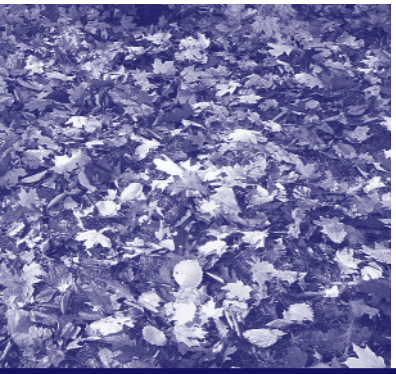
Composting

What Is Composting?

Composting is the controlled thermophilic (130°-150°F) decomposition of organic materials such as leaves, grass, and food scraps by various organisms. Composting can be divided into three types: backyard, or home, composting; vermicomposting; and heat-based composting.

Home composting is the natural degradation of yard trimmings, food scraps, wood ashes, shredded paper, coffee grounds, and other household organic waste by naturally occurring microscopic organisms. Vermicomposting is the natural degradation of similar household organic waste using naturally occurring microscopic organisms and the digestive process of earthworms. Heat-based composting is performed by municipal or commercial facilities that increase the rate of degradation using high temperatures.

Varying amounts of heat, water, air, and food produce different qualities of compost as a final product. Heat-based compost differs from compost produced at ambient temperatures (e.g., a forest floor or home composting) because high temperatures destroy both weed seeds and pathogens. Composts produced by all three systems are crumbly, earthy-smelling, soil-like materials with a variety of beneficial organisms.



Key Points

- Composting is the controlled decomposition of organic materials.
- There are three methods of composting: home or backyard composting, vermicomposting, and heat-based composting.
- Invertebrates and microorganisms in compost are key to the breakdown of the organic materials into a rich soil-like product.
- Quality compost is the result of the proper mixture of carbon and nitrogen sources and adequate amounts of moisture, oxygen, and time. Certain food items should be avoided when home composting.
- More than 67 percent of the waste produced in the United States (including paper) is compostable material.
- Compost is a valuable product that can be used as a soil amendment, mulch, or even to decontaminate natural habitats, storm water, and brownfields.
- Composting helps divert a large portion of America's organic trash from landfills and combustion facilities.

Worms—A Composter's Best Friend

Vermicomposting is a method of composting using a special kind of earthworm known as a red wiggler (*Elsenia fetida*), which eats its weight in organic matter each day. Vermicomposting is typically done in a covered container with a bedding of dirt, newspaper, or leaves. Food scraps (without added fats) can then be added as food for the worms. Over time, the food will be replaced with worm droppings, a rich brown matter that is an excellent natural plant food. Vermicomposting requires less space than normal composting methods, and is therefore ideal for classrooms, apartments, and those in high-density urban areas.

Composting in Action

An easy way to understand all the factors that go into composting is with a hands-on demonstration. A school can provide the perfect medium for these demonstrations. Classes could start a composting bin using food scraps from the cafeteria and yard trimmings from ground maintenance. Depending on the scope of the project, the compost could then be sold to the community in addition to being used on the school campus. Tour a local composting facility, if composting cannot be done at school. For more information on how to start a school composting project, go to the Cornell University composting Web site at <http://compost.css.cornell.edu/composting_homepage.html> or use these suggested activities to get you started:

- Start a compost pile or bin in the school or as a class experiment.
- Try using compost in place of chemical fertilizers, pesticides, and fungicides. Use compost made by the school or buy it from municipalities or private companies.

How Does Composting Work?

Compost contains both carbon and nitrogen sources, which can be simplified as browns (e.g., leaves, straw, woody materials) and greens (e.g., grass and food scraps), respectively. Adequate sources of carbon and nitrogen are important for microorganism growth and energy. The ideal ratio is 30 parts brown to 1 part green. Odor and other problems can occur if the ratio or any of the factors discussed below are not right.

The browns and greens can be mixed together to form compost in a backyard bin or in a municipal compost facility. Whether the composting is done on a small scale or large, the composting process is the same. To encourage decomposition throughout the pile, the compost should be kept moist and turned periodically.

The decomposition of organic materials in composting involves both physical and chemical processes. During decomposition, organic materials are broken down through the activities and appetites of bacteria, fungi, and various invertebrates that will naturally appear in compost, such as mites, millipedes, beetles, sowbugs, earwigs, earthworms, slugs, and snails. These microorganisms and insects found in decomposing matter need adequate moisture and oxygen to degrade the organic materials in the most efficient manner.

What Are the Benefits of Composting?

As a method of handling the large amount of organic waste created in the United States each day, composting makes good environmental sense. Instead of throwing organic materials away, they can be turned into a useful resource.

