Grade 5

THE SCIENTIFIC GARDEN

Unit Overview

In this unit students will plant a Scientific Garden, using science to answer important questions about how to grow healthy soil and plants, abundant food, and how to become successful gardeners and better stewards of the environment. They will utilize the scientific method to test the effects of certain variables (mulch and vermicast) on the growth of bush beans in their garden, and they will observe quantitative and qualitative data in their garden regularly and record data in their journals. Students will conduct a soil sample experiment, explore soil life, and monitor plant health. Key concepts include ʻāina, the importance of observation, data collection, and experimentation for gardeners and farmers, the scientific method, the importance of soil and organic matter, microorganisms (fungi and bacteria), invertebrates, producers, consumers, decomposers, decomposition, photosynthesis, and the soil food web.

RECOMMENDED GRADE LEVEL

Grade 5

This unit is easily adaptable for other grade levels.

LESSON DELIVERY

This unit consists of four 45-minute lessons to be taught at 3 to 5 week intervals (about one lesson per month) over the course of one semester. Regular garden care, observations, and data collection should take place between lessons, and teachers are encouraged to use the Lesson Extensions or create their own extension activities in order to connect the gardens with other classroom learning. Bush bean seeds may be planted year-round.

GARDEN CARE

- Teachers and students are responsible for watering and weeding their garden. Regular applications of organic nutrients (vermicast) are scheduled as part of each lesson.
- Add **Garden Monitor** to the list of classroom jobs assigned; these students should visit the garden daily to water the soil, check on the gardens, and make observations.
- Set up a shared weekly watering schedule amongst grade level teachers and/or parents and garden docents to make sure the garden receives adequate moisture.
- Please do not use synthetic chemicals (pesticides, herbicides, and/or fertilizers) in or around school and home gardens. If necessary, use "OMRI" (organic certified) products only.
- Post the **Garden Agreements** in the classroom and review them often with students.

PRE & POST UNIT SURVEYS, TAKE HOME LETTERS, & STUDENT WORKBOOKS

- Pre and Post Unit Surveys measure student progress related to content knowledge, attitudes, and behavior change related to ʻĀINA Lessons.
- Take Home Letters contain suggested questions/ activities for each lesson for families to help reinforce, engage, and learn along with their child.
- Student Workbooks include Student Worksheets and Take Home Letters, available for download at www.kokuahawaiifoundation.org/aina.
- Regular student observation time in the garden is encouraged with the use of individual Garden Journals or Folders, where drawings and writings can be kept by each student, or a Class Journal where weekly garden observations can be recorded by Garden Monitors.
- Plan to review and select examples of student work to be shared with the Kōkua Hawai'i Foundation.

LESSON EXTENSIONS

Gardens offer infinite, engaging learning opportunities, and teachers are encouraged to utilize them beyond these lessons. The lesson plans include a number of suggested activities (Lesson Extensions) designed for teachers and students to make the most of the gardening experience!

NEED HELP?

Contact the Kōkua Hawai'i Foundation with any questions or comments about this unit:

- aina@ kokuahawaiifoundation.org
- (808) 638-5145

THE SCIENTIFIC GARDEN			
Lesson 1	**Lesson 2**	**Lesson 3**	**Lesson 4**
Gardeners Are Scientists	**Soil and Organic Matter**	**Soil Food Web**	**Conclusions**
SUGGESTED DELIVERY TIMES FOR FALL SEMESTER (3 to 5 weeks apart)			
September	October	November	December
SUGGESTED DELIVERY TIMES FOR SPRING SEMESTER (3 to 5 weeks apart)			
February	March	April	May
LESSON OVERVIEW			
Key Concepts • Observe, data, experiment • Science • Variables that affect plant growth • Mulch and vermicast • Garden Agreements	**Key Concepts** • Healthy soil • Microorganisms • Organic farming • Organic matter	**Key Concepts** • Food Web • Photosynthesis • Producers, consumers, decomposers • Fungi, bacteria, invertebrates • Decomposition	**Key Concepts** • Qualitative and quantitative data • Analyzing data and determining results • Creating and discussing conclusions
Introduction Discuss the similarities between gardeners, farmers, and scientists. Discuss variables that affect plant growth. Discuss the scientific question being asked, layout the garden plan, and assign groups. Introduce the Garden Agreements.	**Introduction** Review the goal and scientific question and share hypotheses for the garden experiment. Discuss the importance of healthy soil, microorganisms, and organic matter. Discuss the soil sample experiment and assign groups.	**Introduction** Review the science experiment and importance of healthy soil. Discuss the soil food web and its main characters, the soil 'F.B.I.' (fungi, bacteria, invertebrates), and their important role as decomposers.	**Introduction** Review the scientific question, hypothesis, and types of data collected. Assign groups for data analysis on soil health (organic matter, soil life abundance, soil life diversity), plant health, and the green bean harvest.
Group Activities Groups will create plots, make signs, plant bush bean seeds, and apply mulch (Plots 3 and 4 only) and vermicast (Plots 2 and 4 only), in order to begin the garden experiment.	**Group Activities** Conduct the soil sample experiment in order to compare the amount of organic matter in the four experimental plots, a sample of compost, and a soil sample from the campus outside the gardens. Care for the gardens and add mulch (as needed) and vermicast to correct plots.	**Group Activities** Use magnifying glasses to closely observe soil life (decomposers) found in soil samples from each experimental plot. Record data on the Soil Life Data Class Data Sheets. Care for the gardens and add mulch (as needed) and vermicast to correct plots. Harvest green beans and record data.	**Group Activities and Class Discussion** Groups use Class Data Sheets to create tables, bar graphs, and conclusions about their data. Draw bar graphs on the board and discuss results and conclusions as a class. Snack on fruits and vegetables and discuss lessons learned.
Follow Up Activities • Daily garden care • Remove cover cloth when sprouts emerge (if used) • Weekly garden observations and data collection • Student Worksheet: Garden Experiment Report: Part I • Lesson Extensions • Take Home Letter	**Follow Up Activities** • Daily garden care • Weekly garden observations and data collection • Student Worksheet: Soil Sample Experiment Report • Harvest, count, weigh, assess for quality, eat green beans and record data in the Harvest Data Class Data Sheet • Lesson Extensions	**Follow Up Activities** • Daily garden care • Weekly garden observations and data collection • Student Worksheet: Soil Food Web • Soil Food Web Game • Harvest, count, weigh, and eat green beans and record data in the Harvest Data Class Data Sheet • Lesson Extensions	**Follow Up Activities** • Continue to care for the gardens and harvest green beans and seeds • Place mulch over bare soil • Student Worksheet: Garden Experiment Report: Part II • Continue discussion of results and conclusions • Lesson Extensions • Submit examples of student work to Kōkua Hawai'i Foundation

ACADEMIC STANDARDS GUIDE: GRADE 5 ALIGNMENT

Common Core Standards (CCSS), Language Arts		
5.RI.3	Reading Information: Key Ideas and Details: Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.	Lesson 3
5.W.1	Writing: Text Types and Purposes: Write opinion pieces on topics or texts, supporting a point of view with reasons and information.	Lessons 1, 2, 3
5.W.2	Writing: Text Types and Purposes: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.	Lessons 1, 2, 3, 4
5.W.7	Writing: Research to Build and Present Knowledge: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.	Lessons 1, 2, 3, 4
5.W.10	Writing: Range of Writing: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	Lessons 1, 2, 3, 4
5.SL.1	Speaking and Listening: Comprehension and Collaboration: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.	Lessons 1, 2, 3, 4
5.SL.5	Speaking and Listening: Presentation of Knowledge and Ideas: Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes.	Lessons 3, 4

Common Core Standards (CCSS), Mathematics		
5.G.1	Geometry: Graph points on the coordinate plane to solve real-world and mathematical problems: Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a give point in the plane located by using an ordered pair of numbers, called its coordinates.	Lesson 4
5.G.2	Geometry: Graph points on the coordinate plane to solve real-world and mathematical problems: Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.	Lesson 4

Hawai'i Content & Performance Standards III (HCPS III)		
HE.3-5.1.3	Healthy Eating and Physical Activity: Explain the importance of a healthy diet as part of a healthy lifestyle	Lesson 4

(Academic Standards Guide continues on page 4)

ACADEMIC STANDARDS GUIDE: GRADE 5 ALIGNMENT (CONTINUED)

Next Generation Science Standards (NGSS)		
Disciplinary Core Ideas		
LS2.A	Interdependent Relationships in Ecosystems	Lessons 1, 2, 3, 4
Science and Engineering Practices		
Obtaining, Evaluating, and Communicating Information: Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.		Lessons 1, 2, 3, 4
Analyzing and Interpreting Data: Use observations to describe patters in the natural world in order to answer scientific questions.		Lessons 1, 2, 3, 4
Developing and Using Models: Use a model to represent relationships in the natural world.		Lessons 1, 2, 3
Crosscutting Concepts		
Patterns: Patterns in the natural and human designed world can be observed and used as evidence.		Lessons 1, 2, 3, 4
Systems and System Models: Systems in the natural and designed world have parts that work together.		Lessons 1, 2, 3, 4

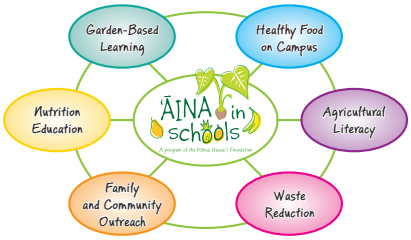
NGSS Performance Expectation: 5-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	Lessons
Developing and Using Models: Modeling in 3-5 builds on K-2 models and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model to describe phenomena. (5-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms and therefore operate as "decomposers." Decomposition eventually restores some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)	**Systems and System Models** • A system can be described in terms of its components and their interactions. (5-LS2-1)	Lessons 1, 2, 3, 4

ABOUT ʻĀINA IN SCHOOLS

ʻĀINA In Schools is a farm to school initiative that connects children to their local land, waters, and food to grow a healthier Hawaiʻi. In addition to encouraging the use of locally grown fruits and vegetables in school meals and snacks, the program includes standards-based nutrition, garden, and compost curricula that empower children to grow their own food, make informed food decisions, and reduce waste. ʻĀINA In Schools also provides field trips to local farms, chef cooking demonstrations in classrooms, as well as waste reduction, garden, and cooking educational opportunities for families and community members.



PUBLISHING INFORMATION

The ʻĀINA In Schools curricula includes Nutrition Education, Garden-Based Learning, and Waste Reduction lessons for kindergarten through sixth grade students.

All ʻĀINA In Schools curricula and materials are property of the Kōkua Hawaiʻi Foundation and are distributed to trained docents and teachers for use at schools participating in the ʻĀINA In Schools program. These curricula and materials may be reproduced for individual classroom use by schools participating in the ʻĀINA In Schools program or by registered users approved by the Kōkua Hawaiʻi Foundation. Reproduction of these curricula and materials is not permitted by unregistered users without the express written consent of the Kōkua Hawaiʻi Foundation.

The registration and training process helps Kōkua Hawaiʻi Foundation to gather teacher feedback on the curricula and to document how many children and schools are being reached through the lessons. Visit our website to become a registered user, sign up for trainings, and gain access to all Kōkua Hawaiʻi Foundation curricula and resource guides. Please direct questions about the ʻĀINA In Schools program and curricula to aina@kokuahawaiifoundation.org.

MAHALO

The Kōkua Hawaiʻi Foundation thanks the following organizations and individuals who have assisted with the development of the ʻĀINA In Schools curriculum and materials:

- **Kōkua Hawaiʻi Foundation:** Kaliko Amona, Lydi Morgan Bernal, Sarah Gelb, Kim Johnson, Julius Ludovico, Summer Maunakea, Debbie Millikan, Deanna Moncrief, Kelly Perry, www.kokuahawaiifoundation.org
- **The Green House:** Betty Gearen and Tia Meer, www.thegreenhousehawaii.com
- **GrowingGreat:** Marika Bergsund and Lori Sherman, www.growinggreat.org
- **Food for Thought:** Marty Fujita, www.foodforthoughtojai.org

Special thanks to the students, teachers, and volunteers who have participated and taught lessons in previous years and provided their valuable feedback to improve them.

Mahalo nui!

Student Worksheet

SCIENTIFIC GARDEN

Grade 5 * Pre-Unit Survey

Name .....

School .....

Teacher .....

I have been at this school since grade: K 1 2 3 4 5 (circle one)

This Pre-Unit Survey is to see what you already know about these topics. It is ok if you don't know any of the answers. You will be learning about these topics this semester. Try your best and have fun!

1. Circle all the variables that can affect plant growth. Circle all that apply:

Soil Composition Wind Air Water Light Weeds Seasons Temperature

Pollination Diversity Fertilizers Mulch Vermicast Singing Pests

2. How can you tell if soil is healthy? Circle ONE answer:

a. The soil is full of life

b. The soil drains well

c. Plants are healthy with few or no problems with pests and diseases

d. All the above

3. What are the four main components of soil? Circle ONE answer:

a. Food scraps, water, dirt, air

b. Water, sand, bacteria, earth

c. Air, water, minerals, organic matter

4. What can you add to soil to improve soil health? Circle ONE answer:

a. Compost b. Vermicast c. Bokashi d. All the above

5. Draw a line to match each word to its correct definition:

a. Decomposition	1. Castings (poop) from composting worms; rich in soluble nutrients
b. Mulch	2. A statement or educated guess that explains a predicted answer to the question being asked
c. Hypothesis	3. The process by which a material is broken down into simple forms of matter
d. Data	4. A material that is used to cover the soil for beneficial purposes
e. Vermicast	5. Facts, statistics, or items of information collected for reference

6. **Do you like gardening? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
7. **Do you like eating fruits and vegetables? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
8. **Do you like cooking? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
9. **Do you like making compost? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
10. **Do you like ʻĀINA Lessons? Circle ONE answer:**
    a. I do not like b. unsure c. I like a little d. I like a lot

11. **Do you and your family grow any food at home? Circle:** Yes or No
    If yes, please list the foods you grow at home: _____

12. **Do you compost at home? (compost pile, worm bins, or bokashi bucket) Circle:** Yes or No

13. **How often do you eat fruits and vegetables? Circle ONE answer:**
    a. I don't eat fruits and vegetables b. 1-2 times a week c. 3-5 times a week d. Every day

14. **Circle the fruits and vegetables that you like to eat:**

Apple Cantaloupe Banana/Maiʻa Blueberries Avocado Coconut/Niu Guava Dragonfruit
Mango Passionfruit/Liliko'i Honeydew Rambutan Tangerine Strawberry Blackberries
Lemon Starfruit Breadfruit/ʻUlu Lychee Orange Papaya Pineapple Watermelon
Radish Spinach Basil Beans Broccoli Squash Zucchini Sweet Potato/ʻUala Corn Tomato
Lettuce Watercress Taro/Kalo Cucumber Green Beans Asparagus Carrots Celery Kale

Other: _____

15. **Describe what ʻāina means to you:** _____
    _____
    _____

16. **List two ways that you take care of the ʻāina:**
    1. _____
    2. _____

17. **Complete the following sentence:**
    My favorite thing about ʻĀINA In Schools Lessons is _____
    _____
    _____

Dear Parent or Caregiver:

This semester, 5th graders will be participating in four ʻĀINA In Schools Garden Lessons. ʻĀINA In Schools, a program of Kōkua Hawaiʻi Foundation, is a farm to school initiative that connects children to their local land, waters, and food to grow a healthier Hawaiʻi. Program components vary from school to school and include nutrition education, garden-based learning, healthy snacks, farm field trips, chef visits, waste reduction, and family and community outreach.

Although the lessons are delivered once a month, the students will be continually engaged in between lessons with regular garden activities that include watering, weeding, making observations, data collection, harvesting, and spending time in the garden.

Photos and Media Releases: By now each of you should have received a Kōkua Hawaiʻi Foundation Media Release Form. We hope that you have filled out this form and have submitted it to your child's classroom teacher. From time to time, KHF takes photos/videos of our lessons to highlight activities that are noteworthy.

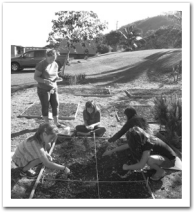
To keep yourself up to date on what your child is doing in ʻĀINA, we suggest putting this up on your refrigerator or bulletin board and follow up as the lessons are delivered. You can help reinforce, engage, and learn along with your child by going over the lessons and activities after each lesson. A unit summary and suggested questions/activity for each lesson are listed below.

Mahalo!

