5th Grade Garden Lessons
(From the Center for Ecoliteracy Curriculum Binder)

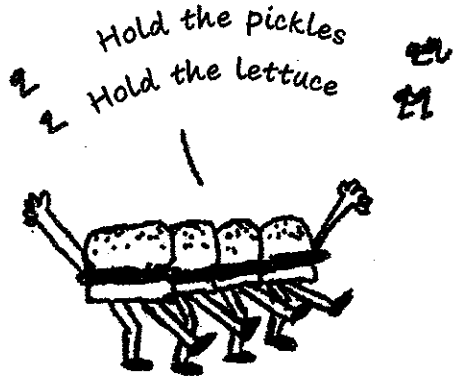
1. Bioburgers (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
2. The Day They Parachuted Cats into Borneo (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
3. You Are What you Eat (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
4. Adapt-A-Seed (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
5. The $1,000,000 Orange (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
6. Colonial Kitchen Garden (c. Growing Great: Inspiring Healthy Eating)
7. 5th Grade Garden Experiment (by Jill Grace and Marika Bergsund, c. Growing Great: Inspiring Healthy Eating)
8. Produce Investigation (c. Lifelab)
9. Flower Power, Part 1 (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
10. Flower Power, Part 2 (c. Roberta Jaffe, Gary Appel, *The Growing Classroom*)
11. 5th Grade Learning Garden Lessons (c. Captain Planet's Learning Gardens)

INDOORS ❀ GRADES 2-6 ❀ FALL, WINTER, SPRING ❀ ACTIVITY

Bioburgers

DESCRIPTION

This activity draws connections between a common fast food and the Big Four essentials of life: air, water, sun, and soil. Students trace the ingredients of a hamburger to their origins of air, water, sun, and soil.



OBJECTIVE

To illustrate the importance of air, water, sun, and soil for life.

MATERIALS

Poster or sketch of a hamburger with bun, cheese, lettuce, etc.

CLASS DISCUSSION

How many of you like hamburgers? What are the basic ingredients of a hamburger? Would you believe that if we are really good detectives we can trace each part of a hamburger, including the bun, the cheese, the meat, etc., back to the same four ingredients? As a matter of fact, these same four ingredients make it possible for each of us to live!

ACTION

1. Design a Food Flow Chart by taping the hamburger poster to the center of the board.

2. Help the students trace the origin of the major ingredients — meat, bun, cheese, tomato — of the hamburger. Begin by asking the students, *Where did the meat come from?* Continue questioning until they reach the source of the ingredients: sun, soil, air, and water. Record responses on the board. Give guidance where needed. Your chart may be a simpler version of the one illustrated on the following page.

WRAP UP

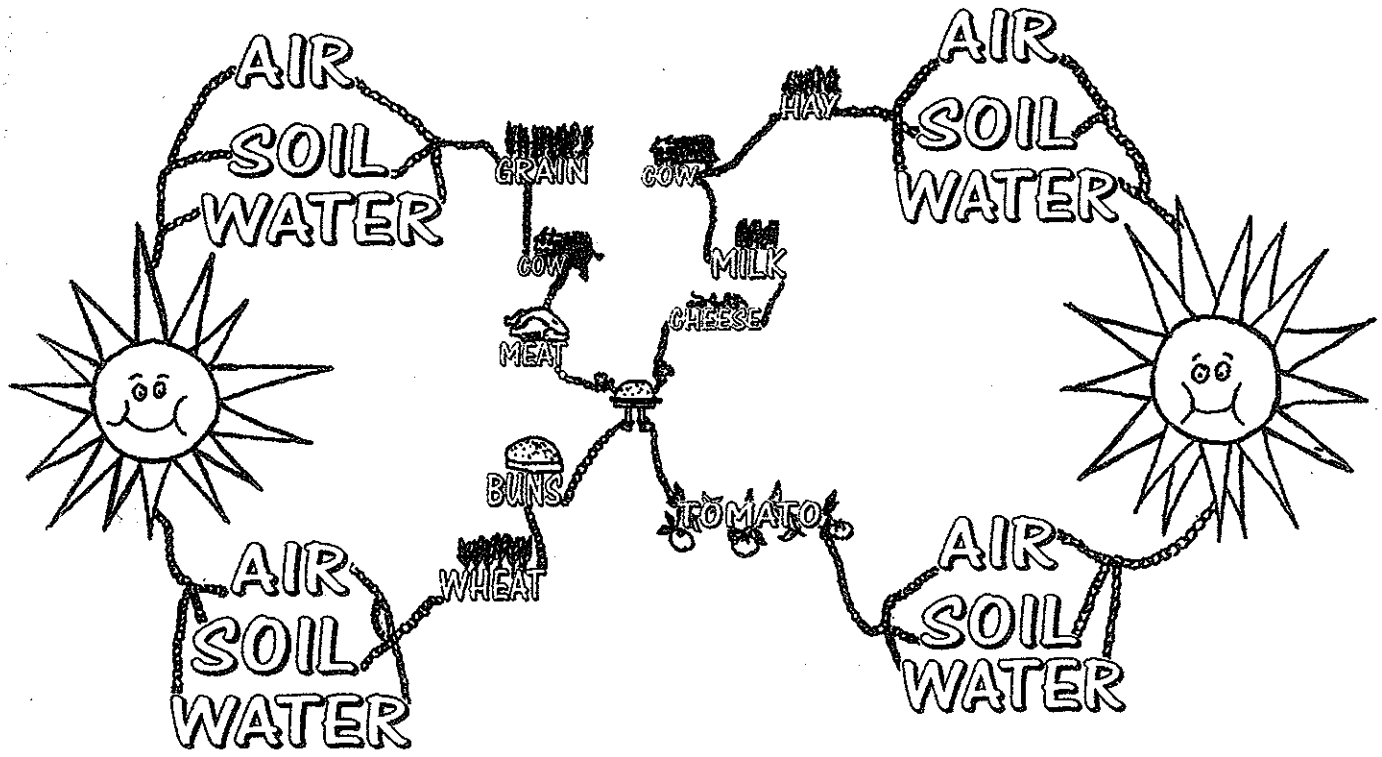
How long could you live without any one of the Big Four essentials of life? Can you identify a living thing that can survive without one of the Big Four? (*Anaerobic bacteria live without air; some fungi live without sunlight; some seaweeds live without soil.*) Ultimately all living things on earth depend on the big four one way or another.

DIGGING DEEPER

1. Ask the students to plan a meal that does not in some way depend on the Big Four. Is this difficult?

2. Have each class member use his or her favorite meal and make a food flow chart tracing the food back to its beginning. Where does all the food ultimately come from?

3. Suggest that students try the same thing, tracing the packaging required at each step. Where does all of the packaging come from? Where does it all ultimately go?



INDOORS ❀ GRADES 5-6 ❀ FALL, WINTER, SPRING ❀ ACTIVITY

The Day They Parachuted Cats into Borneo

DESCRIPTION

Students discuss this story of how DDT (Dichloro-diphenyl-trichloroethane) affected villages in Borneo.

OBJECTIVE

To demonstrate the ramifications of making a single change in an ecosystem.

TEACHER BACKGROUND

See Teacher Background for the previous activity (DDT Chew, p. 225).

MATERIALS

None

CLASS DISCUSSION

When we learn about a new topic, it is helpful to look at the subject's history and find out about its past, and how it has affected people and the environment. *(Explain why the pesticide DDT was banned in the U.S.)*

ACTION

Read aloud the following true story to your students and discuss it. (From Laycock, *Let the Wild Ones Stay Home.*)

> Some time ago, the World Health Organization sent supplies of DDT to Borneo to fight mosquitoes that spread malaria among the people. The mosquitoes were quickly wiped out. But billions of roaches lived in the villages and they simply stored the DDT in their bodies. One kind of animal that fed on the roaches was a small lizard. When these lizards ate the roaches, they also ate a lot of DDT. Instead of killing them, DDT only slowed them down. This made it easier for cats to catch the lizards, one of their favorite foods. About the same time, people also found that hoards of caterpillars had moved in to feed on the roofing materials of their homes. They realized the lizards that previously had kept the caterpillar population under control had been eaten by the cats. And now, all over North Borneo, cats that ate the lizards died from DDT poisoning.
>
> Then rats moved in because there were no cats to control their population. With the rats came a new danger: plague. Officials sent out emergency calls for cats. Cats were sent in by airplane and dropped by parachute.
>
> One simple change in the ecosystem had set off a whole chain reaction.

WRAP UP

Have students identify actions they or others have taken that caused unexpected changes or outcomes. What happens when we change just one thing? What does it mean to be interdependent?

INDOORS ❀ GRADES 5-6 ❀ FALL, WINTER, SPRING ❀ ACTIVITY

You Are What You Eat

DESCRIPTION

Students form a food web by connecting links in the food chain with string.

OBJECTIVE

To illustrate interdependence within a food web.

TEACHER BACKGROUND

Food chains are not isolated; they are interrelated, forming a complex food web. This interdependence allows for diversity in food choices to optimize chances of survival and at the same time helps to keep populations in balance with the food sources. This activity will give students the opportunity to visualize how the complexity of the food web develops from a simple food chain.

MATERIALS

- String
- One piece of paper per student
- Tape
- Science journals
- Reference books (optional)

PREPARATION

At the start of the activity each student will be assigned a different animal or plant. You may want to assign them in advance and have students research their plants and animals to learn where they live, what they eat, and who might eat them.

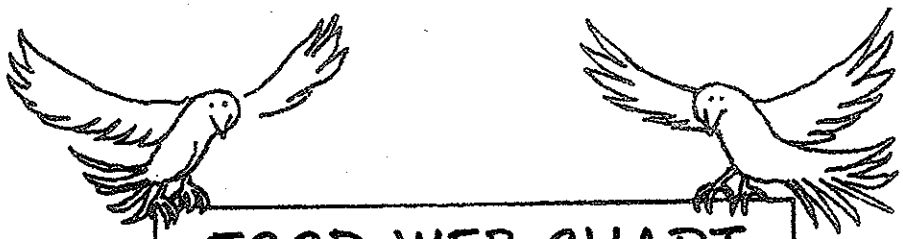
CLASS DISCUSSION

What is a food chain? Do animals always eat the same thing? Can the same type of animal be part of more than one food chain? What happens as these different food chains are brought together?

ACTION

1. Assign students an animal or plant from the chart on the next page. Have them make signs showing the names of their animal. Tape the signs to the front of each desk and arrange the desks in one large circle.

2. Pick any student that is not a plant or decomposer and hand that student the end of a ball of string. Then ask him or her to pick something from the circle that his or her animal depends on, such as an animal or plant it eats. Run the string from the first student to the second. Then ask the second student to pick something that he or she is dependent upon. Continue until all students have at least one part of the string in their hands. You may have to help them understand that plants use nutrients from the plants and animals that decomposers break down. Also, decomposers eat dead things. Encourage the decomposers to choose to eat animals such as mountain lions and vultures that are eaten by nothing else.



FOOD WEB CHART

coyote	fish	algae
mouse	earthworm	oak tree
rabbit	sparrow	cattails
snake	robin	hawk
grass	bear	grasshopper
owl	salmon	duck
snail	mountain lion	beetle
deer	beaver	mite
raccoon	lizard	fly
vulture	gopher	human

3. Continue until all students are connected to the food web and it is too complex to take any further.

4. Ask students what would happen to the food web if: air pollution kills all of the trees; new birds migrate to the area; frost wipes out the insects; the area is strip-mined; trees are planted; flooding inundates the area. Have them think of additional factors that might alter the food web. The students whose roles are directly affected by a given change can tug repeatedly on the string; anyone who feels a tag should tug too, and so on until everyone in the web feels the effect. How can one event affect everyone?