In addition, many organic wastes are not ideally suited for disposal in combustion facilities or landfills. Food scraps and yard trimmings tend to make inferior fuel for combustors because of their high moisture content. Decomposition of organic wastes in landfills can create methane, a greenhouse gas that is environmentally harmful because it destroys atmospheric ozone.

Because yard trimmings and food scraps make up about 24 percent of the waste U.S. households generate (EPA, 2003), backyard or home composting can greatly reduce the amount of

waste that ends up in landfills or combustors. In addition, compost is a valuable product that can be used as a soil additive for backyard gardens and farm lands or in highway beautification and other landscape projects.

The benefits don't end there—composting also makes good economic sense. Composting can reduce a community's solid waste transportation, disposal, and processing costs. In many communities, residents pay for each bag or can of trash they put out for pickup. If a household is composting, it will most likely put less in trash cans and will pay a smaller trash bill.

In backyards and on the community level, interest in composting has increased rapidly over the past several years. Yard trimmings programs constitute the large majority of composting operations in the United States. In these programs, community members place their yard trimmings in a separate bag or container at the curb, which is collected and taken to a municipal composting facility. These facilities create large amounts of compost, which, in many cases, is sold back to community members. People can also purchase compost created by private composting companies.

What Are the Challenges Associated With Composting?

Creating quality compost requires the right mix of materials and attention to moisture, particle size, and temperature. Too little moisture will slow the decomposition, but too much can create odor problems. To avoid attracting pests and rodents, composters should monitor the food scraps put in the compost pile. Meat scraps, fats, and oils are difficult items to compost, attract pests, and should be kept away from the compost pile, and thrown away instead.

While composting increases the rate of natural organic decomposition, it still takes months for compost to mature. If compost is used while it is still "cooking," the high temperatures could kill the plant life on which it is spread. In addition, using compost before it is ready can encourage weed growth because the high temperatures of the pile have not had a chance to kill any potential weed seeds.

What Are Some Emerging Trends in Composting?

A large amount of organic waste is created by institutions, restaurants, and grocery stores—perfect for compost. Across the country, many of

What Can Go Into a Composting Bin?

This list is not meant to be all inclusive. Some food products should not be included because they can attract pests or compromise the quality of the compost.

Materials to Include	Materials to Exclude
Fruit and vegetable scraps	Meats
Tea bags	Dairy foods
Wool and cotton rags	Bones
Coffee grounds with filters	Fats
Grass/Yard clippings	Pet excrement
Leaves	Diseased plants
Egg shells	Grease
Sawdust	Oils (including peanut butter and mayonnaise)
Fireplace ash	
Nonrecyclable paper	
Vacuum cleaner lint	
Fish scraps	

these businesses are participating in pilot projects to compost their food scraps and soiled paper products. These businesses can not only provide a valuable component of compost—organic material—but also can reduce their waste disposal costs significantly.

Compost is also being used as an innovative technology to clean up land contaminated by hazardous wastes, remove contaminants from storm water, facilitate reforestation, and restore wetlands and other natural habitats. Compost has been used to restore soil that is contaminated with explosives, munitions wastes, petroleum, fuel wastes, and lead and other metals. In addition, various biodegradable tableware and dishes have been developed; in particular, cups and plates made with a cellulose-based vegetable polymer.

Additional Information Resources:

Visit the following Web sites for more information on composting and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on composting: <www.epa.gov/compost>
- Cornell University composting site: <http://compost.css.cornell.edu/composting homepage.html>
- U.S. Composting Council Web site: <www.compostingcouncil.org>

To order the following additional documents on municipal solid waste and composting, call EPA toll free at (800) 490 9198 or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *Innovative Uses of Compost Erosion Control, Turf Remediation, and Landscaping* (EPA530 F 97 043)
- *A Collection of Solid Waste Resources* on CD ROM

Science

Compost Critters

Objective

To teach students that nature can "recycle" its own resources.

Activity Description

Students will search for and observe some of nature's recyclers at work, learning what role each plant or animal plays in the recycling process.

Materials Needed

- An outdoor area, such as a yard, park, or garden, that offers access to some of the following: rocks, trees (dead and living), leaf litter, mushrooms
- One or two teacher's aides or parents to help facilitate the outdoor adventure (optional)
- Several sheets of drawing paper and pencils or crayons per student
- One clear viewing container with holes

Key Vocabulary Words

Decay
Mushroom
Millipede
Fungi
Lichen

Duration

Outdoor expedition:
1 hour
In-class follow-up:
30 minutes

Skills Used

Observation/classification
Motor skills

Activity

Step 1: Visit your chosen outdoor area prior to the class trip in order to make sure it is suitable for viewing nature's recyclers. Scout out four specific "stations" for the students to visit, including a live tree, an old decomposing log, a large rock (or board) in the soil, and a leaf-covered patch of soil. To draw insects to a specific spot, you might want to plant a log or board in the soil several days in advance.