In **The Scientific Garden** unit, students will use science to answer important questions about how to grow healthy soil and plants, abundant food, and how to become successful gardeners and better stewards of the environment. They will utilize the scientific method to test the effects of certain variables (mulch and vermicast) on the growth of bush beans in their garden, and they will observe quantitative and qualitative data in their garden regularly and record data in their journals. Students will conduct a soil sample experiment, explore soil life, and monitor plant health. Key concepts include ʻāina, the importance of observation, data collection, and experimentation for gardeners and farmers, the scientific method, the importance of soil and organic matter, microorganisms (fungi and bacteria), invertebrates, producers, consumers, decomposers, decomposition, photosynthesis, and the soil food web.

Lesson 1 - Gardeners Are Scientists

In this lesson, students discuss the role of gardeners and farmers as scientists, and the variables that affect plant growth. They share soil observations collected before the lesson and discuss the design of their garden experiment. In the garden, students create plots and signs, plant bush bean seeds, and add mulch and vermicast to certain plots in order to begin their scientific experiment.



Questions to discuss with your child:

- What do gardeners, farmers, and scientists have in common?
- How do gardens represent larger-scale systems such as farms and natural ecosystems?
- What variables are being tested in this unit?

Suggested home activity:

- Create a rain gauge using a clear cup. Place the cup next to the plants. Observe or record amount of water collected after rainfall.
- Observe the movement of the sun across your home or garden throughout the day. Relate this to the growth patterns of plants.

Lesson 2 - Soil and Organic Matter

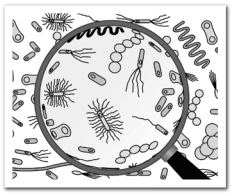
In this lesson, students discuss their garden observations as well as their scientific questions and hypotheses. They discuss the importance of healthy soil and organic matter. In the garden, they will conduct soil sample experiments in order to study the amount of organic matter in different samples of soil. Students care for their garden by adding mulch and vermicast in the appropriate plots watering plots equally, and removing weeds..

Questions to discuss with your child:
- What is organic matter and why is it important?
- Explain the steps of the soil sample experiment.

Suggested home activity:
- Do some soil experiments at home. For more info, visit: *www.soils4kids.org/experiments*

Lesson 3 - Soil Food Web

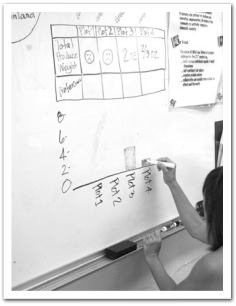
In this lesson, students review the goal of their garden experiment, share observations made, and discuss the importance of healthy soil and the soil food web. They will be introduced to the soil "F.B.I," (fungi, bacteria, invertebrates) and discuss the important role of decomposers. In the garden, students will observe and collect data on soil life, care for their garden, harvest available green beans, and continue their scientific experiment.



Questions to discuss with your child:
- Who are the soil "F.B.I.?"
- Describe the soil food web.

Suggested home activity:
- An excellent resource for in-depth learning about the soil food web and its critical role in nutrient cycling (sustainability) is the book entitled, *Teaming With Microbes: The Organic Gardener's Guide to the Soil Food Web* by Jeff Lowenfels and Wayne Lewis.

Lesson 4 - Conclusions



In this lesson, students review their scientific experiment and discuss the process of analyzing data and creating conclusions. Students will work in groups and use the Class Data Sheets to analyze data on soil health, plant health, and the amount of food produced in their Scientific Garden. The class will then discuss their results and conclusions together. They will enjoy a snack of fresh fruits and vegetables and discuss lessons learned from their Scientific Garden.

Questions to discuss with your child:
- What is the outcome of the experiment?
- Was your hypothesis correct? Why or why not?

Suggested home activity:
- Watch *Dirt! The Movie*. Visit the website: *http://www.dirtthemovie.org/*

If you have any questions or are interested in becoming an 'ĀINA In Schools docent, please do not hesitate to ask.

To learn more about 'ĀINA In Schools at your child's school, please contact your school's 'ĀINA Team Coordinator, or contact:

'ĀINA In Schools
aina@kokuahawaiifoundation.org

Grade 5

THE SCIENTIFIC GARDEN

Lesson 1 * Gardeners Are Scientists

DESCRIPTION

Students will discuss the role of gardeners and farmers as scientists and discuss the variables that affect plant growth. They will share their soil observations collected before the lesson and discuss the design of their garden experiment. In the garden, students will work in groups to create plots and signs, plant bush bean seeds, and add mulch and vermicast to certain plots in order to begin their scientific experiment.

TIME: 45 minutes

SUBJECTS: Language Arts, Science

LEARNING OBJECTIVES

After this lesson students will be able to:

- Describe the commonalities between gardening, farming, and science, including the use of observation, data collection, and experimentation.
- Recognize gardens as smaller-scale representations of larger systems, such as farms and natural ecosystems.
- Recognize and utilize science as a way to gain knowledge and become better gardeners and stewards of the environment.
- Discuss the many variables that affect the growth and health of plants.
- Make observations and record data from their garden.

ACADEMIC STANDARDS*

CCSS, Language Arts: 5.W.1, 5.W.7, 5.W.10 **NGSS:** LS2.A, Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data, Developing and Using Models, Patterns, Systems and System Models **Lesson Extensions:** 5.W.1, 5.W.2, 5.W.7, 5.SL.1, Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data, Developing and Using Models

*A detailed list of the Academic Standards can be found in the Unit Overview document

LESSON OUTLINE

I. Introduction (20 minutes)
   1. Gardener-Farmer-Scientists
   2. Variables That Affect Plant Growth
   3. Garden Experiment Design
   4. Group Activities Overview

II. Group Activities (20 minutes)

III. Closing (5 minutes)
   1. Plant Health Observations & Data Collection

KEY TERMS AND CONCEPTS

ʻĀina - Land; that which feeds, nourishes, and sustains us (e.g., food, water, air)

Data - Facts, statistics, or items of information collected for reference or analysis

Experiment - To try or test, especially in order to discover or prove something

Mulch - Any material that is used to cover the soil for beneficial purposes, including preserving moisture and discouraging weeds

Observe - To see, perceive, or notice; to regard with attention

Science - Systematic knowledge gained through observation and experimentation

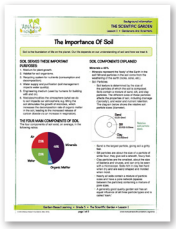
Variable - A factor or condition that is subject to change, especially one that is allowed to change in a scientific experiment in order to test a hypothesis

Vermicast - Castings (poop) from composting worms; rich in soluble nutrients and microbial life (microorganisms); enhances plant growth and health

LESSON MATERIALS

Community Supplies:

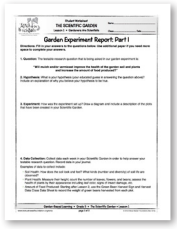
- Twine
- Scissors
- Permanent markers
- Stapler
- Extra staples
- 2 tape measures
- Vermicast (1 cup per class)
- Tape (duct tape or packing tape for sign making)
- Magnifying glasses (1 per student or group)



Background Information: The Importance of Soil

Lesson Supplies:

- Garden Agreements Sign
- Group Activity Cards (6 cards: Sign Making, Plot Making, Planting in Plots 1-2 and 3-4, Mulch, and Vermicast Instructions)
- Bush bean seeds (96 per class plus extras; Note: Bush beans do not require a trellis while pole beans do)
- Water key
- Student Workbook



Student Worksheet: Garden Experiment Report: Part I

Teaching Team To Provide:

- Milk carton (1 per class)
- Chopsticks (12 per class)

School To Provide:

- Garden Journals (1 per student if not using Student Workbooks)
- 12 small garden tools to loosen soil
- Bucket and cups or hose for watering
- 4 pairs garden gloves
- 2 buckets for mulch collection and transportation
- Mulch (about 2 buckets per class; recommended types of mulch include decomposed leaves, grass clippings, "chop and drop" mulch plants (e.g., *Gliricidia sepium*), or composted mulch from Hawaiian Earth Products; raw wood chips are not recommended because of their tendency to draw nutrients from the soil, but may be used in the absence of any alternatives)
- Optional: Cover cloth (e.g., burlap bags)

ACCOMPANYING DOCUMENTS

- ĀINA Pre-Unit Survey
- Take Home Letter
- Guided Notes
- Background Information: The Importance of Soil
- Student Worksheet: Garden Experiment Report: Part I
- Class Data Sheet: Plant Health Observations

ADVANCE PREPARATION

- Discuss lesson preparation and presentation plans with your teaching team.
- Review the Background Information document.
- Make copies of the Class Data Sheet, one per class.
- Make copies of the Student Worksheet and Take Home Letter, one per student if not using the Student Workbook.
- **Assign students into 6 groups that they will continue to work in throughout this unit as they set up their experiment, collect their data and draw conclusions. Have a list ready with student names to assign to the 6 groups and label groups #1-6.**
- Allow students to explore their garden soil by having them dig with hands and tools and make careful observations. How does the soil feel and smell? What creatures live in our garden? Use the magnifying glasses to make close observations of the soil and soil life. Loosen the soil and remove any weeds from in and around the garden bed. Water the soil thoroughly one day before the lesson.
- Gather the mulch to be used for the experiment.
- Have students ready to take notes in their Student Workbooks or Garden Journals.

Class Data Sheet: Plant Health Observations

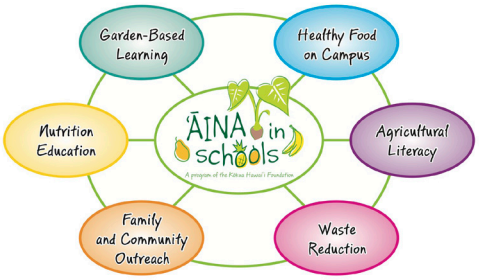
INTRODUCTION

20 MINUTES

"Aloha! We are... (state docents' names) with the ʻĀINA In Schools program. The ʻĀINA In Schools program connects us to our food and land so we can live healthy lives and be great stewards of the environment. ʻĀINA is an important Hawaiian word that means land and that which feeds, nourishes, and sustains us all, including food, water, and air."

"When we come to visit you, we will learn to take care of the ʻāina and grow healthy soil, plants, and food."

Get to know which ʻĀINA components are being implemented at your school so you can briefly refer to them in this section. For example, "Some other classes are exploring nutrition and food choices, some are reducing waste through composting, and some are visiting local farms to learn about where our food comes from."



"This semester we will be growing a scientific garden! We are going to plant beans and use science to answer some important questions about how to grow food and be successful gardeners."

During the discussion, write key terms on the board and have students take notes in their journals.

GARDENER-FARMER-SCIENTISTS

Discuss: "What do gardeners and scientists have in common?" Write Gardeners = Scientists.

- **Observation:** They OBSERVE the world around them with attention.
- **Data Collection:** They record DATA (observations, measurements, etc.) in order to keep track of changes over time and learn from past practices.
- **Experimentation:** They conduct EXPERIMENTS in order to test ideas and answer questions.

"Gardens can help us learn about nature and how to grow food because they are smaller-scale models of larger systems, such as farms and ecosystems. Gardeners and farmers *are* scientists!"

"This semester you all get to be gardener-scientists! Our goal is to learn how to grow healthy soil, healthy plants, and healthy food! SCIENCE is a way to gain knowledge through observation and experimentation. It can help us answer questions about how to be successful gardeners and better stewards of the environment."

VARIABLES THAT AFFECT PLANT GROWTH

"When we conduct a scientific experiment we test the effect of one or more VARIABLES, which are factors or conditions that are subject to change and may affect an experiment's outcome. What variables affect the growth of plants?" As students answer, write the list of variables on the board and have students list them in their journals. Examples include:

- Air (Carbon Dioxide/Oxygen)
- Water/Moisture/Humidity
- Light/Energy
- Weeds
- Space/Room to grow
- Singing/Talking/Positive or Negative Words
- Temperature
- Planting Time (of day, of year, moon cycles)
- Pollination
- Wind exposure
- Nutrients
- Diversity (e.g., variety of plant types, genetic diversity within a species, etc.)
- Synthetic chemicals/poisons
- Soil (e.g., type/composition of the soil, diversity of soil life, plants grown without soil such as in an aquaponics system, etc.)

Have students share about the soil observations they made in the garden before the lesson (see Advance Preparation).

INTRODUCTION CONTINUED

GARDEN EXPERIMENT DESIGN

"In our garden this semester we will plant and care for green beans! The variables that we are going to test in our garden experiment are mulch and vermicast, and the scientific question we are asking is: Will mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"

"What are MULCH and VERMICAST?" Desired answers: Mulch is any material used to cover the soil in order to preserve moisture and discourage weeds. Vermicast is castings (poop) from composting worms that is rich in soluble nutrients and microbial life.

Draw a diagram of the garden bed on the board and divide it into four plots (see diagram below). Have students draw the diagram with labels in their journals.

	No Vermicast	Vermicast
No Mulch	Plot 1	Plot 2
Mulch	Plot 3	Plot 4

"Plots 1 and 2 will have bare soil, while plots 3 and 4 will have mulch covering the soil. Plots 1 and 3 will have no vermicast added, while plots 2 and 4 will have vermicast added each month."

"After the lesson today you will have the opportunity to create your hypothesis to our scientific question using the Garden Experiment Report: Part I Student Worksheet."

GROUP ACTIVITIES OVERVIEW

Students will work together in their same groups throughout the unit. Assign students in equal numbers (about 3-6 students each) to the following groups:

Group 1: Plot Making
Group 2: Sign Making
Group 3: Plot 1 and 2 Planting
Group 4: Plot 3 and 4 Planting
Group 5: Adding Mulch (Plots 3 and 4)
Group 6: Adding Vermicast (Plots 2 and 4)

Assign one student to be a recorder for each group. Recorders should bring their journals and pencils out to the garden and record the activities of their group (e.g., today's date, number of seeds planted in their plot, etc.)

Garden Agreements
Have students take a deep breath, then repeat and discuss the Garden Agreements as listed on the Garden Agreements Sign. Spend some time during this first lesson to review with students the examples on page 2 of the sign.

- I will be SAFE
- I will be KIND
- I will have an OPEN MIND
- I will use my TIME WELL

Give the appropriate Group Activity Card to each group. Assign one student to read the Seed Planting Instructions Card to the four planting groups. Have all groups go to the garden to complete their assigned tasks.

GROUP ACTIVITIES

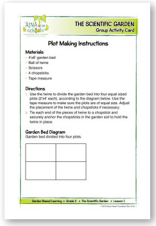
20 MINUTES

Have each group gather in their own area and read the instructions on their Group Activity Card together.

While the Plot and Sign Groups complete their tasks, have the four Seed Planting Groups count out their seeds (24 seeds per plot). Have the Mulch and Vermicast Group first, use buckets to collect their mulch (1 bucket per plot for Plots 3 and 4), and second, measure their vermicast (1/2 cup per plot for Plots 2 and 4)

Group 1: Plot Making

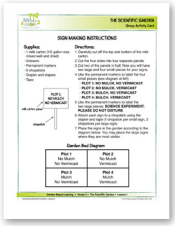
- Create the four experimental plots in the garden bed using twine and chopsticks, according to the instructions on the Plot Making Instructions Group Activity Card.



Plot Making Instructions

Group 2: Sign Making

- Cut the milk carton, label the panels, and attach them to the chopsticks according to the instructions on the Sign Making Instructions Group Activity Card.
- As soon as the signs are ready, place them in the garden to label the plots, according to the diagram on the Sign Making Instructions Group Activity Card.



Sign Making Instructions

Groups 3 & 4: Planting Plots 1-4

- In the appropriate plots, loosen the garden soil with small garden tools. Smooth over the soil so that it is completely level.
- Use the tape measures to create rows and holes for the seeds, according to the diagram and instructions on the Planting Instructions Group Activity Card
- Make sure the plots are labeled with the signs.
- Water the soil thoroughly. Avoid making puddles.

Planting Instructions

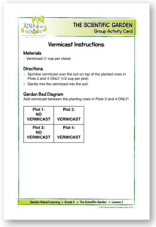
Group 5: Adding Mulch

- After the seeds have been planted, place mulch over the soil on both sides of each planting row in Plots 3 and 4 only, according to the instructions on the Mulch Instructions Group Activity Card.

Mulch Instructions

Group 6: Adding Vermicast

- Sprinkle vermicast over the soil on top of the planted rows in Plots and 4 only (1/2 cup per plot), according to the instructions on the Vermicast Instructions Group Activity Card.
- Gently mix the vermicast into the surface of the soil, being careful not to disturb the newly planted seeds (1" deep).



Vermicast Instructions

If students finish their tasks, have them make additional observations about the garden and record them in their journals.

Optional: Place a cover cloth over the planted seeds.

Students use tape measures to create the four experimental garden plots and to evenly space the planting of bush bean seeds in each plot.

CLOSING

5 MINUTES

Gather all the students in the garden. Ask them to share about their experience.