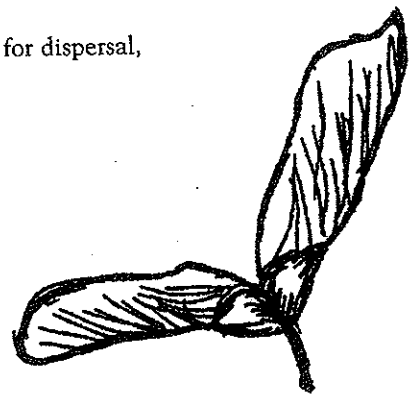
5. Ask students for a different set of plants and animals, all belonging to the same habitat. Be sure to include decomposers in the mix. Write the list on the board. Ask students to write these names in a circle in their journals and draw a food web between them. Ask for volunteers to share examples of the connections they drew.

WRAP UP

John Muir, a famous naturalist and writer said, "When we try to pick out anything by itself we find it hitched to everything else in the universe." Discuss what this means with the class. Ask the following questions: How are you part of the food web? What is the result of making a change in the web? Identify ways in which people are causing changes to the earth. Name an action you have taken that resulted in an unexpected change.

INDOORS ❀ GRADES 4-6 ❀ FALL, WINTER, SPRING ❀ ACTIVITY

Adapt-a-Seed



DESCRIPTION

Students will use human-made materials to adapt seeds for dispersal, such as flying and floating.

OBJECTIVE

To discover some plant adaptations for survival.

MATERIALS

- Seeds: bean, pumpkin, corn, or pea
- Construction paper
- Tape
- Paste
- Collection of materials such as rubber bands, toothpicks, balloons, scissors, pencils, plastic bags, cork, cotton, feathers, tacks, metal springs, wire
- Bell pepper (optional)

CLASS DISCUSSION

What does a new plant grow from? *(a seed)* Where do the seeds come from? *(Plants grow seeds to reproduce more of the same kind of plant.)* How does a seed get to a certain place? Where did the weed seeds in the garden come from? Have you ever seen seeds flying in the air? *(dandelion fluff)* Being carried by a dog? *(burrs, foxtails)* Have you heard of seeds floating on water to a new spot to grow? *(coconuts)* If you examine these seeds, you will see features that help them travel in a special way. A seed has one purpose: to become a new plant. Can you design seeds to travel in different ways?

ACTION

1. Divide the class into small groups.
2. Give each group seeds to be adapted.
3. Ask each group to adapt their seed to float on water for at least five minutes; be thrown at least 2 feet (0.6 m) away from the parent plant; attract a bird or animal; hitchhike on an animal or person for 20 feet (6 m); or fly at least 3 feet (1 m). When dispersal inventions are complete, have students demonstrate how they work.

WRAP UP

Why do seeds have dispersal mechanisms? What might happen if maple seeds fell straight to the ground and grew right under the parent maple?

DIGGING DEEPER

Cut open a pepper and count the number of seeds inside. How many seeds are in one pepper plant? How many pepper plants could grow from the seeds in that one pepper? If one pepper produces 30 peppers, how many plants could be grown from all the seeds of those 30 peppers? Why don't peppers cover the earth?

INDOORS ❀ GRADES 4-6 ❀ FALL, WINTER, SPRING ❀ ACTIVITY

The $1,000,000 Orange

DESCRIPTION

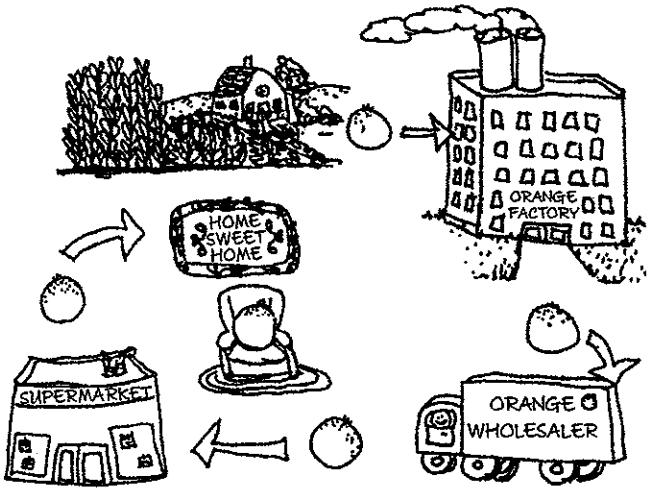
Students make orange "juicicles" to learn the steps and costs involved in processing food from its original form to its final form.

OBJECTIVE

To demonstrate the increased cost of food as it is processed.

MATERIALS

- One orange with price tag
- 1/2 fresh orange per student
- Hand juicer
- Bowl
- Pitcher
- One small paper cup per student
- Masking tape
- One popsicle stick per student
- Freezer space
- Knife
- Cutting board
- Measuring cup
- Water



PREPARATION

Draw the following chart on the board. Have a recorder fill in the chart as the activity progresses.

JOB	PROCESS	MATERIALS	LABOR	ENERGY	COST

CLASS DISCUSSION

What's the difference between an orange and an orange juicicle? What steps do you think are taken to make juicicles from oranges? *(list on board)* What do these steps involve? *(energy, money, labor)* If we turned our class into an orange juicicle factory, how much do you think we would need to charge for a juicicle in order to cover the cost of production? *(Record predictions.)*

ACTION

1. Divide the class so that each group of students has a job from number 4 (below).

2. Take the class through the process of making orange juicicles. With each step, discuss the materials, labor, and energy that would be involved.

3. Have the processors at each step determine how much they would charge for their part of the process. The recorder should record this information and then add up the final cost of the orange juicicles.

4. Jobs and steps:

Farmers	Grow and harvest oranges, truck them to processor.
Slicers	Cut oranges in half until there is one half per person.
Juicers	Squeeze orange halves into a bowl.
Blenders	Stir in 1/3 cup of water to the juice of each orange half.
Packagers	Pour mixture into a small paper cup.
Labelers	Put tape on each cup with product name and ingredients label.
Truckers	Carry orange juicicles to freezer.

5. Have students insert sticks into juicicles after 20 minutes (or as soon as they begin to thicken).

6. Discuss what price the class would sell their product for in order to pay their costs and make a reasonable profit. Why would it be cheaper to buy the ingredients and materials and make it at home?

7. Enjoy the orange juicicles as an afternoon snack.

WRAP UP

Why is it more expensive to buy processed foods than unprocessed foods? Name three advantages of buying processed foods. Name three disadvantages. Describe how having so many processed foods affects our society in terms of jobs, costs, energy use, health. Is the cost of food related to nutritional value?

DIGGING DEEPER

1. Have students research food preparation in other cultures such as that of Native Americans in precolonial times. Compare it with food preparation today.

2. Have students investigate prices of foods in their original form and the same products in processed forms. How many processed products can they find for one original food?

3. Have students research the actual breakdown in cost of a food product that travels from farmer to store. Which is the most expensive step? The least? *(This will vary for each product because there are different processing and transportation requirements. Your County Agricultural Extension should be able to provide you with information.)*

Fifth Grade Spring Lesson

Colonial Kitchen Garden

Objective:

Students will learn about the various plants the Early American settlers and Native Americans used for food, medicine and home life during the time of colonization and the Revolutionary War.

California State Content Standards:

1) Social Science.

5.3 Students describe the cooperation and conflict that existed among the American Indians and between the Indian nations and the new settlers.

2. Describe the cooperation that existed between the colonists and Indians during the 1600s and 1700s (e.g., in agriculture, the fur trade, military alliances, treaties, cultural interchanges).

5.4 Students understand the political, religious, social, and economic institutions that evolved in the colonial era.

1. Understand the influence of location and physical setting on the founding of the original 13 colonies, and identify on a map the locations of the colonies and of the American Indian nations already inhabiting these areas.

5.6 Students understand the course and consequences of the American Revolution.

4. Understand the personal impact and economic hardship of the war on families, problems of financing the war, wartime inflation, and laws against hoarding goods and materials and profiteering.

Lesson Outline:

A. Lesson
   a. Agricultural needs of Colonists—food, medicine, housewares
   b. Use of a kitchen garden
   c. Plants of Native Americans vs. plants brought by Colonists
B. Garden Rules
C. Planting Plans
D. Plant

Seeds/Supplies:

Seeds:
Beans—Lima beans (important crop brought by colonists), Romano or Kentucky Wonder pole beans
Squash—Black Beauty Zucchini or yellow summer squash variety
Onions—bulbs
Corn—any hybrid, short season variety
Carrots—Nantes
Medicinal herbs—basil, dill, cilantro, bee balm, lemon balm

Transplants:
Medicinal herbs--rosemary, thyme,
marjoram, rue, chamomile

Lesson:

Lesson:
Even after many years of living in the colonies in America, families had to grow most or all of their own food to eat. Although they could purchase grains and certain shelf stable foods (like flour or dried beans) by the time of the Revolutionary War, most homes had a small kitchen garden in which they grew fresh vegetables as well as herbs for culinary seasoning and for medicinal use.

1) There was no refrigeration for keeping food fresh or markets for purchasing fresh vegetables. So, families seeking fresh foods needed to grow them themselves. This became particularly important during the time of the war when much of commerce was disrupted and the currency had little value so people could not buy many things that may have been previously available.

2) Families had their own small kitchen garden next to their home that they used to provide fresh vegetables and herbs for flavoring foods and medicinal uses.

3) The vegetables being planted today (beans, corn, carrots and onions) were the basic vegetables used to make Succotash, a common meat stew eaten during these colonial times.

4) There were few doctors and pharmacies, especially in rural areas, so most remedies were created from common herbs grown in the garden—treating upset stomach, headache, cuts and sores, etc. The colonists brought seeds for herbs with them from Europe, and they also learned from the Native Americans how to grow and use some native herbs for seasonings and medicines.

Planting Directions:

1) Seeds
   a. Carrots--make rows 6 inches apart and ¼ inch deep. Place seeds 1 inch apart in row. Do not let students dig holes for seeds. Have student pinch and pat to cover rows after they place seeds.

b. Onions—plant in rows 6 inches apart. Bulbs must be planted 3 inches deep. Use unsharpened pencils or small dowels marked at 3 inch depth to make holes. Instruct students about the top and bottom of the onion bulb and be sure they are planting them right side up.

c. Corn and Beans--plant seeds two inches apart in rows 1 foot apart. Beans must have support from trellis or support fence between rows of beans. Seeds should be planted 1 inch deep. Have students insert their finger down to first knuckle to make hole. Do not have them cover seeds until all have been planted in row.

d. Squash--plant in two foot diameter circle, with circles two to three feed apart. Seeds should be planted six to a circle, one inch deep. Have students insert their finger down to first knuckle to make hole. Do not have them cover seeds until all have been planted in circle. Squash may also be grown up trellis or fence like beans.

2) Herbs

a. Seeds (cilantro, basil, dill)--make rows 6 inches apart and ¼ inch deep. Place seeds 1 inch apart in row. Do not have students dig holes for seeds. Have students pinch and pat to cover rows after they place seeds.

b. Nursery transplants—assign 2-3 students to each transplant. Plant transplants one foot apart. Students take turns digging hole, as deep as a seedling and one inch wider, removing transplant from pot (turn upside down and tap, catching plant as it falls out, not by pulling out of pot by neck of plant), planting in hole and patting down dirt around it.

Teacher Information

Fifth Grade Spring Lesson

Colonial Kitchen Garden

Today your class will plant vegetables and herbs that would commonly be grown by families for food, medicine and home life during the later Colonial and Revolutionary War periods. They will learn:

1) Because there was no refrigeration or markets, families needed to grow much of their own fresh food. This was also important during the Revolutionary War when commerce and trading was interrupted and currency had uncertain value so that it was difficult to buy items that might previously have been available.

2) Because there were not many doctors or pharmacies, families also grew many medicinal herbs to treat common illnesses such as stomache ache, headache and cuts.

3) Students will grow the basic ingredients for Succotash—corn, lima beans, carrots and onions—which was meat stew very common in Colonial America.

California State Content Standards:

1) Social Science.

5.3 Students describe the cooperation and conflict that existed among the American Indians and between the Indian nations and the new settlers.

2. Describe the cooperation that existed between the colonists and Indians during the 1600s and 1700s (e.g., in agriculture, the fur trade, military alliances, treaties, cultural interchanges).

