plant hardiness zone. The USDA map separates the country into 11 zones based on temperature highs and lows.

Learning Standards

How does *Sow and Grow* align with Common Core State Standards?

Grade	CCSS	Sow and Grow Component
	Grade 1	
1	**Reading: Key Ideas and Details** **R.1** Ask and answer questions about key details in a text	**Lesson 9 Extension:** Read "The Magic School Bus" in a Beehive and have students complete the Honeybees worksheet
1	**Reading: Craft and Structure** **R.5** Distinguish between information provided by pictures or other illustrations and information provided by the words in a text	**Lesson 1:** Briefly introduce methods of growing (or have students research methods) using illustrations or diagrams
1	**Writing: Range of Reading and Level of Text Complexity** **R.10** With prompting and support, read informational texts appropriately complex for grade 1	**Lesson 2 Extension:** Have students research the history of community gardens
1	**Writing: Text Types and Purposes** **W.7** Participate in shared research and writing projects	**Lesson 14 Extension:** Read "Earl the Earthworm Digs for His Life" and have students create a poster about worm bins **Lesson 1 Extension:** Have students research alternative growing methods for the different climates and regions of the world **Lesson 2 Extension:** Have students research the pros and cons of conventional farming
1	**Writing: Research to Build and Present Knowledge** **W.8** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question	**Lesson 8:** Students become "weed experts" through library and field research **Lesson 3 Adaptation:** Have students fill out "On the Farm" worksheet to guide discussions and questions with a farmer

How does *Sow and Grow* align with Common Core State Standards?

1	**Speaking and Listening:Comprehension and Collaboration** **SL.2** Ask and answer questions about key details in a text read aloud or information presented orally or through other media	**Lesson 1:** Facilitate discussion on general gardens **Lesson 3:** Engage students in discussion on fruits and vegetables
1	**Speaking and Listening: comprehension and Collaboration** **SL.3** Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood	**Lesson 3 Adaptation:** Have students fill out "On the Farm" worksheet to guide discussions and questions with a farmer **Lesson 9 Extension:** Invite a beekeeper to visit the class and have students complete the Honeybees worksheet
1	**Measurement and Data:** **MD.1**Meausre lengths indirectly and by iterating length units	**Lesson 12 Extension:** Measure water in order to do soil density experiment **Lesson 4:** Have students fill out Seed it! Plant it! Grow it! Sow it! Paper including measurement of growth for each plant
1	**Measurement and Data:** **MD.1**Represent and interpret data	**Lesson 12 Extension**: Measure water in order to do soil density experiment **Lesson 4**: Have students fill out Seed it! Plant it! Grow it! Sow it! Paper including measurement of growth for each plant
	Grade 2	
2	**Reading: Key Ideas and Detail** **R.1** Ask and answer such questions as *who, what where, when, why and how* to demonstrate understanding of text	**Lesson 9 Extension:** Read "The Magic School Bus" in a Beehive and have students complete the Honeybees worksheet

How does *Sow and Grow* align with Common Core State Standards?

2	**Reading: Key Ideas and Detail** **R.3** Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text	**Lesson 5:** Place each part of the plant life cycle in order
2	**Reading: Integration of Knowledge and Ideas** **R.7** Explain how specific images contribute to and clarity a text	**Lesson 1:** Briefly introduce methods of growing (or have students research methods) using illustrations or diagrams
2	**Writing: Text Types and Purposes** **W.2** Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.	**Lesson 2 Extension:** Have students research the history of community gardens and write short paper about their findings
2	**Writing: Research to Build and Present Knowledge** **W.7** Participate in shared research and writing projects	**Lesson 2 Extension:** Have students research the histor of community gardens and write a short paper about their findings **Lesson 8:** Students become "weed experts" through library and field research **Lesson 3 Adaptation:** Have students fill out "On the Farm" worksheet to guide discussions and questions with a farmer
2	**Speaking and Listening: Comprehension and Collaboration** **SL.1** Participate in collaborative conversation with diverse partners about grade 2 topics and texts with peers and adults in small and large groups	**Lesson 1:** Facilitate discussion on general gardens **Lesson 3:** Engage students in discussion on fruits and vegetables

How does *Sow and Grow* align with Common Core State Standards?

3	**Speaking and Listening: Presentation of Knowledge and Ideas** **SL4.** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant descriptive details, speaking clearly at an understandable pace	**Lesson 1:** Have students research the histpry of garden **Lesson 5:** Research the different methods of growing plants
3	**Math: Measurement and Data** **3.ND** Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes	**Lesson 4:** Track and measure growth of plants under various conditions
	Grade 4	
4	**Reading: Integration of Knowledge and Ideas** **R9.** Integrate information from two texts on the same topic in order to write or speak about the subject knoledgeably	**Lesson 2:** Research the history of gardens **Lesson 1:** Research various methods of growing plants **Lesson 6:** Research and compare different modified stems and roots
4	**Writing: Text Types and Purposes** **W2.** Write informative/explanatory texts to examine a topic and convey ideas and information clearly	**Lesson 2:** Research the history of gardens **Lesson 1:** Research various methods of growing plants **Lesson 6:** Research and compare different modified stems and roots
4	**Writing:Research to Build and Present Knowledge** **W7.** Conduct short research projects that build knowledge through investigation of different aspects of a topic	**Lesson 2:** Research the history of gardens **Lesson 1**: Research various methods of growing plants **Lesson 6:** Research and compare different modified stems and roots

How does *Sow and Grow* align with Common Core State Standards?

3	**Speaking and Listening: Presentation of Knowledge and Ideas** **SL4.** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant descriptive details, speaking clearly at an understandable pace	**Lesson 1:** Have students research the histpry of garden **Lesson 5:** Research the different methods of growing plants
3	**Math: Measurement and Data** **3.MD** Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes	**Lesson 4:** Track and measure growth of plants under various conditions
	Grade 4	
4	**Reading: Integration of Knowledge and Ideas** **R9.** Integrate information from two texts on the same topic in order to write or speak about the subject knoledgeably	**Lesson 2:** Research the history of gardens **Lesson 1:** Research various methods of growing plants **Lesson 6:** Research and compare different modified stems and roots
4	**Writing: Text Types and Purposes** **W2.** Write informative/explanatory texts to examine a topic and convey ideas and information clearly	**Lesson 2:** Research the history of gardens **Lesson 1:** Research various methods of growing plants **Lesson 6:** Research and compare different modified stems and roots
4	**Writing:Research to Build and Present Knowledge** **W7.** Conduct short research projects that build knowledge through investigation of different aspects of a topic	**Lesson 2:** Research the history of gardens **Lesson 1**: Research various methods of growing plants **Lesson 6:** Research and compare different modified stems and roots

How does *Sow and Grow* align with Common Core State Standards?

4	**Speaking and Listening: Comprehension and Collaboration** **SL1.** Engage effectively in a range of collaborative discussions with diverse partners on Grade 4 topics	**Lesson 1:** Facilitate discussions with class about gardens **Lesson 2:** Discuss community needs and how a garden might help to meet those needs **Lesson 9:** Complete KWL chart on pests vs. bugs as a class
4	**Speaking and Listening : Comprehension and Collaboration** **SL2.** Identify the reasons and evidence a speaker provides to support particular points	**Lesson 9 Extension:**Facilitate discussion with a beekeeper **Lesson 3:** Facilitate discussion with farmer about seasonality
4	**Math: Measurement and Data** **4.MD** Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit	**Lesson 4:** Have students measure plant growth under various conditions **Lesson 10:** Have students measure various materials for soil expiriment
4	**Math: Measurement and Data** **4. MD** Represent and interpret data	**Lesson 4:** Have students interpret plant growth measurements to determine the best growing conditions
	Grade 5	
5	**Reading: Key Ideas and Details** **R3.** Explain the relationship or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text	**Lesson 1:** Have students research and compare different methods of planting **Lesson 3:** Have students research tasks of a farmer then form questions to interview a farmer
5	**Reading: Craft and Structure** **R5.** Compare and contrast overall structure of events, ideas, concepts, or information in two or more texts	**Lesson 2:** Have students research the history of gardens

How does *Sow and Grow* align with Common Core State Standards?