Discuss with students:

- What do gardeners, farmers, and scientists have in common?
- How do gardens represent larger-scale systems such as farms and natural ecosystems?
- What are our goals in conducting this garden experiment and what variables are being tested?
- Share your hypothesis (educated guess) on which plot will have the healthiest soil and plants and will produce the most food (green beans).

"Please take good care of your gardens and make sure to visit them every day to water the soil, make observations, and record them in your journals. It is very important that the soil stays moist. The seeds must have water to grow! They are your responsibility to care for as a class."

PLANT HEALTH OBSERVATIONS & DATA COLLECTION

"Also, as soon as your seeds sprout observe and record your observations, comparing the health of the plants in each plot. Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease. Use the Plant Health Observations Class Data Sheet to record your observations."

All students must wash their hands thoroughly with soap and water after working in the garden. Demonstrate the proper hand washing method: Wet, lather, and scrub hands and wrists with soap for 15 seconds (sing the ABC's), then rinse thoroughly. Be conscious of keeping hands clean after washing.

Determine a central location in the classroom to keep all Student Workbooks (or Student Worksheets, Class Data Sheets, and student journals). These are essential for students to collect data between lessons and draw conclusions during lesson 4.

Class Data Sheet:
Plant Health Observations

Seeds must stay constantly moist in order to grow.

FOLLOW UP GARDEN CARE

Follow Up Garden Care is the responsibility of the classroom teacher and students.

- Assign one or more **Garden Monitors** to water the garden and check for sprouts every day. Supplement as needed; it is critical that the soil stay evenly moist during sprouting. Feel the soil with your hand to a depth of about 2-3" to ensure that the soil is adequately moist.
- If the soil is covered with a cover cloth, remove it as soon as the first sprouts appear (within about 4 to 10 days). Hang to dry and store for future use.
- Remove weeds from in and around the garden bed.
- Students must wash their hands thoroughly with soap and water after working in the garden.

FOLLOW UP ACTIVITIES

Follow Up Activities are the responsibility of the classroom teacher.

- Have students visit the garden weekly to observe and record their observations on the Plant Health Observations Class Data Sheet, comparing the health of the plants in each plot. Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease. When assessing the leaf color, consider these guidelines:
  - The plant is healthy if most of the leaves are a vibrant/dark green color and new growth (small, healthy leaves) appears at the top of the stems.
  - The plant may be stressed (unhealthy) if most of the leaves are light green to yellow.
  - The presence of a few brown (dead) leaves is normal for the lower leaves on the bean plants. However, the plant may be dying if most of the leaves are brown.
- Have students complete the Garden Experiment Report: Part I Student Worksheet, using the following discussion sections as a guide to helping students answer the questions on the worksheet.
- **Scientific Method:**
  - Discuss with students the Scientific Method, which uses the following steps to systematically answer testable research questions (have students list the steps of the Scientific Method in their journals): 1) Question, 2) Hypothesis, 3) Experiment, 4) Collect and Analyze Data, 5) Conclusion.
- **Testable Research Questions:**
  - Discuss with students that a testable research question identifies a specific variable that will be tested. One example of a testable research question is, "Will my plants produce more food if I sing to them?" In this example a particular variable is selected (singing) in order to test its effect on the amount of food produced.
  - Have students think of and write down one or more examples of testable research questions.
  - Review the testable research question that is being asked in the garden experiment that was set up during the lesson: "Will mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"
- **Control & Variable Groups:**
  - Discuss with students the importance of creating a 'control' group and a 'variable' group so that the effect of the variable being tested can be seen. In the example mentioned in the previous section, the 'control' group of plants would not be sung to, and the 'variable' group of plants would be sung to. All other variables should remain constant.
  - The variables that are being tested in our garden experiment are mulch and vermicast. Plot 1 is the control group that does not receive either!
- **Hypothesis & Explanation:**
  - Discuss with students that a hypothesis is a statement or educated guess; it is your predicted answer to the question you are asking.
  - Have students create and record their hypotheses on the Student Worksheet, with explanation, for their garden experiment, according to the testable research question that is being asked.
- **Data Collection:**
  - It is essential to have students make and record daily or weekly observations in their scientific garden. Have students include detailed descriptions of what they observe, and include labeled drawings.
  - Examples of observations and data to collect from the garden (in order to answer the testable research question) include:
    - Soil Health: How does the soil look and feel? What kinds of soil life are observed?
    - Plant Health: Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease.
    - Amount of Food Produced: The Harvest Data Class Data Sheet will be introduced during Lesson 2 to enable students to record the quantity and weight of green beans harvested.
  - Remember, our goal is to grow healthy soil, plants, and food!

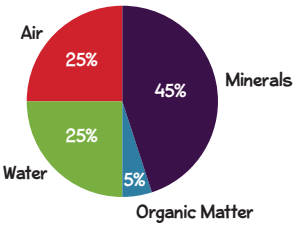
LESSON EXTENSIONS

Rain Gauge
(5.W.7, 5.SL.1, Developing and Using Models, Analyzing and Interpreting Data)

1. Have students make a rain gauge, place it in the garden, and measure and record rainfall daily in order to study an additional and important variable, water. Discuss the results as a class.
2. Materials: plastic bottle, scissors, stake (e.g., paint mixing stick), strong tape, ruler, data table (create).
    1. Use the scissors to carefully cut the top off of the water bottle, just above the top of the label.
    2. Tape the stake to the outside of the water bottle so that the top of the stake is level with the top of the rain gauge (opening of the bottle), and the bottom half of the stake can be submerged in the soil in the garden.
    3. Place the rain gauge securely into the garden soil. Have students use the ruler and data table to measure and record daily rainfall by placing the ruler into the open bottle and measuring the level of water (in inches or centimeters). Be sure that they measure before watering and empty the bottle after watering in case water from the hose gets into the rain gauge (or place it in an area that will not receive irrigation). Collecting rainfall data in the morning will minimize loss of water due to evaporation.

Soil Investigation
(5.SL.1)

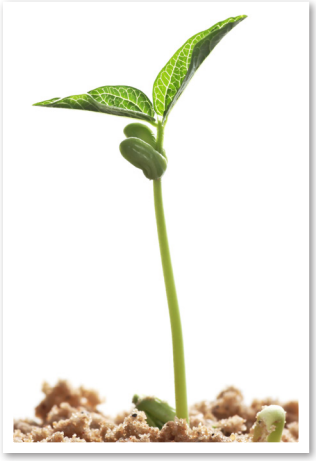
1. Discuss with students: "What is soil made of?" Draw the pie chart as you explain that on average, soil contains these ratios of:
    - 45% Minerals (the "body" of the Earth: sand, silt, and clay)
    - 5% Organic Matter (organic mulch, compost, worms and other soil life)
    - 25% Air ("pores" or spaces between soil particles)
    - 25% Water (an essential component for life)



2. With a healthy balance of each of these components, soil life, plants, and people will thrive!

Life's Miracle In Time Lapse
(5.W.1, 5.W.2, 5.SL.1, Obtaining, Evaluating, and Communicating Information)

1. Show students a time lapse video (e.g., YouTube) of bean plants sprouting. Have them watch it several times, recording observations as they watch. What new observations do they notice each time?
2. Have students write a reflection (e.g., opinion piece, poem, story) about what they have seen.
3. Discuss with students:
    - What feelings did you experience by watching a seed grow into a plant?
    - What part of the plant begins to grow first?
    - Did you notice how quickly the stem starts to grow once the roots are established?
    - How does the soil look? Dry or moist, dark or light colored? What is the role of moisture in causing the seed to sprout and the plant to grow?
    - Point out the difference between cotyledons and the true leaves of each seedling. Cotyledons are "seed leaves" that are the first to emerge after germination. They are formed from the two halves of the seed attached to the plant embryo. Usually they will fall off as the rest of the plant grows. The true leaves form after the cotyledons and have a distinct shape, which can be recognized according to the species of plant.



Cotyledons (or "seed leaves," the lower, rounded pair of "leaves" pictured above) emerge first, then the "true leaves" (upper, pointed leaves) by which different plant types can be distinguished.

THE SCIENTIFIC GARDEN

Lesson 1 * Gardeners Are Scientists

Name .....

Class ..... Date .....

KEY TERMS AND CONCEPTS

‘Āina - Land; that which feeds, nourishes, and sustains us (e.g., food, water, air)

Data - Facts, statistics, or items of information collected for reference or analysis

Experiment - To try or test, especially in order to discover or prove something

Mulch - Any material that is used to cover the soil for beneficial purposes including preserving moisture and discouraging weeds

Observe - To see, perceive, or notice; to regard with attention

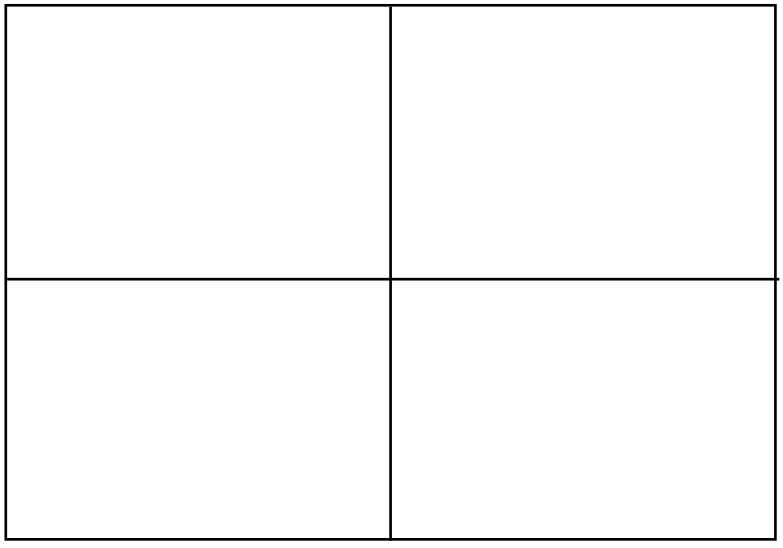
Science - Systematic knowledge gained through observation and experimentation

Variable - A factor or condition that is subject to change, especially one that is allowed to change in a scientific experiment in order to test a hypothesis

Vermicast - Castings (poop) from composting worms; rich in soluble nutrients and microbial life (microorganisms); enhances plant growth and health

Part 1 Directions: Use this space to record your notes, drawings, and observations.

Part 2 Directions: Use this space to draw a diagram of the four plots in your garden bed. Label the number of each plot and label if the plot contains mulch and/or vermicast.



The Importance Of Soil

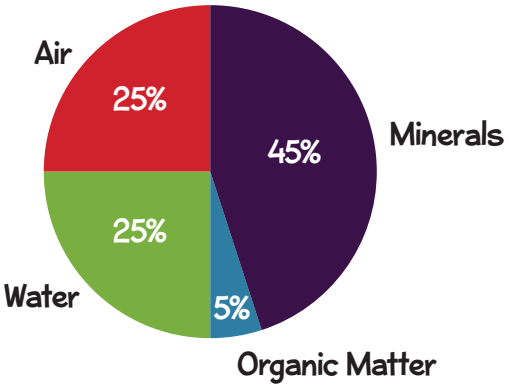
Soil is the foundation of life on the planet. Our life depends on our understanding of soil and how we treat it.

SOIL SERVES THESE IMPORTANT PURPOSES:

1. Medium for plant growth.
2. Habitat for soil organisms.
3. Recycling system for nutrients (consumption and decomposition).
4. Water supply and purification (soil management impacts water quality).
5. Engineering medium (used by humans for building with and on).
6. Mediates/modifies the atmosphere (what we do to soil impacts our atmosphere; e.g., tilling the soil stimulates the growth of microbes, which increases the decomposition rate of organic matter in the soil, leading to the increased release of carbon dioxide via an increase in respiration).

THE FOUR MAIN COMPONENTS OF SOIL

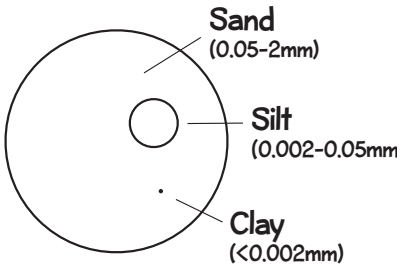
The four components of soil exist, on average, in the following ratios:



SOIL COMPONENTS EXPLAINED

Minerals = 45%

- Minerals represent the 'body' of the Earth in the soil! Mineral particles in the soil come from the weathering of the earth (rocks, coral, etc.).
- Soil Particles:
  - Soil texture is determined by the size of the particles of which the soil is composed. Soils contain a mixture of sand, silt, and clay particles. The different sizes of these particles affects the properties of soil, including drainage ('porosity'), and water and nutrient retention. The diagram below shows the relative soil particle sizes (diameter).



Relative soil particle sizes.

- Sand is the largest particle, giving soil a gritty feel.
- Silt particles are about the size of a particle of white flour; they give soil a smooth, floury feel.
- Clay particles are the smallest, about the size of bacteria and viruses, and can only be seen with a microscope. Soils rich in clay feel hard when dry and are easily shaped and molded when moist.
- Nearly all soils contain a mixture of particle sizes and have a pore network (spaces between the particles) containing a mixture of pore sizes.
- A generally good quality garden soil has an equal influence of all three particle types and is called 'loam.'

Organic Matter = 5%

- Organic matter in the soil is any material that originates from life/living organisms.
- It is either living (i.e. soil organisms such as worms and bacteria) or formally living (i.e. fallen leaves, compost, dead insects, etc.). Within the organic matter component of the soil, these approximate/average ratios exist:
  - Living organisms = <5%
  - Fresh organic residue = <10%
  - Active organic matter = 33-50% (simple compounds such as amino acids and proteins that feed soil organisms)
  - Stabilized organic matter = 33-50% (humic compounds which may be thousands of years old; the 'back bone')
- Adding organic matter to the soil (mainly in the form of compost and mulch) is the best way to improve the living environment for plants in nearly all soils.
- Organic matter helps build and stabilize soil structure, improving the soil drainage (permeability) as well as water and nutrient retention.

Air = 25%

- Air in the soil exists in the 'pores' or spaces between soil particles.
- Plant roots breathe oxygen, just like we do! Therefore there must be a sufficient level of air ('aeration') in the soil.
- What happens when we step on the garden soil or when a truck or tractor drives over the soil on a farm or in the school yard? The soil is compacted: the particles are pushed together, eliminating pore space between the particles. This leaves much less room for air and water in the soil. This is why plants thrive in soft soils that do not receive compaction. Be sure not to step in your garden bed!

Well defined garden pathways are important for avoiding compaction and maintaining healthy soil.

Water = 25%

- Water is an essential ingredient for ALL life!
- Water is an essential ingredient in photosynthesis, the process that enables plants to convert the sun's energy into carbohydrates and oxygen.
- Explore photosynthesis with students.

Carbon Dioxide + Water + Energy
=
Oxygen + Carbohydrates

- It is essential that people understand the importance of water and manage it well. For example:
  - Do not over water your garden.
  - Collect rainwater to use for irrigation.
  - Understand your watershed and the flow of water through your ahupua'a (watershed) as well as our impact in positive and negative ways.

IMPROVING SOIL HEALTH

- Healthy soil holds moisture well, drains well, and grows healthy plants that have few or no problems with pests and diseases. Healthy soil is full of life!
- A general rule for improving soil health is to add organic matter! Examples of ways to do this include incorporating living compost (produced on-site vs. commercial sterile compost) into the soil, fertilizing garden soil with vermicast (worm casting which contain an abundance of beneficial microbial life), and placing organic mulch over bare soil in order to retain moisture, discourage weeds, and supply a food source for soil life.

FURTHER INFORMATION

- *Dirt! The Movie* is a thought provoking film to watch with students. Educational resources including further information, film screening discussion guide, teacher notes, student worksheets, lesson plans, soil songs, and more are available here: https://www-tc.pbs.org/independentlens/dirt-the-movie/resources/dirt_discussion.pdf.
- An excellent resource for in-depth learning about the soil food web and its critical role in nutrient cycling (sustainability) is the book entitled, *Teaming With Microbes: The Organic Gardener's Guide to the Soil Food Web* by Jeff Lowenfels and Wayne Lewis.

Name .....

Class ..... Date .....

Garden Experiment Report: Part I

Directions: Fill in your answers to the questions below. Use additional paper if you need more space to complete your answers.

1. Question: The testable research question that is being asked in our garden experiment is:

"Will mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"

2. Hypothesis: What is your hypothesis (your educated guess in answering the question above)? Include an explanation of why you believe your hypothesis to be true.

3. Experiment: How was the experiment set up? Draw a diagram and include a description of the plots that have been created in your Scientific Garden.

4. Data Collection: Collect data each week in your Scientific Garden in order to help answer the testable research question. Record data in your journal.