5.4 Students understand the political, religious, social, and economic institutions that evolved in the colonial era.

1. Understand the influence of location and physical setting on the founding of the original 13 colonies, and identify on a map the locations of the colonies and of the American Indian nations already inhabiting these areas.

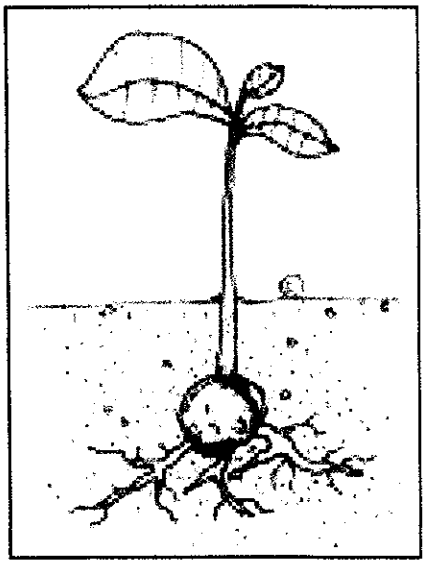
5.6 Students understand the course and consequences of the American Revolution.

4. Understand the personal impact and economic hardship of the war on families, problems of financing the war, wartime inflation, and laws against hoarding goods and materials and profiteering.

Please visit the garden regularly to see your garden grow! Hold an Open House in June to talk to your students about their garden.

5th Grade
Garden Experiment

Introduction:



Rather than plant a garden with the intent to harvest, 5th grade students will plant a garden with the intent to **experiment**. Students will choose a variable (such as light, water, or nutrients) they will test in their experiment. They will have the opportunity to plant their garden box, wait for the plants to establish, and then begin experimenting. Throughout this process, students will keep detailed records in their science journals including a complete scientific write up. Their scientific write up will include the following sections: hypothesis, experiment, results, and conclusion.

This lesson supports several of the California State Science Standards including, most importantly, the majority of the Investigation and Experimentation Standards.

To be prepared for this experiment, students should have previously studied plants (botany) in their science class. Their study of plants should have included topics such as plant part function (roots, stems, leaves, etc.), transpiration (the flow of water and nutrients in a plant), and photosynthesis (the process of making food from light energy).

Warm-up:

Brainstorm with your team about what plants need to survive. Write your ideas in your science journal.

Pre-Experiment:

When scientists perform experiments, they must have prior knowledge about the thing the wish to study. Scientists gain this knowledge through their education, reading, library research, past experiences, etc. Scientists use their prior knowledge to design an experiment to test a question.

Have the students record the following in their science journals:

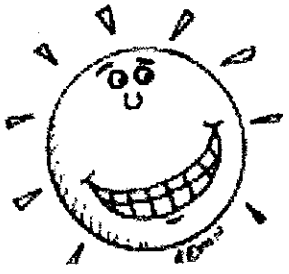
Question: What do plants need to survive? (Mention that we will focus on environmental conditions)

Mention to the students that to test this question, the scientist will set up an experiment. If, for example, the scientist chooses to test what will happen if he/she over-waters their plants, how will the scientist know if he/she got meaningful results? They will know by setting up a control so they have something to compare it to.

Control - An experiment set-up under normal conditions

Variable - One of the changes in a situation that may affect the outcome of an experiment. Scientists try to test only one variable at a time. (If they want to test two variables, they would set up two experiments.)

Ask for student input from their brainstorming session. What environmental conditions do plants need to survive? Write their responses on the board.



CO_2
H_2O
Light
Nutrients (minerals and vitamins)
Growth medium (soil, sand, gravel, etc.)
Temperature

Discuss which variables will be difficult to control in our garden (i.e., CO_2). Inform students that we will eliminate these variables as options in our experiment since they are difficult to control.

Vote: Have students vote on which variable they would like to test. Which way will they go with the variable? Too much or too little?

Have the students record the results of their vote in their science journals. 

Important Side notes:

Light

It is difficult to create an experimental set-up in the garden that provides too much light. We'll have to eliminate or reduce light instead.

Nutrients

Organic nutrients: Organic nutrients are currently used in our garden. They are slow releasing, meaning that it takes longer for organic materials to break down and become useable for the plant.

Inorganic nutrients: Some inorganic nutrients unsafe when used in an edible garden (toxic to people). Most inorganic nutrients are safe. We will use inorganic nutrients in experiments where the students choose to over-fertilize because they are fast releasing.

Water

If students choose to under-water their plants, the sprinkler system will be cut-off completely from their box. Students will have to hand-water on a reduced schedule.

If students choose to over-water their plants, the sprinkler system will remain on and students will have to hand-water in-between.

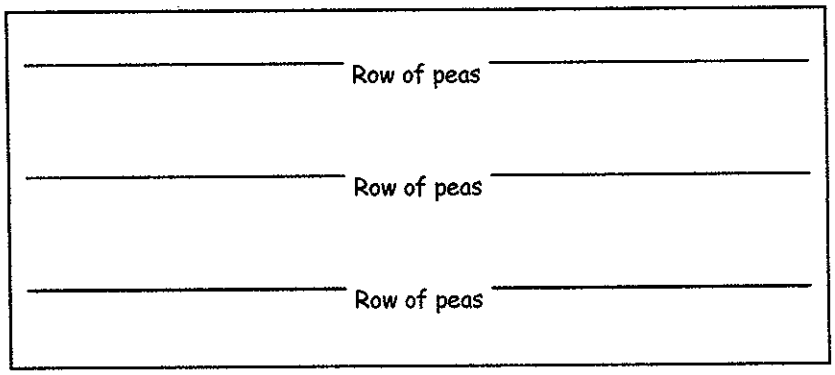
Growth medium

Due to the set-up of our garden beds, we will be unable to adjust the growth medium.

Plants:

Sugar snap peas (seed) About 60-70 days to maturity

Garden Box Design

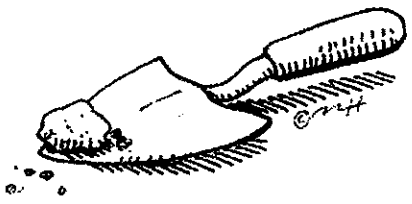


Each class will have one box to test their variable.
Entire 5th grade will share the control box.

Planting:

Your students will be assigned an area of the garden box to plant. Each student will be able to plant a part of your classes box and the control.

Now, we wait!



We will wait until the plants are **established** (mature plants) before doing our experiment and changing the variable (approximately 4-5 weeks). This ensures that other variables, such as poor germination, will not be confounding factors (unforeseen variables) in our experiment.

Hypothesis:

We will hypothesize about what will inhibit plant growth.

It is important for students to understand that we are not just guessing. We have background knowledge on plants and plant growth and using our knowledge and experiences we will formulate our hypothesis.

Have students record the following under the heading "Hypothesis" in their science journals: 

Question:	We are interested in discovering what can harm plant growth.
Hypothesis statement:	We hypothesize that plants need ____A____ to grow.
Explanation:	Without ____A____, plants can't ____B____.
If/then prediction:	Therefore, if we ____C____ then the plant growth will be negatively affected.

A = environmental condition students voted on (i.e., water)
B = consequence (i.e., photosynthesize)
C = variable (i.e., reduce the amount of water the plants receive)

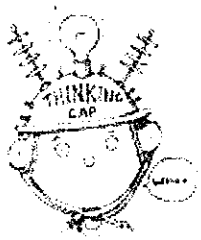
Remember: a hypothesis is a possible cause or possible testable outcome that reflects the knowledge and past experiences of the scientist.

Experiment:

Have students record the following in their science journals: 

1) What they are planting
2) Diagram of their garden box
3) Map of the garden (including location of the control box and location of their variable box).

Students should then work on their idea for **Experimental Design:**



Students should write their thoughts for experimental design in their journals. Remind students that as scientists, we have to find a balance between what is realistic, and what will give us dramatic results. Have students record all information in their science journals. It is important for each student to do this on their own (as this satisfies an important investigation & experimentation content standard) even if this is different from what the class will do later.

They are to write about: 

1) Describe the materials (tools, equipment, etc.) needed to run your class experiment.

2) Describe how you would run the experiment, step-by-step. Include:
   - Planting instructions
   - When experiment will begin
   - What observations you will make
   - How long the experiment should run for

3) Describe what changes you expect to see in the plants.

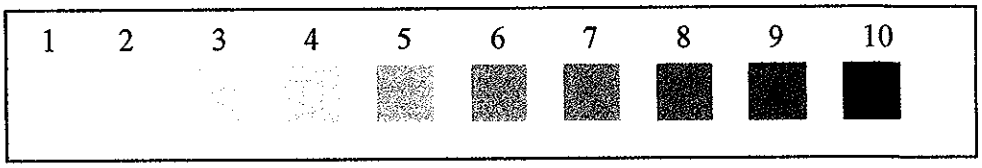
After students have recorded their ideas for experimental design, have a class discussion and decide what the class as a whole will do. The variable should then begin to be implemented (for example, place shade cloth on box), and students should make their first observations of the plants.

Observations

We recommend having students target their observations to only two factors: leaf color and plant height. This will simplify data analysis for them in the future. (Most students indicate that they feel plant chlorophyll production will be affected in the experiment - which influences color - and that plant growth will be affected - which, in pea plants, can influence plant height. So this supports what most students are thinking.)

Helpful hint:

To ensure that students are observing plant color in the same way (eliminating bias of the observer), make up a plant color scale that students can use. Go to a home decorating center, gather together paint squares of various shades of green, and make a scale similar to the diagram below. Students can then assign a number value to their observation, transforming their observational data into numerical data.



Color scale

Smooth operation

Schedule

Create a schedule with your students so everyone knows who will be applying treatments and making observations and what day/time they are responsible for doing so.

Equipment

Have a box available in your classroom with all of the materials needed to apply a treatment and record observations. When the time arrives for a group to go out to the garden and work, they can take the box with them and have everything they need. Here are some suggestions of what to put in each box:

Water variable box

Watering key, egg timer, two separate clip boards with blank data sheets, plant color scale, measuring tape, and pencils.

Light variable box

Two separate clip boards with blank data sheets, plant color scale, measuring tape, and pencils.

Nutrient variable box

Fertilizer, measuring cup, watering key, two separate clip boards with blank data sheets, plant color scale, measuring tape, and pencils.

Sample Methods

Methods for varying water

Last week, the radish and lettuce plants were "thinned". Every other plant was removed to open up space for the remaining plants to grow better.

The plants are already watered every day at 6:00 a.m. for 15-minutes. We will add extra water to the plants on Monday, Wednesday, and Friday at lunch for 10-minutes. Three students will take a shift in the garden. While one student is watering the plants, one student will make observations of the plants in the control box, and another student will make observations of the plants in the water variable box. We will do this experiment for a 4-week period.

Procedures for over-watering plants:

1) Use the watering key to turn on the water faucet all the way.
2) Set sprayer on "shower"
3) Turn the timer to 30 minutes, then back to 10 minutes
4) Go to the plant box and hold down sprayer handle all the way
5) Evenly spray the plants in the entire box, being careful not to let water spray outside of the box.
6) When the timer goes off, let go of sprayer handle to stop the water.
7) Turn off water faucet.
8) Replace watering key.
9) Coil up the hose neatly.
10) Put away all equipment.

Methods for varying light

Last week, the radish and lettuce plants were "thinned". Every other plant was removed to open up space for the remaining plants to grow better.

We built a wooden frame inside the perimeter of the light variable box. The frame has a height of 5 feet. The entire frame is evenly draped in shade cloth that keeps out 75% of the light (so only 25% of the light can reach the plants). We secured the shade cloth to the frame using zip ties. We will make our observations in the garden once a week on Friday at lunch. Two students will take a shift in the garden. One student will make observations of the plants in the control box, and another student will make observations

of the plants in the light variable box. We will do this experiment for a 4-week period.

Methods for varying nutrients

Last week, the radish and lettuce plants were "thinned". Every other plant was removed to open up space for the remaining plants to grow better.