5	**Reading: Integration of Knowledge and Ideas** **R9.** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably	**Lesson 1:** Have students research and compare different methods of planting **Lesson 3:** Have students research tasks of a farmer then form questions to interview a farmer
5	**Writing: Research to Build and Present Knowledge** **W7.** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic	**Lesson 4:** Monitor the growth of plants under various conditions and report findings in the form of a written document **Lesson 12:** Do soil experiment to test the density of soil and report findings in the form of a written document **Lesson 14:** Research bacteria and report findings in the form of a written document
5	**Writing: Research and Present Knowledge** **W9.** Draw evidence from literary or informational texts to support analysis, reflection, and research	**Lesson 1:** Have students research and compare different methods of planting **Lesson 3:** Have students research tasks of a farmer then form questions to interview a farmer
5	**Speaking and Listening: Comprehension and Collaboration** **SL 1.** Engage effectively in a range of collaborative discussions with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly	**Lesson 1:** Facilitate garden discussion **Lesson 2:** Have students work in small groups to create a garden plan and present it to the class **Lesson 13:** Have students brainstorm ways around food waste
5	**Speaking and Listening: Comprehension and Collaboration** **SL 3.** Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence	**Lesson 3:** Have students interview a farmer **Lesson 9:** Have students interview a beekeeprer

How does *Sow and Grow* align with Common Core State Standards?

5	**Speaking and Listening:Presentation of Knowledge and Ideas** **SL4.** Report on a topic or text or present an opinion sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace	**Lesson 8:** Research and report findings on weeds
5	**Math: Number and Operations in Base Ten** **5.NBT** Read, write and compare decimals to thousandths	**Lesson 4:** Have students track plant growth under various conditions
5	**Math: Measurement and Data** **5.2 MD** Represent and interpret data	**Lesson 12:** Do experiment measuring density of soil **Lesson 4:** Have students track plant growth and interpret data
	Grade 6	
6	**Reading: Craft and Structure** **R4.** Determine the meaning of words and phrases as they are used in a text, include figurative and connotative meanings; analyze the impact of a specific word choice on meaning and tone	**Lesson 9:** Define the word pest **Lesson 8:** Define the word weed
6	**Reading: Integration of Knowledge and Ideas** **R7.** Integrate information presented in different media or formats as well as in words to develop a coherent understanding of a topic or issue	**Lesson 10:** Determine components of soil through examination and research **Lesson 6:** Identify different parts of a plant by investigation and research
6	**Reading: Integration of Knowledge and Ideas** **R8.** Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not	**Lesson 5:** Have students compare different methods of gardening

How does *Sow and Grow* align with Common Core State Standards?

6	**Writing:Text types and Purposes** **W2.**Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection, organization, and analysis of relevant content	**Lesson 14:** Research bacteria and report findings **Lesson 8:** Research weeds and report findings in the form of a written report **Lesson 6:** Research plant parts and report findings in the form of a written report
6	**Writing: Research to Build and Present Knowledge** **W7.** Conduct a short research project to answer a question, drawing on several sources and refocusing the inquiry when appropriate	**Lesson 8:** Use the scientific method to answer the question "What is a weed?" **Lesson 12:** Do a short experiment to measure the density of soil **Lesson 4:** Track plant growth under various conditions
6	**Writing: Research to Build and Present Knowledge** **W7.** Gather relevant information from multiple prind and digital sources/assess the credibility of each source; and quote or paraphrase the data and conclusion of others while avoiding plagiarism and providing basic bibliographic information for sources	**Lesson 8:** Research and report findings on weeds **Lesson 2:** Research the history of gardens **Lesson 1:** Research different types of gardens **Lesson 14:** Research bacteria and report findings
6	**Speaking and Listening: Comprehension and Collaboration** **SL1.** Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues building on others' ideas and expressing their own clearly	**Lesson 1:** Facilitate garden discussion **Lesson 2:** Have students work in small groups to create a garden plan and present it to the class **Lesson 13:** Have students brainstorm ways around food waste
6	**Speaking and Listening: Comprehension and Collaboration** **SL3.** Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not	**Lesson 3:** Have students interview a farmer **Lesson 9:** Have students interview a beekeeprer

How does *Sow and Grow* align with Common Core State Standards?

6	**Math: Ratios and Proportional Relationships** **6.1** **RP** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities	**Lesson 12:** Use ratios to compare and contrast soil types
6	**Math: Expressions and Equations** **6.9 EE** Use variables to represent two quantities in a real-world problem that change in relationship to one another	**Lesson 4:** Identify variables and their relationships in plant growth experiment
	Grade 7	
7	**Reading: Craft and Structure** **R4.** Determine the meaning of words and phrases as they are used in a text, include figurative and connotative meanings	**Lesson 9:** Define the word pest **Lesson 8:** Define the word weed
7	**Reading: Integration of Knowledge and Ideas** **R8.** Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and evidence is relevant and sufficient to support the claims	**Lesson 5:** Have students compare different methods of gardening
7	**Writing:Text types and Purposes** **W2.**Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection, organization, and analysis of relevant content	**Lesson 14:** Research bacteria and report findings **Lesson 8:** Research weeds and report findings in the form of a written report **Lesson 6:** Research plant parts and report findings in the form of a written report
7	**Writing: Research to Build and Present Knowledge** **W7.** Conduct a short research project to answer a question, drawing on several sources and refocusing the inquiry when appropriate	**Lesson 8:** Use the scientific method to answer the question "What is a weed?" **Lesson 12:** Do a short experiment to measure the density of soil **Lesson 4:** Track plant growth under various conditions

How does *Sow and Grow* align with Common Core State Standards?

7	**Writing: Research to Build and Present Knowledge** **W7.** Gather relevant information from multiple prind and digital sources/assess the credibility of each source; and quote or paraphrase the data and conclusion of others while avoiding plagiarism and providing basic bibliographic information for sources	**Lesson 8:** Research and report findings on weeds **Lesson 2:** Research the history of gardens **Lesson 1:** Research different types of gardens **Lesson 14:** Research bacteria and report findings
7	**Speaking and Listening: Comprehension and Collaboration** **SL1.** Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues building on others' ideas and expressing their own clearly	**Lesson 1:** Facilitate garden discussion **Lesson 2:** Have students work in small groups to create a garden plan and present it to the class **Lesson 13:** Have students brainstorm ways around food waste
7	**Speaking and Listening: Comprehension and Collaboration** **SL3.** Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not	**Lesson 3:** Have students interview a farmer **Lesson 9:** Have students interview a beekeeprer
7	**Math: Ratios and Proportional Relationships** **7.1** **RP** Recognize and represent proportional relationships between quantities	**Lesson 12:** Use ratios to compare and contrast soil types
7	**Math: Expressions and Equations** **7.4 EE** Use variable to represent quantities in real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities	**Lesson 4:** Identify variables and their relationships in plant growth experiment

How does *Sow and Grow* align with Common Core State Standards?

Grade 8		
8	**Reading: Craft and Structure** **R4.** Determine the meaning of words and phrases as they are used in a text, include figurative and connotative meanings	**Lesson 9:** Define the word pest **Lesson 8:** Define the word weed
8	**Reading: Integration of Knowledge and Ideas** **R8.** Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced	**Lesson 5:** Have students compare different methods of gardening
8	**Writing:Text types and Purposes** **W2.**Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection, organization, and analysis of relevant content	**Lesson 14:** Research bacteria and report findings **Lesson 8:** Research weeds and report findings in the form of a written report **Lesson 6:** Research plant parts and report findings in the form of a written report
8	**Writing: Research to Build and Present Knowledge** **W7.** Conduct a short research projects to answer a question, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration	**Lesson 8:** Use the scientific method to answer the question "What is a weed?" **Lesson 12:** Do a short experiment to measure the density of soil **Lesson 4:** Track plant growth under various conditions

How does *Sow and Grow* align with Common Core State Standards?

