

## DESCRIPTION

Students will review aerobic composting, discuss decomposition, and discover the steps for creating and maintaining a vermicomposting system. They will build and maintain a worm bin in order to recycle fruit and vegetable waste and create nutrient-rich, living fertilizer for the garden soil and plants.

**TIME:** 60 minutes

**SUBJECTS:** Language Arts, Science

## LEARNING OBJECTIVES

After this lesson students will be able to:

- Understand that vermicomposting helps reduce waste, recycle nutrients, and nourish the garden soil and plants.
- Discuss decomposition and recognize the role that decomposers play in creating compost.
- Build and maintain a vermicomposting system and explain the main ingredients needed as well as what not to include.



## ACADEMIC STANDARDS\*

**CCSS, Language Arts:** 3.RF.3, 3.W.1, 3.W.2, 3.W.10, 3.SL.1 **NGSS: NGSS:** 3-LS4-3, LS4.C, Influence of Science, Engineering and Technology on Society and the Natural World, Patterns, Systems and System Models **Lesson Extensions:** 3.W.1, 3.SL.1, LS4.C. Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data

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

## LESSON OUTLINE

- I. Introduction (20 minutes)
  1. Aerobic Compost Review
  2. Decomposition
  3. Main Vermiculture Ingredients & the L.A.W.
  4. Weekly Tasks
  5. Group Activities Overview
- II. Group Activities (30 minutes)
  1. Getting to Know the Worms (10 minutes)
  2. Bedding and Food Prep (10 minutes)
  3. Building the Bin (10 minutes)
- III. Closing (10 minutes)

## KEY TERMS AND CONCEPTS

**Aerobic** - Refers to the presence of air (oxygen) in the system

**Decomposers** - Organisms that break down dead or decaying material and carry out decomposition, e.g., fungi, bacteria, worms

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

**Leachate** - Liquid that comes out of the drain of a worm bin; pour back into the bin or dilute with water and add to soil around trees; do not use on edible plant parts (e.g., lettuce leaves)

**Mindful** - Conscious or aware of something; to focus attention on the present moment

**Vermicast/Vermicompost** - Also known as worm castings or worm poop; used as a nutrient-rich, living fertilizer; contains water-soluble nutrients that are relatively easy for plants to absorb; contributes to microbial life and nutrient cycling in the soil

**Vermicomposting/Vermiculture** - A system that uses composting worms to convert organic matter into vermicompost/vermicast

## LESSON MATERIALS

### Community Supplies:

- Sample of finished, sorted vermicast
- Plastic dish tub with water
- Optional: Hanging scale (to weigh compost ingredients)

### Lesson Supplies:

- Decomposers Sign
- Garden Agreements Sign
- The Worm Song Sign
- Compost Map Answer Cards: Aerobic; Decomposers (F.B.I.); L.A.W.; Shredded Paper & Cardboard; Fruit & Vegetable Scraps; Composting Worms; Water
- Worm bin (one large bin per class or grade level); see Advance Preparation
- Composting worms (about one handful per bin)
- Spray bottle with water
- Student Workbook and Class Data Workbook



Compost Map Answer Cards

### Teaching Team to Provide:

- Stack of newspaper, cardboard, and paper egg cartons
- Food waste: A diverse mix of fruit, grain, and vegetable scraps (no papaya seeds, garlic, onion, citrus fruit, minimal citrus rinds)
- Container to catch the leachate (e.g., large plastic food container)

### School to Provide:

- Compost/Garden/Science Journals (1 per student) if not using Student Workbooks

### Vermicomposting Resource Sheet



Weekly Vermiculture Log



Many types and sizes of worm bins exist, from commercial to home-made.