The plants are already receiving an organic nutrient. We will add extra inorganic nutrients to the plants. The inorganic nutrient we are using is 16-16-16 (16% Nitrogen, 16% Phosphate, 16% Potassium). Reading the directions on the package, we calculated that for our sized box, we will add $\frac{1}{4}$ pound (or $\frac{1}{2}$ cup) of the fertilizer at a time.

We will add the nutrient every week on Friday at lunch. Three students will take a shift in the garden. While one student is adding the nutrient, one student will make observations of the plants in the control box, and another student will make observations of the plants in the water variable box. We will do this experiment for a 4-week period.

Procedures for adding extra nutrients:

1) Measure $\frac{1}{2}$ cup of fertilizer
2) Put the fertilizer in the red "whirlybird"
3) Don't touch the white circle on the "whirlybird", it should stay on 4.
4) Go to the nutrient variable box and stand at one end, holding the "whirlybird" close to the plants.
5) Press down on the thumb piece and turn the white handle counter clockwise.
6) Walk slowly, while turning handle and pressing, to the other end of the box.
7) If there is still more fertilizer left, repeat the process. Try to evenly spread the pellets across the entire box.
8) Go to the hose and use the watering key to turn on the water.
9) Take the hose back to the box, make sure the setting on the sprayer is on "shower", and lightly and evenly water plants.
10) Turn off water faucet.
11) Replace watering key.
12) Coil up hose neatly.
13) Put away all equipment.

Results:

Students will record their results (plant observations) at regular intervals. The first observation should be made before initially applying the first treatment. Then, additional observations should be made at the regular interval decided upon by the class. Students should record their results in two separate data tables, one table for the plants in the control box, and one table for plants in the variable box.

Have students use two pages of their science journals for data tables. 
One page will be the data table for the control box, the other page will be the data table for the variable box. Students can offer input on what they think is important to observe on the plants to determine if the growth is affected by the variable.

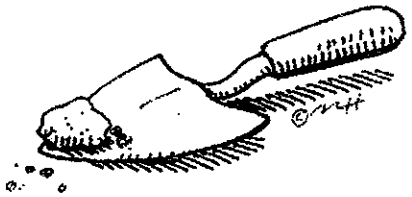
Sample data table with entries from two observations

Data table for control box

Date	Leaf Color	Plant Height	Other
10/18	*4*	*5.4cm*	*Plants look healthy.*
10/25	*4*	*5.8cm*	*Plants began growing on trellis.*

On the next page is a blank data table that can be copied and placed on clipboards for use in the garden. The information will then be shared with the class and transferred into the data table in students' science journals.

Garden Data Sheet



Person recording observations: _____

Date: _____

Box observing (circle one): Control Variable

Date	Leaf Color	Plant Height	Other

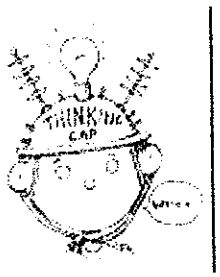
Important notes:

Conclusion:

The experiment should ideally stop when changes are observed between the control box and the variable boxes (usually after a 4-8 week period). At this point, it would be helpful to make a master data sheet of the observations for each box that compiles all of the data. I cover a large cabinet door with butcher paper in my classroom that has a "master data table" for the class. It is the job of students that are observing in the garden to copy their data on the master table.

Students should have the opportunity to observe the compiled data in a small group, and discuss the following:

- Any patterns or trends in plant growth, color, etc. (evidence)
- What caused these patterns and trends (inferences).
- What confounding factors (hidden variables) may have affected their data.
- Do the results verify their original hypothesis? Why? Why not?
- Is more information needed to support a specific conclusion?



In their science journals, students should then:

- Record the information from their discussion.
- Summarize what they learned from the project.
- Include information about what they would do differently next time.

Important:

Students often end up with results that are different from their original hypothesis. Remind students that it's ok for experiments to end up with a different result than they expected and hypothesized about. It's not because they did a "bad" job. Scientists constantly revise the way they do experiments based on information from their experimental results that are different than expected or hoped for. As Thomas Edison once said, "I haven't failed, I've found 10,000 ways that don't work". Focus on the positive, what would they do differently next time?

PRODUCE INVESTIGATION

- Find an item you like to eat _____

- Find two items that you have never seen before

_____ _____

- Find an item that looks like it came from another planet _____

Now, Using the Produce Cards *(purchase California Department of Education's Fruit and Vegetable Cards or use other produce photo cards with nutritional information such as one's found at www.harvestofthemonth.com)* . . . . . .

- Find an item that has at least 20% of Daily Value of Vitamin A_____
  Vitamin A helps maintain skin and helps vision.

- Find an item that has at least 20% of Daily Value of Vitamin C_____
  Vitamin C helps the body heal and fight infections.

- Find an item that has at least 10% of Daily Value of Fiber _____
  Fiber helps food move through your body.

- Find a root _____ Find a flower_____

- Find a stem_____ Find a fruit _____

- Find a leaf_____ Find a seed_____

(Look on the back of the Produce Cards for root, stem, leaf, flower, fruit, and seed pictures)

- Find an item grown far away (more than 300 miles) from Santa Cruz?

_____ was grown in _____, _____ miles away from Santa Cruz.

Look for this label next to locally grown foods. If a food has this label it means it was grown in or next to Santa Cruz County. Local food is usually fresher and the money you spend stays in the community.
Write down four items that have this label:

_____ _____

_____ _____

- Create an Organic Rainbow: write down an organic item of each color of the rainbow.

  Red: _____ Orange: _____ Yellow: _____

  Green: _____ Purple: _____

- Write your definition of "organically grown":

INDOORS, OUTDOORS ❀ GRADES 4-6 ❀ SPRING ❀ ACTIVITY

Flower Power, Part One

DESCRIPTION

Students dissect and draw flowers to learn about their parts.

OBJECTIVE

To learn the structure and function of flower parts.

TEACHER BACKGROUND

Evolutionarily advanced plants (angiosperms) produce flowers, where the sex cells are contained for the plant's reproduction. The *stamen* is the male organ for reproduction and is composed of the *anther* and the *filament* (or stalk). At the tip of the filament is the anther, the organ that produces the pollen. *Pollen* is composed of fine powder-like grains that contain the male sex cells. The *pistil* is the female organ; its parts are composed of the *stigma*, *style*, and *ovary*. During pollination, male pollen lands on the stigma, travels down the style, and fertilizes the ovary. This fertilized egg develops into the seed. *Sepals* are the leaf-like parts under the petals. They are usually green and photosynthetic (able to produce food from the sun). *Petals* can be all colors and shapes, and have a variety of smells. They serve to attract pollinators.

Note: Members of the daisy family (*Asteraceae*), such as daisies and sunflowers, are not good examples to use in this activity because they have composite flowers. What looks like one flower is actually made up of many — the "disk" flowers in the center and the "ray" flowers that look like petals. Each disk flower and each ray flower is a separate reproductive unit, with its own pistils and stamens, though many of them are actually sterile.

MATERIALS

❀ Drawing and coloring materials

CLASS DISCUSSION

Each flower seems to be unique, with its own special beauty. But all flowers are composed of the same parts. You and your friends are all unique, but you all have the same parts too: eyes, ears, noses, fingers, and so on. The difference is that different types of flowers have different numbers of these parts; for example, one type of flower might have four petals while another type has five.

ACTION

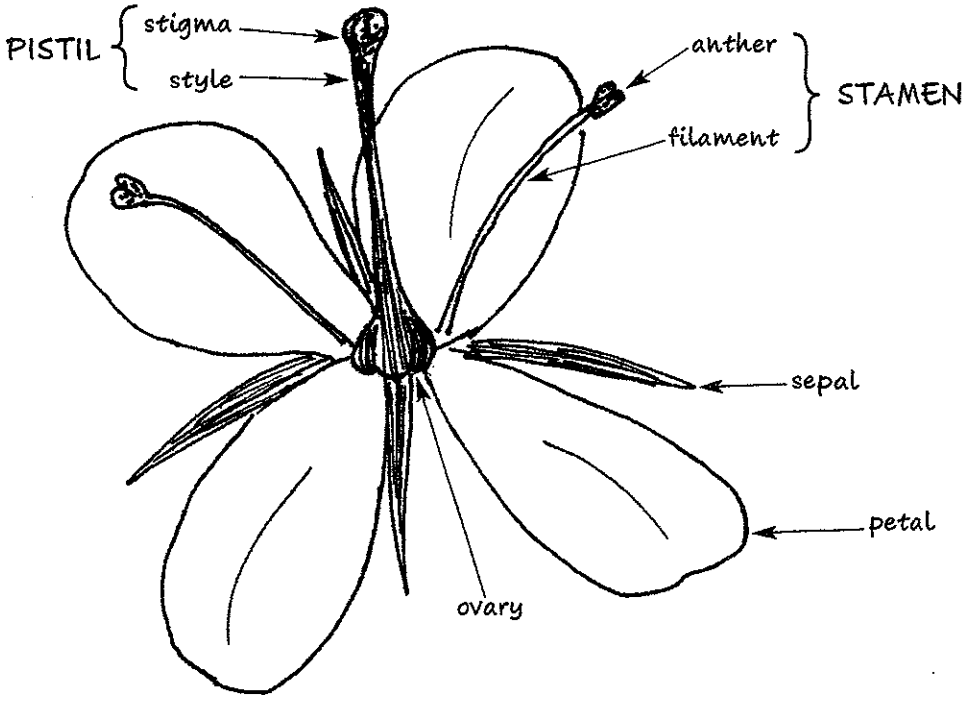
1. Divide the class into small groups.

2. Ask each group to go into the garden and carefully collect one flower, preferably one that no other group has. Simple flowers with easily identifiable parts are foxglove, sweet pea, tomato, potato, bean, mustard, poppy, lily, nasturtium.

3. When groups return, ask them to look carefully at their flower; then have them spend some time drawing a colored picture of it.

4. Ask the students to take their flowers apart gently and draw each part. Use the drawings as a guide to flower parts and discuss the function of each part.

5. Students should examine, draw, and label the sepals, petals, pistil, and stamens.



WRAP UP

What is the name of the pollen-bearing, male part of the flower? What is the female part? What part of the flower swells to become the fruit and seeds? How does pollen get to the pistil? List things that would change if there were no more flowers.

INDOORS ❀ GRADES 4-6 ❀ SPRING ❀ ACTIVITY

Flower Power, Part Two

DESCRIPTION

Students role-play flowers and pollinators, and find their perfect match.

OBJECTIVE

To learn about pollinators and their relationship to flowers.

TEACHER BACKGROUND

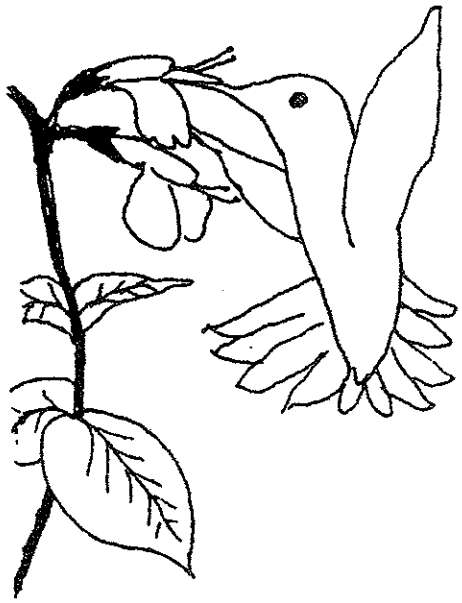
Flowering plants have evolved various methods of pollination. Some flowers are wind pollinated and have very light pollen grains that are blown from plant to plant. Flowers attract many pollinators in different ways. Insect-pollinated plants often produce nectar or pollen that insects collect for food. As an insect enters the flower to get food, it is dusted with pollen. When the insect enters the next flower, some of the pollen brushes off onto the stigma. Other flowers use specific odors or colors to attract pollinators. By impersonating flowers and pollinators, students learn that there are a great variety of pollinators and that each has a special relationship to a certain kind of flower.