8	**Writing: Research to Build and Present Knowledge** **W8.** Gather relevant information from multiple prind and digital sources/assess the credibility of each source; and quote or paraphrase the data and conclusion of others while avoiding plagiarism and providing basic bibliographic information for sources	**Lesson 8:** Research and report findings on weeds **Lesson 2:** Research the history of gardens **Lesson 1:** Research different types of gardens **Lesson 14:** Research bacteria and report findings
8	**Speaking and Listening: Comprehension and Collaboration** **SL1.** Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues building on others' ideas and expressing their own clearly	**Lesson 1:** Facilitate garden discussion **Lesson 2:** Have students work in small groups to create a garden plan and present it to the class **Lesson 13:** Have students brainstorm ways around food waste
8	**Speaking and Listening: Comprehension and Collaboration** **SL3.** Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced	**Lesson 3:** Have students interview a farmer **Lesson 9:** Have students interview a beekeeprer
8	**Math: Expressions and Equations** **8.6EE** Understand the connections between proportional relationships, lines, and linear equations	**Lesson 4:** Identify variables and their relationships in plant growth experiment
8	**Math: Functions** **8.4** Construct a function to model a linear relationship between two quantities	**Lesson 4:** Identify variables and their relationships in plant growth experiment

Appendix

Fold

JANUARY

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

WEEK 1:

- Order needed tractor implements, parts, hand tools, and supplies
- Dig into storage pit for more potatoes, turnips, carrots, and other root vegetables
- Brush snow away from beehive entrances so bees can take body cleansing flights on sunny days
- Service tractor and market truck; check and change fluids

WEEK 2:

- Prune raspberry canes on any day 45 degrees or over
- Plan greenhouse planting schedule - how many of each variety will be planted and when
- Check tractor implements for loose bolts, broken parts, etc. Grease and repair as needed
- Clean greenhouses, remove old mulch and stakes, level off soil

WEEK 3:

- Weatherize greenhouse by closing up the ends and putting doors on
- Use up last years preserves and canned vegetables
- Set up heat tape for starting seeds in their germination trays in the greenhouse
- Goats are very pregnant
- Sow colored peppers for later transplanting to greenhouse

WEEK 4:

- In germination trays: sow herbs, flowers, celeriac, parsley destined for later transplanting to field
- Sow eight most popular heirloom tomato varieties for growing in greenhouse for early-season harvest
- In greenhouse: Direct-sow alliums, including leeks, scallions, red, yellow, white onions
- Join local CSA
- Goat kids born this week and next

Fold

WEEK 1:

- Cut, chop, and stack firewood for woodstove each week during the cold season
- Order fruit trees, bush fruit, and strawberry plugs
- Start cleaning out the barn

WEEK 2:

- Await arrival of this season's seeds, ordered in December
- Boxes of seed packets arrive almost every day, all month long
- Dig into storage pit to retrieve carrots, beets, turnips, and potatoes

WEEK 3:

- Start repairing and building new crates for vegetables
- Sharpen and oil hand tools
- Spread year-old compost on fields

WEEK 4:

- On first sunny day, check beehives; if honey stores depleted, feed sugar-water to ensure healthy population of pollinators

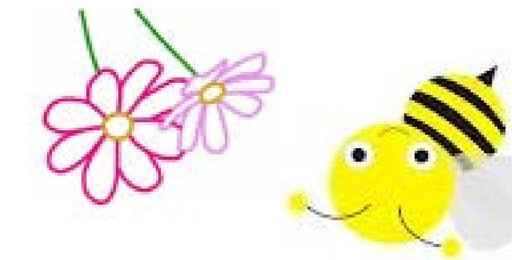
Fold

FEBRUARY

What are farmers harvesting?

What activities are farmers doing during this month?

MARCH



What are farmers harvesting?

What activities are farmers doing during this month?

Fold

Asparagus

Spinach

WEEK 1:

- Get the last root vegetables out of the storage pit
- Last wood chopping for the season!
- In the greenhouse: Sow radicchio, lettuce, eggplant, peppers, broccoli and cabbage into germination trays
- Bring year-old compost up to greenhouse to make soil blocks
- Start pruning fruit trees, grapevines, kiwis, bush fruits
- Prepare field for first tilling; begin digging overwintered burdock and Jerusalem artichokes

WEEK 2:

- In greenhouse: Direct-sow brassica (broccoli, cabbage, kale, kohlrabi, Brussel sprouts, collards)
- Move hens from barn to pasture
- Do early inspection of beehives; check for brood and eggs
- In field: Start filling under cover crops as needed, allowing them to decompose and release nutrients to feed the vegetables
- Ramp (wild leek) harvest begins, and runs through mid-April
- Goat cheese making begins

WEEK 3:

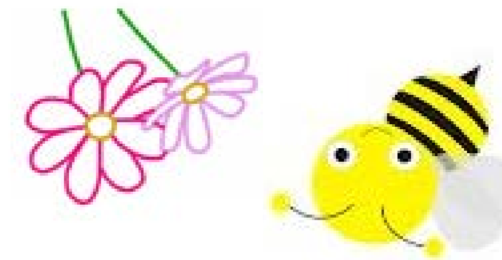
- In greenhouse: Sow herbs, basil; sow second planting of lettuce
- Check garlic in the field. If it's not poking through its winter blanket, pull mulch away
- In greenhouse: Select tomato seedlings for growing in greenhouse for early harvest & plant one seedling per soil block
- Start mulching rhubarb, raspberries, fruit trees, bush fruits
- Sow oats & clover in last year's veggie field - this year's fallow field

WEEK 4:

- If soil is dry enough, plant first fields of lettuce, spinach, kohlrabi, Japanese turnips, mustard and turnip greens, collards
- In greenhouse: Sow second crop of eggplant, peppers, & main crop of tomatoes to transplant into field
- Finish cleaning out barn and start making compost for next year
- In greenhouse: Make soil blocks and block out herbs, flowers, and lettuce destined for the field
- Start planting new fruit trees, bush fruits, brambles, & strawberries
- In greenhouse: Block out strongest parsley, broccoli, cabbage seedlings from germination trays into soil blocks destined for the field
- Begin planting veggie seeds in the field each and every week, weather-permitting, until September

Fold

APRIL



What are farmers harvesting?

What activities are farmers doing during this month?

Fold

Asparagus Onions Spinach

Lettuce Peas

WEEK 1:

- In field: Plant potatoes, onion sets; rake straw away from strawberries
- Prune back all perennial herbs; dig out mint to keep it under control
- In greenhouse: Block out celeriac, celery, eggplant, and peppers destined for field transplanting
- In field: If soil conditions are right, plant first peas, sugar snaps, snow peas, parsnips, parsley, scallions, leeks, shallots, fennel, radicchio, endive, dandelion
- In field: Plant first lettuce, spinach, kohlrabi, Japanese turnips, mustard and turnip greens, collards, arugula, radishes, carrots, beets, choi, dill, cilantro, daikon, rapini
- Transplant tomato seedlings into greenhouse for early harvest; Mulch sorrel and chives
- Transplant first lettuces from greenhouse to field to sell in May

WEEK 2:

- In greenhouse: Transplant soil blocks with colored peppers and cucumbers into hoophouse where direct-seeded brassica transplants were dug up
- Apricot & plum trees are in bloom - hope we don't have a late frost!
- Transplant kale, broccoli, cabbage & kohlrabi from greenhouse to field
- In greenhouse: Sow 2nd planting of tomatoes & basil in germination trays
- In greenhouse: Block out first planting of tomato seedlings from germination trays to soil blocks
- In greenhouse: Start blocking out basil; second planting of peppers & eggplants

WEEK 3:

- Rake mulch off strawberry rows
- Transplant onions, leeks, scallions from greenhouse to field
- Peach, cherry & pear trees blossom
- Sow Japanese cucumbers into greenhouse area where direct-seeded allium transplants were
- Clean and sharpen harvest knives; order harvest supplies such as twist-ties, bags, and knives
- Start moving trays of transplants outside on warm days to harden off

WEEK 4:

- In greenhouse: Start blocking out 2nd planting of lettuces & tomatoes
- Strawberries start to blossom
- Goat kids are weaned—milking & cheese-making continue
- In field: First planting of beans, soybeans, corn, cucumbers, summer squash, basil
- Harvest first asparagus
- The long season of hoeing & weeding begins
- Time to plant your window sill, patio, or backyard garden

Fold

MAY

What are farmers harvesting?