Step 2: Discuss recycling with the students and explain the following concepts (refer to the Teacher Fact Sheet titled *Composting* on page 141 for background information):

- Why we recycle and why nature also needs to recapture the value of its organic waste.
- What kinds of "trash" get "recycled" in nature.
- Who recycles these materials. Discuss the plants and animals, such as snails, slugs, beetles, millipedes, earthworms, fungi, pillbugs, snowbugs, mushrooms, and lichen that perform nature's recycling work.

Step 3: Divide the class into small groups of three to four students. Explain that the students are now adventurers on a mission to locate and study nature's recyclers at work. Remind students that it's very important to observe, but not touch or disturb the recyclers or their habitat.

Step 4: Lead the students to your predetermined outdoor area and stop at each of the four stations. At each station, first lead a discussion (see below) and then give each group

of students the chance to get up close and make individual observations. A list of suggested topics and discussion questions for each station follows:

Station #1–Live Tree

- Ask students what makes the tree grow. Where are its roots? Where does it get its food from?
- Will the tree live forever?
- Are its leaves falling to the ground?

Station #2–Dead, Decaying Log

- Ask students how this tree is different from the live one.
- Have them touch and smell its bark. How is it different than the live bark? Is it dry or damp?
- Do the students see evidence of the wood being eaten? By what?
- Have the students look in the crevices and cracks for any of nature's recyclers at work. If they see ants, spiders, millipedes, mushrooms, etc., ask them the following questions:
  - — Is it a plant or animal?
  - — What's its name?
  - — How does it move? How many legs does it have?
  - — What color is it?
  - — Why is it living under this dead log? What does it eat?
  - — How many of these creatures are living together?
- If it's possible (and safe), capture a few of these recyclers in your clear container and let the students view them up close. You may want to impose an item limit to prevent too much disruption for the critters. Students could draw the recyclers they see in nature or wait until they return to the classroom and draw from memory. Make a point of returning the creatures safely to their homes after the viewing is over.

Station #3–Large Rock or Board

- Have the students watch as you carefully lift the rock from its position. Ask students to look at what's underneath it.
- What's it like under the rock? Is it dark and moist?
- Can the students see any of nature's recyclers at work here? If they do see life, ask them the same questions as above:
  - — Is it a plant or animal?
  - — What's its name?
  - — How does it move? How many legs does it have?
  - — What color is it?
  - — Why is it living under this rock or board? What does it eat?
  - — How many of these creatures are living together?

Station #4–Leaf Litter and Soil

- Have the students use their hands to dig through the leaves and into the soil.
- Ask them to compare these leaves to the leaves still on the live tree. How are they different? Are these leaves older? Are they wet or dry?
- Have the students look for evidence of nature's recyclers; again, identify and discuss any animals or plants that they find.
- Ask the students to feel and smell the soil. How does it compare to the dead log they visited earlier?

Step 5: Before returning to the classroom, visit the live tree station again. Ask students to think again about where this tree gets its food. Discuss how the decaying log, busy creatures, and moist, rich soil all play a role in keeping the tree alive.

Assessment

1. Back in the classroom, pass out paper and colored pencils or crayons to the students. Have each student draw one of the recyclers he or she saw outside. Ask each student to verbally describe to the class how this creature moves, what it's called, and what recycling role it plays in nature.
2. Ask the students how they are like nature's recyclers. Do they recycle anything at home? How does it get reused?
3. Have the students draw a tree in different stages of its life, showing the tree 1) budding, 2) in full growth, 3) with leaves falling, 4) as a dead tree, having fallen as a log and decaying back into the earth, and 5) as a new tree growing from the soil.

Enrichment

1. Engage students in a role-playing activity. Have students pretend that they are different recyclers (ants, millipedes, worms, mushrooms, spiders). Ask the students how these animals or plants moved or behaved. Have the students imitate this behavior.
2. Study nature's recyclers in the winter by collecting some leaf litter, bringing it inside, and warming it with a lamp. Dormant recyclers, such as millipedes, ants, spiders, and worms will come to life under the heat.
3. Conduct another nature walk, this time giving each student a recyclable paper bag. Have them collect dead leaves, sticks, nuts, or other teacher-approved items on their walk. When students return to the classroom, discuss what role these items have in nature and in the natural cycle of life. Is the item dead or alive, what is it called, is there any evidence of nature's recyclers at work? Help them glue or tape these items on a piece of construction paper and display them. Have the students perform leaf rubbings by placing a leaf under a piece of paper and coloring over it to reveal its shape and texture. Ask the students to explore how each leaf is similar or different from others.

science

Compost Chefs

Objective

To teach students how composting can prevent food scraps and yard trimmings from being thrown away and how different components, such as air, moisture, and nitrogen, affect composting.