Examples of data to collect include:

- **Soil Health:** How does the soil look and feel? What kinds (number and diversity) of soil life are observed?
- **Plant Health:** Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease.
- **Amount and Quality of Food Produced:** Starting after Lesson 2, use the Green Bean Harvest Sign and Harvest Data Class Data Sheet to record the quantity, weight, and quality of green beans harvested from each plot.

Garden Experiment Report: Part II

Directions: Fill in your answers to the questions below. Use additional paper if you need more space to complete your answers.

5. Results: As a class, you discussed the results shown by the data collected from the Scientific Garden. Briefly describe the results presented by each group (i.e., which plot(s) produced the most desirable results):

Organic Matter Results:

Soil Life Diversity and Abundance Results:

Plant Health Results:

Harvest Results: Quantity of Green Beans:

Harvest Results: Weight of Green Beans:

Harvest Results: Quality of Green Beans:

6. Conclusion: Describe your conclusion to the garden experiment by answering our scientific question, **"Did mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"**. Was your hypothesis true or false?

7. Lessons Learned: Describe what you learned from the garden experiment.

8. Further Study: List two scientific questions that you would be interested in finding out the answer to:

Class Data Sheet

THE SCIENTIFIC GARDEN

Lesson 1 * Gardeners as Scientists

Name .....

Class ..... Date .....

Plant Health Observations

Directions:

1. Visit your garden plot weekly to observe and record your observations, compare the health of the plants in each plot. Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease. When assessing the leaf color, consider these guidelines:
   - The plant is healthy if most of the leaves are a vibrant/dark green color and new growth (small, healthy leaves) appears at the top of the stems.
   - The plant may be stressed (unhealthy) if most of the leaves are light green to yellow.
   - The presence of a few brown (dead) leaves is normal for the lower leaves on the bean plants. However, the plant may be dying if most of the leaves are brown.
2. In the columns below include detailed descriptions of what you observe in each plot.
3. If you run out of space in the data tables ask your teacher to give you a blank sheet.

Date	Plot 1	Plot 2	Plot 3	Plot 4

Class Data Sheet

THE SCIENTIFIC GARDEN

Lesson 1 * Gardeners as Scientists

Name .....

Class ..... Date .....

Plant Health Observations

Date	Plot 1	Plot 2	Plot 3	Plot 4

Grade 5

THE SCIENTIFIC GARDEN

Lesson 2 * Soil and Organic Matter

DESCRIPTION

Students will discuss their garden observations as well as their scientific questions and hypotheses. They will discuss the importance of healthy soil and organic matter. In the garden they will conduct soil sample experiments in order to study the amount of organic matter in different samples of soil. Students will care for their garden by adding mulch and vermicast in the appropriate plots, watering plots equally, and removing weeds.

TIME: 45 minutes

SUBJECTS: Language Arts, Science

LEARNING OBJECTIVES

After this lesson students will be able to:

- Understand the meaning of the term 'organic' and how it relates to agriculture.
- Recognize that decaying organic matter is an essential food source for living soil organisms.
- Understand that healthy soil is important for growing healthy plants.
- Conduct a soil sample experiment.

ACADEMIC STANDARDS*

CCSS, Language Arts:
5.W.1, 5.W.2, 5.W.7, 5.W.10
NGSS: LS2.A, Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data, Developing and Using Models, Patterns, Systems and System Models Lesson
Lesson Extensions: 5.W.2, 5.W.7, 5.SL.1

*A detailed list of the Academic Standards can be found in the Unit Overview document

LESSON OUTLINE

I. Introduction (20 minutes)
1. Science Experiment Review
2. The Importance of Healthy Soil
3. Organic Matter
4. Group Activities Overview

II. Group Activities (20 minutes)
1. Soil Sample Experiment (10 minutes)
2. Garden Care (10 minutes)

III. Closing (5 minutes)
1. Green Bean Harvest Data Collection

KEY TERMS AND CONCEPTS

Microorganisms - Any organism too small to be seen by the unaided eye, such as bacteria, protozoa, and some fungi and algae

Organic - Of or relating to an organism, a living entity

Organic Farming - A form of agriculture which uses nature-based techniques (such as crop rotation and composting) to maintain soil fertility, and which excludes or strictly limits the use of manufactured inputs (such as pesticides, fertilizers, and genetically modified organisms)

Organic Matter - Material that is either living (e.g., worms, roots, and bacteria), or that originated from life (e.g., fallen leaves, dead roots, and dead insects)

LESSON MATERIALS

Community Supplies:

- 2 permanent markers
- Measuring cup set
- Vermicast (1 cup per class)
- Hanging scale (to weigh green beans harvested)

Lesson Supplies:

- Jars of equal size, with lids (6 per class)
- Soil Sample Experiment Instructions Card
- Garden Agreements Sign
- Green Bean Harvest Sign
- Student Workbook

School To Provide:

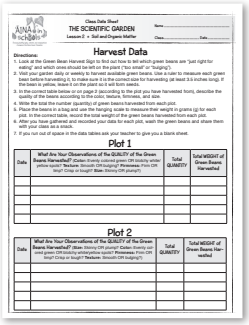
- Garden Journals (1 per student if not using Student Workbooks)
- 6 small garden tools
- 2 shovels (for harvesting compost and campus soil samples)
- Bucket and cups or hose for watering
- Mulch (about 2 buckets per class if needed to replenish in Plots 2 and 4; recommended types of mulch include decomposed leaves, grass clippings, "chop and drop" mulch plants (e.g., *Gliricidia sepium*), or composted mulch from Hawaiian Earth Products; raw wood chips are not recommended but may be used in the absence of any alternatives)

ACCOMPANYING DOCUMENTS

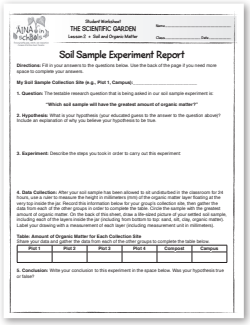
- Guided Notes
- Student Worksheet: Soil Sample Experiment Report
- Class Data Sheet: Harvest Data

ADVANCE PREPARATION

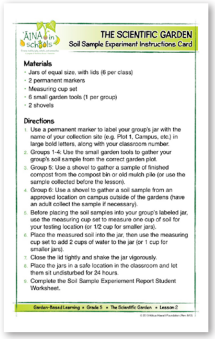
- Discuss lesson preparation and presentation plans with your teaching team.
- Make copies of the Class Data Sheet, one per class.
- Make copies of the Student Worksheet, one per student if not using the Student Workbook.
- Harvest a sample of finished compost from the school's compost bin or old mulch pile for Group 5's soil sample (or have students do this during the lesson).
- Determine a locations on campus, outside of the gardens, where Group 6 will take their soil sample (see Introduction and Group Activities sections for details).
- Have students ready to take notes in their Student Workbooks or Garden Journals.



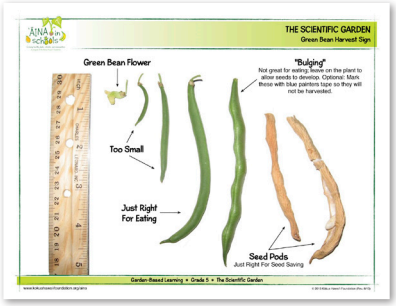
Class Data Sheet: Harvest Data



Student Worksheet: Soil Sample Experiment Report



Soil Sample Experiment Instructions Card



Green Bean Harvest Sign

INTRODUCTION

20 MINUTES

During the discussion, write key terms on the board and have students take notes in their Student Workbooks or journals.

SCIENCE EXPERIMENT REVIEW

"What is the goal of our garden experiment?" Desired answer: To learn how to grow healthy soil, plants, and food!

Have students bring out their Student Worksheets from Lesson 1 and share their hypotheses to the scientific question that is being asked. Have students share some observations they have made and data they have recorded in their journals since Lesson 1. Ask students to share whether they have observed any differences so far between the soil or plants in each of the experimental garden plots.

PLANT HEALTH OBSERVATIONS CHECK IN

Have students turn to the Plant Health Observations Class Data Sheet in their Student Workbooks. Ask students to share some observations of the health of their plants. Review the attributes of healthy plants such as the vibrant/deep green color of leaves and new growth appearing at the top of stems. Ask students to share some other characteristics of healthy plants.

THE IMPORTANCE OF HEALTHY SOIL

"Did you know that soil is one of the most important variables in the garden? It is so important, in fact, that some people say that a successful gardener or farmer doesn't grow food, she or he grows healthy soil! This is because healthy soil grows healthy plants and food."

"How can you tell if your soil is healthy?" Desired answers:

- It holds moisture well.
- It drains well.
- The plants are healthy with few or no problems with pests and diseases.
- It is full of life!

"One important way to improve soil health is to add organic matter."

ORGANIC MATTER

Discuss: "What does the term ORGANIC mean?"

- ORGANIC refers to life, or organisms, which are living things like people, plants, animals, insects, and MICROORGANISMS, which are organisms too small to be seen by the unaided eye.
- ORGANIC FARMING is a form of agriculture that respects life and works with nature to maintain healthy, living soil while producing food.
- Organic food is food grown without the use of toxic chemicals (pesticides, fertilizers, genetically modified organisms (GMOs)).

Discuss: "What is ORGANIC MATTER in the soil?"

- ORGANIC MATTER in the soil is any material that is either living (like worms, roots, and bacteria), or that originated from living organisms (like fallen leaves, dead roots, and dead insects).
- Decaying organic matter is a very important food source for soil life.
- Living soil organisms break down organic matter, recycling nutrients and making them available to plants.

Discuss: "How can we add organic matter to the soil?"

- Cover the soil with organic mulch (Plots 3 and 4).
- Add compost to the soil.
- Add vermicast to the soil (Plots 2 and 4).

GROUP ACTIVITIES OVERVIEW

"Today we will conduct a soil sample experiment, taking samples from each garden plot and from our compost pile and one location on campus outside of the garden. Our scientific question is: Which soil sample will have the greatest amount of organic matter?"

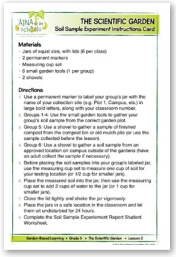
"We will also care for the gardens by adding mulch and vermicast in the appropriate plots, watering the plots equally (in order to keep the water variable constant among all experimental plots), and removing weeds."

INTRODUCTION

CONTINUED

Assign students to the following six groups according to their groups set in Lesson 1.

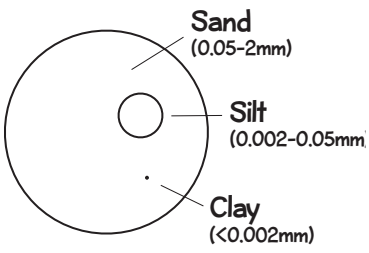
Group 1: Plot 1 Soil Sample Experiment
Group 2: Plot 2 Soil Sample Experiment
Group 3: Plot 3 Soil Sample Experiment
Group 4: Plot 4 Soil Sample Experiment
Group 5: Compost Pile Soil Sample Experiment
Group 6: Other Campus Location Soil Sample Experiment



Soil Sample Experiment Instructions Card

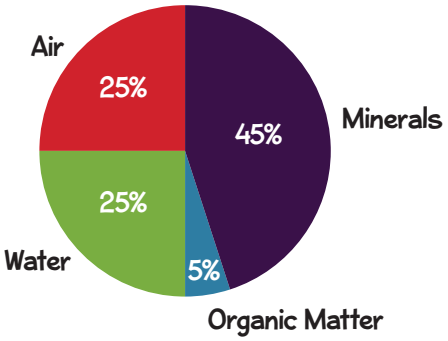
Have a student volunteer read the Soil Sample Experiment Instructions Card to the class.

Briefly explain that soil consists of different sized particles, from largest to smallest: sand, silt, and clay. Different types of soil have varying amounts of each particle type, as well as the amount of organic matter. By using this simple technique to conduct a soil sample experiment, it is possible to determine the amount of sand, silt, clay, and organic matter in each sample. Soil particles will settle in layers inside the jars according to their size, with sand (the largest and heaviest particle) settling at the bottom, then a layer of silt, then clay. The organic matter will float in a layer on top of the water inside the jar. Students will measure this layer in order to compare the different amounts of organic matter in each soil sample.



Relative soil particle sizes.

Refer to the Background Information: The Importance of Soil document from Lesson 1 for more information on the four main components of soil.



The four main components of soil in their average ratios.

Garden Agreements

Have students take a deep breath, then review the Garden Agreements:

- I will be SAFE
- I will be KIND
- I will have an OPEN MIND
- I will use my TIME WELL

Give one jar to each group and have students label the jars with the name of their group's collection site and their classroom number, using the permanent makers. Bring the Soil Sample Experiment Instructions Card for reference.

Organic Matter
Water
Clay
Silt
Sand

GROUP ACTIVITIES

20 MINUTES

SOIL SAMPLE EXPERIMENT *(10 minutes)*

Have the groups follow the directions provided on the Soil Sample Experiment Instructions Card in order to collect a soil sample from their assigned location.

1. Have students use a permanent marker to label their group's jar with the name of their collection site (e.g., Plot 1, Campus) in large bold letters, along with their classroom number.
2. Groups 1-4: Have students use the small garden tools to gather their soil sample from the correct garden plots. Dig straight down into the soil (about 6") in order to gather the sample from the soil surface and root zone.

3. Group 5: Use a shovel to gather a sample of finished compost from the compost bin or old mulch pile (or use the sample collected before the lesson).
4. Group 6: Use a shovel to gather a soil sample from an approved location on campus outside of the gardens (have an adult collect the sample if necessary).
5. Before placing the soil samples into the labeled jars, have each group use the measuring cup set to measure one cup of soil for their testing location (or 1/2 cup for smaller jars).

6. Have each group place the measured soil into their jar, then use the measuring cup set to add 2 cups of water to the jar (or 1 cup for smaller jars).
7. Close the lids tightly and shake the jars vigorously.

8. Place the jars in a safe location in the classroom and let them sit undisturbed for 24 hours.

GARDEN CARE *(10 minutes)*

After conducting their soil sample experiments, students may remain in their groups in order to complete the following tasks.

1. **Mulch (2 groups, for Plots 3 and 4):** If necessary (to replenish mulch added during Lesson 1), place mulch over the soil on both sides of the planting rows in Plots 3 and 4 only.
2. **Vermicast (2 groups, for Plots 2 and 4):** Sprinkle vermicast over the soil on top of the planted rows in Plots 2 and 4 only (1/2 cup per plot). Gently mix the vermicast into the surface of the soil around the base of each bean plant, being careful not to disturb the roots.
3. **Water (1 group):** Use the buckets and cups or hose to water all four garden plots with an equal amount of water.
4. **Remove Weeds (1 group):** Remove weeds from in and around the garden bed.

Moments after shaking, some of the largest particles (sand and silt) have begun to settle at the bottom. Smaller particles (clay) will settle within 24 to 48 hours of sitting undisturbed, as organic matter is also separated out in a layer at the very top.

CLOSING

5 MINUTES

Gather all students in the garden. Ask them to share about their experience.

Discuss with students:

- Describe the term ORGANIC and how it relates to agriculture.
- What is ORGANIC MATTER and why is it important?
- What is the scientific question that is being asked in our soil sample experiment?
- What is your hypothesis to our scientific question for this experiment: "Which soil sample will have the greatest amount of organic matter?"

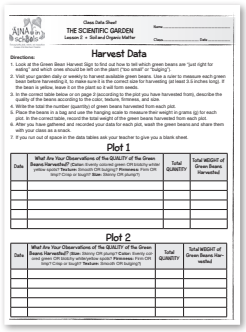
"Please take good care of your gardens and make sure to visit them every day to water the soil, make observations, and record them in your Student Workbooks. It is very important that the soil stays moist. The plants are your responsibility to care for as a class."

GREEN BEAN HARVEST DATA COLLECTION

"Also, look closely for any green beans that begin to form and grow. Use the Green Bean Harvest Sign to determine which beans to harvest. Record data on the quality of the green beans harvested, quantity or amount of green beans harvest, and the weight on the Harvest Data Class Data Sheet in order to help answer our larger scientific question: Will mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"

When assessing the quality of green beans harvested, consider the following guidelines:

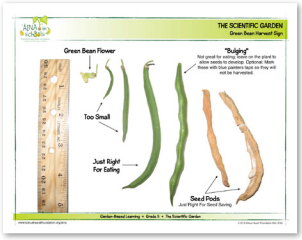
- **Color:** Are the green beans evenly colored a vibrant green OR are there blotchy white/yellow spots?
- **Texture:** Are the green beans smooth OR are they rough "rust"?
- **Firmness:** Are the green beans strong and firm OR limp? Are they crisp or tough?
- **Size:** Are the green beans skinny OR bulging?