What activities are farmers doing during this month?

WEEK 4:

- Start mulching kale & potatoes. Trellis greenhouse tomatoes, 2nd string
- The 3 dogs begin guarding vegetables from night-time marauders
- Harvest for Markets
- Buy warm-weather starts (tomatoes, peppers, etc.) for your garden; Go to Farmers' Markets
- Thin peaches, apples, pears so remaining fruit will be bigger
- Harvest for CSA
- In field: Plant winter squash and pumpkins. Transplant second tomato sowing to field
- Transplanting done! Take down greenhouse doors and open up ends; put away transplanting supplies

- First Farmers' Market of the Season
- Apple trees in bloom

WEEK 3:

- Transplant tomatoes, peppers, eggplants to the field (unless there is still a danger of frost)
- In field: Last planting of Japanese turnips, mustard & turnip greens, mizuna; Plant muskmelon and watermelons
- Key time for hand-weeding and liberating carrots, parsnips, and parsley. In field: First planting of pumpkins, winter squash
- Harvest for Markets
- Buy cool-weather herb & brassica starts for garden. Go to Farmers' Market
- Transplant sweet potatoes into field
- Plant storage carrots (they grow big & sweet all season, for good storage all winter)

- Wash harvest boxes & baskets
- Begin cutting & drying chamomile for teas. Pull out raspberry suckers & re-mulch all fruit

WEEK 2:

- In field: Last planting of daikon, spring onions, spinach; plant dry beans & corn (popcorn, Indian corn, and for cornmeal)
- Wash market truck inside & out; check & repair tents & tables, clean market signs, make new signs
- Put up trellises for peas and green-house cucumbers; trellis greenhouse tomatoes, 1st string
- Day-old chicks arrive in the mail & are kept in the brooder under heat lamps
- First market harvest: Rhubarb, asparagus, green onions, green garlic, spinach, mesclun, radishes, beets, carrots
- In greenhouse: sow third planting of tomatoes for fall harvest
- Start thinning lettuce; do the first hilling of potatoes
- Go to Farmers' Markets

WEEK 1:

- Weeds growing like crazy
- Weed onions, now or never!
- End of spinach harvest, first carrot harvest; Harvest for CSA
- First harvest of summer raspberries, black raspberries
- First harvest of new potatoes; Harvest for Markets
- Go to Farmers' Markets

WEEK 4:

- First zucchini and bunched onions harvest; Harvest for CSA
- Trellis tomatoes, third string; Start harvesting root crops every Thursday afternoon
- Harvest for Markets
- Go to Farmers' Markets

WEEK 3:

- First broccoli harvest; Harvest for CSA
- Start mulching peppers and eggplants
- Prune heirloom and cherry tomatoes
- First harvest of snow peas & sugar snap peas; Harvest for Markets
- Go to Farmers' Markets

WEEK 2:

- Till between tomato rows, hoe between plants, and drive 350 poles into ground for trellises
- In field: Last planting of radishes, arugula, and choi
- Start trellising tomatoes down in the field; Harvest for CSA
- Set up bird netting to keep the darn birds off the blueberries
- First harvest of currants—red, white, black; Harvest for Markets
- Go to Farmers' Markets

WEEK 1:

- First strawberry harvest; Harvest for markets
- First cutting of hay, to be used for animal feed or mulch

Apples Asparagus Lettuce
Apricots Beans Okra
Blackberries Beets Onions
Blueberries Broccoli Peas
Cantaloupe Cabbage Potatoes
Cherries Carrots Radishes
Gooseberries Cauliflower Rhubarb
Nectarines Cucumbers Spinach
Peaches Eggplant Summer squash
Plums Garlic Sweet corn
Raspberries Horseradish Tomatoes
Strawberries Kohlrabi Turnips
Watermelons Leeks

Asparagus Kohlrabi
Beets Leeks
Broccoli Lettuce
Brussel sprouts Onions
Cabbage Peas
Cauliflower Radishes
Cucumbers Rhubarb
Cherries Spinach
Gooseberries Summer squash
Strawberries Tomatoes
Greens Turnips

Fold

Fold

JUNE

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

JULY

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

WEEK 1:

- Prime time for beans; go to Farmers' markets
- Freeze beans for winter
- First planting of fall Japanese turnips, mustard and turnip greens and broccoli raab
- Harvest for CSA
- Add pole extensions to tomato trellises to continue trellising up to eight feet high
- As kids return to school, move to all day Thursday harvest to make up for lost labor
- Harvest for markets
- Prime time for sweet corn; Go to Farmers' markets

WEEK 2:

- Freeze corn for winter; first grape harvest
- Last planting of dill and cilantro; Till earth to get ready for planting overwintered spinach and next year's garlic
- Harvest for CSA
- Till down first corn planting and plant first fall cover crops
- First harvest of muskmelon
- Harvest for markets
- Go to Farmers' markets

WEEK 3:

- First harvest of pears and Asian pears
- Harvest honey crop at the end of main nectar flow
- Harvest for CSA
- Begin sowing cover crops weekly for each spent vegetable bed

Apples	Garlic
Blackberries	Horseradish
Blueberries	Leeks
Cantaloupe	Lettuce
Grapes	Onions
Nectarines	Peas
Peaches	Peppers
Pears	Popcorn
Plums	Potatoes
Raspberries	Radishes
Strawberries	Rhubarb
Watermelon	Spinach
Beans	Summer squash
Beets	Winter squash
Carrots	Tomatoes
Cucumbers	Turnips
Eggplant	

Fold

- First harvest of watermelons
- Harvest for markets
- Go to Farmers' markets

WEEK 4:

- Harvest for CSA
- Fall roots and greens start coming in
- Harvest for markets

Apples	Watermelon	Okra
Apricots	Lima beans	Onions
Blackberries	Beans	Peas
Blueberries	Beets	Peppers
Cantaloupes	Broccoli	Potatoes
Grapes	Cabbage	Pumpkins
Nectarines	Carrots	Radishes
Peaches	Cucumbers	Rhubarb
Pears	Eggplant	Summer squash
Plums	Garlic	Sweet corn
Raspberries	Horseradish	Tomatoes
Strawberries	Leeks	Turnips

WEEK 1:

- All week long—dig, sort & hang garlic from barn rafters to dry for future markets and next year's planting
- Do second hay cutting, weather permitting
- Japanese beetle patrol begins in the fruit orchard & brambles; Harvest for CSA
- Add honey supers to the top of the hive as needed; extract honey, time-permitting

WEEK 2:

- 1st harvest of blueberries; trellis tomatoes, fourth string; harvest for Market
- Plant storage beets; last planting of cucumbers, summer squash; harvest for markets
- Go to Farmers' markets
- Put turkeys on pasture so they can enjoy insects & dandelion greens
- Start fall plantings & hope for rain so they germinate; radish, arugula, Chinese cabbage, daikon, kohlrabi
- Harvest for CSA
- Harvest first blackberries & summer apples
- Trellis tomatoes, fifth string; harvest for market
- First eggplant & pepper harvest; harvest for markets
- Go to Farmers' markets

WEEK 3:

- Start tying dogs near sweet corn at night to keep raccoons away
- Sow supper cover crop on bare beds as early crops harvested out
- First taste of tomatoes; first sweet corn; harvest for CSA
- Harvest first peaches
- Trellis tomatoes, sixth string; harvest for market
- Harvest for market
- Go to Farmers' markets

WEEK 4:

- Harvest first ground cherries
- Plant fall turnips, radish, choi; last planting of carrots, beets, chard, basil, & beans
- Harvest for CSA
- Pull dry onions
- Trellis tomatoes, seventh string; Harvest first luscious tomatoes, enough now to bring to market
- Harvest for markets
- Go to Farmers' markets

Fold

AUGUST

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

SEPTEMBER

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

Apples
Cantaloupe
Grapes
Peaches
Plums
Raspberries
Watermelon
Beans
Beets
Broccoli
Brussel sprouts
Cabbage
Cauliflower
Cucumbers
Eggplant
Garlic
Greens

Horseradish
Kohlrabi
Lettuce
Okra
Onions
Peas
Peppers
Popcorn
Potatoes
Pumpkins
Radishes
Rhubarb
Spinach
Summer squash
Sweet potatoes
Winter squash
Tomatoes
Turnips

WEEK 1:

- Sow cover crops on beds harvested out the previous week
- Curing of sweet potatoes complete; Harvest for CSA
- Harvest all winter squash and pumpkins before hard freeze and load up on hay racks to store in the barn
- Start harvesting Indian corn, popcorn, and dry beans; Harvest for markets
- Go to Farmers' markets

WEEK 2:

- Close up greenhouses to protect veggies from cool nights
- Start harvesting all remaining winter radishes, celeriac, turnips, and beets before night temperatures fall into mid-20s
- Move hayracks of winter squash out on sunny days to cure in the sun; move back inside on frosty nights; Harvest for CSA
- Harvest for markets

WEEK 3:

- Go to Farmers' markets
- After frost kale, chois, and other fall greens sweeter, now at their prime time; Harvest for markets
- Carve pumpkin and roast seeds
- Plant garlic saved from July; harvest for next year's garlic crop
- Harvest for CSA
- Freeze greens for winter
- Sow cover crops on beds harvested out the previous week
- Start cutting firewood whenever there's free time; Harvest for CSA
- Harvest for Farmers' markets
- Prepare garlic beds so garlic can be planted whenever conditions are right

WEEK 4:

- Go to Farmers' Markets
- Harvest apples and crab apples to press for cider
- Bring equipment into shed; Harvest for markets
- Harvest for markets
- Curing of sweet potatoes complete; Harvest for CSA
- Move hayracks of winter squash out on sunny days to cure in the sun; move back inside on frosty nights; Harvest for CSA
- Harvest for markets
- Bring equipment into shed; Harvest for markets
- Carve pumpkin and roast seeds
- Plant garlic saved from July; harvest for next year's garlic crop
- Harvest for CSA
- Freeze greens for winter
- Sow cover crops on beds harvested out the previous week
- Start cutting firewood whenever there's free time; Harvest for CSA
- Harvest for Farmers' markets
- Prepare garlic beds so garlic can be planted whenever conditions are right
- Go to Farmers' markets

Fold

Apples
Blueberries
Cantaloupe
Grapes
Nectarines
Peaches
Pears
Plums
Raspberries
Watermelon
Beans
Beets
Broccoli
Cabbage
Carrots
Cauliflower
Eggplant

Garlic
Horseradish
Kohlrabi
Leeks
Lettuce
Okra
Onions
Peas
Peppers
Pumpkins
Radishes
Rhubarb
Spinach
Summer squash
Winter squash
Sweet corn
Sweet potatoes
Tomatoes
Turnips

WEEK 1:

- Harvest first chois, Japanese turnips, & turnip greens
- Move apprentices' starting time up to 6:30 to account for shorter days; Sow cover crops on beds harvested out the previous week
- First winter squash; harvest for CSA
- Tomato harvest begins to slow as days shorte;
- Start braiding garlic to sell
- Harvest for markets
- First frost any time now; Prune fall raspberries and feed to goats

WEEK 2:

- Go to Farmers' market
- Dogs return to guard & protect fall lettuces & radicchio from deer
- Sow cover crops on beds harvested out the previous week
- Finish up last hoeing and weeding jobs of the season
- Harvest for CSA

WEEK 3:

- Go to Farmers' markets
- Getting dark around 7:30 p.m.; rush to finish harvest as daylight dwindles
- Start harvesting on Wednesdays to compensate for shorter days; Harvest all green tomatoes before 1st frost
- Check hives, ensure there are 80-120lbs of honey remaining in each hive for winter
- Can't see outside 'til after 6 a.m. so start harvest day in shed cleaning & braiding garlic; harvest for markets
- Move apprentices' starting time up to 6:30 to account for shorter days; Sow cover crops on beds harvested out the previous week
- First winter squash; harvest for CSA
- Tomato harvest begins to slow as days shorte;
- Start braiding garlic to sell
- Harvest for markets
- Go to Farmers' market
- Dogs return to guard & protect fall lettuces & radicchio from deer
- Fall lettuces start coming in; harvest for CSA
- Start harvesting on Wednesdays to compensate for shorter days; Harvest all green tomatoes before 1st frost
- Harvest for CSA

WEEK 4:

- Go to Farmers' markets
- Dig sweet potatoes if soil temp falls below 56 degrees; Cure for 1 week at 90 degrees & 90% humidity
- Harvest for markets
- Go to Farmers' markets

WEEK 4:

- Sow cover crops on beds harvested out the previous week; Start picking fall pears
- Harvest for CSA

WEEK 3:

- Plant spinach that will overwinter and be ready for first markets next May; harvest for markets
- Billy goat & nanny goats get together (wink-wink); Kids begin their five month gestation; harvest for markets
- Tomatoes usually killed by frost by now; harvest for markets
- Go to Farmers' markets

Fold

OCTOBER

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

NOVEMBER

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

DECEMBER

What are farmers harvesting?

What activities are farmers doing during this month?

Fold

Broccoli
Popcorn
Potatoes
Pumpkin
Spinach
Winter squash
Sweet potatoes
Turnips

WEEK 1:

- Move root crops to storage pit
- Begin reviewing and compiling past season's yields, field notes, etc.
- Mulch garlic after first night in teens
- Clean and put away hand tools
- Move hens to barn for winter

WEEK 2:

- Make last goat cheese of the season; no more goat milk until kids born in March
- Wrap beehives with tar paper for winter insulation
- Finish review of season's yields and start preparing orders from seed catalogs
- Dig into storage pit for the first time, take out carrots, potatoes, beets, winter radishes, rutabagas and more

WEEK 3:

- Order tomatoes
- Send in seed order
- Mulch strawberries after ground is frozen

WEEK 4:

- Make beeswax candles with spent honeycomb
- Wassail the apple trees to ensure a good harvest next year!

Apples
Pears
Beets
Broccoli
Cabbage
Cauliflower
Garlic
Greens
Horseradish
Lettuce
Onions
Peas
Peppers
Popcorn
Potatoes
Pumpkins
Spinach
Winter squash
Sweet potatoes
Tomatoes
Turnips

WEEK 1:

- Start harvesting remaining carrots, parsnips, burdock, and sunchokes before ground starts freezing; Harvest for CSA
- Harvest for market
- Go to last Farmers' Markets
- Begin weekly sawing, chopping and hauling of wood for woodstove to heat house
- Shell dry beans; dry corn for flour and popcorn

WEEK 2:

- Announce renewal for CSA memberships; Harvest for CSA
- Grind corn and wheat flour
- Add mouse guard to entrance of beehive, making sure bees have adequate ventilation
- Mulch overwintered burdock

WEEK 3:

- Harvest for CSA
- Harvest for Thanksgiving Market
- Remove any remaining tomato trellis poles, twine, cages from field
- Last CSA pickup of the season
- Till in tomato vines and mulch if ground is dry enough
- Clean fields for winter

WEEK 4:

- Dig storage pit to keep carrots, beets, turnips, daikon, Jerusalem artichokes, potatoes, and other roots for hearty winter meals

How to: *Jar Testing* for soil type

SANDY SOIL	SILTY	CLAY SOIL
0-10% Clay	7-27% Clay	40-100% Clay
0-15% Silt	28-50% Silt	0-40% Silt
90%-100% Sand	23-52% Sand	0-45% Sand

photo: sustainablegarden.com

1. Fill a quart jar about one-third full with topsoil and add water until the jar is almost full.
2. Screw on the lid and shake the mixture vigurously, until all the clumps of soil have dissolved.
3. Now set the jar on a windowsill and watch as the larger particles begin to sink to the bottom.
4. In a minute or two the sand portion of the soil will have settled to the bottom of the jar (see illustration). Mark the level of sand on the side of the jar.
5. Leave the jar undisturbed for several hours. The finer silt particles will gradually settle onto the sand. You will find the layers are slightly different colors, indicating various types of particles.
6. Leave the jar overnight. The next layer above the silt will be clay. Mark the thickness of that layer. On top of the clay will be a thin layer of organic matter. Some of this organic matter may still be floating in the water. In fact, the jar should be murky and full of floating organic sediments. If not, you probably need to add organic matter to improve the soil's fertility and structure.