Activity Description

Students will create four compost bins that differ in their amounts of air, moisture, and nitrogen. Students will observe and record the differences these conditions cause in the composting process.

Materials Needed

- Four thin, plastic buckets (5 gallons each) or other plastic container (e.g., milk jug)
- One hand drill or punch-type can opener
- One copy of the *Compost Chef* worksheet per student
- Grass clippings (shredded, if possible)
- Vegetable and fruit peels
- Weeds (shredded, if possible)
- Hay (shredded, if possible)
- Sawdust
- Coffee grinds
- Thermometer
- Bloodmeal
- One marker or pen
- Tape
- Four pieces of construction paper (3 by 5 inches each)
- Garden trowel

Key Vocabulary Words

Compost
Nitrogen
Oxygen
Decompose
Bedding
Organic

Duration

Set-up: 1 hour

Follow-up: 15 minutes to 1 hour on an occasional basis for up to 4 weeks

Skills Used

Computation
Observation/classification
Motor skills

Activity

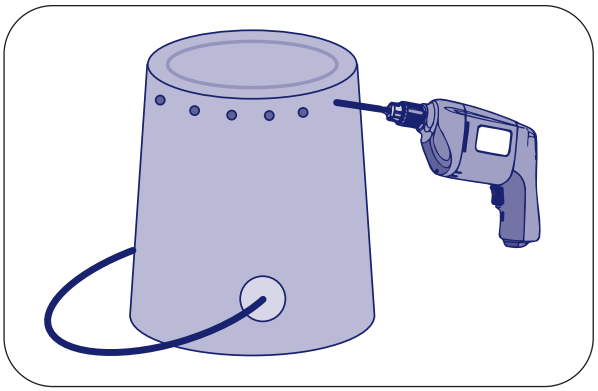
Step 1: Photocopy and distribute one copy of the *Compost Chef* worksheet to each student. Introduce the following concepts (refer to Teacher Fact Sheet titled *Composting* on page 141 for background information):

- Explain to the class what compost is and how it is made.
- Discuss why composting is important in managing and reducing trash that is sent to landfills.
- Explain how composting works, and how nitrogen, oxygen, and water all play a part in the creation of compost.

Journal Activity

Ask students to pretend they are gardeners. Ask them if they would use compost to help their gardens grow. Why or why not?

Step 2: Pick an appropriate project space. This activity can either be conducted in an indoor area of the classroom that has been covered with a protective drop cloth or in a designated area outside of the school. If you choose to leave the compost buckets outside, make sure the chosen area will not be disturbed by recess or after-school activity. Use the hand drill and carefully poke several holes in the sides (near the bottom) of three of the buckets or milk jugs.



Step 3: Have the students sit in a circle within view of you and the compost buckets. Divide the class into four groups and assign a group of students to each bucket. Using the construction paper and marker, label the buckets "one" through "four."

Step 4: Work with each group of students to set up the buckets. As each mixture is created, discuss its ingredients and ask students to record the "recipe" on their *Compost Chef* worksheets. Following are directions for setting up each bucket:

Bucket #1–Compost lacking nitrogen.

- Place mostly "brown" carbon-containing materials in the bucket, such as dead leaves, straw, and coffee grounds. On top, add a few vegetable and fruit peels.
- Moisten, but do not soak, the mixture with water.

Bucket #2–Compost lacking moisture.

- Place a mixture of "green" grass clippings (make sure they are dry), bloodmeal, and vegetable and fruit peels in the bucket.
- Place a few layers of "brown" dead leaves, straw, and coffee grounds into the mixture.
- Do not add any water.

Bucket #3–Compost lacking air circulation.

- Use the bucket without the holes.
- Place several layers of mostly high-nitrogen grass clippings, bloodmeal, vegetable peels, and fruit peels in the bucket.
- Moisten the mixture with water.

Bucket #4–"Perfect" Compost.

- Layer (in an alternating pattern) leaves, coffee grounds, straw, and vegetable and fruit peels, and a small amount of grass clippings in the bucket.
- Moisten the mixture with water.

Step 5: Explain that, as compost chefs, the students must monitor their creations. Give each group written instructions on how to care for its compost bucket over the next few weeks. For example:

Bucket #1

- Use a garden trowel to stir your compost mixture regularly: once every 3 days for the first 2 weeks, then once per week.
- Add a dash of moisture to your compost mixture with a sprinkle of water every other week.

Bucket #2

- Use the garden trowel to stir your compost mixture regularly: once every 3 days for the first 2 weeks, then once per week.
- Keep your compost mixture dry.