Harvest Data

Plot 1

Plot 2

Class Data Sheet: Harvest Data



Green Bean Harvest Sign

All students must wash their hands thoroughly with soap and water after working in the garden.

Collect all Student Workbooks and Class Data Sheets (or Student Worksheets, Class Data Sheets, and student journals). Store in a central location in the classroom where students have access to them for weekly observation and data collection.

FOLLOW UP GARDEN CARE

Follow Up Garden Care is the responsibility of the classroom teacher and students.

- Continue to have Garden Monitors and other students visit and water the garden daily.
- In preparation for harvesting as soon as the first green beans are ready, review the Green Bean Harvest Sign with students in order to find out how to tell which green beans should be harvested ("just right for eating") and which should be left on the plant ("too small" or "bulging").
- Have students use the Harvest Data Class Data Sheet to record harvested green bean quality, the total number of green beans harvested from each plot, and the weight of green beans harvested from each plot.
- Remove weeds from in and around the garden bed.
- Students must wash their hands thoroughly with soap and water after working in the garden.

FOLLOW UP ACTIVITIES

Follow Up Activities are the responsibility of the classroom teacher.

- Have students visit the garden weekly to observe and record their observations on the Plant Health Observations Class Data Sheet, comparing the health of the plants in each plot. Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease. When assessing the leaf color, consider these guidelines:
  - The plant is healthy if most of the leaves are a vibrant/dark green color and new growth (small, healthy leaves) appears at the top of the stems.
  - The plant may be stressed (unhealthy) if most of the leaves are light green to yellow.
  - The presence of a few brown (dead) leaves is normal for the lower leaves on the bean plants. However, the plant may be dying if most of the leaves are brown.
- Have students complete the Soil Sample Experiment Report Student Worksheet, using the following discussion sections as a guide to helping students answer the questions on the worksheet.
  - **Scientific Method:** Review the steps of the Scientific Method with students.
  - **Testable Research Question:** Review with students the scientific question that is being asked in the soil sample experiment: "Which soil sample will have the greatest amount of organic matter?"
  - **Data Collection and Conclusion:** After the contents have settled (undisturbed in a safe location in the classroom for 24 hours), assist students in measuring the organic matter layers in their jars (in millimeters, mm), recording the data on their Student Worksheets, comparing the results from the different samples, and forming their conclusions.

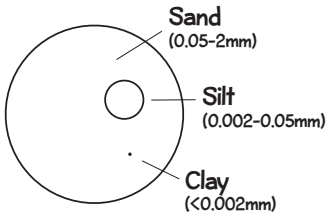
Green leaves and new growth on a healthy bean plant.

After settling for at least 24 hours, organic matter has formed a distinct layer at the very top inside the jars.

LESSON EXTENSIONS

Minerals In Soil
(5.W.2, 5.W.7, 5.SL.1)

1. Discuss with students:
   - The different types of minerals in soil are sand (large particles, 2.0-.05mm), silt (medium sized particles, .05-.002mm), and clay (microscopic particles, <.002mm).
   - Different combinations and amounts of these minerals give soil different characteristics (for example, how well it retains or drains water and nutrients).
2. Use visual aids to compare the relative size of each mineral type. If a particle of sand were the size of a beach ball, a particle of silt would be the size of a baseball, and a particle of clay would be the size of a bead!



3. Help students use this information to interpret the layers in their settled soil samples, collected during the lesson. Sand particles are the heaviest of the three and settle out first at the bottom of the jar. Silt is the next heaviest particle and will settle in a layer above the sand. The silt layer is darker than the sand. Clay, the lightest particle in the mix, can take from one to two days to settle out of the solution. The clay layer that settles on top of the others is extremely fine textured and light in color. Organic matter in the sample will float to the very top.
4. Discuss how soil mineral particles are created (through weathering, erosion, etc.).
5. Have students take notes and write explanatory texts based on their observations and the discussion.

Measuring Soil pH Levels
(5.W.2, 5.W.7, 5.SL.1)

1. Discuss with students:
   - Soil pH is a measurement on a scale from acid (low pH) to alkaline (high pH).
   - Soil pH has a direct affect on plant health, because it determines the availability of nutrients that plants can use!
   - In general, the ideal soil pH level for garden plants is 6 to 6.5.
2. Have students take a soil sample from each of the four plots and submit them for testing by the University of Hawai'i Agricultural Diagnostic Service Center in order to discover the soil pH (and other available information if desired).
   - Follow the instructions on this document: https://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-9.pdf. Submit the form contained in the document.
   - When the results are returned, have students compare and discuss the results as a class, then write informative/explanatory texts based on the experiment and discussion.

Name .....

Class ..... Date .....

KEY TERMS AND CONCEPTS

Microorganisms - Any organism too small to be seen by the unaided eye such as bacteria protozoa and some fungi and algae

Organic - Of or relating to an organism, a living entity

Organic Farming - A form of agriculture which uses nature-based techniques (such as crop rotation and composting) to maintain soil fertility, and which excludes or strictly limits the use of manufactured inputs (such as pesticides, fertilizers, and genetically modified organisms)

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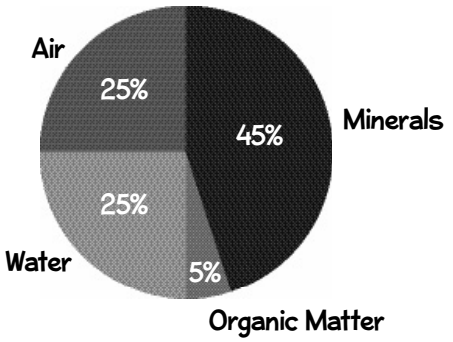
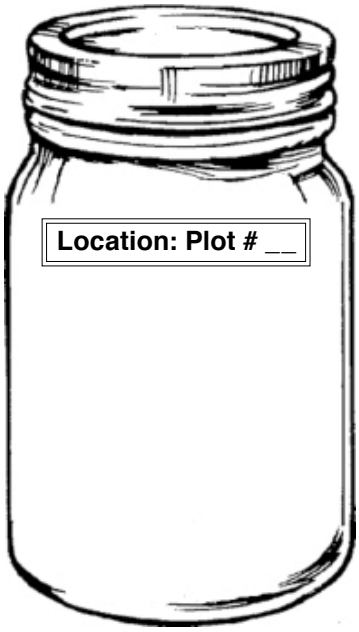


The four main components of soil in their average ratios.

Part 1 Directions: Use this space to record your notes, drawings, and observations.

Part 2 Directions: Draw the results of your soil experiment here. (Label: sand, silt, clay, water, and organic matter)



Soil Sample Experiment Report

Directions: Fill in your answers to the questions below. Use the back of the page if you need more space to complete your answers.

My Soil Sample Collection Site (e.g., Plot 1, Campus):_____

1. Question: The testable research question that is being asked in our soil sample experiment is:

"Which soil sample will have the greatest amount of organic matter?"

2. Hypothesis: What is your hypothesis (your educated guess to the answer to the question above)? Include an explanation of why you believe your hypothesis to be true.

3. Experiment: Describe the steps you took in order to carry out this experiment:

4. Data Collection: After your soil sample has been allowed to sit undisturbed in the classroom for 24 hours, use a ruler to measure the height in millimeters (mm) of the organic matter layer floating at the very top inside the jar. Record this information below for your group's collection site, then gather the data from each of the other groups in order to complete the table. Circle the sample with the greatest amount of organic matter. On the back of this sheet, draw a life-sized picture of your settled soil sample, including each of the layers inside the jar (including from bottom to top: sand, silt, clay, organic matter). Label your drawing with a measurement of each layer (including measurement unit in millimeters).

Table: Amount of Organic Matter for Each Collection Site
Share your data and gather the data from each of the other groups to complete the table below.

Plot 1	Plot 2	Plot 3	Plot 4	Compost	Campus

5. Conclusion: Write your conclusion to this experiment in the space below. Was your hypothesis true or false?

Name .....

Class ..... Date .....

Harvest Data

Directions:

1. Look at the Green Bean Harvest Sign to find out how to tell which green beans are "just right for eating" and which ones should be left on the plant ("too small" or "bulging").
2. Visit your garden daily or weekly to harvest available green beans. Use a ruler to measure each green bean before harvesting it, to make sure it is the correct size for harvesting (at least 3.5 inches long). If the bean is yellow, leave it on the plant so it will form seeds.
3. In the correct table below or on page 2 (according to the plot you have harvested from), describe the quality of the beans according to the color, texture, firmness, and size.
4. Write the total the number (quantity) of green beans harvested from each plot.
5. Place the beans in a bag and use the hanging scale to measure their weight in grams (g) for each plot. In the correct table, record the total weight of the green beans harvested from each plot.
6. After you have gathered and recorded your data for each plot, wash the green beans and share them with your class as a snack.
7. If you run out of space in the data tables ask your teacher to give you a blank sheet.

Plot 1

Date	What Are Your Observations of the QUALITY of the Green Beans Harvested? (**Color:** Evenly colored green OR blotchy white/ yellow spots? **Texture:** Smooth OR rough "rust"? **Firmness:** Firm OR limp? Crisp or tough? **Size:** Skinny OR bulging?)	Total QUANTITY	Total WEIGHT of Green Beans Harvested

Plot 2

Date	What Are Your Observations of the QUALITY of the Green Beans Harvested? (**Color:** Evenly colored green OR blotchy white/ yellow spots? **Texture:** Smooth OR rough "rust"? **Firmness:** Firm OR limp? Crisp or tough? **Size:** Skinny OR bulging?)	Total QUANTITY	Total WEIGHT of Green Beans Harvested

Name .....

Class ..... Date .....

Harvest Data

Plot 3

Date	What Are Your Observations of the QUALITY of the Green Beans Harvested? (**Color:** Evenly colored green OR blotchy white/yellow spots? **Texture:** Smooth OR rough "rust"? **Firmness:** Firm OR limp? Crisp or tough? **Size:** Skinny OR bulging?)	Total QUANTITY	Total WEIGHT of Green Beans Harvested

Plot 4

Date	What Are Your Observations of the QUALITY of the Green Beans Harvested? (**Color:** Evenly colored green OR blotchy white/yellow spots? **Texture:** Smooth OR rough "rust"? **Firmness:** Firm OR limp? Crisp or tough? **Size:** Skinny OR bulging?	Total QUANTITY	Total WEIGHT of Green Beans Harvested

Grade 5

THE SCIENTIFIC GARDEN

Lesson 3 * Soil Food Web

DESCRIPTION

Students will review the goal of their garden experiment, share observations made, and discuss the importance of healthy soil and the soil food web. They will be introduced to the soil "F.B.I." (fungi, bacteria, and invertebrates) and discuss the important role of decomposers. In the garden students will observe and collect data on soil life, care for their garden, harvest available green beans, and continue their scientific experiment.

TIME: 45 minutes

SUBJECTS: Language Arts, Science

LEARNING OBJECTIVES

After this lesson students will be able to:

- Understand that healthy soil is full of life.
- Describe and draw a simple diagram of the soil food web.
- Explain that through the work of decomposers (decomposition), nutrients are recycled and made available to plants.
- Make careful observations in the garden and record garden data.

ACADEMIC STANDARDS*

CCSS, Language Arts: 5.W.7, 5.W.10 **NGSS:** LS2.A, Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data, Developing and Using Models, Patterns, Systems and System Models Lesson **Lesson Extensions:** 5.RI.3, 5.W.1, 5.W.2, 5.W.7, 5.W.10, 5.SL.1, 5.SL.5

*A detailed list of the Academic Standards can be found in the Unit Overview document

LESSON OUTLINE

I. Introduction (20 minutes)
   1. Science Experiment Review
   2. Healthy Soil Review
   3. Soil Food Web
   4. Decomposers
   5. Group Activities Overview

II. Group Activities (20 minutes)
   1. Soil Life Observations and Data (10 minutes)
   2. Garden Care (10 minutes)

III. Closing (5 minutes)

KEY TERMS AND CONCEPTS

Bacteria - Unicellular organisms; widely distributed in soil, water, air, and on or in the tissues of plants and animals

Consumers - Organisms that eat other living things (e.g., animals, insects, some plants)

Decomposers - Organisms that break down organic matter and carry out decomposition (e.g., fungi, bacteria, invertebrates)

Decomposition - The process by which a material is broken down into simpler forms of matter

Food Web - A system of interlocking and interdependent food chains where matter and energy are transferred from one organisms to another

Fungi - Plural of fungus; spore-producing organisms that feed on organic matter; includes molds, yeast, mushrooms, and toadstools

Invertebrate - An animal lacking a backbone, such as an insect (arthropod) or a worm (annelid)

Photosynthesis - The process by which green plants ("producers") and some other organisms use sunlight, carbon dioxide, and water to produce sugars (carbohydrates) and oxygen

Producers - Organisms that produce their own food (e.g., plants)

LESSON MATERIALS

Community Supplies:
- Magnifying glasses (1 per student or group)
- Vermicast (1 cup per class)
- 6 plastic wash bins
- Harvest basket

Lesson Supplies:
- Soil Food Web Sign
- 6 Decomposers Signs (one for each group)
- Garden Agreements Sign
- Green Bean Harvest Sign
- Ball of yellow yarn (about 50 yards)
- Student Workbook

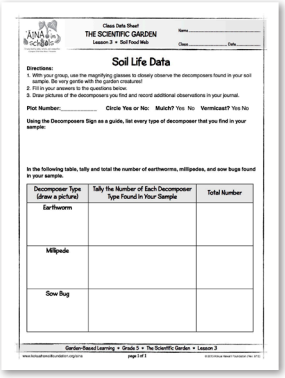
School To Provide:
- 6 Clipboards
- Garden Journals (1 per student if not using the Student Workbook)
- Trowel for gathering soil samples
- Bucket and cups or hose for watering
- Mulch (about 2 buckets per class if needed to replenish in Plots 2 and 4; recommended types of mulch include decomposed leaves, grass clippings, "chop and drop" mulch plants (e.g., *Gliricidia sepium*), or composted mulch from Hawaiian Earth Products; raw wood chips are not recommended but may be used in the absence of any alternatives)

ACCOMPANYING DOCUMENTS

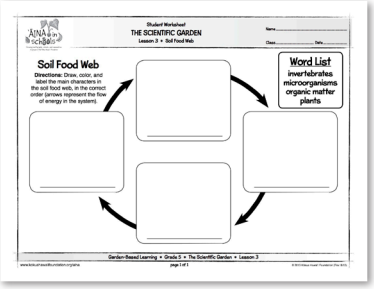
- Guided Notes
- Student Worksheet: Soil Food Web
- Class Data Sheet: Soil Life Data (6 total)

ADVANCE PREPARATION

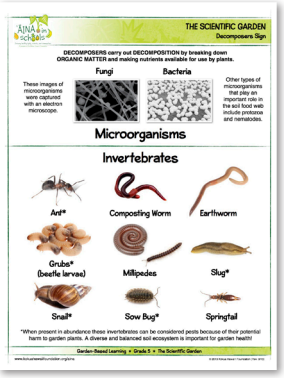
- Discuss lesson preparation and presentation plans with your teaching team.
- Make copies of the Class Data Sheet, 6 per class.
- Make copies of the Student Worksheet, one per student if not using the Student Workbook.
- Prepare the garden soil samples before the lesson by placing several scoops of soil from each plot into different plastic wash bins. Be sure to label each bin with the correct the plot number (e.g., tape a piece of paper to each bin with the plot number). Keep the bins out of the sun in order to protect the soil life they contain.
- Have students ready to take notes in their Student Workbooks or Garden Journals.



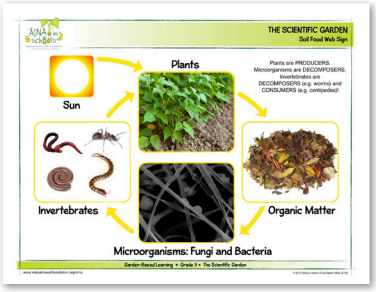
Class Data Sheet: Soil Life Data



Student Worksheet: Soil Food Web



Decomposers Sign



Soil Food Web Sign

INTRODUCTION

20 MINUTES

During the discussion, write key terms on the board and have students take notes in their Student Workbooks or journals.

SCIENCE EXPERIMENT & DATA COLLECTION REVIEW

"What is the goal of our garden experiment?" Desired answer: To learn how to grow healthy soil, plants, and food!

Have students share some observations they have made and data they have recorded in their student workbooks since Lesson 2. Ask students if they have noticed any differences among the plots and whether they have begun to formulate potential conclusions to their scientific questions.

Ask students if they have harvested and tasted any of the fresh green beans from the garden. Review the data gathered on the Harvest Data Class Data Sheet.