Soil Types

1. Sand
   - Made up of large particles, feels dry and gritty
   - Drains rapidly, less nutrient absorption by plants due to runoff
   - Lightweight and temperature warms quicker than other soil types
2. Silt
   - Made up of smaller particles than sand, smooth to the touch
   - Retains water a little longer than sandy soil, but cannot hold onto nutrients
   - Tends to be cold with poor drainage, compacts easily, poorly aerated
3. Clay
   - Made up of the smallest particles of the three and therefore has good water storage qualities; it is smooth when dry and sticky when wet
   - Little aeration, slow draining, good nutrient retention
   - Clay soil takes a while to warm up in the springtime and can be heavy to work with especially when hardened and compact
4. Peat
   - Dark brown or black in color, easily compressed, high in water and rich in organic matter, spongy to the touch
   - Heavy when saturated, but its ability to hold water helps to protect roots from damage during wet seasons
   - Contains acidic water and can be used to regulate soil chemistry or pH levels
5. Saline
   - Common in extremely dry regions, it can cause damage to plant growth, and difficulty with germination and irrigation
   - Identifiable by a white layer coating the surface of the soil, poor plant growth and leaf tip burn on young leaves
6. Loam
   - Dark, mealy, soft, dry and crumbly; ideal soil type
   - Good water and nutrient retention qualities, while also having good drainage and aeration
   - Essentially a balance of particle sizes (sand, silt, clay) and decaying organic material; if your soil favors on particle, you can "condition" your soil by adding compost, compost tea or soil inoculants (microorganisms).

What is soil?

The word "soil" is often used interchangeably with the word "dirt," but the two do not actually refer to the same thing. Dirt is simply the small, brown pile of mud or dust particles we may hold in our hand. Soil, however, is a complex material composed of organic matter (decaying remains of plants and animals), minerals (sand, silt, clay), water, and air. Lastly, soil contains many small and microorganisms (organisms too small to see with the naked eye alone) such as bacteria that help break down organic matter.

Five Functions of Soil

What's in Soil?

Soil is formed through a complicated process involving many elements. Soil begins with parent material—various types of sediment left by glaciers or volcanoes—which is then broken into finer particles through a combination of temperature, water, and wind over a long period of time. As plants and animals die, their remains are added to this material, and as they decay, their nutrients are added. Water and air infiltrate the soil as it is moved by wind and living organisms. Eventually, healthy subsoil and topsoil are formed, but this process takes hundreds of years.

Healthy soil is composed of 45% minerals, 25% water, 25% air, and 5% organic matter and can be a variety of colors and textures. Soil can be classified by one of 6 categories. There are two ways to identify which type of soil you have, one is to dampen a small amount and roll it between your fingers, looking particle size, water retention (moisture), and aeration (space between particles). The other is *jar testing*.

Healthy Soil

Growing healthy food begins with healthy soil. Soil is the foundation of human nourishment and of life, making it one of the most valuable natural resources the earth has to offer.

Unfortunately, soil is not a limitless natural resource and is used at a much faster rate that the earth can create and replenish it. With water covering 75% of the Earth's surface, fertile, tillable soil only makes up slightly greater than 6%. Human practices have a significant impact on the little available fertile soil, many of which can be detrimental to the quality and usability of the soil available for growing food.

Considerations

Testing
Soil testing can be useful in managing and understanding the mineral nutrition of soil as well as indicating the presence of harmful contaminants. The composition of your soil may determine planting, fertilization, soil preparation, and whether remediation or planting in a raised bed is necessary. For more a more technical and in-depth discussion of soil testing and pH NCSU offers a great *Gardeners Guide to Soil Testing* (http://www.cals.ncsu.edu/agcomm/publications/Ag-614.pdf)

Where to test?
University of Illinois Extension has a list of Labs offering free soil testing. Listed below are locations that offer testing for home samples, agriculture samples, interpretation for samples and testing for heavy metals such as lead and arsenic.

A&L Great Lakes Agricultural Lab 3505 Conestoga Dr Fort Wayne, IN 46808-4413 Phone: (260)483-4759 Fax: (219) 483-5274 http://www.algreatlakes.com Email: Lab@algreatlakes.com	**GMS Laboratories** 23877 E. 00 North Rd, PO Box 61 Cropsey, IL 61731 Phone: (309) 377-2851 Fax: (309) 377-2017 http://www.gmslab.com/pages/home Email: office@gmslab.com
SGS Belleville 1511 E. Main St., PO Box 175 Belleville, IL 62222 Phone: (618) 233-0445 Fax: (618) 233-7292 https://serviceloc.sgs.com Email: soilservices@sgs.com	**SGS Toulon** 117 E. Main St Toulon, IL 61483 Phone: (309) 286-2761 Fax: (309) 286-6251 https://serviceloc.sgs.com Email: soilservices@sgs.com

My soil is contaminated, now what?
A major concern of urban gardeners is the possibility of dangerous contaminants in soil, but even if it turns out that your soil has contaminants, there are solutions available. One is to excavate the contaminated soil and to replace it with clean soil, but this option can be time intensive and expensive; another is bio-remediation—growing specific plants known to draw certain contaminants up from the soil, but the rate of absorption is a slow process and is not practical for most gardens.
The most feasible option for most school and community garden spaces is to build raised beds with untreated lumber, lined with landscaping fabric to prevent roots from growing into contaminated soil, and filled with clean soil. For more information on how to build your own raised garden bed, including how much soil you'll need: http://thefoodproject.org/sites/default/files/DIY-bag-manual-2012.pdf
Cornell has also published a guide to best practices when dealing with contaminated soils that can be useful when looking at things to take into consideration. Available here:
http://cwmi.css.cornell.edu/Soil_Contaminants.pdf

Make your own soil: Compost

Compost is simply decomposing food waste and other organic materials such as yard waste and manure decompose. During decomposition, tiny bacteria and fungi break down waste and form humus, a dark brown, soil-like material. This material, also known as compost, can be added to the garden's soil to improve structure by adding valuable nutrients that help plants grow. Creating your own compost is an easy and effective way to reduce food waste while providing a nutrient dense growing material for your garden.
See the *Composting 101* guide for more information about starting your own composting system.

