SCRAPS INTO SOIL LAB

People and the Planet
Lessons for a Sustainable Future

INTRODUCTION

When we throw away garbage, from plastic wrap to a banana peel, it is taken to a landfill where it is buried and can take years to **decompose**. As a result, landfills are quickly filling up. According to the U.S. Environmental Protection Agency (EPA), each person in the U.S. generates an average of 4.9 pounds of trash per day. That's over 1,700 pound of trash a year – the weight of three vending machines!

The EPA also estimates that about 30 percent of the waste generated by a household is **compostable** but only 4 percent is actually composted. Composting speeds up the natural process of decomposition and diverts natural, **organic waste** from landfills. When natural, organic waste is separated into a compost pile, it gets mixed with **decomposers**, the beneficial bacteria and fungi in soil, and as long as there's sufficient water and oxygen, it quickly decays into nutrient-rich soil that is perfect for the garden. That same organic waste left to decompose in a landfill, however, would lack exposure to oxygen and decomposers and as a result, would take years to decay and produce harmful methane gas in the process.

As the U.S. population grows and consumption continues to increase, it is important to consider the personal steps we can take to lessen our impact and the benefits of composting for waste management.

MATERIALS

- Scissors
- Masking or duct tape
- Daily Observation Sheet (provided)

For each group:

- 4 clear two-liter soda bottles
- Spoon
- Soil (from outside, with no worms)
- Water (preferably distilled)
- Compostable items (See Recommended Composting Materials list)
- Lab Report (provided)

CONCEPT

Most of the organic waste created by a household can be composted and made into usable soil.

OBJECTIVES

Students will be able to:

- Differentiate between organic and inorganic waste products.
- Distinguish between constant, independent and dependent variables, and record findings in a lab report.
- Examine the difference in decomposition rates between organic and inorganic waste.
- Assess how composting can impact the amount of waste that goes into landfills.

SUBJECTS

Science (life, Earth and environmental)

SKILLS

Planning and carrying out investigations, observing, collecting and analyzing data, critical thinking, identifying trends and patterns, comparing and evaluating, modeling natural systems

METHOD

Students complete a lab activity to observe how organic and inorganic waste decomposes over time in a natural setting.

PROCEDURE

1. Before starting this lab, ask each student to bring in a clear two-liter soda bottle, with the label removed. Use scissors to cut off the top of each soda bottle, about four inches below the cap, and poke five to seven holes in the top (of the cut-off part). If students can't bring one from home, you can also ask the school cafeteria or bring some in yourself.

2. Invite students to share what they already know about composting. Then ask students, "Why do some things decompose over time while others to not?"

3. Discuss the following definitions:

   Composting: the process of breaking down organic household materials, especially food scraps and yard trimmings, into nutrient-rich soil.

   Decomposition: the process of breaking down any dead object into simpler substances like carbon dioxide, water, sugars, salts, and minerals.

   Decomposer: things like bacteria, fungus, and insects that help in the decomposition and composting processes by breaking down matter.

4. Divide students into small groups of four and distribute one copy of the Lab Report per group. Explain that over the next few weeks, they will be working in these groups to observe if and how certain "trash" items decompose.

5. Within their groups, students will observe four different compost bins: one with yard waste, one with food scraps, one with paper products, and one with human-made products. Each group will provide their own items to compost and should decide among themselves who will be responsible for bringing in each item. (One person should bring a yard waste item, one person a food waste item, and so on.)

   Alternate Procedure: Each small group could bring in just one item and build just one bin. During the data collection portion of the lab, students could gallery walk among the different groups' bins to record findings for each type of object. This would significantly reduce the prep time and number of bottles needed.

   Recommended Composting Materials:
   Bottle 1: Yard waste (leaves/grass)
   Bottle 2: Food waste (banana peel, apple core, slice of bread, clean egg shell, carrot)
   - Do not allow students to bring in any dairy or meat item to compost. This would cause your bottles to smell.

   Bottle 3: Un-coated paper products (napkin, notebook paper, small paper bag, coffee filter)
   Bottle 4: Man-made products (aluminum can, Styrofoam cup, plastic bag, small yogurt container)
   - You may need to cut these items so that they fit into the bottle.

6. When students have brought their items to class, they should get into their groups of four, and spread their four items on the table in front of them. Have them work in their group to answer questions 1, 2, and 3 (the goal, hypothesis, and variables identification) on the Lab Report and discuss as needed.