## ACCOMPANYING DOCUMENTS

- Resource Sheet: How To Create a Vermicomposting System
- Guided Notes
- Class Data Sheet: Weekly Vermiculture Log

## ADVANCE PREPARATION

- Discuss lesson preparation and presentation plans with your teaching team.
- Review the Resource Sheet: How To Create a Vermicomposting System.
- Make copies of the Guided Notes, one per student if not using the Student Workbook.
- Make copies of the Weekly Vermiculture Log Class Data Sheet, one per class if not using the Class Data Workbook.
- Prepare worm bins(s) (one large bin per class or grade level). If creating a home-made worm bin from a large plastic tub, drill drainage holes in the bottom of the tub and air holes in the lid.
- Determine a location for the worm bin that is completely removed from direct sunlight. Make sure there is space under the bin for leachate to drain out; the leachate may drain onto the soil or be collected in a container that must be emptied at least once a week.
- Set up the demonstration materials in the classroom.
- Have students ready to take notes in their journals if not using Student Workbooks.



## INTRODUCTION

20 MINUTES

“Aloha! Today is our second ‘ĀINA In Schools lesson on composting.” During the discussion, write key terms on the board and have students take notes in their Student Workbooks or journals. **Use the Compost Map Answer Cards to help lead discussion.**

### AEROBIC COMPOST REVIEW

“Why is composting important?” Desired answers: Composting reduces waste and recycles nutrients, using free, locally available “waste” materials and working with nature to nourish our garden soil and plants.

“What are the main ingredients in an aerobic compost pile?” Desired answers: Organic matter (carbon, nitrogen, life), air, and water. “Why is it called AEROBIC composting?” Desired answer: Air is present in the composting system, allowing the soil F.B.I. (fungi, bacteria, and invertebrates) to thrive. **Workbook Question #1:** Write AEROBIC on the board and have students write in the answer.

### DECOMPOSITION

“The organisms that live in our composting systems are called DECOMPOSERS, because they carry out DECOMPOSITION, which is the breakdown of materials (organic matter) into simpler forms, such as you find in finished compost, where the original materials are no longer recognizable!” Show the Decomposers Sign. **Workbook Question #2:** Write DECOMPOSERS on the board and have students write in the answer.

### MAIN VERMICULTURE INGREDIENTS & THE L.A.W.

“Last lesson you learned about the L.A.W. What does the L.A.W. stand for?” Desired answer: Life, Air, and Water. “Correct! The F.B.I. (decomposers) work for the

L.A.W. because they are the Life of the L.A.W. Today, we will build a different kind of composting system that follows the L.A.W. by using the same main ingredients of life/organic matter (carbon, nitrogen, and decomposers) air, and water, but with one main difference in the type of decomposers involved. We will create a worm bin, which is also called a VERMICULTURE or VERMICOMPOSTING system.” A system that uses composting worms to convert organic matter into vermicompost/vermicast is called VERMICULTURE or VERMICOMPOSTING.

**Workbook Question #3:** Have students write in VERMICULTURE. **Workbook Question #4:** Write the main vermiculture ingredients on the board. Use the Compost Map Answer Cards during the discussion and have student write in the main ingredients.

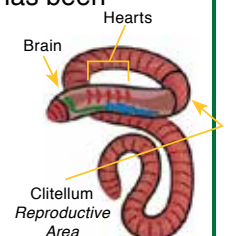
#### 1. Life/Organic Matter (3 types):

- **Carbon and Nitrogen:** Show students the newspaper and food waste. “Based on what you learned in our last lesson, can you determine which of these is the carbon material and which is the nitrogen material for our vermicomposting system?”
- Newspaper provides the carbon and food waste provides the nitrogen.
- In the worm bin, the carbon layer covers the nitrogen layer in order to discourage fruit flies and odors.
- If the worm bin smells bad, it is probably because it contains too much nitrogen (food waste). Feed the worms weekly when almost all of the previously added food waste has been digested.

- **Decomposers:** Show students the live composting worms and point out the composting worms image on the Decomposers Sign. “Do these look like the type of



Decomposers Sign



## INTRODUCTION

## CONTINUED

earthworms that you find in the garden? No. These are a different kind of worm called a composting worm. We only use these types of worms in the vermicomposting system.”

- The worm bin will also be filled with other types of decomposers, including microorganisms. In fact, it is the bacteria on the food waste and in the guts of composting worms that do the main work of decomposition in a worm bin!
- Always wet your hands before holding the worms so their bodies do not dry out.
- Always keep the worms protected from direct sunlight.
- Worms have five hearts and no eyes or bones! Always handle them very gently.