MATERIALS

- ❀ Pins to attach tags to students
- ❀ Construction paper
- ❀ Marking pens

CLASS DISCUSSION

Unlike animals, plants can't move from place to place to find their mates. How then does the pollen from one flower get to the pistil of another flower? That's where pollinators come in. A pollinator is anything that helps spread pollen. There are all kinds of pollinators: birds, bats, bees, bugs, and more! Even the wind is an important pollinator. Pollinators may drink nectar from the flowers, and some, such as honeybees, collect and eat the pollen, too. In the process they spread pollen from flower to flower without even trying. Once the pollen fertilizes the egg in the flower ovary, the plant will go on to produce fruit and seeds. So we have pollinators to thank for most of our fruits and nuts and many of our vegetables, too. Scientists estimate that one out of three things we eat is thanks to pollination by bees.



ACTION

1. Write the following list on the board:

Pollinator	*Type of Flower Preferred*
Beetle	White or dull-colored flowers with a fruity or spicy fragrance
Honeybee	Flowers with showy, bright petals, often blue or yellow
Mosquito	Small flowers, often white or green
Butterfly	Red, orange, blue, or yellow flowers
Bat	Large flowers with fruity fragrance and lots of nectar
Hummingbird	Red flowers with little or no fragrance
Moth	White or yellow flowers with heavy fragrance
Wind	Small, odorless, colorless flowers

Grasses, corn, and so on tend to be wind pollinated. Since they rely on the wind, they don't have to produce showy or scented flowers to attract pollinators.

2. Divide the class into two groups. One group will be Pollinators, the other Flowers.

3. Assign each member of the flower group a flower type.

4. Have members of the flower group write on construction paper a short description of what type of flower they are (bright red, no scent; white, very sweet smelling) and pin the descriptions to their shirts.

5. Now take the pollinator group aside and whisper an identity (honeybee, wind, bat) to each member.

6. Then have the two groups mingle silently. Have each pollinator refer to the list on the board in order to find his or her appropriate flower. Remind the class that there can be more than one pollinator to a flower because different pollinators may like the same type.

7. Since the pollinators have no identifying tags, have each flower guess, in turn, the identity of his or her pollinator (*"I'm a bright red flower, so you're probably a hummingbird."*)

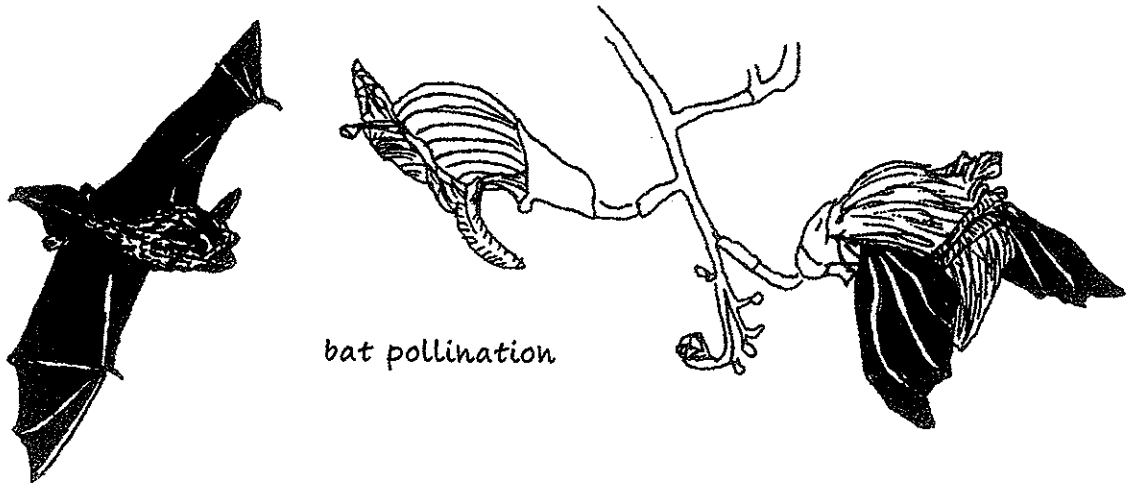
8. Now go outdoors and have the pollinators find a real flower they like! Then ask the flowers to look around the garden for their real pollinators. Can they find any bees, hummingbirds, beetles, or wind?

WRAP UP

When you look at insects near flowers now, what will you try to observe? Most scientists believe that flowers and their pollinators coevolved. That means that they changed over time to suit each other; they adapted to each other. How does this coevolution benefit the flower? How does it benefit the pollinator? During this activity you learned that often several pollinators like the same flower. For example, bees and butterflies often visit the same type of flower. How would more than one pollinator be an advantage for the flower?

DIGGING DEEPER

Go outdoors with students and sit quietly near some flowers. Watch carefully. What pollinators do you observe? How long does a pollinator stay on each flower?



bat pollination

5th Grade Learning Garden Lessons: Student Pre- and Post-Test

Date: _____ Name: _____ School: _____

Circle one: **PRE** or **POST**

P is for Poppies

What event caused the US to enter World War 1? _____

Why was it considered patriotic for US citizens to grow gardens during World War 1?

_____

What did farmers do when US citizens started growing their own food? _____

Tell about trenches during World War 1: _____

Which Plant is Which?

Scientists first classified plants and grouped them together based on _____

Now scientists classify plants and group them based on _____

What is one way you can tell that a plant is a monocot? _____

Which type of plant has been on earth longer: algae or oak trees? _____

Voluminous Veggies

There are four ways to measure the volume of an object, such as a square watermelon. Tell one way:

_____

How would you measure the volume of a liquid? _____

Which is a measurement of a three dimensional object: area or volume? _____

Healthy Eating

Do you 'eat healthy'? _____ How? _____

Going Outside

Do you like being outside at school? yes no Why? _____

Learning

Do you like learning outside? yes no Why? _____
When you are at school, is it easier to learn things inside the classroom or outside? _____
What do you like to learn about? _____
Do you learn more easily when you make and do things? or when you read? _____
Do you have any other comments about learning outside?

_____

NOTE TO TEACHERS: Please mail this pre- or post-test to Captain Planet Foundation at 133 Lucky Street, Atlanta, GA 30303. Cobb Co. teachers may send tests to Sally Creel via CCSD mail. Include teacher name to be included in a drawing for prizes and resources. Also, we'd appreciate your tips and suggestions on Learning Garden lessons you teach: http://captainplanetfoundation.org/learninggarden-resources/

Lesson 1: P is for Poppies

Grade
5

Standards
SS5H8a

Time
2-3 hours

Supplies
(per student)
- red corn poppy seeds
- Internet- connected computer
- copy of *In Flanders' Field* by John McCrae

(per class)
- garden or meadow
- trowels
- hoes or shovels
- gloves
- Linda Granfield's book: *Where Poppies Grow: A World War I Companion*

Overview
5th grade students will learn about World War I history through gardening and plants.

What they will learn
- Life in trenches
- Trench gardens on the warfront
- War gardens on the homefront
- Role of the Lusitania bombing
- Food conservation during the War
- US Food Administration
- American contributions to the War
- Treaty at Versailles

How they will learn it
- View photos and videos
- Excerpts from book
- Researching and planting a war garden
- Photos and primary sources on web site
- Primary source research on the web
- Students replicate 4-minute appeals
- Student garden or recycling projects
- Primary source research on the web

Using information learned in this lesson students will care for the Earth by planting poppies in remembrance or designing a project to reduce waste as Americans did during the World War I. This lesson was inspired by teachers and volunteers at Ford Elementary School.

Essential / Guiding Question
How can the tradition of gardening in this country give us a sense of place and a perspective on historical events?

Engaging Students
Students will watch a short video on life in the trenches during World War 1 and divide into teams to explore any aspect of trench warfare or trench life about which they are curious.

Exploration

Using primary source documents, students will investigate life in the trenches, the bombing of the Lusitania, American involvement in the war, ways by which Americans at home planted gardens and conserved food in order to feed U.S. troops and the Entente, and the effects of the Treaty at Versailles. Groups of students will design and implement projects to demonstrate how food shipments to the troops and our starving Allies (the Entente) were made possible without rationing because Americans grew produce locally; pledged to give up foods on Meatless Mondays and Wheatless Wednesdays; ate every scrap of leftover food; changed food habits and ate parts of plants not previously eaten; and wasted nothing, so that wheat, meat, sugar and fat could be sent overseas.

Explanation

Students will be able to articulate why the U.S. entered World War 1 and what contributions Americans made to the War effort, on and off the field, including the shared sacrifice of food conservation, growing gardens at home, and sending food to the U.S. and Entente troops.

Debriefing

The key ideas in this lesson are:

- After three years of war, American soldiers were drawn into The Great War by German attacks on shipping
- Americans at home sacrificed for the war effort by limiting the types and quantities of things they ate so that meats, wheat, sugar and fats could be sent overseas to US soldiers and starving allied Entente troops
- Poppies are recognized as a symbol of keeping the faith with war dead, and to remember the horrors of war so history does not repeat itself.

Environmental Stewardship

Students will apply what they learned to care for the Earth by designing and planting a remembrance garden OR planning and carrying out a project to reduce waste, re-use scrap metal and recycle things, as Americans did in WWI.

Evaluation

Students will prepare and present an authentic 4 minute speech about food conservation, as US Food Administration officials did to encourage food conservation and ask Americans to pledge their support.

CONTEXT FOR LESSON ACTIVITIES

Standards

Georgia Performance Standards

SS5H8 The student will describe U.S. involvement in World War I and post-World War I America

a. Explain how German attacks on U.S. shipping during the war in Europe (1914 - 1917) ultimately led the U.S. to join the fight against Germany; include the sinking of the Lusitania and concerns over safety of U.S. ships, U.S. contributions to the war, and the impact of the Treaty of Versailles in 1919.

Background Information

A PBS *Teacher's Guide to The Great War* is available, including videos, maps, and handouts, summarized at this web site http://www.pbs.org/greatwar/chapters/index.html

Significant events of the Great War in a timeline with links: http://www.worldwar1.com/heritage/heritag2.htm

Teacher Preparation

- Arrange for online resources to be shared with students via Smartboard or Internet-connected computer with LCD projector, and for students to have access to computers for further research using primary sources.
- Determine where poppy gardens or meadows may be planted and make sure there are no underground utilities.
- Order poppy seeds in advance. (Poppies may be planted in fall or spring).
- Determine how to divide students into small groups for trench project, Lusitania research, and a demonstration about the American contribution to the war effort. These groups may present plans for a class remembrance project that students can agree upon. Student may research and practice as a group for their individual speeches.
- To evaluate student mastery of the concepts in this lesson, allow time for students to present their 4 minute speeches

as US Food Administration workers, convincing citizens to pledge to contribute to the War effort.

PROCEDURES FOR LESSON ACTIVITIES

The Great War: Trenches and No Man's Land

- Show students video, photos and diagrams of trench warfare, as well as writings about trench gardens.
  a. Trench warfare and life illustrated: http://www.infobarrel.com/Trench_Warfare_WW1
  b. Trench diagrams and manual: http://www.forumeerstewereldoorlog.nl/viewtopic.php?t=15263
  c. German and French trenches in archival footage: http://www.pbs.org/greatwar/chapters/ch1_trench.html
  d. Trench Gardens: The Western Front during World War I: http://defiantgardens.com/the-book/excerpts/
  e. WW1 Factoids: http://facts.randomhistory.com/world-war-i-facts.html
- Based on the time soldiers had available to dig elaborate trenches and even grow trench gardens, students will infer that much of the war was a long stalemate that took place along stationary war fronts
- Divide students into small groups and allow them to explore further some aspect of trench life that interests them or sparks their curiosity (e.g. using flattened cardboard boxes to create a life-sized model of a trench, planting a trench garden, calculating how many rats would be born in the trenches in one year, etc.) Note: it is not safe to dig an actual 7' deep trench without danger of collapse.