7. Build your compost bins! Give each group four bottles. For each bottle, students should:

    a. Add two inches of soil to the bottle.
    b. Place one of the group's four objects in the bottle.
    c. Add soil until the object is covered by two inches.
    d. Write the object name on a piece of tape and use it to label the bottle.
    e. Tightly tape the top of the bottle back on the top.

8. Have groups place their bins in the same area of the room (similar lighting and temperature). Or, weather permitting, you could place all of your bottles in an outdoor area.

9. Distribute copies of the Daily Observation Sheet for each student per day to record data. Or, students can use a lab notebook to record data from the experiment.

10. At the same time each day, have students meet with their small group and use a spoon to add water until the soil is just moist, like a wrung out sponge. The water will speed up the decomposition process because the bacteria at work in the bins need water to survive. Next, students should mix their bins by gently shaking the bottle (shaking gently will minimize soil spilling out). Items should still be buried between the layers of soil after shaking. Mixing the soil allows oxygen to reach the decomposers buried in the soil and speeds up decomposition.

11. After they shake the bottles, have each group make observations of the appearance and smell of each of the compost bins. (Has the object broken apart? Is it smaller? Is it slimy? Does it smell? Has the color changed?) They should record all observations in either an interactive notebook or on a copy of their Daily Observation Sheet. It may be helpful to have the students take or sketch pictures of the bins to show progression.

12. If time permits, allow groups to share observations with the class.

13. After about a week, make a class list on the board of the items that are decomposing the fastest and slowest. Students should notice that the items that are decomposing faster are made of natural materials. At this point, allow students to revise their hypothesis about what items will decompose and which will decompose the fastest and record their thinking on their lab report (question 4).

14. Continue to observe the bins daily and let the experiment run as long as possible – the longer it runs, the more decomposition you will see. It will take around three weeks to see significant decomposition.

15. At the end of the experiment, have students complete question 5 on their lab report – final conclusion and analysis. Students should be able to tell that natural materials (leaves, food scraps) decomposed quickly while human-made materials did not decompose. Students should also be able to see that items made from plants (un-coated paper products) showed decomposition as well.

16. Identify the difference between organic and inorganic waste.

Organic waste: derived from natural materials, like plants or animals (food scraps, yard trimmings, paper products)

Inorganic waste: derived from materials other than plant or animal matter, like sand, dust, glass, or synthetics (plastics, Styrofoam, rubbers, etc.)

Ask students to identify which items in the lab were organic and which were inorganic.

17. Go through the Discussion Questions as a class.

18. During this process, you may want to have your students research how long it typically takes common household items to decompose in a landfill. See the list below for scientists' estimates, but keep in mind that these times vary depending on landfill conditions like water, temperature, and aeration. Additional information can easily be found online.

Item	Decomposition Time
Toilet paper/Napkins	1-3 weeks
Paper plate	1 week-2 months
Banana/Orange peel	2-5 weeks
Cotton rag	1-5 months
Rope	3-14 months
Newspaper	3-6 months
Carry-out food bag	4-8 months
Wool sock	6 months-2 years
Cardboard	2 years
Plastic bag	10-20 years
Leather shoe	25-50 years
Nylon Fabric	30-40 years
Plastic beverage container	100 years
Aluminum can	250-500 years
Disposable diaper	300 years
Styrofoam egg carton	Undetermined; as much as 1,000,000 years or never
Glass jar/bottle	Undetermined; as much as 1,000,000 years or never

Source: Highland Environmental Learning Center, Highland, CA

19. To extend the project, add the soil from bins with organic materials to an existing compost bin or school garden, or use it to start a new school-wide compost bin or garden. (Inorganic materials should be removed from the soil and thrown away or recycled.)

Answers to Lab Report

1. *To determine if and how quickly certain trash items will decompose.*
2. *Answers will vary.*
3. *a. The rate of decomposition.*
   b. The type of item composted.
   c. The size of the container, amount of soil in the container at the beginning, environment (sunlight, temperature), and time observed.
4. *Answers will vary.*
5. *Answers will vary.*

DISCUSSION QUESTIONS

1. What conclusions did you draw from running this experiment? What materials can be composted?

Organic waste such as yard waste, food waste, and paper products all decomposed – they can be added to a compost pile to make healthy soil instead of going to a landfill. Inorganic products did not decompose, meaning they cannot be composted.