2. **Air:** Demonstrate how to shred the newspaper lengthwise into 1 inch strips, then add air by separating/fluffing the strips. “The carbon material serves as the bedding for the worms; it must be light and fluffy so that air can flow through. Make sure you do not compact or press down on the bedding material. Just like in our first lesson, we are creating an aerobic environment where worms and other decomposers can thrive.”



3. **Water:** Demonstrate how to moisten the shredded, fluffed newspaper strips by dunking them in the wash tub with water. Allow the water to drain off before placing the bedding in a layer at the bottom of the empty worm bin. Use your hands to separate/fluff the strips so that air can flow through and the bedding is not matted. “As we know, water is essential for life! Did you know that worms breathe through their skin? Their environment needs to be moist in order for the worms to thrive. If you see that the bedding in your worm bin is dry, be sure to add water to keep it moist.”



**The Bin:** Show students the bottom of the bin where the drainage holes are located. “Even though worms need plenty of moisture, they cannot swim and can drown if the water is not able to drain out. Also, it is important to keep the worm bin in the shade, out of direct sunlight so it does not get too hot inside.”

**Vermicast:** Show students the sample of finished vermicast. “This is what the worms produce. It is called VERMICAST, VERMICOMPOST, or worm poop! It is a favorite food for plants because it contains nutrients that plants are able to use, and beneficial microorganisms that contribute to the recycling of nutrients in the soil. We can dissolve the vermicast in water and water our garden soil with it, or we can allow the vermicast to dry, then mix it with garden or potting soil.”

## WEEKLY TASKS

**Feeding the Worms:** Review the types of foods that are and are not allowed in the worm bin:

- **What goes in:** Pieces of raw or cooked fruit and vegetables, tea bags, paper towels. Coffee grounds, citrus peels, tomatoes, breads, and grains are OK to add in small quantities.
- **What stays out:** Anything spicy, salty, or vinegary, dairy products, processed/junk foods, fat/oil, fish, meat, garlic, onion and NO PAPAYA SEEDS! (which may cause the worms to become sterile and cause the colony to die out).

**Adding Bedding Material:** “Bedding material (carbon/shredded newspaper/cardboard/paper egg cartons) will also decompose over time. Add more as needed to keep the food waste covered. Make sure it is fluffy and moist!”

**Leachate:** “LEACHATE is the dark liquid that drains out of the bottom of the worm bin. It is filled with nutrients for the plants, but also some potentially harmful microorganisms. It may be diluted with water and poured onto the soil/mulch around trees on campus. Do not use it directly on the edible parts of plants. If your leachate is draining into a collection container, be sure to empty it at least once a week.”

## GROUP ACTIVITIES OVERVIEW

“Today we will observe our composting worms up close, then prepare the materials needed to build our worm bin. Materials like newspaper not only serve as a source of food for our worms but help to provide structure to their home, give them places to hide, and keep the bin well aerated. Remember that worms need air to breathe like we do. They also need water but not so much that

## INTRODUCTION

CONTINUED

their home becomes water-logged. The newspaper helps to soak up extra liquid and also keep the environment moist.”

### Garden Agreements

Have students take a deep breath, then repeat and discuss the Garden Agreements as listed on the Garden Agreements Sign:



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

Divide the students into three groups for bedding and food preparation. The Group Activities may take place in the classroom or outside in the garden/compost area.

## GROUP ACTIVITIES

30 MINUTES

### GETTING TO KNOW THE WORMS (10 minutes)

Encourage students to observe the composting worms closely using their eyes and sense of touch by holding the worms very gently in their open palms. Make sure their hands are moist first (use the spray bottle with water). Do not force students to hold the worms if they are not comfortable doing so.



“Please be MINDFUL when handling the worms by being conscious their needs and treating them with kindness and respect. If we take care of them they will help us reduce waste and create vermicompost.”

“When you are finished you may begin helping to prepare the bin materials.”

### BEDDING AND FOOD PREP (10 minutes)

Have the two groups prepare the bin materials:

1. **Bedding Base (Carbon):** Like the large sticks and palm fronds used in the first layer of the aerobic compost pile, the shredded cardboard and paper egg cartons help to aerate the system. Tear cardboard and paper egg cartons into one inch pieces (50/50 ratio of cardboard to paper egg cartons is preferred)
2. **Food Waste (Nitrogen):** Prepare the food waste by tearing or cutting large pieces into smaller ones, making sure there are no papaya seeds and few if any citrus rinds.