Bucket #3

- Add a sprinkle of water to your compost mixture every week.
- Make sure you don't stir your mixture.

Bucket #4

- Add a sprinkle of water to your compost mixture every week.
- Use the garden trowel to stir your mixture regularly: once every 3 days for the first 2 weeks, then once per week.

Step 6: At each interval of stirring or watering, have all of the groups visit each compost bucket and record their findings, including temperature, appearance, and smell. Students can use their *Compost Chef* worksheets for this task.

Step 7: After 4 weeks, have the students use the trowels to dig into each compost pile and examine it closely. Ask them to compare and contrast the compost in each bucket. Ask students which mixture decomposed the most.

Step 8: Use the finished compost from Bucket #4 as soil for classroom plants or a garden. Have students explore how compost aids new vegetative growth.

1. Ask students to list the most important ingredients for a good compost pile (nitrogen, water, and air circulation). Have them explain what role each ingredient plays in decomposition. Ask each group to name the missing ingredient in its mixture (Group #4 won't have a missing ingredient).
2. Have the students explain how composting reduces the amount of waste that we send to landfills.
3. Ask students to think of places in nature where composting might occur naturally.

1. Collect and evaluate the data on each student's *Compost Chef* worksheet. Have the students create charts or graphs based on the temperature data they collected. Which pile had the highest mean temperature? What does a high temperature mean in terms of decomposition?
2. Explore composting as a natural cycle. Study the nitrogen cycle and have students make diagrams of its components. (The nitrogen cycle is the continuous cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in soil, assimilated, and metabolized.) Use composting as a lead-in to discuss other natural cycles.
3. Start a schoolwide compost bin using the appropriate wastes from school lunches. Have students decide which wastes can be added to the pile and have different classes watch over and stir the pile each week. Have each participating class start a small flower garden plot, using the compost as a soil amendment.

Compost Chef

Name: _____

Bucket #1

Week 1
Temperature:
Appearance:
Smell:

Week 2
Temperature:
Appearance:
Smell:

Week 3
Temperature:
Appearance:
Smell:

Week 4
Temperature:
Appearance:
Smell:

Ingredients:

Bucket #2

Week 1
Temperature:
Appearance:
Smell:

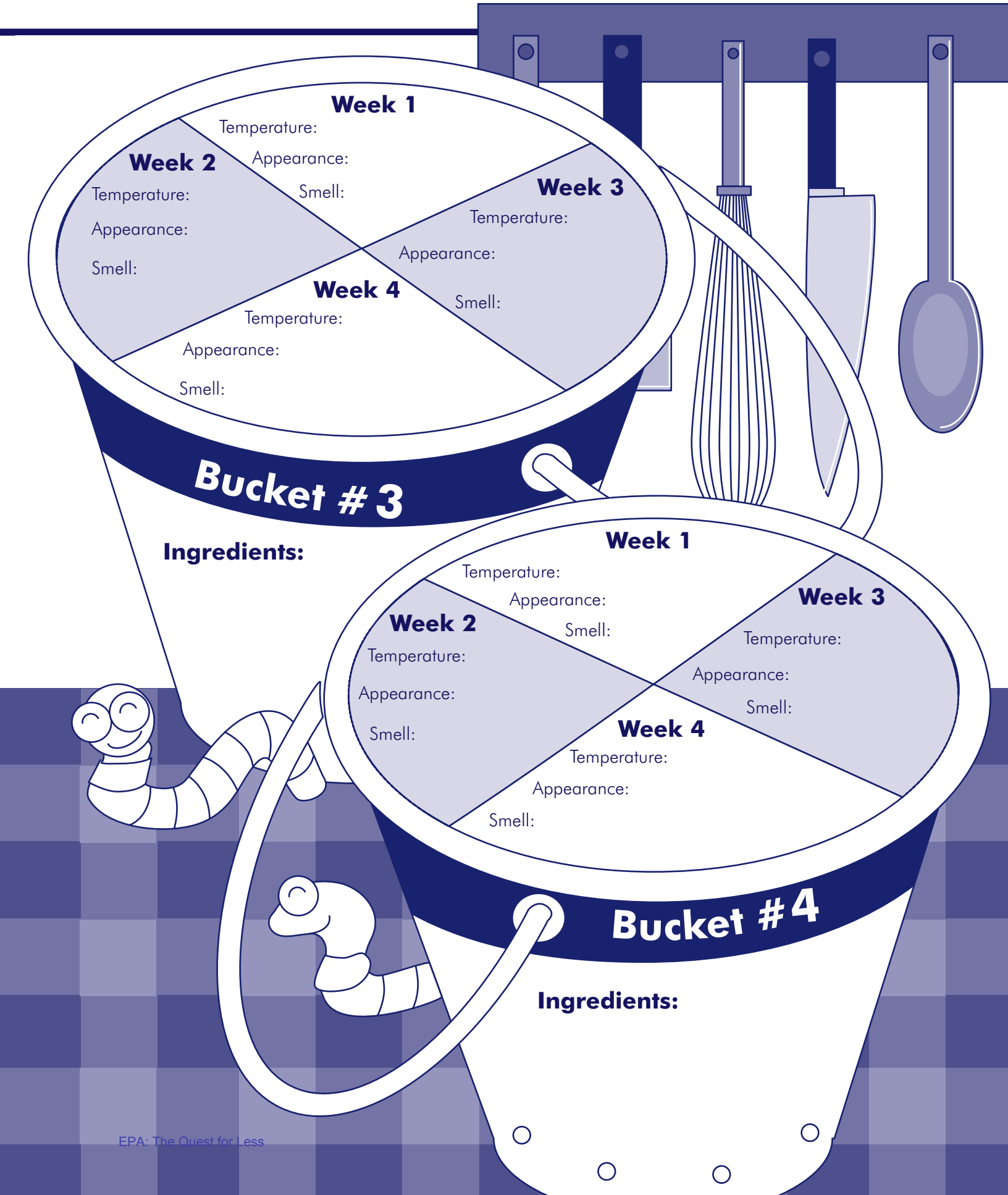
Week 2
Temperature:
Appearance:
Smell:

Week 3
Temperature:
Appearance:
Smell:

Week 4
Temperature:
Appearance:
Smell:

Ingredients:

Student Handout



science

math

Compost Crops

Prerequisite: This activity involves the use of previously made compost. Your students can use the compost they made from completing one of the following activities: Compost Chefs or Worms at Work.

Objective

To teach students how composting can prevent food scraps and yard trimmings from being thrown away and to show them the usefulness of compost in gardening.

Activity Description

Students will assess the effectiveness of compost as a soil amendment by planting and comparing two garden plots—one that relies just on dirt and one that relies on their homemade compost.

Materials Needed

- *Compost* (See prerequisite above)
- Two 4- by 4-foot garden plots in the schoolyard
- Two packets of flower seeds (have your students vote on the type and color)
- Two seed packets of a vegetable that grows well in your locale
- One watering can
- Two garden trowels
- One copy of the *Compost Crop* worksheet per student
- One tape measure or ruler

Key Vocabulary Words

Decompose
Compost
Root
Nutrient

Duration

Setup: 1 hour
Follow-up each week: 15 minutes

Skills Used

Computation
Observation/classification
Motor skills

Activity

Step 1: Locate and mark the two schoolyard garden plots you plan to use, making sure they receive plenty of direct sunlight. Secure permission for gardening from the proper school authorities.

Step 2: Discuss composting with the students and explain the following concepts (refer to the Teacher Fact Sheet titled *Composting* on page 141 for background information):

- Recap how the students made the compost and what materials they used.
- Discuss how this compost can now be used in a garden.
- Explain why compost can be more effective than just natural soil.

Step 3: Take the class outside to the garden plots and divide the students into two groups. Explain how the composting experiment will work. Tell one group that they will only add water to the soil to help their plants grow. Give the other group a bucket of compost and tell them to use the trowels to mix it into their soil before watering it.

Journal Activity

Ask students to pretend they are world-famous gardeners giving an interview about the secrets of their success. How do they make their plants grow so well?

Step 4: Have each group plant flower seeds and vegetable seeds according to packet instructions in their respective plots.

Step 5: Ask the students to predict which plot will grow better and faster. Have them record their predictions and reasoning on their *Compost Crop* worksheets.

Step 6: Break each of the two groups into pairs of students and assign each pair a week during which they are gardeners. During that week, those students are responsible for visiting their group's plot each day. They should water it and use the tape measure or ruler to record any changes in plant growth on their *Compost Crop* worksheets. Create a gardener calendar for the classroom to remind students when it's their turn to watch over the plots.

Step 7: After 4 or 5 weeks, have the entire class visit the garden plots again. Discuss which plot's plants grew faster. Ask student volunteers to gently dig up one plant from each plot. Have the students examine and compare the root structures of each plant. Have several students dig around in the plots' soil, discuss the differences in texture or moisture they find, and have them notice how many earthworms or bugs they find.

Step 8: If the vegetables in the plot are ripe, pick them and have a class snack from the compost harvest.

Assessment

1. Have students list the benefits of composting, both from the standpoint of preventing waste and as a garden soil supplement.