SOIL SAMPLE EXPERIMENT REVIEW

Review with students the scientific question that was being asked in the soil sample experiment: "Which soil sample will have the greatest amount of organic matter?" Have a student in each group share the amount of organic matter recorded for each collection site. Have students fill in the data for all soil samples and share their conclusions.

HEALTHY SOIL REVIEW

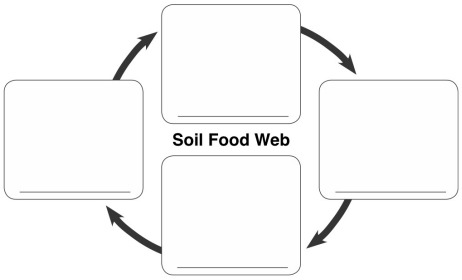
"What is the most important thing we can do as gardeners to grow healthy plants?" Desired answer: Create healthy soil!

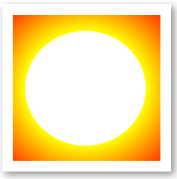
Review with students: "How can you tell if your soil is healthy?" Desired answers:

- It holds moisture well.
- It drains well.
- The plants are healthy with few or no problems with pests and diseases.
- It is full of life!

SOIL FOOD WEB

"Healthy soil is living soil! In fact, an entire FOOD WEB exists in healthy soil, where matter and energy are transferred among producers, consumers, and decomposers." On the board, draw four large boxes with arrows between them and around the words "Soil Food Web" as shown in the diagram. Have students follow along on page 18 of their Student Workbooks during the discussion.





"What is the source of all the energy on Earth?" Desired answer: The sun. **Have a student draw a picture of the sun above the soil food web diagram.**

"What living organisms use the sun's energy plus water and carbon dioxide to grow and produce food and oxygen through the process of PHOTOSYNTHESIS?" Desired answer: Plants. **Have a student draw a picture of a plant in the box at the top of the circle.** Label the box 'Plants.' "Plants are called PRODUCERS because they produce their own food." Draw an arrow pointing from the sun to the plant. "In this diagram, the arrows represent the flow of energy and matter in the system."

INTRODUCTION CONTINUED

"As plants grow, new leaves form and old leaves fall off the plants and onto the soil. What is another name for this material besides 'fallen leaves'? We discussed it during Lesson 2." Desired answer: Organic matter. Ask students to name other examples of organic matter. **Have a student draw a sketch of organic matter in the box to the right of the plant.** Label the box 'Organic Matter.'

"What microscopic organisms feed on organic matter?" Desired answer: MICROORGANISMS including FUNGI and BACTERIA. **Have a student draw a "magnified" sketch of microorganisms in the box at the bottom of the circle.** Label the box 'Microorganisms: Fungi and Bacteria.' "These are called DECOMPOSERS because they break down (decompose) organic matter."

"What other creatures live in the garden and feed on fungi, bacteria, and organic matter?" Desired answer: Insects and worms. "These creatures are called INVERTEBRATES, which are animals without a backbone. They are DECOMPOSERS that break down organic matter, such as worms, and CONSUMERS that eat decomposers and other consumers, such as centipedes." Ask students to share about the kinds of creatures they have observed in the garden and whether they have noticed any differences among the experimental plots. **Have one or more students draw simple sketches of invertebrates in the remaining box.** Label the box 'Invertebrates.'

"Now we have a complete soil food web!" Show the Soil Food Web Sign.

Soil Food Web Sign

DECOMPOSERS

Point to the last two boxes discussed. "Together these important creatures form the soil 'F.B.I.': fungus, bacteria, and invertebrates! They are DECOMPOSERS that carry out DECOMPOSITION, breaking down organic matter and making the nutrients available for plants to use again. They are an essential part of the soil food web because they recycle nutrients in the soil, allowing matter and energy to continue cycling through the system continuously." Show the Decomposers Sign and briefly discuss some of the 'F.B.I. agents.' "Thanks to the work of decomposers, there is no waste in nature!"

Decomposers Sign

GROUP ACTIVITIES OVERVIEW

"In the garden today everyone will get to explore the life in the soil. We will also care for our garden together." Divide the students into their assigned groups:

Group 1: Plot 1 Soil Life Observation
Group 2: Plot 2 Soil Life Observation
Group 3: Plot 3 Soil Life Observation
Group 4: Plot 4 Soil Life Observation
Group 5: Compost Pile Soil Life Observation
Group 6: Other Campus Location Soil Life Observation

Explain that each group will use magnifying glasses to observe the decomposers/invertebrates they find in their soil sample, then tally and total the number of certain types of creatures on their group's Soil Life Data Class Data Sheet.

Garden Agreements

Have students take a deep breath, then review the Garden Agreements:

- I will be SAFE
- I will be KIND
- I will have an OPEN MIND
- I will use my TIME WELL

Give one Decomposers Sign and one Soil Life Data Class Data Sheet with a clipboard to each group. Have students bring their journals and pencils to the garden.

GROUP ACTIVITIES

20 MINUTES

SOIL LIFE OBSERVATIONS AND DATA *(10 minutes)*

Have students use the magnifying glasses to closely observe the decomposers (invertebrates) found in their soil sample (collected by the teaching team before the lesson). Remind students to be very gentle with the garden creatures. Also remember that there are billions of microscopic decomposers (microorganisms) present that we cannot see! Have students follow the instructions on their Soil Life Data Class Data Sheets on page 20-21 of the Student Workbook.

Soil Life Diversity: Using the Decomposers Sign as a guide, help students identify and circle the different types of decomposers found in their sample in the Diversity Table of the Soil Life Data worksheet. Have students draw a picture of each decomposer found.

Soil Life Abundance: Help students tally and total the number of decomposers found in their sample. Have students draw pictures of the decomposers and record the total amount of decomposers in the Abundance Table of the Soil Life Data worksheet.

As students finish up, have students share their data and gather the data from the other groups to complete both tables on page 21.

GARDEN CARE *(10 minutes)*

After making soil life observations and recording their data, students may remain in their groups in order to complete the following tasks

1. **Group 1: Add mulch.** If necessary, add mulch (to replenish mulch added during Lesson 1), place mulch over the soil on both sides of the planting rows in Plots 3 and 4 only.
2. **Group 2: Sprinkle vermicast** over the soil on top of the planted rows in Plots 2 and 4 only (1/2 cup per plot). Gently mix the vermicast into the surface of the soil around the base of each bean plant, being careful not to disturb the roots.
3. **Group 3: Harvest plots 1-2.** All students must wash their hands well with soap and water before harvesting green beans from the garden. Use the Green Bean Harvest Sign as a guide to harvesting green beans that are "just right for eating." Record data on the Harvest Data Class Data Sheet. Gather green beans in the harvest basket and keep the basket clean by keeping it off of the ground. Garden produce must be washed before being eaten.
4. **Group 4: Harvest plots 3-4.** Record data on the Harvest Data Class Data Sheet.
5. **Group 5: Remove Weeds.** Remove weeds from in and around the garden bed.
6. **Group 6: Water.** Use the buckets and cups or hose to water all four garden plots with an equal amount of water.

CLOSING

5 MINUTES

Gather all the students in the garden. Ask them to share about their experience.

Discuss with students:

- According to your results, what soil sample has the greatest diversity of soil life? What soil sample has least?
- What soil sample has the greatest abundance of soil life? What soil sample has the least?
- Who are the soil "F.B.I."?
- Describe the soil food web.
- What do decomposers do and why are they important?

"Please take good care of your gardens and make sure to visit them every day to water the soil, make observations, and record them in your journals. It is very important that the soil stays moist. The plants are your responsibility to care for as a class."

All students must wash their hands thoroughly with soap and water after working in the garden.

Collect all Student Workbooks and Class Data Sheets (or Student Worksheets, Class Data Sheets, and student journals). Store in a central location in the classroom where students have access to them for weekly observation and data collection.

FOLLOW UP GARDEN CARE

Follow Up Garden Care is the responsibility of the classroom teacher and students.

- Continue to have Garden Monitors and other students visit and water the garden daily.
- Have students use the Green Bean Harvest Sign and Harvest Data Class Data Sheet to tally and total the number of green beans harvested from each plot and record the weight of green beans harvested from each plot, then wash and eat them!
- Remove weeds from in and around the garden bed.
- Students must wash their hands thoroughly with soap and water after working in the garden.

FOLLOW UP ACTIVITIES

Follow Up Activities are the responsibility of the classroom teacher.

- Have students visit the garden weekly to observe and record their observations on the Plant Health Observations Class Data Sheet, comparing the health of the plants in each plot. Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease.
- Have students complete the Soil Food Web Student Worksheet.
- Play the Soil Food Web Game with students:
  1. Have each student choose which character they want to be in the soil food web (e.g., plant, organic matter, bacteria, invertebrate). Have students create their own name tags, displaying their character names.
  2. Designate one student volunteer to be the sun. He or she will start the game holding the yellow yarn ball.
  3. Students will form a visual representation of the soil food web by holding onto the yellow yarn (representing the matter and energy) and passing the yarn ball between the soil food web characters, according to the flow of energy in the system (i.e. from sun, to plant, to organic matter, to decomposers, and back to plants).

LESSON EXTENSIONS

In Depth Soil Exploration
(5.W.1, 5.W.2, 5.W.10)

1. Allow students to spend time observing the soil. Have them make comparisons between their garden soil and other types of soil found around campus.
2. Have students write a story about where their soil came from (time and space).
3. Have students write poems about their soil and seeds.
4. Watch the movie *Dirt!* with students here: http://www.dirtthemovie.org/ Educational resources including further information, film screening discussion guide, teacher notes, student worksheets, lesson plans, soil songs, and more available here: https://www-tc.pbs.org/independentlens/dirt-the-movie/resources/dirt_discussion.pdf

Food Chains and Food Webs
(5.RI.3, 5.W.7, 5.SL.1)

1. Have students read the book *Who Eats What? Food Chains and Food Webs* by Patricia Lauber. Discuss the book together as a class.
2. Have students (individually or in groups) research and present to the class about a specific food web or food chain, especially ones that relate to their local environment.
3. Discuss as a class how these food webs, chains, and ecosystems have been impacted by humans and what we can do to help restore nature's balance.

Investigating Arthropods
(5.W.7, 5.SL.1, 5.SL.5)

1. Discuss with students:
   - An arthropod is any invertebrate with a segmented body, jointed limbs, and usually a chitinous shell that undergoes molting, including insects (three segments), spiders, and crustaceans.

   - What types of arthropods have we observed in our garden soil? For example, millipedes, cockroaches, beetles, pill/sow bugs, centipedes, ants.
   - What types of arthropods do we eat? For example, crabs, lobsters, shrimp (all crustaceans).
   - Worms are not arthropods. They are a different type of invertebrate called "annelids" (belonging to the phylum Annelida).

   - The largest arthropod in the world is the coconut crab.
   - Arthropods are the most abundant type of animal on earth!
2. Have students select a type of arthropod about which to research and write a report. Have students create visual displays and share their work as a class.

Guided Notes

THE SCIENTIFIC GARDEN

Lesson 3 * Soil Food Web

Name .....

Class ..... Date .....

KEY TERMS AND CONCEPTS

Bacteria - Unicellular organisms; widely distributed in soil, water, air, and on or in the tissues of plants and animals

Consumers - Organisms that eat other living things (e.g., animals, insects, some plants)

Decomposers - Organisms that break down organic matter and carry out decomposition (e.g., fungi, bacteria, invertebrates)

Decomposition - The process by which a material is broken down into simpler forms of matter

Food Web - A system of interlocking and interdependent food chains where matter and energy are transferred from one organisms to another

Fungi - Plural of fungus; spore-producing organisms that feed on organic matter; includes molds, yeast, mushrooms, and toadstools

Invertebrate - An animal lacking a backbone, such as an insect (arthropod) or a worm (annelid)

Photosynthesis - The process by which green plants ("producers") and some other organisms use sunlight, carbon dioxide, and water to produce sugars (carbohydrates) and oxygen

Producers - Organisms that produce their own food (e.g., plants)

Directions: Use this space to record your notes, drawings, and observations.

Name .....

Class ..... Date .....

Soil Life Data

With your group, use the magnifying glasses to closely observe the decomposers found in your soil sample. Be very gentle with the garden creatures! Fill in your answers to the questions below and record any additional observations in your Student Workbook or journal.

Plot Number:_____ **Circle Yes or No:** **Mulch?** Yes No **Vermicast?** Yes No

Part 1 Directions: Using the Decomposers Sign as a guide, circle the different types of decomposers found in your sample in the **Diversity Table** below.

Part 2 Directions: Tally and total the number of decomposers found in your sample. Draw pictures of the decomposers you find and record the total amount of decomposers in the **Abundance Table** below.

1. Diversity: Circle the decomposer type found and draw a picture	2. Abundance: Tally the Number of Each Decomposer Found In Your Sample	Total Number
Ant		
Composting Worm		
Earthworm		
Grub		
Millipede		
Slug		
Snail		
Sow Bug		
Other:		
Other:		
	GRAND TOTAL OF DECOMPOSERS FOUND:	

Soil Life Data

Part 3 Directions: List the number of different types of decomposers found in the Diversity Table below. Share your data and gather the data from the other groups to complete the table.

Diversity Table

Plot 1	Plot 2	Plot 3	Plot 4	Compost	Campus

Part 4 Directions: Put the grand total number of all decomposers found in the Abundance Table below. Share your data and gather the data from the other groups to complete the table.

Abundance Table

Plot 1	Plot 2	Plot 3	Plot 4	Compost	Campus

Name .....

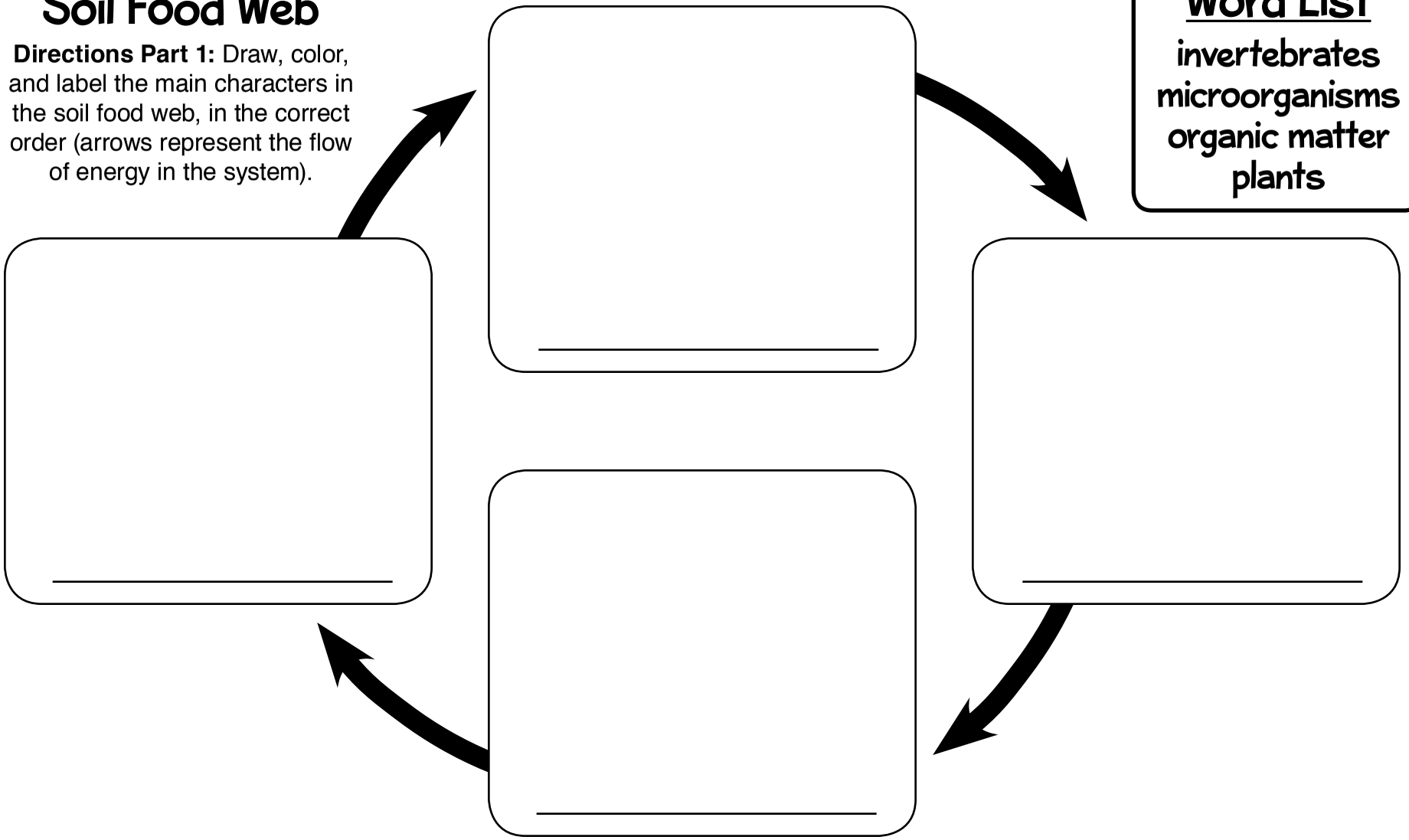
Class ..... Date .....