3. **Cover (Carbon):** Tear long strips of newspaper (about 1 inch wide by 12 inches long), fluff them to separate the sheets, and dunk them in the wash bin with water. Let them drip dry for a few seconds before placing them in the worm bin.

Optional: Use the hanging scale to weigh the food waste in order to keep a record of how much waste is being diverted from the landfill.



Coconut coir (shredded coconut husk fiber) can also be used as bedding (carbon) for the worms.

### BUILDING THE BIN (10 minutes)

Gather the groups for the bin building. “We are going to build our worm bin carefully by adding fluffed, moist newspaper strips, followed by the worms with vermicast. We are including some of the vermicast material because it contains very important microorganisms and other creatures that help prepare the food waste for the worms to digest. We are building an ecosystem in which many different organisms work together.”

Have students add the worms and vermicast, distributing them over the entire bedding material. Add the food waste. Place another layer of fluffed, moist newspaper strips over the worms, vermicast, and food waste. Replace the lid.

**All students must wash their hands thoroughly with soap and water after working with the vermiculture system.**



## CLOSING

10 MINUTES

Gather all the students in the classroom or garden/compost area. Have students refer to their Guided Notes and ask them to share about their experience.

Discuss with students:

- What are the main ingredients in a VERMICOMPOSTING system, and what should not be included?
- What types of DECOMPOSERS live in a worm bin?
- List and describe the important weekly tasks for maintaining a healthy worm bin.

Repeat the list of weekly tasks to students, including feeding the worms (review do's and don'ts of what to feed them), adding fluffed, moist bedding as needed, and emptying the leachate (to be diluted and poured into the soil around trees around campus).

## FOLLOW UP VERMICULTURE CARE

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

- Assign two to four **Vermiculture Monitors** per week to feed the worms, add properly prepared, moist bedding, spray additional water as needed, and empty the leachate (diluting it and applying it to the soil around trees on campus). Have Vermiculture Monitors complete the Weekly Vermiculture Log.
- Optional: Have students weigh and record the amount of food waste they add to the bin(s) each week.
- Refer to the How To Create A Vermicomposting System Resource Sheet for additional tips and troubleshooting.
- Students must wash their hands thoroughly with soap and water after working with the vermiculture system.

“As long as the worms have everything they need and a comfortable environment, they will reproduce quickly and the colony will grow, allowing them to process more and more food waste. You can easily start more worm bins once your worm population is large enough. In about 4 to 6 months we will harvest the finished vermicast together and use it to help the gardens!”

“Every time you eat a healthy snack or meal, think about what you can do with the peels and other parts of fruits and vegetables that you don't eat. If you throw them in the trash, the nutrients can't get recycled to be used by plants. But if you feed them to the worms or your aerobic compost pile, the recycled nutrients will be given to our garden plants, allowing more fresh, healthy food to grow.” **Workbook Question #5:** If time permits have students draw and label the main ingredients on their worm bin diagram.

## FOLLOW UP ACTIVITIES

**Follow Up Activities are the responsibility of the classroom teacher.**

- Have students complete the Guided Notes. Review together as a class.
- Have students keep a journal about the composting experience including notes, opinions, drawings, poems, stories, etc.
- Continue to have students care for the aerobic compost pile(s) as described in the Follow Up section of Lesson 1.



## LESSON EXTENSIONS

### Annelid Digestive System (LS4.C)

1. Discuss with students the body structure and function of worms:

- Worms belong to a group of animals called annelids. The annelid family includes lots of different kinds of worms, but one thing they have in common is that their bodies are segmented. Segmented means they contain repeating units of the same thing. Are our bodies segmented? No.
- Annelids are very good at breaking down large food materials because of their digestive system. Let's compare their digestive system to ours. Humans have many parts of our digestive system, beginning with a mouth that chews our food and extending through our stomach and our intestines. The digestive system of a worm is much simpler and looks much like a hollow tube. Demonstrate by showing a cardboard tube.
- The pharynx or muscular band is near the mouth and helps to push the food down the worm's body. Guess what comes out the other end? Worm poop! It is also called worm castings or vermicast.