The Sinking of the Lusitania as the Precipitating Event that Drew the U.S. into the War

- Provide students with Internet access to primary source material so they can investigate the Lusitania, its cargo, passengers, accommodations, why it was bombed, by whom, how it affected the American role in the Great War.
  a. Lusitania tour: http://www.lusitania.net/tour.htm
  b. Lusitania memorabilia: http://www.lusitania.net/memorabilia.htm
  c. Lusitania timeline: http://www.lusitania.net/Chronology.htm
    - Students will deduce what passengers ate based on Lusitania menus; compare to popular and healthy eating today.
    - Students will recognize the bombing of the ship as the precipitating event that drew the US into the Great War.

American Contribution to the Great War Effort

- Divide students into small groups (same or different from previous groups)
- Provide students with Internet access to research the impact of American Expeditionary Forces fighting in Europe
- Provide students with Internet access or copies of primary source documents from the US Food Administration, including home instructions and pledge cards, so they can investigate primary sources to learn about. . .
  a. Conserving Food for the War Effort
  http://www.archives.gov/southeast/education/resources-by-state/wwi-conserving-food.htm
  b. U.S. Food Administration letters
  http://www.archives.gov/southeast/education/resources-by-state/images/wwi-food-administration-letters.pdf
  c. Food Pledge Card and instructions: http://libcudl.colorado.edu/wwi/pdf/i71764422.pdf
- Each student group will design and implement a project to demonstrate one aspect of how food shipments to the troops and Allies (Entente) were made possible without rationing because Americans grew produce locally; pledged to give up foods on Meatless Mondays and Wheatless Wednesdays; ate every scrap of leftover food; changed eating habits and ate parts of plants not previously eaten; and wasted nothing, so that wheat, meat, sugar and fat could be sent overseas. Note: this is not a report but a project that is intended to draw in classmates.

The Ultimate Sacrifice

- Provide each group with a copy of the poem "In Flanders' Fields" to read aloud, and a history of the poppy in signifying remembrance of dead soldiers and of the Great War.
  a. "In Flanders' Fields": http://www.cal-mum.com/poppy.htm
  b. poppy as a symbol of remembrance: http://www.cal-mum.com/poppy.htm#Moina

Divide / share primary source documentation from the book "Where Poppies Grow: A World War 1 Companion"

- Ask students to determine what is the "ultimate sacrifice" some soldiers make. (death due to battle, disease, etc.)
- Invite students to explore more about poppies and try to figure out why they bloomed in battlefields of France and Belgium, among bodies of dead soldiers. (The seeds are distributed easily and grow where ground is disturbed).

- Encourage students to research poppy plant needs, and to design and create a remembrance garden or meadow of red corn poppies. (Note: Poppies are perennials in zones 4-9 and annuals elsewhere. They can be planted in fall or spring. Students may find hardiness zone by entering zip code: http://planthardiness.ars.usda.gov/PHZMWeb/)

Treaty at Versailles and Aftermath

- Students will investigate the treaty to learn that it did not include Wilson's 14 Points for a lasting peace, did include formation of the League of Nations, required that Germany apologize for being main cause of the War and punished Germany by forcing it to pay reparations in cash, coal, livestock, ships, mines, trains, aspirin, farm equipment, land, vehicles, cables, etc.
- Are poppies important or not? Ask students to reflect on why it is better to remember something as unpleasant as the deaths of soldiers and the horrors of war, or to put it behind and go on with life? Do students think the nations that fought in the Great War remained at peace after the Treaty at Versailles was signed? Why or why not? (World War II began just over 20 years later. Germany cited harsh punishments after World War I as one of the reasons to go to war again).
- For more information on casualties during the Great War and on how the Treaties were carried out or failed to be carried out, here is a summary:
    a. The Aftermath of the War: http://www.historylearningsite.co.uk/treaty_of_versailles.htm

V is for Victory

An excellent next lesson about World War II is based on the book, Lily's Victory Garden by Helen L. Wilbur.

- The Teacher Guide by Jillian Hume provides a number of worksheets and activities: http://www.gale.cengage.com/pdf/TeachersGuides/LilyGuide.pdf
- Another excellent activity regarding World War II is the holocaust remembrance project based on the poem: *I Never Saw Another Butterfly*. After reading the poem and learning about concentration camps, students can create butterfly art to contribute to a museum exhibit commemorating the lives of children lost in the Terezin concentration camp: http://www.hmh.org/ed_butterfly3.shtml

Assessment for 'P is for Poppies'

Student Name(s): _____ **Date:** _____

Level of Mastery → / Benchmark or Performance Measure ↓	 Mastered task @ 90%+ accuracy: 5 pts	 Mastered task @ 85% accuracy: 4 pts	 Mastered task @ 80% accuracy: 3 pts	 More learning needed	TOTAL POINTS
Trench warfare exploration	Explored an aspect of trench life through a hands-on project or re-enactment	Completed research but did not do a hands-on reenactment	n/a	No attempt	
Lusitania investigation	Researched the Lusitania before it sunk, analyzed diet based on menus, recognize the sinking as precipitating event that involved US in war	Read some of the primary source documents but did not analyze, food, role in involving US	n/a	No attempt	
Project: American contributions to the Great War	Created a war garden, adopted Meatless Mondays or Wheatless Wednesdays, tried eating unfamiliar parts of plants or similar authentic investigation & made speech as US Food Admin workers did to inspire patriotism and articulate need for shared sacrifice	Project shows research and knowledge of subject matter but speech does not fully make the case connecting gardens and food to homefront sacrifice on behalf of the war	n/a	No attempt	
The Ultimate Sacrifice	Designed and carried out a remembrance garden project that reflected on the sacrifices made during the World War I	Designed project but did not follow through to completion	n/a	No attempt	
Treaty at Versailles	Primary source research on the effects of the treaty and Hitler's resentment of its harshness	Able to explain terms of treaty but not its impact on Germany	n/a	No attempt	
TOTAL in LAST BOX →					/25 pts

Lesson 2: Which Plant is Which?

Grade
5

Standards
GPS Science S5L1. b
NGSS LS1.A , LS4.A

Time
approx 1.5 - 2 hours over 1 or 2 days

Supplies
(for student)
- Gloves
- Trowels

(for the class)
- Signs on stakes for giant plant key
- Role play cards
- Plants
- Craft sticks for plant markers

Overview
5th grade students will learn about the Plant kingdom by investigating how and why plants are identified and classified.

What they will learn
- Classification of organisms
- Plant structures, features
- Plant identification
- Dichotomous keys
- Plant keys and taxonomy
- Monocots vs. Eudicots
- Clads vs keys
- Care for the Earth

How they will learn it
- Create their own classification systems
- Plant Scavenger Hunt
- Create a Wanted poster describing plant
- Make a dichotomous key for anything
- Life Size Plant Key simulation game
- Distinguish by any plant part
- Create botanical gardens in key and clad
- Contribute to database on biodiversity

Essential / Guiding Question
How can we identify plants we grow or find and contribute authentic scientific research to a national database on plants?

Engaging Students
Students create their own classification system for grouping and identifying plants in the garden or schoolyard habitat.

Exploration
Students go on a Plant Scavenger Hunt to investigate different plant structures, create dichotomous keys, become expert in one plant, create a Wanted Poster describing its characteristics and search for it; role-play plant species and sort themselves by running through a Life Size Plant Kingdom Key; divide flowering plants into monocots and eudicots using any one plant part to compare specimens (leave, fruit, seed, root, flower), and understand

the difference in keys and clads by designing and planting a visual representation of each.

Explanation
Students will be able to articulate how and why plants are classified, and to distinguish between keys and clads as methods for classifying organisms based on similarity of physical characteristics vs. shared evolutionary history.

Debriefing
Teacher will provide context for student activities. See Background Information for details.

Environmental Stewardship
Students use the information learned in this lesson to care for the earth by report ing plant species located in the schoolyard to the Discover Life database as a contribution to research on the diversity and distribution of species in Georgia.

Evaluation
A rubric is available to assess student performance in lesson activities.

CONTEXT FOR LESSON ACTIVITIES
Standards
Georgia Performance Standards
S5L1. Students will classify organisms into groups and relate how they determined the groups with how and why scientists use classification.
b. Demonstrate how plants are sorted into groups

Next Generation Science Standards
Core Idea LS1: From Molecules to Organisms- Structure and Processes
LS1.a Structure and Function
Core Idea LS4: Biological Evolution- Unity and Diversity
LS4.a Evidence of Common Ancestry and Diversity

NAAEE Standards
Strand I Questioning, Analysis and Interpretation
a. Questioning—Learners are able to develop questions that help them learn about the environment and do simple investigations.
b. Designing Investigations—Learners are able to design simple investigations.
c. Collecting information—Learners are able to locate and collect information about the environment and environmental topics.
e. Organizing information—Learners will be able to summarize observations and describe data, construct, read, and interpret maps, graphs, tables, diagrams, and other displays of data.
f. Working with models and simulations—Learners understand that relationships, patterns, and processes can be represented by models.
Strand 2.2 The living environment
a. Organisms, populations, and communities—Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.
b. Heredity and evolution—Learners have a basic understanding of the importance of genetic heritage.

Background Information for Teacher (TMI for Students)
There are many valid ways to categorize and classify things.
- Scientists used to classify plants according to physical similarities, especially of leaves.
- Linnaeus classified plants based on 24 different arrangements of flower stamens. (reproductive structures)
- Mnemonic device for taxonomic classifications: Kindly Place Cover On Fresh Green Spring vegetables.

- OR David Come Out For God's Sake (botanists use "division" instead of "phylum")
  Kingdom, Phylum/Division, Class, Order, Family, Genus, Species
- Modern classification systems group organisms based on common ancestors / evolutionary history
- What separates plants from all other organisms = ability to photosynthesize and make own food
- Plant Names and Classification ppt on history of plant classification schemes (teacher background- not students)
- 1.74 million named organisms on Earth (excluding bacteria) / 320,000 species of plants identified / estimated 80,000 plant species yet to be discovered (estimated total = 390,800 plant species on Earth excluding algae)
- 18,783 species native plants in US vs 2,972 species native animals in US
- 80,500 species vertebrate animals vs 6,755,830 species invertebrates vs. 390,800 species plants
- "What makes a Plant a Plant" notes by Dr. Dirnberger include posters on difference in monocots and eudicots: http://science.kennesaw.edu/~jdirnber/Bio2108/Lecture/LecBiodiversity/BioDivPlants.html

Teacher Preparation

Print checklists for the Plant Scavenger Hunt (one per team of 2-4: attached).
- Print, laminate and cut apart color copies of role play cards for Life Size Plant Key activity (attached).
- Print and laminate Life Size Plant Key signs (attached), staple to stakes, and place in ground per diagram.
- Obtain plants classified in different orders and/or ask students to each bring a plant to create a Botanical Garden plant key (cycads, ferns, cacti, gingkos, mosses, liverworts, hornworts, gymnosperms, monocots, eudicots, etc.) and place plant specimens within the key. Offer a prize for unrepresented families.

PROCEDURES FOR LESSON ACTIVITIES

Engaging Students

"Imagine labels in garden got blown away.... how would you know which plant was which?"
- Organize students in teams of 2-3 / establish boundaries, timeframe, and signal for returning.
- Send students to the garden (schoolyard) in small teams and charge them with naming plants and creating a system to group or classify them (yes, they can make up the names).
- Ask students to create a visual display, write a description, or orally explain their classification system.
- Share results: tally the characteristics or types of information students used to group plants; # of categories.
- Explain that, over the years, scientists have used various different criteria to group plants too.
  - Leaf characteristics
  - Flower structure (Linnaeus) / kingdom-phylum-order-family- genetics / evolutionary history / clads
- Ask students to brainstorm some reasons for categorizing, classifying and identifying plants.
  - Helps to study, identify, protect.

Exploration

Plant Scavenger Hunt
- Distribute plant scavenger hunt checklists with clipboards / students will need pencils.
- Establish timeframe, boundaries and signal for returning .
- Send students out to observe plant structures and to identify, photograph or collect items on list.
- Share results with entire class.