Soil Food Web

Directions Part 1: Draw, color, and label the main characters in the soil food web, in the correct order (arrows represent the flow of energy in the system).

Word List

invertebrates
microorganisms
organic matter
plants



Student Worksheet

THE SCIENTIFIC GARDEN

Lesson 3 * Soil Food Web

Name .....

Class ..... Date .....

Directions Part 2: Fill in your answers to the questions below.

1. Who are the soil 'F.B.I.?' What do F, B, and I stand for? _____

_____

2. Give examples of invertebrates that you have seen in your garden. _____

_____

_____

3. Which invertebrate is your favorite and why? _____

_____

_____

4. What do decomposers do and why are they important? _____

_____

_____

5. Write a paragraph that explains the soil food web. _____

_____

_____

_____

Grade 5

THE SCIENTIFIC GARDEN

Lesson 4 * Conclusions

DESCRIPTION

Students will review their scientific experiment and discuss the process for analyzing data and creating conclusions. Students will work in groups and use the Class Data Sheets to analyze data on soil health, plant health, and the amount of food produced in their Scientific Garden. The class will then discuss their results and conclusions together. They will enjoy a snack of fresh fruits and vegetables and discuss lessons learned from their Scientific Garden.

TIME: 45 minutes

SUBJECTS: Language Arts, Math, Science

LEARNING OBJECTIVES

After this lesson students will be able to:

- Analyze data using tables and graphs.
- Form conclusions to their experiment and discuss lessons learned.
- Recognize the difference between qualitative and quantitative data and results.

ACADEMIC STANDARDS*

CCSS, Language Arts: 5.W.2, 5.W.7, 5.W.10, 5.SL.1, 5.SL.5 **CCSS, Mathematics:** 5.G.1, 5.G.2 **NGSS:** LS2.A, Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data, Patterns **Lesson Extensions:** 5.W.7, 5.SL.1, HE.3-5.1.3

*A detailed list of the Academic Standards can be found in the Unit Overview document

LESSON OUTLINE

I. Introduction (5 minutes)
   1. Science Experiment Review
   2. Group Activities Overview

II. Group Activities (15 minutes)
   1. Data Analysis

III. Class Discussion (15 minutes)
   1. Conclusions

IV. Closing and Snack (5 minutes)

KEY TERMS AND CONCEPTS

Conclusion - Statements that researchers make about the outcomes of an experiment/ study based on the evaluation of their results; determining whether a hypothesis was true or false in order to answer scientific questions

Data - Facts, statistics, or items of information collected for reference or analysis

Qualitative - Measuring the quality of something rather than its quantity; e.g., using descriptions

Quantitative - Measuring the quantity of something rather than its quality; e.g., using numbers

Results - An outcome; the analysis or visualization of data by using graphs, etc.

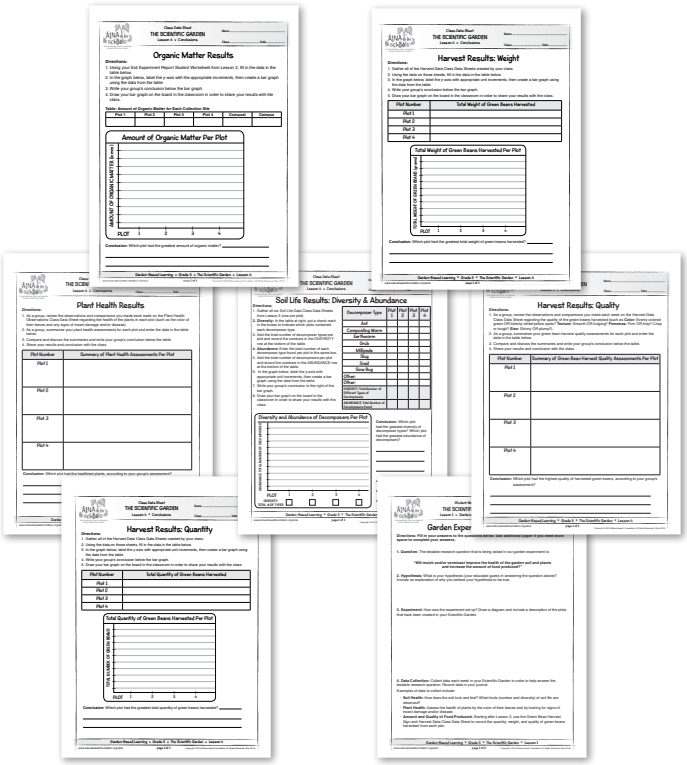
LESSON MATERIALS

Community Supplies:
- Hanging scale
- 2 serving platters (for snack)

Lesson Supplies:
- Garden Agreements Sign
- Student Workbook
- 6 Large graph paper sheets (1 per group)

Teaching Team To Provide:
- Locally grown fruits and/or vegetables for the snack

School To Provide:
- Garden Journals (1 per student if not using Student Workbooks)
- Bucket to collect snack waste
- Whiteboard space
- Color markers



Class Data Sheets and Student Worksheet

ACCOMPANYING DOCUMENTS

- Class Data Sheet: Organic Matter Results
- Class Data Sheet: Soil Life Results: Diversity and Abundance
- Class Data Sheet: Plant Health Results
- Class Data Sheet: Harvest Results (Quantity)
- Class Data Sheet: Harvest Results (Weight)
- Class Data Sheet: Soil Life Results: (Quality)
- Student Worksheet: Garden Experiment Report: Part II
- ʻĀINA Post-Unit Survey

ADVANCE PREPARATION

- Discuss lesson preparation and presentation plans with your teaching team.
- Make copies of the Class Data Sheets, one of each per class.
- Make copies of the Student Worksheet, one per student if not using the Student Workbook.
- Harvest or purchase and prepare fresh locally-grown fruits and vegetables for the snack.
- Have students do a final harvest of green beans and gather their final harvest data before the lesson, being sure to record the data on the Harvest Data Class Data Sheet.
- Gather all Student Worksheets and Class Data Sheets from all previous lessons.
- Have students bring out their Student Workbooks or Garden Journals.

INTRODUCTION

5 MINUTES

Have students bring out their Student Worksheets and Class Data Sheets from all previous lessons, as well as their journals if not using the Student Workbooks.

SCIENCE EXPERIMENT REVIEW

"What is the goal of our garden experiment?" Desired answer: To learn how to grow healthy soil, plants, and food!

"What is the testable research question that is being asked in our garden experiment?" Desired answer: Our testable research question is: "Will mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"

"What types of data have we gathered in order to answer our scientific question?" Desired answers: 1) Soil health (amount of organic matter, abundance and diversity of soil life); 2) Plant health (weekly assessment and comparison); and 3) Harvest/amount of food produced (number, weight, and quality of green beans harvested from each plot).

GROUP ACTIVITIES OVERVIEW

"Today is our last lesson in the Scientific Garden unit. We will work in our groups to analyze the DATA we have collected, then discuss our RESULTS as a class and make our CONCLUSIONS!"

Assign student groups to the following six data analysis groups:

Group 1: Soil Health: Organic Matter
Group 2: Soil Health: Diversity and Abundance
Group 3: Plant Health
Group 4: Harvest: Quantity of Green Beans
Group 5: Harvest: Weight of Green Beans
Group 6: Harvest: Quality of Green Beans

Garden Agreements
Have students take a deep breath, then review the Garden Agreements:

- I will be SAFE
- I will be KIND
- I will have an OPEN MIND
- I will use my TIME WELL

Give each group their appropriate Class Data Sheet. All Class Data Sheets are also found in their Student Workbooks for reference.

GROUP ACTIVITIES

20 MINUTES

DATA ANALYSIS *(20 minutes)*

Students will work in their groups for the entire 20 minutes to analyze their assigned data, according to the instructions on their Class Data Sheets.

Soil Health (Organic Matter):

1. Review all 6 Soil Health Data Class Data Sheets from Lesson 3 (1 per plot, compost, campus location).
2. Using the Soil Sample Experiment Report Student Worksheet from Lesson 2, fill in the data in the table on the Organic Matter Results Class Data Sheet.
3. In the graph on the Class Data Sheet, label the y-axis, then create a bar graph using the data from the table.
4. Write the group's conclusion below the bar graph.
5. Draw the bar graph on the board in the classroom.

Soil Health (Soil Life Diversity & Abundance):

1. Gather all six Soil Life Data Class Data Sheets from Lesson 3 (one per plot).
2. Diversity: In the table at right, put a check mark in the boxes to indicate which plots contained each decomposer type.
3. Add the total number of decomposer types per plot and record the numbers in the DIVERSITY row at the bottom of the table.
4. Abundance: Enter the total number of each decomposer type found per plot in the same box.
5. Add the total number of decomposers per plot and record the numbers in the ABUNDANCE row at the bottom of the table.
6. In the graph below, label the y-axis with appropriate unit increments, then create a bar graph using the data from the table.
7. Write your group's conclusion to the right of the bar graph.
8. Draw your bar graph on the board in the classroom in order to share your results with the class.

Plant Health:

1. Gather and review all Plant Health Observations Class Data Sheets regarding the health of the plants in each plot (such as the color of their leaves and any signs of insect damage and/or disease).
2. As a group, summarize your plant health assessments for each plot and enter the data on the Plant Health Results Class Data Sheet.
3. Compare and discuss the summaries and write your group's conclusion below the table.
4. Share your results and conclusion with the class.

Harvest (Quantity of Green Beans):

1. Review all of the Harvest Data Class Data Sheets created by the class.
2. Using the data on those sheets, fill in the data in the table on the Harvest Results: Quantity Class Data Sheet.
3. In the graph on the Class Data Sheet, label the y-axis, then create a bar graph using the data from the table.
4. Write the group's conclusion below the bar graph.
5. Draw the bar graph on the board in the classroom.

Harvest (Weight of Green Beans):

1. Review all of the Harvest Data Class Data Sheets created by the class.
2. Using the data on those sheets, fill in the data in the table on the Harvest Results: Weight Class Data Sheet.
3. In the graph on the Class Data Sheet, label the y-axis, then create a bar graph using the data from the table.
4. Write the group's conclusion below the bar graph.

Draw the bar graph on the board in the classroom.

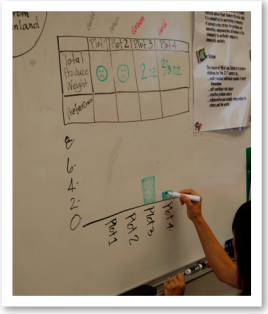
Harvest (Quality of Green Beans):

1. Review the observations and comparisons you made each week on the Harvest Data Class Data Sheet on the quality of the green beans harvested. Such as Color: Evenly colored green OR blotchy white/yellow spots? Texture: Smooth OR rough "rust"? Firmness: Firm OR limp? Crisp or tough? Size: Skinny OR bulging?
2. As a group, summarize your green bean harvest quality assessments for each plot and enter it on the Harvest Results: Quality Class Data Sheet.
3. Compare and discuss the summaries and write your group's conclusion below the table.
4. Share your results and conclusion with the class.

CLASS DISCUSSION — 15 MINUTES

CONCLUSIONS

Have each group present their results to the class (2 minutes per group) and have students take notes in their journals. Distinguish for students the difference between QUALITATIVE data, which measures quality (e.g., using descriptions, as in the Plant Health Results and Harvest Results: Quality group), and QUANTITATIVE data, which measures quantity (e.g., using numbers, as in the groups that created graphs).



Together as a class, discuss the cumulative findings of all groups. Are there one or more plots that consistently stand out above the rest in terms of soil and plant health and the amount of food produced? What can we learn from this about how to grow healthy gardens and abundant fresh foods? If possible, have students do their presentation in the garden.

CLOSING AND SNACK — 5 MINUTES

Discuss with students:

- Was your hypothesis true or false?
- What hidden variables may have affected the data (e.g., differences in sun/wind/water exposure between the plots)?
- What other observations did you make?
- If you were to redo this experiment, how would you change it?
- Discuss the importance of repeating science experiments. Repeated analysis means more reliable results.
- If you were to do another experiment what question would you ask? What variable would you choose?
- How can we use all the information we learned? For example, we can grow gardens using the methods that resulted in the most food and healthiest soil and plants in our garden experiment.

Students must wash their hands thoroughly with soap and water before enjoying the snack of fresh locally-grown fruits and vegetables. Invite students to share what they are thankful for and what they enjoyed about their experience with the Scientific Garden.

Have students place snack waste in a bucket and then add it to the school's compost pile when finished.

FOLLOW UP GARDEN CARE

Follow Up Garden Care is the responsibility of the classroom teacher and students.

- This is the final lesson of the semester. Continue to have your students water and visit the garden daily to help keep the soil alive. Use mulch materials to cover bare soil, protecting it from the sun, preserving moisture, and discouraging weeds.
- Continue to harvest and eat fresh green beans from the garden.
- Collect any yellow or brown/dry seed pods from the plants. The green bean seeds may be dried and stored for future planting, or given to students to take home for planting.

FOLLOW UP ACTIVITIES

Follow Up Activities are the responsibility of the classroom teacher.

- Review this semester's garden experience, including the key concepts for the unit, which are ʻāina, the importance of observation, data collection, and experimentation for gardeners and farmers, the scientific method, the importance of soil and organic matter, microorganisms (fungi and bacteria), invertebrates, producers, consumers, decomposers, decomposition, photosynthesis, and the soil food web.
- Continue the discussion with students about the data, results, and conclusions gained from the Scientific Garden.
- Have students complete the Garden Experiment Report Part II Student Worksheet.
- Have students create a final journal entry about their garden experience this semester. Have them share their work with the class.
- Administer the ʻĀINA Post Unit Survey immediately following the final lesson and review.
- Save and submit examples of student work to Kōkua Hawaiʻi Foundation.

LESSON EXTENSIONS

More Science in the Garden
(5.W.7, 5.SL.1, SC.5.1.1, SC.5.1.2, SC.5.2.1)

1. Gather input from students about what other scientific questions they would like to ask and explore.
2. In groups or as a class, have the students select one or more scientific questions with which to experiment.
3. Carry out the experiment(s) during the remainder of the semester or the following semester.
4. Have students conduct research projects about garden-related topics of interest to them.

The Benefits of Eating "Close to the Source"
(5.SL.1, HE.3-5.1.3)

1. Discuss with students the benefits of eating foods that are "close to the source" including:
   - Locally-grown foods that are fresher, healthier, and tastier, support local farmers and communities, and reduce the environmental impact of long distance transportation.
   - High quality whole foods that come straight from nature and fuel our bodies and minds.

Name .....

Class ..... Date .....

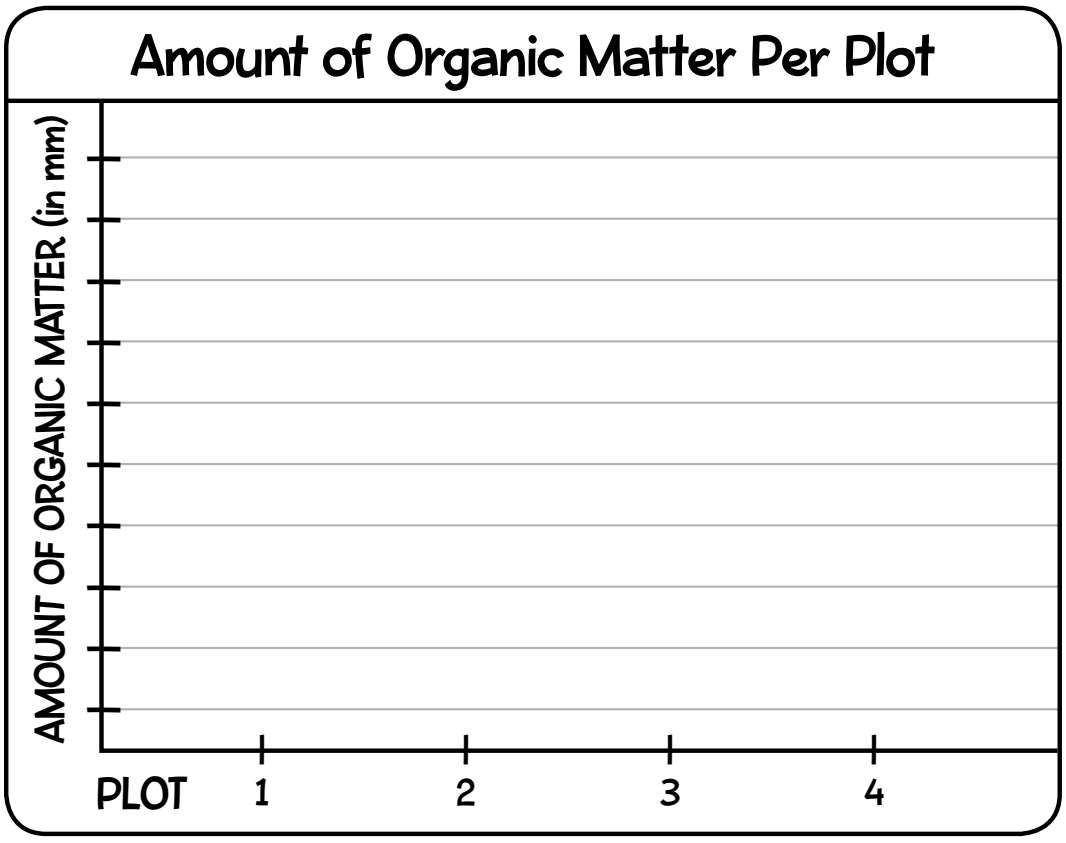
Organic Matter Results

Directions:

1. Using your Soil Experiment Report Student Worksheet from Lesson 2, fill in the data in the table below.
2. In the graph below, label the y-axis with the appropriate increments, then create a bar graph using the data from the table.
3. Write your group's conclusion below the bar graph.
4. Draw your bar graph on the board in the classroom in order to share your results with the class.