Soil and compost Resources

Buy the Yard
2215 Main St.
Evanston, IL 60202
847-733-0635
www.buytheyardinc.com

Compost Supply, Inc.
P.O. Box 3328
Glen Ellyn, IL 60138-3328
630-858-8070

Cowsmo Compost and Potting Soil (organic approved)
S1843 County Road U
Cochrane, WI 54622-8120
608-626-2571
Email: rosenow@mwt.net
http://www.cowsmocompost.com/

E-Z Tree Recycling
7050 South Dorchester Avenue
Chicago, IL 60637
(773)493-8600
http://e-ztreerecycling.com/index.htm

Gethsemane Garden Center
5739 N Clark St
Chicago, IL 60660
773-878-5915
http://www.gethsemanegardens.com/

Grand Street Gardens
2200 W Grand Ave
Chicago IL 60612
312-829-8200
http://www.grandstreetgardens.com

Lake Street Landscape Supply
1810 W. Lake Street
Chicago, IL 60612
312-226-0760
www.lakestreetsupply.com

Midwest Organics Recycling
28353 N. Darrell Road
McHenry, IL 60051
847-483-9116
http://www.compostmatters.com/

Midwest Trading
P.O. Box 388
Maple Park, IL 60151
630-365-1990
http://www.midwest-trading.com/products/

Raised Bed Building Materials

Lake Street Landscape Supply
1810 W. Lake Street
Chicago, IL 60612
312-226-0760
www.lakestreetsupply.com

REBuilding Exchange
Affordable building materials (lumber), education and training opportunities, technical assistance and community-based projects.
3335 W 47th St
Chicago, IL 60632
773-847-3761
http://www.rebuildingexchange.org/

Other

Chicago Sustainable Backyards Rebate Program
(rebates for trees, native plants, compost bins and rain barrels)
http://www.cityofchicago.org/content/city/en/depts/cdot/provdrs/conservation/outreachgreenprograms/svcs/chicago_sustainablebacky

Fresh from the Farm

Sevengenerationsahead.org

Composting 101

Why Compost?

Compost is a mixture of decaying organic materials such a dead leaves, kitchen vegetable scraps and other plants. It keeps plants and soil healthy.

Benefits of Composting:

1. Reduce:
Composting your garden debris and kitchen vegetable scraps reduces the amount of garbage you produce.

2. Reuse:
Composting reuses waste that would have gone to landfills.

3. Restore:
Compost improves both the physical condition and the fertility of the soil and provides some nutrients to plants.

4. Save Money:
By composting you save money instead of buying soil amendments and mulch.

5. It's EASY and FUN!

How Does Composting Work?

Composting works by mixing greens and browns materials in a bin. Water is required to keep it moist then air and living organisms help decompose the organic materials in to a dark rich material called humus.

What Can I Compost?

Do Compost:

Greens:
Fruit and vegetable trimmings
Young weeds
Coffee grounds
Egg shells
Citrus rinds
Tea bags
Straw and hay

Browns: Fallen leaves Woody prunings Untreated sawdust
Black and white newspaper

Don't Compost:

Plywood or treated wood sawdust
Meat, bones or fish
Dairy products or grease
Grains, breads or beans
Dog, cat or bird feces
Diseased plants

Composting Tip:

Any food scraps (greens) should be buried and mixed in the center of the bin.This will prevent animals and rodents digging in to the pile, flies and potential odors.

Compost Bins

What Type of Compost Bin Do I Need?

There are many different types of compost bins available for purchase and you can build one if you are handy. Furniture or make one based on your needs, resources and available space.

Considerations:

How much does a compost bin cost?

The cost of a compost bin can vary from free (using recycled material) to $300 and up. See page 4 for plans and resources to build your own.

What size and type compost bin should I get?

The size of your compost bin depends on how much green and brown waste you have to compost.

Where should I locate the compost bin?

1. In a convenient area.
2. Be close to a water source and have free contact with soil.
3. The bin should have indirect exposure to sun.
4. Located away from direct wind, rain and low-lying areas with standing water.

Basic Composters for Purchase

$100 to $300


Wood Bin with Slats


Bath Medicine


Tumbler

Composters to Build

$0 to $300*


Wood Fence


Tank Can


Tumbler


3 Bin Wood and Wire


3 Bin Wood

*Consider using recycled wood to avoid using pressure treated wood.

How Do I Compost?

Basic Composting

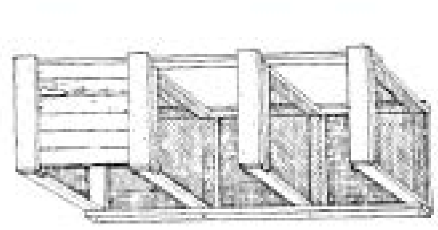
Complete in 4 to 12 Months

Basic composting consists of layering 1/2 green and brown materials and watering and turning the pile as needed.

1. Add brown and green materials as you generate them. Try to add equal amounts to the bin.
2. Materials should be cut in to 6" pieces or smaller.
3. Any food scraps should be buried and mixed in the center to avoid animals digging in to the pile and flies.
4. Water as needed. Keep materials moist and wet like a sponge. If it gets too wet, add more materials or turn the pile.
5. Turn the compost each time you add new materials or turn once a week if possible.
6. Compost is complete when it is dark brown, looks like soil and smells earthy. You can sift the compost and use it immediately. Any large or unfinished pieces can be returned to the bin.
7. Compost will be ready in 4-12 months.

Batch Composting

Complete in 3 to 6 Months



Batch composting is also called hot composting and works best with 2 or more bins that are each 3' X 3'.

1. Fill the bin with 2" to 3" inches of well chopped brown and green materials. Alternate layers till bin is full watering between layers.
2. Keep materials moist and wet like a sponge. If it get too wet, add more materials or turn the pile.
3. Turn materials each time you add more materials or once a week.
4. Compost is complete when it is dark brown, looks like soil and smells earthy. You can sift the compost and use it immediately. Any large or unfinished pieces can be returned to the bin.
5. Compost will be ready in 3-6 months.

Composting 101 Resources:

Composters for Purchase:

Earth Machine Composters
earthmachine.com
$100.

Indoor Composters
naturemill.com
$289. to $399.

Tumbling Composters
upcycle-products.com
$119.99

Worm Compost Bins
wormfactory.us
$79 to $125

Composters to Build:

3 Bin Wire and Wood Composter:
www.uaex.edu/other_areas/publications/pdf/fsa-6033.pdf

Rotating Barrel Composter:
http://www.rdn.com/pages/compost/rotating_barrel.html

Composting Bins:
http://www.extension.umn.edu/distribution/horticulture/components/3296-02.html#02

Web Sites:

Composting Basics
http://urbanext.illinois.edu/homecompost/basics.html

Compost Publications and Fact Sheets:
http://whatcom.wsu.edu/ag/compost/mcpubs.htm

Waste: Reduce, Reuse, Recycle and Composting
http://www.epa.gov/osw/conserve/rrr/composting/

Books:

The Rodale Book of Composting: Easy Methods for Every Gardener
by Grace Gershuny and Deborah L. Martin

Let it Rot!: The Gardener's Guide to Composting
by Stu Campbell

Easy Composters You Can Build
by Nick Noyes

Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting System
by Mary Appelhof and Mary F. Fenton

Sources: Cooperative Extension Service, Northeast Regional Agricultural Engineering Service, "Composting to Reduce the Waste Stream," NE AES-43
Chicagohomecomposting.org
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Resources compiled by Debbie Kang, School Garden Educator dkang@singtee.com
The Singing Seed

How does Sow and Grow meet the Next Generation Science Standards?

Read below for more information on how components of Sow and Grow help classrooms meet Next Generation Science Standards for elementary and middle school students.