Wanted: Dead or Alive
- Each student will choose one plant (present in scholyard) in which s/he will become expert.
- After researching the plant's characteristics and habitat, s/he will describe the plant on a Wanted Posted.
- Wanted poster template: http://www.studentposters.co.uk/temp_files/wanted-poster-template.doc
- During a visit to schoolyard habitat, each student will locate a specimen of her/his plant.
- Students will exchange Wanted posters and search for each other's plants.

Dichotomous Key
- Create a sample key with class, using one shoe from each student and pairing opposing statements.
- While sorting with the students, write the corresponding key.

- Go to the garden in teams and create a key to differentiate plants, using student-developed criteria.
- Compare results.

Monocots vs. Eudicots

- Students will divide flowering plants into monocots and eudicots using any one plant part to compare specimens (leave,
  fruit, seed, or flower) and explain how that criterion was applied. (Background Info: What Makes a Plant).

Life Size Plant Kingdom Key

- Stake "Life Size Plant Kingdom Key or Clad" signs to make a race course in a field, in order of the diagram.
- Diagrams for clads and keys may be found at Dr. Dirnberger's web site:
  http://science.kennesaw.edu/~jdirnber/Bio2108/Lecture/LecBiodiversity/BioDivPlants.html
- Pass out role play cards to students and ask them to line up at the beginning of Life Size Key.
- Students should run the course one at a time, self-sorting as they go.
- Review the plants represented at each part of the key and let class decide if classification is correct.
- Collect old / pass out new role play cards and repeat process.
- Photo credits for plant role cards: *http://plantspages.com/freeplantimages.htm
** http://www.sciencekids.co.nz/pictures/plants.html *** http://www.plant-pictures.net/

Design and Plant a Botanical Garden

- Charge students with designing and planting a botanical garden arranged as a dichotomous key or as a clad.
- They may also use signs, labels, lines, as necessary to label and arrange plants; photograph their results.
- Divide class into two teams to design and/or plant the key and clad gardens, and compare.

Explanation

- Students should be able to articulate the rationale for classifying plants.

Debriefing

- There are lots of reasons why people distinguish among and group plants every day.
- Major schemes: similar characteristics (Linnaeus' taxonomy) and shared evolutionary history (clads)
- Reasons scientists group plants (to study related organisms, to identify and recognize, to protect, etc.)

Environmental Stewardship

- Students will report the plants they have identified in the schoolyard to the Discover Life database as a contribution to research on the biodiversity and distribution of species in their area.
- Discover Life: http://www.discoverlife.org/pa/

Evaluation

Each student should demonstrate mastery in classifying plants and distinguishing btwn dichotomous key, clad.

Plant Scavenger Hunt Checklist

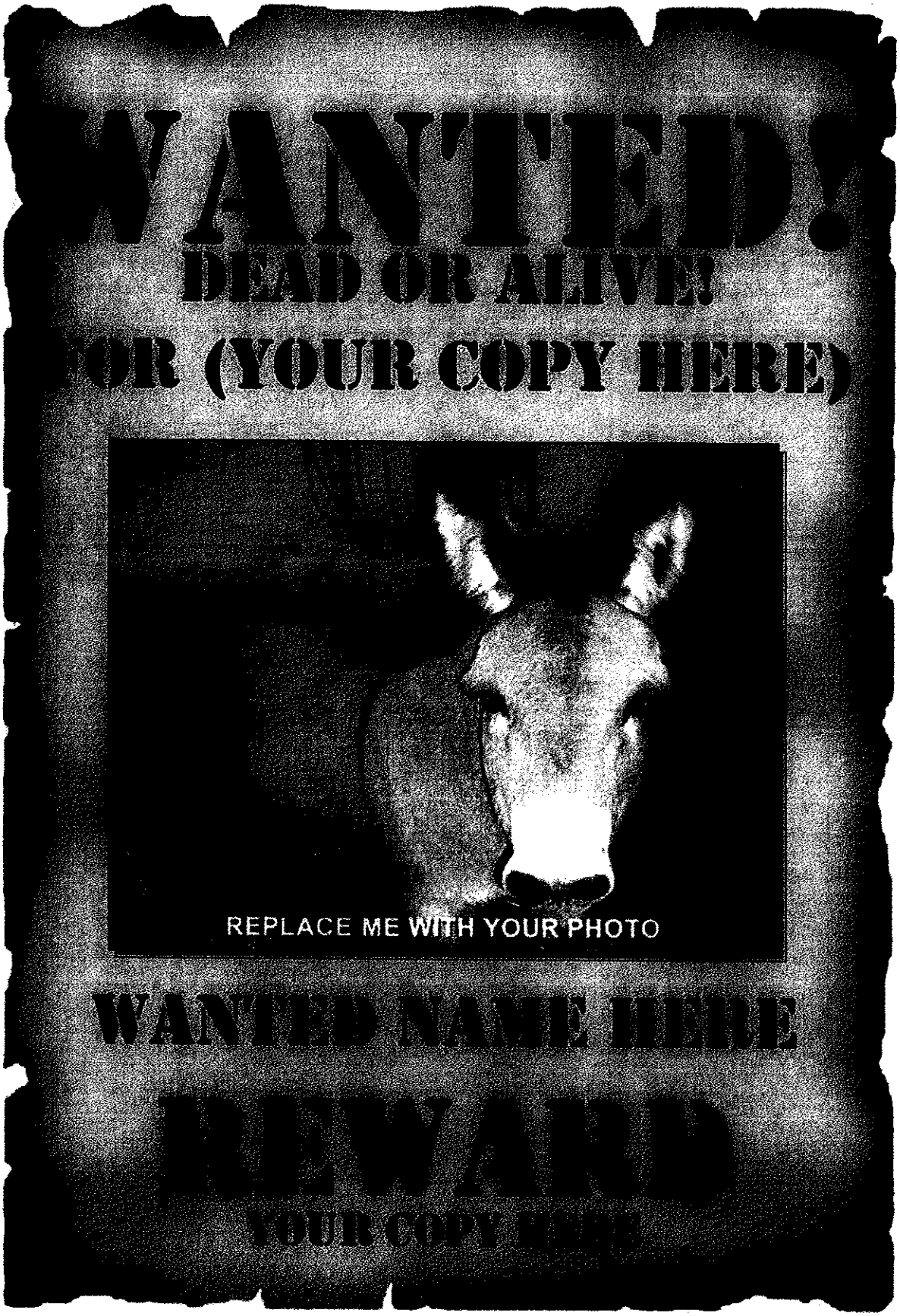
Name(s) _____ Date: _____

- a plant with needle-like leaves
- a plant with seeds in a fruit
- a plant with a nut
- a plant with opposite leaves
- a plant with alternate leaves
- a plant that is flowering
- a plant with leaflets
- a plant with smooth-edged leaves
- a plant with an edible root
- a plant with an edible stem
- a plant with an edible fruit
- a plant with a leaf that is hairy or velvety underneath
- a plant with a leaf that has been damaged
- a plant that is eaten by other organisms
- a plant that makes its own food
- other: _____
- other: _____

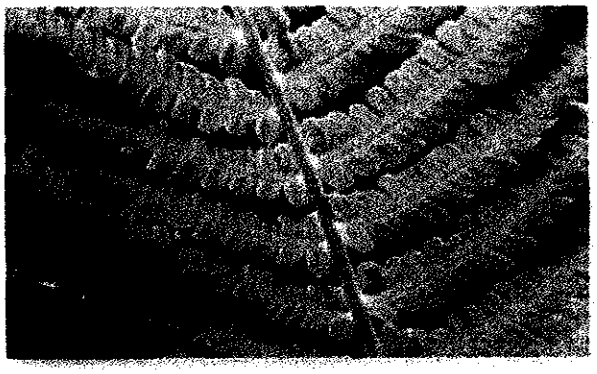
Which Plant is Which? Assessment

Student Name(s): _____ **Date:** _____

Level of Mastery → / Benchmark or Performance Measure ↓	 **Mastered task / 90%+ accuracy: 5 pts**	 **Mastered task / 85% accuracy: 4 pts**	 **Mastered task / 80% accuracy: 3 pts**	 **More learning needed**	**TOTAL POINTS**
Student has created and demonstrated own plant classification system.	Student's original classification system used to group 6 or more plants; any criteria for grouping plants is articulated.	Student grouped fewer than 6 plants and was able to articulate criteria for groups	Student grouped three or fewer plants and was able to articulate criteria for groups	Student did not group any plants or could not articulate how he grouped them.	
Student went on Botanical Safari and found plant structures that are key to many classification systems.	Student found all items on checklist; able to articulate how each item met the criteria	Student found most items on checklist	Student found a few items on checklist	Student did not find any items on checklist	
Student created dichotomous key to sort plants; and role-played a plant sorting itself thru a key.	Student's dichotomous key included opposite or exclusionary statements at each step; student self-sorted in life size key	Key is incomplete	Key is non-functional	Key was not attempted	
Student became an expert on a plant species; created a Wanted poster; found and observed the sp.	Student Wanted poster contains common and Latin names, descriptions of leaves, flower or fruit; specimen was found and identified	Poster contains some required elements	Poster has few required elements	Poster was not attempted	
Student planted or labeled a botanicalgarden ; contributed to Discover Life database	Key or clad showed different levels of organization and correctly identified characteristics thru genus and species	Key or clad had some minor errors	Key or clad was incorrect	Key or clad was not attempted	
TOTAL in LAST BOX →					**_/25 pts**


WANTED!
DEAD OR ALIVE!
OR (YOUR COPY HERE)
REPLACE ME WITH YOUR PHOTO
WANTED NAME HERE
REWARD
YOUR COPY HERE

SAMPLE ROLE PLAY CARDS FOR LIFE-SIZE PLANT KEY (HAVE STUDENTS MAKE MORE)



FERN*

HORSETAIL

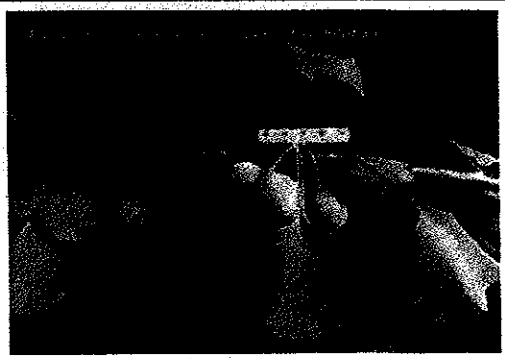
CLUB MOSS

CYCAD

VIRGINIA PINE

WHITE OAK

CORN / MAIZE**



GINGKO

SAMPLE ROLE PLAY CARDS FOR LIFE-SIZE PLANT KEY

SUGAR MAPLE*

LIVERWORT

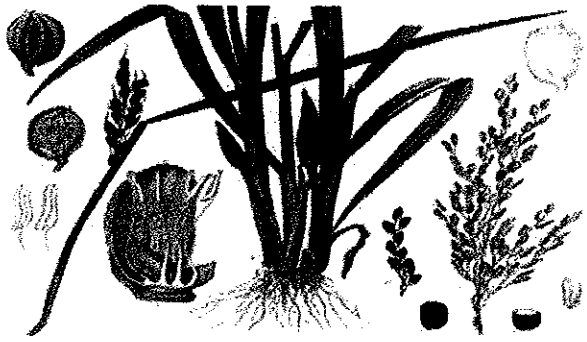
MILKWEED

MOSS*

HORNWORT

WHEAT*

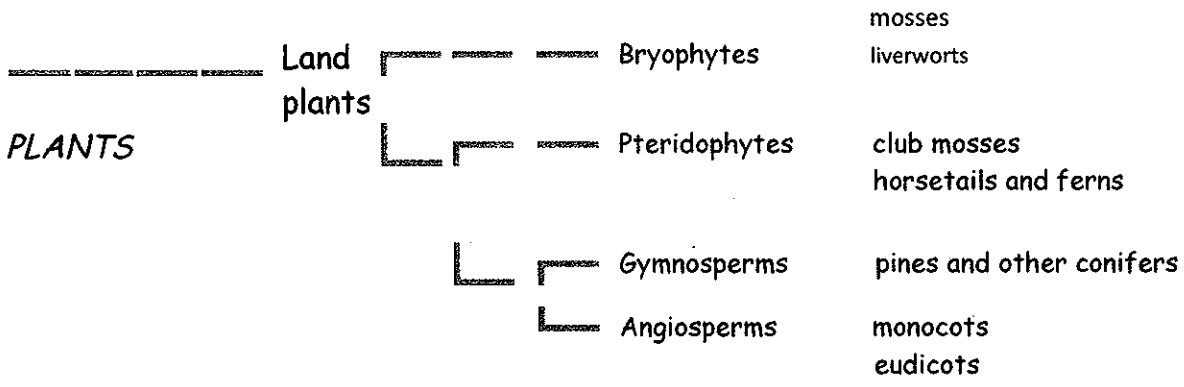
GRASS*



RICE**

LIFE SIZE PLANT KEY SIGNS

Arrange Plant Key signs in this order. Students will run the course from left to right. Signs are to be placed at each junction, including those junctions not marked in blue below
Have students each make up several plant picture cards to bring in and add to the game.