Table: Amount of Organic Matter for Each Collection Site

Plot 1	Plot 2	Plot 3	Plot 4	Compost	Campus



Conclusion: Which plot had the greatest amount of organic matter? _____

_____

_____

Name .....

Class ..... Date .....

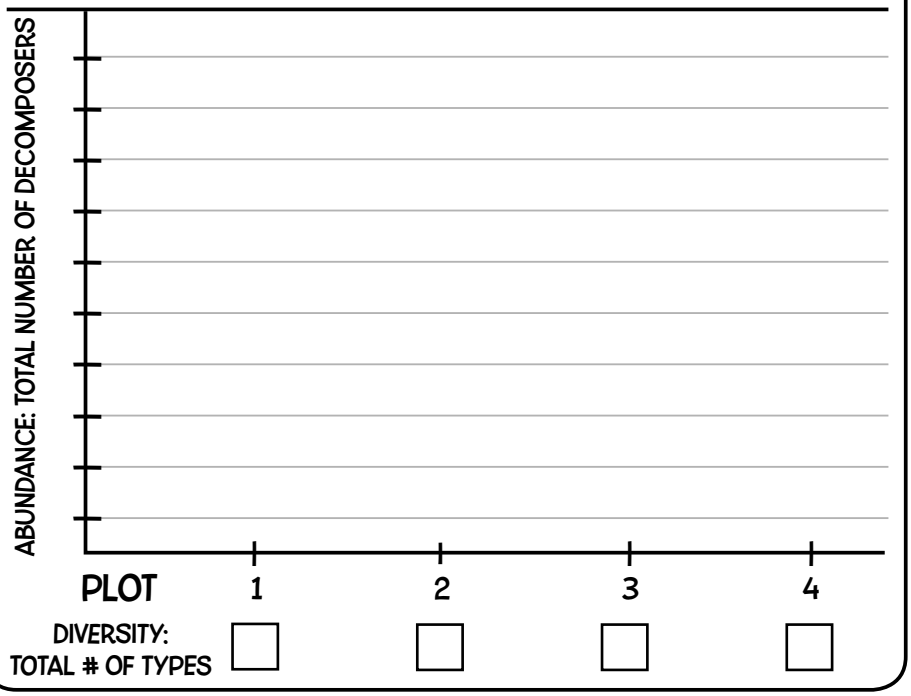
Soil Life Results: Diversity & Abundance

Directions:

1. Gather all six Soil Life Data Class Data Sheets from Lesson 3 (one per plot).
2. **Diversity:** In the table at right, put a check mark in the boxes to indicate which plots contained each decomposer type.
3. Add the total number of decomposer types per plot and record the numbers in the DIVERSITY row at the bottom of the table.
4. **Abundance:** Enter the total number of each decomposer type found per plot in the same box.
5. Add the total number of decomposers per plot and record the numbers in the ABUNDANCE row at the bottom of the table.
6. In the graph below, label the y-axis with appropriate unit increments, then create a bar graph using the data from the table.
7. Write your group's conclusion to the right of the bar graph.
8. Draw your bar graph on the board in the classroom in order to share your results with the class.

Decomposer Type	Plot 1	Plot 2	Plot 3	Plot 4
Ant				
Composting Worm				
Earthworm				
Grub				
Millipede				
Slug				
Snail				
Sow Bug				
Other:				
Other:				
DIVERSITY: Total Number of Different Types of Decomposers				
ABUNDANCE: Total Number of Decomposers found				

Diversity and Abundance of Decomposers Per Plot



Conclusion: Which plot had the greatest diversity of decomposer types? Which plot had the greatest abundance of decomposers?

Name .....

Class ..... Date .....

Plant Health Results

Directions:

1. As a group, review the observations and comparisons you made each week regarding the health of the plants in each plot (such as the color of their leaves and any signs of insect damage and/or disease).
2. As a group, summarize your plant health assessments for each plot and enter the data in the table below.
3. Compare and discuss the summaries and write your group's conclusion below the table.
4. Share your results and conclusion with the class.

Plot Number	Summary of Plant Health Assessments Per Plot
Plot 1	
Plot 2	
Plot 3	
Plot 4	

Conclusion: Which plot had the healthiest plants, according to your group's assessment?

Name .....

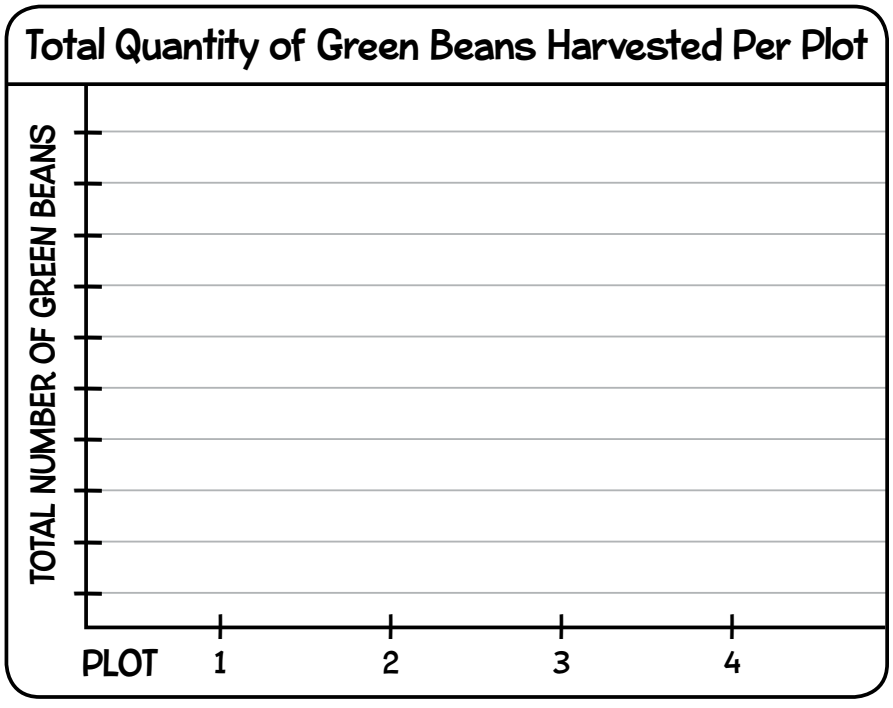
Class ..... Date .....

Harvest Results: Quantity

Directions:

1. Gather all of the Harvest Data Class Data Sheets created by your class.
2. Using the data on those sheets, fill in the data in the table below.
3. In the graph below, label the y-axis with appropriate unit increments, then create a bar graph using the data from the table.
4. Write your group's conclusion below the bar graph.
5. Draw your bar graph on the board in the classroom in order to share your results with the class.

Plot Number	Total Quantity of Green Beans Harvested
Plot 1	
Plot 2	
Plot 3	
Plot 4	



Conclusion: Which plot had the greatest total quantity of green beans harvested? _____

_____

_____

Name .....

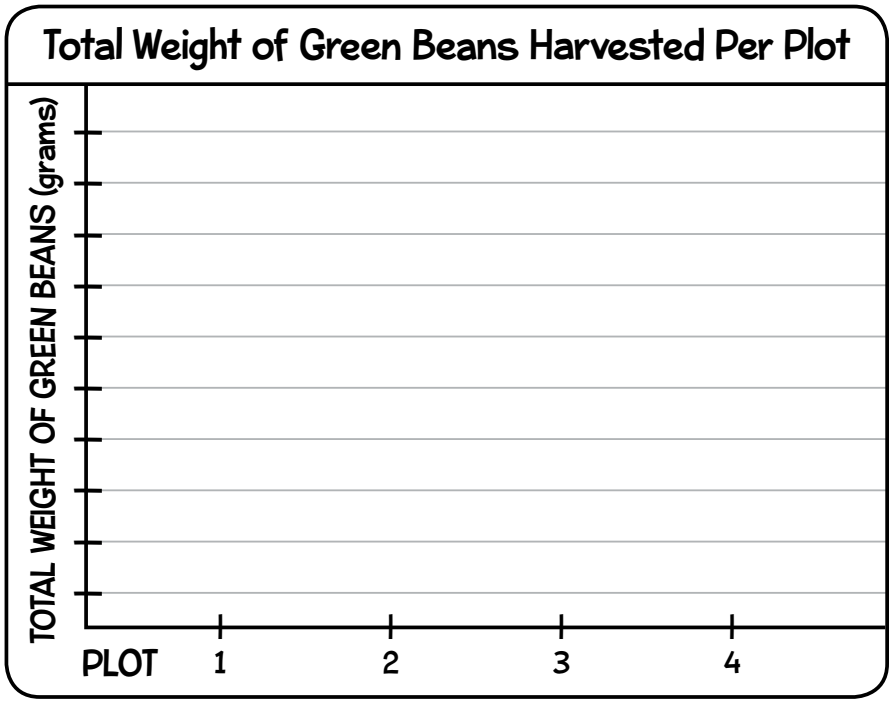
Class ..... Date .....

Harvest Results: Weight

Directions:

1. Gather all of the Harvest Data Class Data Sheets created by your class.
2. Using the data on those sheets, fill in the data in the table below.
3. In the graph below, label the y-axis with appropriate unit increments, then create a bar graph using the data from the table.
4. Write your group's conclusion below the bar graph.
5. Draw your bar graph on the board in the classroom in order to share your results with the class.

Plot Number	Total Weight of Green Beans Harvested
Plot 1	
Plot 2	
Plot 3	
Plot 4	



Conclusion: Which plot had the greatest total weight of green beans harvested? _____

_____

_____

Harvest Results: Quality

Directions:

1. As a group, review the observations and comparisons you made each week on the Harvest Data Class Data Sheet regarding the quality of the green beans harvested (such as **Color:** Evenly colored green OR blotchy white/yellow spots? **Texture:** Smooth OR bulging? **Firmness:** Firm OR limp? Crisp or tough? **Size:** Skinny OR plump?).
2. As a group, summarize your green bean harvest quality assessments for each plot and enter the data in the table below.
3. Compare and discuss the summaries and write your group's conclusion below the table.
4. Share your results and conclusion with the class.

Plot Number	Summary of Green Bean Harvest Quality Assessments Per Plot
Plot 1	
Plot 2	
Plot 3	
Plot 4	

Conclusion: Which plot had the highest quality of harvested green beans, according to your group's assessment?

_____

_____

_____

Name .....

Class ..... Date .....

Garden Experiment Report: Part I

Directions: Fill in your answers to the questions below. Use additional paper if you need more space to complete your answers.

1. Question: The testable research question that is being asked in our garden experiment is:

"Will mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"

2. Hypothesis: What is your hypothesis (your educated guess in answering the question above)? Include an explanation of why you believe your hypothesis to be true.

3. Experiment: How was the experiment set up? Draw a diagram and include a description of the plots that have been created in your Scientific Garden.

4. Data Collection: Collect data each week in your Scientific Garden in order to help answer the testable research question. Record data in your journal.

Examples of data to collect include:

- **Soil Health:** How does the soil look and feel? What kinds (number and diversity) of soil life are observed?
- **Plant Health:** Assess the health of plants by the color of their leaves and by looking for signs of insect damage and/or disease.
- **Amount and Quality of Food Produced:** Starting after Lesson 2, use the Green Bean Harvest Sign and Harvest Data Class Data Sheet to record the quantity, weight, and quality of green beans harvested from each plot.

Garden Experiment Report: Part II

Directions: Fill in your answers to the questions below. Use additional paper if you need more space to complete your answers.

5. Results: As a class, you discussed the results shown by the data collected from the Scientific Garden. Briefly describe the results presented by each group (i.e., which plot(s) produced the most desirable results):

Organic Matter Results:

Soil Life Diversity and Abundance Results:

Plant Health Results:

Harvest Results: Quantity of Green Beans:

Harvest Results: Weight of Green Beans:

Harvest Results: Quality of Green Beans:

6. Conclusion: Describe your conclusion to the garden experiment by answering our scientific question, **"Did mulch and/or vermicast improve the health of the garden soil and plants and increase the amount of food produced?"**. Was your hypothesis true or false?

7. Lessons Learned: Describe what you learned from the garden experiment.

8. Further Study: List two scientific questions that you would be interested in finding out the answer to:

Student Worksheet

SCIENTIFIC GARDEN

Grade 5 * Post-Unit Survey

Name .....

School .....

Teacher .....

I have been at this school since grade: K 1 2 3 4 5 (circle one)

1. Circle all the variables that can affect plant growth. Circle all that apply:

Soil Composition Wind Air Water Light Weeds Seasons Temperature

Pollination Diversity Fertilizers Mulch Vermicast Singing Pests

2. How can you tell if soil is healthy? Circle ONE answer:

a. The soil is full of life

b. The soil drains well

c. Plants are healthy with few or no problems with pests and diseases

d. All the above

3. What are the four main components of soil? Circle ONE answer:

a. Food scraps, water, dirt, air

b. Water, sand, bacteria, earth

c. Air, water, minerals, organic matter

4. What can you add to soil to improve soil health? Circle ONE answer:

a. Compost b. Vermicast c. Bokashi d. All the above

5. Draw a line to match each word to its correct definition:

a. Decomposition	1. Castings (poop) from composting worms; rich in soluble nutrients
b. Mulch	2. A statement or educated guess that explains a predicted answer to the question being asked
c. Hypothesis	3. The process by which a material is broken down into simple forms of matter
d. Data	4. A material that is used to cover the soil for beneficial purposes
e. Vermicast	5. Facts, statistics, or items of information collected for reference

6. **Do you like gardening? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
7. **Do you like eating fruits and vegetables? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
8. **Do you like cooking? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
9. **Do you like making compost? Circle ONE answer:**
   a. I do not like b. unsure c. I like a little d. I like a lot
10. **Do you like ʻĀINA Lessons? Circle ONE answer:**
    a. I do not like b. unsure c. I like a little d. I like a lot

11. **Do you and your family grow any food at home? Circle:** Yes or No
    If yes, please list the foods you grow at home: _____

12. **Do you compost at home? (compost pile, worm bins, or bokashi bucket) Circle:** Yes or No

13. **How often do you eat fruits and vegetables? Circle ONE answer:**
    a. I don't eat fruits and vegetables b. 1-2 times a week c. 3-5 times a week d. Every day

14. **Circle the fruits and vegetables that you like to eat:**

    Apple Cantaloupe Banana/Maiʻa Blueberries Avocado Coconut/Niu Guava Dragonfruit
    Mango Passionfruit/Liliko'i Honeydew Rambutan Tangerine Strawberry Blackberries
    Lemon Starfruit Breadfruit/ʻUlu Lychee Orange Papaya Pineapple Watermelon
    Radish Spinach Basil Beans Broccoli Squash Zucchini Sweet Potato/ʻUala Corn Tomato
    Lettuce Watercress Taro/Kalo Cucumber Green Beans Asparagus Carrots Celery Kale

    Other: _____

15. **Describe what ʻāina means to you:** _____
    _____
    _____

16. **List two ways that you take care of the ʻāina:**
    1. _____
    2. _____

17. **Complete the following sentence:**
    My favorite thing about ʻĀINA In Schools Lessons is _____
    _____
    _____