2. Discuss with students the formation and composition of vermicast:

- Carbon, nitrogen, air, water, and life are the main ingredients for producing vermicast. Have students name examples of different types of organic matter (carbon, nitrogen, and life) that can be added to a vermicomposting system.
- Vermicast contains nutrients for plants (organic nitrogen, nitrate, ammonia) and many, many beneficial microorganisms such as bacteria, fungi, protozoa, and nematodes that also reside in the worm gut and aid in digestion.



Vermicast is an excellent source of nutrients and living organisms that benefit soil and plant health.

3. Discuss with students the benefits of vermicast in contrast to other methods of fertilizing plants.

- By adding vermicast to garden soil, plants receive the benefits of the nutrients *and* the living organisms, who will continue the process of decomposition and nutrient cycling in the soil, creating a more sustainable growing system.
- This is much different than adding inorganic/ synthetic fertilizer to the soil, which actually harms soil life, disrupting the natural process of nutrient cycling and making the plants dependent on the synthetic fertilizer.
- Certain technologies associated with industrial agriculture, such as the use of synthetic chemicals (e.g., pesticides, fertilizers), genetic modification, and heavy machines that use fossil fuels, have led to dramatic changes in environmental health, food quality, and the health and make-up of communities by consolidating farmland (fewer people involved), creating monocultures (destroying biodiversity), increasing environmental pollution (soil erosion and poisoned soil and water), and diminishing our understanding of the importance of healthy, living soil.



Synthetic fertilizers harm soil life, disrupting the natural process of nutrient cycling.



Heavy machines compact the soil, damaging living soil systems and increasing soil runoff and erosion.



Soil health and biodiversity are critical to agriculture, humanity, and Earth's ecosystems.



## LESSON EXTENSIONS

CONTINUED

## Rethinking "Waste"

(3.W.1, 3.SL.1, Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data)

1. Discuss with students how the act or habit of composting relates to caring for the planet:
  - Composting reduces waste. In nature there is no waste. Approximately 30 to 50% or more of our "waste" is compostable. By making compost we can significantly reduce



the amount of "waste" we send to the landfill or incinerator.

2. Have students do a Trash Check where they will collect and analyze data to discover how much and what kinds of "waste" are produced. Separate trash can contents into 4 categories: Compostable, Reusable, Recyclable, "Refusable" (i.e. trash that cannot be composted, reused, or recycled and that we must find an alternative to using). The Trash Check may take any of several forms:
  - Have the class save and inspect all of the trash thrown into your classroom's trash can for one day (or one week).
  - Have each student save all of the trash he/she produces in one day (or one week), then analyze it and report to the class.
  - Arrange a one-day Trash Check at your school, focusing on either cafeteria, classroom, office, or yard waste, or all types.
3. Have students share their Trash Check results with the school and create an advertising campaign for composting!

## CAFETERIA TRASH CHECK!



AMOUNT OF LUNCH TRASH				AMOUNT OF LUNCH TRASH			
Date	1 <sup>st</sup> Bin	2 <sup>nd</sup> Bin	Total	Date	1 <sup>st</sup> Bin	2 <sup>nd</sup> Bin	Total
Monday 3/3	80 lbs	127 lbs	207 lbs	Monday 3/3	79 lbs	70 lbs	149 lbs
Tuesday 3/4	75 lbs	89 lbs	162 lbs	Tuesday 3/4	85 lbs	73 lbs	158 lbs
Wednesday 3/5	62 lbs	78 lbs	140 lbs	Wednesday 3/5	72 lbs	92 lbs	164 lbs
Thursday 3/6	70 lbs	63 lbs	133 lbs	Thursday 3/6	95 lbs	126 lbs	221 lbs
Friday 3/7	83 lbs	96 lbs	179 lbs	Friday 3/7	74 lbs	67 lbs	141 lbs
The Weekly Total:	368 lbs	453 lbs	821 lbs	The Weekly Total:	381 lbs	328 lbs	709 lbs