Make the following signs and put them on stakes at the appropriate junctions:

<- Bryophytes I Pteridophytes ->

<- Mosses I Liverworts ->

<- Pteridophytes I Vascular Seed Plants ->

<- Club mosses I Horsetails and Ferns ->

<- Gymnosperms I Angiosperms ->

<- Monocots I Eudicots ->

Lesson 3: Voluminous Veggies in the Math Garden

Grade
5

Standards
MCC5.MD.4, MCC5.MD.5, MCC5G1, MCC5G1

Time
approx 1.5 - 2 hours

Supplies
(per pair of students)
- clear shoe box (possibly)
- scissors
- duct tape
- seeds or plants for bonsai (squash, melon, pumpkin, or gourds)
- seeds for giant veggies
- measuring tape or ruler
- cube nets (patterns) or math unit cubes
- glue or tape
- grid or graph paper
- string
- tape or sticky notes
- 3 dowel rods
- graduated cylinder or beaker
- serrated cake server

(per class)
- garden veggies (1 per team: eggplant)

Overview
5th grade students will explore coordinates, area and volume in the garden.

What they will learn
- Life in trenches
- Trench gardens on the warfront
- War gardens on the homefront
- Role of the Lusitania bombing
- Food conservation during the War
- US Food Administration
- American contributions to the War
- Treaty at Versailles

How they will learn it
- View photos and videos
- Excerpts from book
- Researching and planting a war garden
- Photos and primary sources on web site
- Primary source research on the web
- Students replicate 4-minute appeals
- Student garden or recycling projects
- Primary source research on the web

Essential / Guiding Question
What math do gardeners need to know? How can we calculate the volume of our harvest and the capacity of our garden beds?

Engaging Students
Garden Battleship

With a garden bed marked off as the first quadrant of a coordinate grid, students will graph the location of plants or garden landmarks to represent their vessels and play a version of the classic children's game: Battleship.

Exploration
Engineering Challenge: Growing Bonsai and Gigantic Fruit and Veggies

Show students a rectangular fruit / veggie (or picture of square watermelon and ask if they think it is real. (It is). Invite them to think of ways they could grow veggies in rectangular prism shapes: bonsai fruit! Which veggie? What requirements will a plant need for a container? Challenge pairs of students

to concur on a design and implement their plan). For instance, one possibility would be to cut a hole in the end of a clear plastic shoebox and put it vertically over a garden plant, taping the lid (now side) shut and forcing the plant to grow inside. (Months later, after harvest, cut the fruit into unit cubes to measure volume). Also allow students to plant and grow plants from seeds bred to produce gigantic specimens. Eventually, they will be challenged to think of ways to measure the volume of the resulting veggies.

Voluminous Veggies

While waiting for the bonsai and gigantic fruits to grow to maturity so they can be measured, students will practice calculating the volume of other vegetables and fruits.

There's Dirt in my Bed!

Students will calculate a garden bed's capacity for soil. Explain to students the protocol for tiling to determine area, and layering unit cubes inside a larger cube to determine volume. Students will create unit cubes from cube nets (foldable patterns) and measure the inside of various containers (volume); comparing this method to multiplication of area times height; and comparing both methods to multiplication of the length of three edges that meet at any corner.

Explanation

Students will be able to explain the relationship between area and volume, and articulate why volume can be determined four ways: by multiplying area times height, or multiplying the lengths of the three edges that come together in any corner, or by counting the unit cubes that can be stacked in a solid figure, or measuring displacement.

Debriefing

Teacher will provide context for student activities. See Background Information for details.

Environmental Stewardship

Pairs of students will be challenged to develop a method for calculating the total volume of edible plant parts harvested from the garden this year, and defend their method when presenting it to peers. The class will select the soundest method, noting its limitations, and apply it throughout the year to create a cumulative total.

Students will used what they have learned in the lesson to help the Earth by designing a new garden for future development, sketching and labeling its dimensions and area, and calculating its maximum capacity for soil (volume).

Evaluation

A rubric is available to assess student performance in lesson activities.

CONTEXT FOR LESSON ACTIVITIES

Standards

Standards: Common Core Math

MCC5.MD.4, MCC5.MD.5, MCC5G1, MCC5G1

MCC5.MD.4 Measure volume by counting unit cubes in a solid

MCC5.MD.5 Relate volume to addition and multiplication in solving real-life math problems about volume

a. Show that packing a rectangular prism with unit cubes = multiplying edge lengths = height x area

b. Volume is additive.

MCC5.MD.3 understand concept of volume measurement

a. A unit cube can be used to measure volume.

b. A solid figure packed with n unit cubes has volume of n c. u.

MCC5G1 Use axes to define a coordinate system. Understand (x,y) convention

MCC5G2 Represent real world and math problems by graphing points in a coordinate plane and interpreting coordinate values of points

Background Information

Growing a Square Watermelon
http://www.instructables.com/id/Grow-a-square-watermelon/
Common Core Frameworks: 5th grade Volume and Measurement
https://www.georgiastandards.org/Common-Core/Common Core Frameworks/CCGPS_Math_5_Unit7FrameworkSE.pdf
Common Core Frameworks: 5th grade 2-D Figures
https://www.georgiastandards.org/Common-Core/Common Core Frameworks/CCGPS_Math_5_Unit6FrameworkSE.pdf
Common Core Frameworks: 5th grade Geometry and Coordinates
https://www.georgiastandards.org/Common-Core/Common Core Frameworks/CCGPS_Math_5_Unit5FrameworkSE.pdf


Teacher Preparation

- Assemble materials required for the lesson.
- Provide graph or cross grid paper for Battleship game (1st quad)
- Free online graph paper: http://incompetech.com/graphpaper/
- Divide the class into pairs
- Mark off a garden bed as the first quadrant of a coordinate grid. Choose a corner to serve as the intersection of x and y axes. Insert a dowel to serve as the 0,0 point at that corner. Tie string or twine to the dowel, run the string down the side of the garden bed to the right, tie it to a dowel inserted at the end of the bed, and mark it with numbers at regular intervals. Do the same for the y axis, along the perpendicular side of the garden bed starting at the 0,0 point. Sticky notes taped to twine, or just painter tape looped over the twine and stuck to itself, work well for assigning numbers along the x and y axes.

PROCEDURES FOR LESSON ACTIVITIES

Garden Battleship

- Each student will secretly choose two plants or landmarks in the garden bed to represent the location of his or her battleships and mark these items on graph paper by circling the corresponding coordinate pairs (x,y). A small ship should include one coordinate pair, and a second, larger ship should include two adjacent coordinate pairs.
- Each garden battleships occupies the area of a 2-D solid figure, at a location represented by the x and y coordinates. Ask student to compare area to volume, and imagine how they could play Garden Battleship in 3-D (with the height of each ship represented).
- Students will group up in pairs and play Garden Battleship by calling out coordinate pairs to represent the shots they fire and marking whether they scored a hit or miss, depending on the response from opponent.

Engineering Challenge: Growing Bonsai and Gigantic Fruit

- Show students a rectangular fruit / veggie (or picture of square watermelon) and ask if they think it is real. (It is). Invite them to think of ways they could grow veggies in rectangular prism shapes: bonsai fruit! Ask which vegetables or fruit would work best? What requirements will a plant need for a container? Allow each pair of students to concur on a design and implement their plan. For instance, one possibility would be to cut a hole in the end of a clear plastic shoebox and place the box vertically over a garden plant, taping the lid (now side) shut and forcing the plant to grow inside. Months later, after harvest, cut the fruit into unit cubes to measure volume.
- Show students pictures of giant vegetables. (Google "giant pumpkin boat race") Ask how they think it is possible to

grow such big fruit. (Extended growing season and optimal conditions are helpful, but seed that has been bred for bigger and bigger specimens, generation after generation, is necessary to grow giants). Allow students to plant and grow plants from seeds bred to produce gigantic specimens. Some may not mature until time for next year's class to use. Cabbages are a good giant plant to grow in winter and harvest during same school year. Eventually, students should be challenged to think of ways to measure the volume of the resulting veggies, which may be very irregular in shape.

There's Dirt in My Bed!

- Students will gain a conceptual understanding of the distinction between area and volume by tiling the area of a 2-D shape with unit squares, and by layering the volume of a hollow 3-D shape with unit cubes. They can then compare tiling and layering to the use of multiplication, in determining the area and volume of a garden bed. Using this information, students will calculate how much soil the garden can hold. This can be done with a scale model (shoebox) and math cube manipulatives, or students can make their own measuring unit-cubes with cube nets (folding patterns). cube nets http://www.senteacher.org/wk/3dshape.ph

Voluminous Veggies

- While waiting for the bonsai and gigantic fruits to grow to maturity so they can be measured, harvest or buy other garden veggies for students to practice measuring volume. Modify a veggie to have a regular solid shape e.g. cut an eggplant into a cube or rectangular prism. Explain to students that there are four ways to get a correct answer but do not provide formulas or methods. Allows small groups of students to explore, problem-solve, calculate, and share their answers and techniques. Provide a serrated plastic cake server for cutting (free from grocery bakery department); a graduated cylinder, beaker or measuring cup; and measuring tape or ruler to each group. After all the groups have explained their result and method, review the four protocols for calculating volume: multiplying area times height, or multiplying the lengths of the three edges that come together in any corner (actually: l x l x h), or by counting the unit cubes that can be stacked in a solid figure, or by placing an object in water and measuring displacement. Then allow students time to try the methods they have not yet explored and compare results.

Environmental Stewardship

- Challenge students to devise a way to total the volume of all edible plants raised in the school garden this year.
- Encourage students to be creative in designing, sketching, and labeling measurements (including volume) on a plan for a new garden bed. This garden bed should combine different shapes

Assessment for Voluminous Veggies

Student Name(s): _____ **Date:** _____

Level of Mastery → / Benchmark or Performance Measure ↓	 Mastered task @ 90%+ accuracy: 5 pts	 Mastered task @ 85% accuracy: 4 pts	 Mastered task @ 80% accuracy: 3 pts	 More learning needed	TOTAL POINTS
Garden Battleship	Correctly identified coordinate pairs in the first quadrant, while playing battleship	Played battleship but not always accurate when locating coordinate pairs	n/a	No attempt	
Bonsai and Gigantic Fruit and Veggies	Designed a method for growing a bonasi fruit and planted, tended seeds for giant veggies	Started a bonsai fruit or planted giant seeds	n/a	No attempt	
Voluminous Veggies	Calculated volume of a solid regularly shaped fruit using four different methods	Calculated volume using 2-3 methods	Calculated volume using one method; lacked understanding of concept	No attempt	
Dirt in My (Garden) Bed	Applied math to real world calculating volume of a garden bed to determine amount of soil needed, noted amount correctly	Calculated volume correctly but lacked correct units	n/a	No attempt	
Engineering Challenge: Design a garden with multiple levels and figure volume, or devise a way to calculate total the volume of total garden harvest for year	Used knowledge of volume and creativity to solve a real world problem	Made progress in attempt to solve real world problem without completing it	n/a	No attempt	
TOTAL in LAST BOX →					_____/25 pts