2. Why does organic waste decompose and inorganic waste does not?

Decomposers (in this lab, mostly fungi and bacteria) are able to feed on non-living organic matter and break it down into smaller parts.

3. Describe energy transfers that occurred in the compost bottles with organic matter. How is this similar or different to how energy would transfer in a real-world ecosystem?

In this lab, energy was transferred from the organic waste to the decomposers, like bacteria and fungi, allowing them to grow and creating soil. The same process would occur in a real-world ecosystem, only there would be a third energy transfer from the soil to the plants that grow in it.

4. When organic waste goes to a landfill, do you think it decomposes like it did in this experiment? Why or why not?

Answers will vary. Ask students to describe the conditions that were in their compost bottles. Explain that landfills are not "mixed" or "watered" and therefore have little flow of water or oxygen. It is difficult for decomposers to survive without the right balance of moisture and oxygen, so the decomposition process in a landfill takes much longer than it would in a compost pile. It can help to imagine if the compost bottles were only filled with paper, for example, and no soil. The paper would not have broken down because decomposers would not have been present. Also, items in a landfill are often buried in the pile of garbage and not exposed to sunlight, further slowing decomposition.

5. Three out of the four bottles in the experiment showed decomposition. Think about the garbage that you throw away at home or at school – is most of it organic material or inorganic? What would happen to the amount of waste you send to the landfill if you composted all of your organic waste?

Answers will vary. The amount of waste that goes to landfills would most likely decrease significantly if all students' organic materials were composted.

6. What are some benefits to composting organic waste instead of throwing it in the garbage or down the garbage disposal?

   Answers may include: less space taken up in the landfill, fewer toxic gases released into the environment from landfills, less water and energy to separate out the food waste at water treatment plants, healthy soil to use for gardening.

7. Are there things you can do with inorganic items so they don't end up in the landfill either?

   Yes. Items like aluminum cans and plastics can be recycled or reused. This will further cut down on landfill waste. Other items like batteries, old paint, old cell phones or computers can be taken to disposal sites set up by your county.

8. Do you think everything will eventually decompose in a landfill?

   Students may have different opinions. While most items should eventually decompose, it may take millions of years or more because there is little water or oxygen in a landfill to speed up the decomposition process. Some items, like a glass bottle or Styrofoam cup, may never fully decompose.

ASSESSMENT

Students write 3-5 sentences explaining if they think composting is an effective way to reduce landfill waste and why.

FOLLOW-UP ACTIVITIES

1. Now that students know organic items decompose faster than inorganic items, set up another experiment to explore the effects of adding worms to a compost pile. This is known as vermicomposting. Set up two larger compost bins, both with natural items, and add worms to one of the bins (the most commonly used composting worms are red wrigglers). Because of the worms involved, you will need to take some extra precautions during your vermicomposting (keeping the area dark, monitoring the temperature, etc). Observe the difference in decomposition rates and discuss why the worms speed up decomposition (they eat the scraps and also aerate the soil as they move). Red wriggler worms can be purchased from a local tackle shop or easily ordered online through Amazon.com or garden supply retailers.

2. Research your own city's composting program. Then, compare your local plan with the large scale composting operations that are set up in cities like San Francisco, Seattle, or Toronto. Discuss how each work and how each community benefits from the programs in place.

Data Sources:
Environmental Protection Agency, Composting At Home, https://www.epa.gov/recycle/composting-home#basics; Highland Environmental Learning Center.

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LAB REPORT

Name: _____ Date: _____

Lab Title: _____

1. Goal of the lab	

2a.	Which items will decompose?	
2b.	Rank the items in order of fastest decomposition to slowest.	

3a.	Independent Variable		
3b.	Dependent Variable		
3c.	Constants	1. 2.	3. 4.

4a.	Which items will decompose?	
4b.	Rank the items in order of fastest decomposition to slowest.	

5a.	Did the data support your hypothesis?	
5b.	Which items decomposed?	
5c.	Rank the items in order of fastest decomposition to slowest.	
5d.	How did the dependent variable impact the independent variable?	
5e.	Why do you think this was true?	

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DAILY OBSERVATION SHEET

Name: _____ Date: _____

Day of Experiment: _____ Time: _____

Write or draw what your group observes in each of the bottles. Remember to record observations on both the appearance and smell of the object – Has it broken apart? Is it smaller? Is it slimy? Does it smell? Has the color changed?

Item 1:	Item 2:

Item 3:	Item 4:

Overall Observations: _____