Key Standards	Sow and Grow Lessons
Elementary School: Patterns and Cycles 1-ESS1-2 Relationships in Ecosystems 3-LS4-3 Engineering Design 3-5-ETS1-1 and 2 Matter and Energy in Organisms and Ecosystems 5-LS2-1 *Middle School:* Growth/Development of Organisms MS-LS4-5 Relationships in Ecosystems MS-LS2-5 Engineering Design MS-ETS1-1	LESSON 1: SCHOOL AND COMMUNITY GARDENS Grades 1-8 • Students will maximize garden growth in a limited planning space • Students will draw parallels between the basic needs of humans and those of plants **Lesson addresses:** Botany, environmental engineering **Methods used:** Venn diagrams, individual or group research projects,
Elementary School: Relationships in Ecosystems 2-LS4-1 Engineering Design 3-5-ETS1-1 and 2 Relationships in Ecosystems 3-LS4-3 and 4 Matter and Energy 5-LS1-1, 5-PS3-1 Earth's Systems 5-ESS3-1 *Middle School:* Growth, Development and Reproduction of Organisms MS-LS4-5 Relationships in Ecosystems MS-LS2-5 Human Impacts MS-ESS3-3 Engineering Design MS-ETS1-1	LESSON 2: URBS IN HORTO Grades 1-8 • Students will observe that gardens take many forms • Students will consider all of the elements of designing, planting, and maintaining a garden • Students will design a community garden plan and justify their choices **Lesson addresses:** Civics, community planning, engineering, conventional vs. organic farming **Methods used:** Research in the community, historical research, anthropological research methods

Elementary School: Earth's Systems 5-ESS3-1 Matter and Energy 5-PS3-1 *Middle School:* Growth, Development and Reproduction of Organisms MS-LS1-5 Relationships in Ecosystems MS-LS2-3	LESSON 3: HARVEST CALENDAR Grades 5-8 • Students will examine the tasks a farmer does on the farm during each month • Students will differentiate between growing and harvest seasons • Students will identify the annual cycles of work on a farm **Lesson addresses:** Farming, seasonality, work and types of jobs **Methods used:** Seasonality worksheet
Elementary School: Space Systems: Patterns and Cycles 1-ESS1-2 Weather and Climate 3-ESS2-1 Relationships in Ecosystems 2-LS2-1 Life Cycles and Traits 3-LS3-2 Relationships in Ecosystems 3-LS4-3 Structure, Function and Information Processing 4-LS1-1 Matter and Energy 5-PS3-1 Matter and Energy 5-LS2-1 *Middle School:* Human Impacts MS-ESS3-3 Matter and Energy Cycling MS-LS2-3	LESSON 4: GARDEN TRANSITIONS Grades 1-8 • Students will observe and evaluate the needs of a garden according to the season • Students will create a list of garden tasks according to season and formulate a plan to implement them • Students will prepare the garden space for the coming season **Lesson addresses:** Working in a garden throughout the school year **Methods used:** Basic **math** to track garden progress, record keeping, seed growth estimates
Elementary School: Relationships in Ecosystems 2-LS2-1 Life Cycles and Traits 3-LS1-1 Matter and Energy 5-PS3-1 Structure, Function and Information Processing 4-LS1-1 *Middle School:* Matter and Energy MS-LS1-6	. LESSON 5: PLANT LIFE CYCLE Grades 1-8 • Students will identify the 8 stages of the plant life cycle and the unique characteristics of each stage • Students will identify at what stage different garden crops are ready for harvest **Lesson addresses:** Botany, life cycles **Methods used:** Hands on investigation, individual research

Elementary School: Relationships in Ecosystems 2-LS4-1 Structures and Properties of Matter 2-PS1-1 Life Cycles and Traits 3-LS1-1 Structure, Function and Information Processing 4-LS1-1 *Middle School:* Matter and Energy in Organisms and Ecosystems MS-LS1-4, MS-LS2-3	. LESSON 6: PLANT PARTS Grades 1-8 • Students will identify the six parts of the plant • Students will assess how each plant part contributes to the plant's survival • Students will recognize visual characteristics of each plant part • Students will categorize different fruits or vegetables based on plant parts. **Lesson addresses:** Botany, parts of a plant, life cycles, food science, cooking, food education **Methods used:** Matching (seed matching), tactile exploration, writing
Elementary School: Relationships in Ecosystems 2-LS4-1 Structures and Properties of Matter 2-PS1-1 Life Cycles and Traits 3-LS1-1 Structure, Function and Information Processing 4-LS1-1	. LESSON 7: PLANT PARTS WE EAT Grades 1-8 • Students will identify fruits and vegetables as parts of a plant • Students will be able to make connections between plant part function and nutritional benefits **Lesson addresses:** Botany, culinary education, kitchen skills **Methods used:** Cooking
Middle School: Matter and Energy MS-LS1-4 and 5 MS-LS4-5 Relationships in Ecosystems MS-LS2-4 and 5	. LESSON 8: DANDELION, CRABGRASS, AND BURRS, OH MY! Grades 5-8 • Students will evaluate which plants are "weeds" in the garden • Students will name beneficial and/or harmful properties of weeds **Lesson addresses:** Botany, plant identification **Methods used:** Hands on investigation in the garden

Elementary School: Structures and Properties of Matter 2-PS1-1 Relationships in Ecosystems 2-LS2-2 Life Cycles and Traits 3-LS3-2 Structure, Function and Information Processing 4-LS1-1 Matter and Energy 5-PS3-1 Matter and Energy 5-LS2-1 *Middle School:* Matter and Energy Relationships in Ecosystems MS-LS2-3 and 4	. LESSON 9: PEST OR POLLINATOR? Grades 1-8 • Students will discriminate between helpful vs. harmful bugs • Students will define four different roles bugs may play in a garden • Students will examine the value of a diverse presence of organisms in a garden space **Lesson addresses:** Types of insects, animal kingdom, life cycles, human impacts on environment **Methods used:** KWL chart, descriptive writing, worksheet on honeybees
Elementary School: Relationships in Ecosystems 3-LS4-3 Matter and Energy 5-LS2-1, PS3-1 Space Systems 5-PS1-1 *Middle School:* Growth, Development and Reproduction of Organisms MS-LS1-5 and 7 Relationships in Ecosystems MS-LS2-3 and 5	LESSON 10: WHAT'S IN SOIL? Grades 1-8 • Students will analyze soil samples and identify the five components of soil • Students will predict how organic matter breaks down to form healthy soil • Students will assemble "ingredients" and create the beginnings of soil **Lesson addresses:** Soil, minerals, human impact on environment, decomposition, compost, farming, environmental awareness **Methods used:** Soil experiments and exploration, research on farming methods and changes in the environment
Elementary School: Matter and Energy 5-LS2-1 Earth's Systems 5-ESS3-1 *Middle School:* Matter and Energy MS-LS2-4 and 5 Human Impacts MS-ESS3-3 Engineering Design MS-ETS1-1	LESSON 11: SOIL ON EARTH Grades 5-8 • Students will appraise the value of soil based on the amount of fertile soil available on Earth • Students will predict how not having access to healthy soil affects the people who live nearby **Lesson addresses:** Soil, minerals, botany, Earth science, conservation, proportions and percentages **Methods used:** Investigation of different climates/regions/terrains, research of soil types and agriculture

Elementary School: Matter and Energy 5-LS2-1 *Middle School:* Growth, Development and Reproduction of Organisms MS-LS1-5 Relationships in Ecosystems Matter and Energy MS-LS2-3 through 5 Human Impacts MS-ESS3-3	LESSON 12: SOIL EXPERIMENT Grades 5-8 • Students will differentiate between soil types • Students connect plant needs to which soil type is best suited for them **Lesson addresses:** Soil, botany, life cycles **Methods used:** Record keeping, experimental design, group work
Elementary School: Matter and Energy 5-LS2-1 Earth's Systems 5-ESS3-1 *Middle School:* Human Impacts MS-ESS3-1 and 3 Engineering Design MS-ETS1-1, 2, 3, 4 Matter and Energy MS-LS2-3	LESSON 13: FROM WASTE TO RESOURCE Grades 5-8 • Students will identify decomposition and observe how it leads to compost • Students will link composting to the plant cycle • Students will use the waste cycle to create a valuable garden resource **Lesson addresses:** Compost, human impacts on the environment, decomposition **Methods used:** KWL chart, observations in the classroom and at home, experimental design
Elementary School: Matter and Energy 5-LS2-1 Earth's Systems 5-ESS3-1 *Middle School:* Human Impacts MS-ESS3-1 Engineering Design MS-ETS1-1, 2, 3, 4 Matter and Energy MS-LS2-3	LESSON 14: CLASSROOM COMPOSTING Grades 5-8 • Students will utilize a natural function to create a valuable garden resource • Students will build and maintain a classroom worm compost bin **Lesson addresses:** Compost, human impacts on the environment, engineering, civics and local government **Methods used:** Creation of a classroom or school compost system, research of municipal composting, creation of a compost guide for other schools

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