Enrichment

1. Use the two garden plots as a lead-in to a more in-depth science lesson on soil and compost. Compare the relative amounts of materials in different soil samples. Have student volunteers collect a handful of soil from each plot. For each sample, fill a liter (or quart) jar about one-quarter full of soil, then add water to about the three-quarter level. Screw the lid on tightly and shake hard for about a minute. Let the jars stand for several minutes. The mixture will separate into layers, with the largest particles (gravel and sand) settling on the bottom, and finer particles (clay and silt) settling above. Organic matter—leaves, twigs, and any animal matter—will float on top of the water. Discuss the differences between the soil and compost/soil plot samples. Explore the components of your local soil and compost.
2. Have the students compile their measurements and recordings from their *Compost Crop* worksheets on the board. Depending on the age group, ask all of the students to make graphs charting the growth in each plot. Ask them why plants in the compost plot grew more quickly.
3. Discuss the root structures of the plants from the different plots. Ask students if the plant from the compost plot was more developed in its root structure? Why?
4. Ask the students to think about the differences in the soil of the two plots. Did they see more earthworms in the compost plot? Why? Why would these creatures be attracted by the compost? How did the presence of earthworms affect the growth of the plants?
5. Start a schoolwide compost bin using the appropriate wastes from school lunches. Have students decide which wastes can be added to the compost pile and have different classes watch over and stir the pile each week. Have each participating class start a small flower garden plot, using the compost as a soil amendment.

Student Handout

Name: _____

Compost Crop Worksheet

Plot #	Amount of Water Added	Soil Status (How It Looks and Smells)	Presence of Plant Growth? Which Plants?	Measurement of Plant Growth (mm)	Thoughts or Observations
Day 1					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 2					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 3					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 4					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 5					
Plot #1 (just soil)					
Plot #2 (compost and soil)					

Worms at Work

Objective

To teach students that food scraps and yard trimmings can be made into compost instead of being thrown away.

Activity Description

Students will create a compost bin using worms and food scraps and monitor changes in the bin over time.

Materials Needed

- Large plastic bin (about 8 to 16 inches deep) with holes in the bottom for aeration
- Tray for underneath the bin
- Two bricks or other large sturdy objects
- 9 to 14 pounds of newspaper
- One bag of potting soil
- 1 pound of red worms
- Food scraps (such as bread, vegetables, fruits, eggshells, grains, coffee grounds, tea bags) Do NOT include meat, bones, mayonnaise, fish, peanut butter, candy, or nonfood items
- Tarp or drop cloth
- Bucket or other carrying container
- Household gloves (optional)
- Copy of *Vermicomposting Data Sheet* for each student

Key Vocabulary Words

Compost
Vermicomposting
Castings
Decompose
Bedding
Organic

Duration

Setup: 1 hour
Follow-up: 15 minutes to 1 hour on an occasional basis

Skills Used

Computation
Observation/classification
Motor skills

Activity

Step 1: Explain to the class what compost is and how it is made (refer to the Teacher Fact Sheet titled *Composting* on page 141). Discuss the use of worms, the need for and use of organic waste, and other vocabulary words. During the course of this lesson, inform students of good and bad foods to use in composting, as well as the reason why it is better to compost than to throw food scraps away.

Step 2: Place bin on top of two bricks and put tray under bin.

Step 3: Have the students tear each sheet of newspaper lengthwise into strips that are 1 to 3 inches wide and place half of the pile in the bin.

Step 4: Have the students multiply the number of pounds of newspaper by 3 to determine the total amount of water needed (a pint of water weighs a pound, and a gallon of water

Journal Activity

Have students write a poem, such as a limerick, that describes what compost looks like and how it feels when touched.

weighs 8 pounds). Then add half of the water to the bin with newspapers.

Step 5: Sprinkle two handfuls of soil and the rest of the newspaper and water. Have the students mix the contents well and distribute evenly in the bin.

Step 6: Gently place the worms on top of the bedding, spreading them evenly. Keep the bin uncovered so the students will see the worms moving down into the bedding to avoid light.

Step 7: Use the attached data sheet to record all activities surrounding the worm bin, including the date the bin was set up, the number of worms (or pounds of worms) added to the bin, and the number of people contributing food scraps (number of people in the class). For the remainder of steps for this activity, have students record the date and day food is added, including the type of food and its weight, as well as the amount of water added. The compost bin should always remain moist.

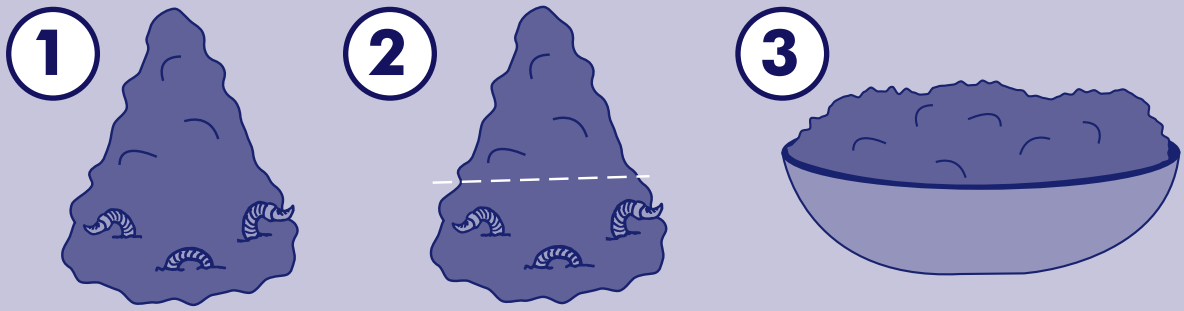
Step 8: Use food scraps that you brought from home or that you asked students to bring from home or save from school lunch, and have students add them to the bin. Food can be added daily, weekly, or monthly. Do not overload the system; bury food relatively evenly amongst the different "plots." On the data sheet, instruct students to keep track of how much food they are providing the worms and where it is placed (see diagram on data sheet).

Step 9: Place a sheet of newspaper over the top of the bin to prevent flies from circulating near the area. Store the bin in a cool place out of direct sunlight, and keep the lid tightly shut.

Step 10: Have students check the bin frequently as they add food scraps to see the changes that occur. After a period of 3 to 6 months, depending on the size of the container, most of the food and bedding will be transformed into worm castings, the nutrient-rich waste materials that worms excrete.

Step 11: In order to harvest the compost, or humus, for use (if you choose to), you must change the bedding and temporarily remove the worms. Spread out a tarp or drop cloth in an open area and dump out the entire contents of

Step 11: How To Harvest Compost



1. Divide compost materials into several cone-shaped piles (larger on the bottom).
2. Scoop off the material from the top of the piles.
3. Put the castings into a container to carry out to the garden.

the bin. Have students help you divide the materials into several cone-shaped piles (larger on the bottom, so the worms will burrow into it and avoid the light). Direct students to scoop off the material from the tops of the piles, and put the castings into a container to carry out to the garden (see illustration on the previous page for help). Repeat this procedure until most of the compost is harvested.

Step 12: Have students put worms back in the bin, along with any uncomposted food and old bedding. Your class can start a new stock of bedding and add in any additional worms to begin the process again.

Step 13: Create a garden in which to use the compost as a soil amendment, or use the compost on the schools' beds or lawn.

NOTE: Other critters may make their way into the compost bin. Many are beneficial, including mold, bacteria, sow bugs, beetle mites, white worms, snails and slugs, flies, round worms, and millipedes. You do NOT want the following in your bin, however: flat worms, ground beetles, centipedes, ants, and pseudo scorpions. If you find any of these organisms, start over.

Assessment

1. Ask students to define and describe decomposition.
2. Ask students why it is beneficial to compost items instead of throwing them away.

Enrichment

Ask the students to make observations about the worm bin each week. Do smaller pieces of food tend to break down faster than larger ones? What does the compost smell like? What organisms do they notice? Are the worms multiplying?

1. Have students take the temperature of the worm bin once a week to determine the variations that occur while food is composted. Use a thermometer that can measure up to 170°F. Have the students create bar graphs showing the increase or decrease in temperature over time.
2. Let students use a pH paper to test the acidity of the worm bin once a week. Does the pH change based on the foods that are added? Have the students keep a record of the foods that are added and the pH and chart a graph showing the correlation. If the soil is too acidic, the worms may try to leave the bin. Try adding a little lime.
3. Give students gloves to gently examine the critters inside the bin once a week. You might also examine a sample of the soil under a microscope (at the beginning of composting, bacteria are present that help break down the food; later larger organisms such as sowbugs and round worms play a larger role.) Obtain an identification guide to invertebrates and insects and see how many you can identify. Have students draw the different kinds of critters and discuss the differences in each (number of legs, body parts, function).

Student Handout

Name:_____

Vermicomposting Data Sheet

Date bin was set up:_____

Number of worms (or pounds of worms) added to bin: _____

Number of people contributing food scraps on a regular basis: _____

Date	Day	Weight of food added	Type of food added	Amount of water added	Buried in site #	Notes

(If you run out of spaces, get an extra copy of this sheet from your teacher.)

On the back of this paper, draw the worm bin, including its dimensions, and assign plots to certain sections so you can track decomposition of food placed in each numbered area.

Harvest date: _____

Total days:_____

Total weight of food buried: _____

Weight of uneaten food left over:_____

Average weight buried per day: _____

Example: