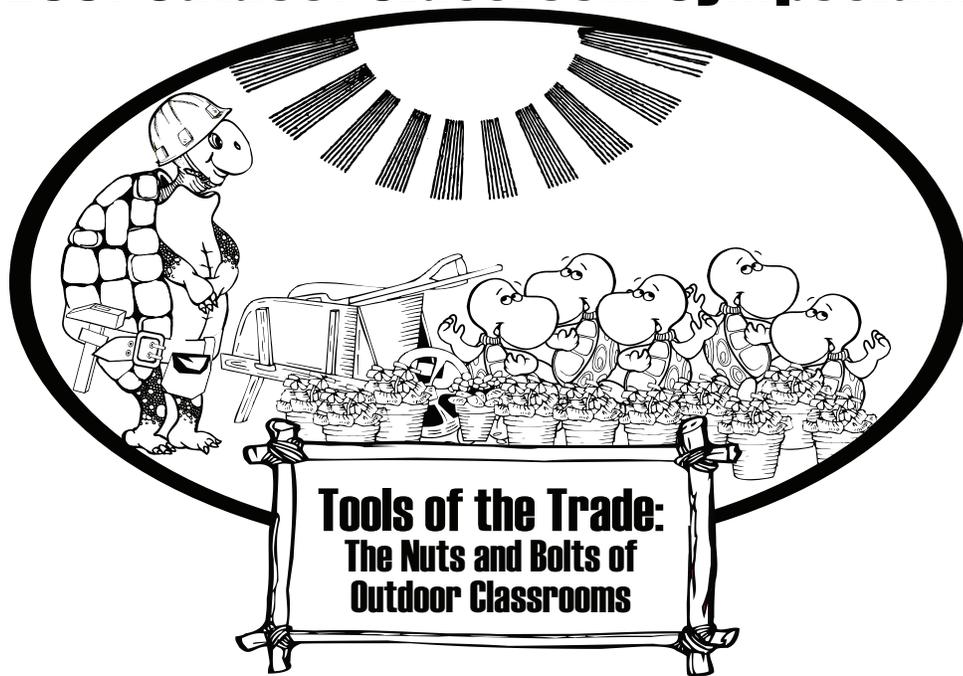


2007 Outdoor Classroom Symposium



4:00 - 4:45 PM • Short Sessions

Materials Provided by the Speakers from the Following Sessions:

Creation Stations
A Variety of Educators

Schoolyard Geology: Using Local Rocks, Minerals, and Soils to Teach Earth Science Concepts
Nan Huebner, Fernbank Science Center

Hammer Out the Details of Composting
Suki Janssen, Athens-Clarke County Recycling Division

WONDERFUL WORKING WORMS !!

When food scraps are thrown into the garbage, a valuable resource is turned into a liability. At significant financial and environmental cost, garbage has to be picked up, transported and buried or burned. Composting food waste with worms (also referred to as vermi-composting) provides an alternate use for kitchen waste which creates a natural nutritious food (soil) for a variety of plants.

What are some of the benefits of worm composting?

- (1) Reduce household waste
- (2) Save garbage disposal costs
- (3) Produce a high quality garden compost and recycle organics back to the earth
- (4) Demonstrates two of the most important natural processes: biodegradation and soil production
- (5) Breed worms for fishing

What kind of worms are best?

Eisenia foetida, commonly called "redworms" or "red wigglers" are most often used to process kitchen waste into compost. They will be very happy living in a covered box which has air holes on all sides, located in a room with a temperature between 55 and 77 degrees Fahrenheit. Redworms require very moist bedding and love to eat a variety of kitchen wastes. **Do not** use nightcrawlers which are the large burrowing worms.

What do redworms eat?

Worms are not fussy when it comes to eating, although they prefer some foods more than others. Some of their favorite foods are listed below:

- | | |
|----------------------------------|-------------------------------|
| ☺ apples/peels | ☺ cucumbers |
| ☺ baked beans | ☺ egg shells ** |
| ☺ banana peels | ☺ fruit peels |
| ☺ biscuits or stale bread | ☺ cantaloupe |
| ☺ cabbage, celery, turnip leaves | ☺ pizza crust |
| ☺ cereal of any kind | ☺ popcorn |
| ☺ cheese | ☺ potatoes, tomatoes |
| ☺ coffee grinds/paper filters | ☺ carrots and other vegetable |
| ☺ tea leaves/bags | ☺ peels and leaves |
| ☺ watermelon | ☺ shredded newspaper |

** Good source of calcium carbonate which is needed for worm reproduction

How much do worms eat?

In the best of conditions, redworms will eat an amount equivalent to their own weight each day. **One pound of redworms** living in a **4 cubic foot bin** (2' wide by 2' long by 1' high) will eat about **4 to 6**

pounds of kitchen waste in a week. Worms need a good variety of produce scraps to keep an even chemical balance in the soil which keeps them healthy. Mostly fruit or tomato waste could make the soil too acidic. When you go on vacation, you do not need a "worm sitter" because the worms will eat their bedding when there is a shortage of fresh kitchen waste. The bedding is intended to be a food supplement and eventually becomes part of the compost. Worm bins are very easy to maintain. The redworms are happiest when they are fed, kept moist and not disturbed while they are working (which is all the time!). Depending upon the desired outcome, worm bedding should be changed as follows every 3 to 6 months:

1. In 3 months, the number of redworms will be high, but the compost will not be quite finished.
2. At 4 months, the number of redworms will still be high, plus the quality of compost will be fairly good.
3. After 6 months, many redworms will have died, but the quality of the compost will be very good. The resulting compost will be primarily worm castings (worm manure).

What about odors and bugs?

When properly constructed and maintained, worm bins will not give off an offensive odor. Avoiding spoiled foods and meat scraps will prevent unwanted odors. If the bin does not have air holes on the sides and bottom, leave the worms in the bedding and turn the contents about once a week. Worms need air to work at capacity. Burying or covering fruit peelings completely will prevent fruit flies from being attracted to the worm bin. Alternatively, you can place several layers of newspaper on top of the inside surface area of the worm bin. This newspaper will prevent fruit flies from finding the food waste. Every so often you will have to replace the newspaper sheets as they get wet and worn. Just tear the sheets up and place in the worm bin and the worms will eventually eat the paper.

What is the recipe for a happy worm bin!

One box approximately 4 cubic feet (2' X 2'), but no deeper than 15 inches (to prevent anaerobic conditions from developing). Attached to this packet is a step by step example for constructing a worm bin. **Note: 1/4 pound of worms per 1 square foot inside surface area of worm bin per 1 to 1 1/2 pounds of food per week.**

Soak 6 pounds of shredded newspaper overnight in a bucket of warm water. This will be used for the bedding for the worms.

Add approximately 2 cups of water to 4 cups of peat moss or soil and soak overnight. (the grit is necessary for good worm digestion).

Combine wet shredded paper and moist soil or peat moss. Mix this material in the 4 cubic foot worm bin and spread loosely and evenly to assure that worms will be comfortable in their new home.

After making sure that the new bedding and surroundings are at a temperature level between 55 and 77 degrees Fahrenheit, place 1 pound of *Eisenia Foetida* (redworms or red wigglers) worms in their new home. See attached sheet for locations where you can purchase worms.

Begin adding kitchen produce scraps right away. Scraps may be spread evenly on top of the bedding or buried in sections each day. Don't forget the egg shells, so your worms will reproduce.

Locate the worm bin in a location (kitchen, garage or basement) where the temperature will generally be between 55 and 77 degrees Fahrenheit. In the mid-80's, they'll live but reproduction and food consumption by the worms slows. Please don't freeze or burn up your earthworms!

How do you change the bedding?

Change the bedding every 3 to 5 months and remove the newly made soil/compost. To change the worm bedding you may want to dump the bin contents and gently brush aside the new soil product a little at a time. The worms will keep moving away from the light until they are all huddled together in a pile as the soil is removed. Place fresh bedding in the bin and add the worms. They will start making new "vermicompost" all over again. An alternative method is to use a larger bin with a removable center divider. Place new bedding in one half at a time. When it is time to change the bedding, place the fresh mixture in the empty half. Remove the divider and allow the worms to migrate by adding produce scraps to the new bedding only. In about 2 to 3 weeks, most of the worms will have moved and the compost can be removed. Reinsert the divider and start over. As a final alternative, you could stop feeding the worms for one week and at the same time allow the material in the bin to become dryer and then place a screen mesh on top with some bedding and moist food waste. The worms will crawl up though the screen mesh to the new material. Remove the screen after three days and you will have captured a majority of the worms in your bin. Remove compost from the bin, add bedding and food waste and reintroduce the worms to the worm bin and start the process over again.

How about worm composting for a school or science project?

Redworms or Red Wigglers are shy and will burrow into bedding when they are exposed to bright light. However, the worms will show no reaction to red light. A red plexiglass side panel or lid would allow direct observation of worm activity.

Where do I get redworms or red wigglers for my worm bin?

Redworms are a favorite bait for fishing, so you could try a local bait shop for the worms. You can also contact the following locations for worms by mail order:

- | | |
|---|---|
| 1. Mr. V. A. Hegwood
245 Bryant Road
Brooklyn, MS 39425
601/598-2580 | 3. Carolina Biological Supply
2700 York Road
Burlington, NC 27215
800/334-5551 |
| 2. Recycle-it Corporation
800/769-1044 | 4. Flowerfield Enterprises
107332 Shaver Road
Kalamazoo, Michigan 49002
616/327-0108 |

As The Worm Turns

Instructions for setting up and maintaining your worm world

GETTING STARTED -

SUCCESSFUL WORM FARMING REQUIRES THREE EASY STEPS.

Step 1 - Bedding

Moist bedding provides the medium that worms need to survive. Shredded newspaper is the best bedding material because it is readily available, provides excellent moisture retention, and preparation is simple and fun for children.

- ▶ **Materials Needed:** newsprint (black and white pages only)
cool tap water
garden soil (do not use potting soil; it may contain chemicals)
one crushed egg shell
pail for mixing materials
worm bin (vented for good air flow)
- ▶ Shred the newspaper by fully opening sheet, tearing it lengthwise down the centerfold, gathering the two halves, tearing them lengthwise again, and repeating the process until you have strips ranging from 1/4 to 1 inch wide. Put the shredded strips in pail.
- ▶ Gradually mix the water, garden soil, and crushed egg shell with the shredded paper. The bedding should be damp but not sopping wet.
- ▶ Transfer the new bedding to worm bin. It should not be packed too tightly.
- ▶ Add worms to the top of the bedding, leave top off of the container for an hour or so. Make sure you have good air circulation.

Step 2 - Feeding

Worms are really not picky eaters. They like most organic waste but will not eat anything inorganic, like plastic. They will only eat hard food after natural degradation softens it. Don't exclude these foods, just do not be concerned if it takes awhile for them to disappear. It does help if you break up or puree hard foods in a processor.

Red worms do not have teeth. Instead, they digest food material in their gizzard. The gizzard needs a small amount of grit to grind food. That is why you added a handful of garden soil to your bin.

Many variables will affect how much your worms will eat. For example, they are more active at room temperature than at 40 degrees. A general rule is that worms will consume up to half their weight in food waste per day. If you start with 1/4 lb. of worms, you can expect them to eat up to 1/4 lb. of food per day. Start with small bits of food until the worms population increase. Do not overload the system. Overfeeding can lead to odor problems.

Step 3 - Harvesting

Before long you will notice increasing amounts of worm castings. Besides the educational benefits, this is one natural reward for you composting efforts. Casting is the best natural plant fertilizer available. You can compare plants and vegetables grown with castings to those grown without is another educational opportunity that you can explore with your class. It completes the recycling loop and illustrates how important worms and other organisms are to the balance of our ecosystem.

HOW TO HARVEST CASTINGS

- ▶ **Materials Needed:** 1 small plastic sheet
Light source (either a lamp or bright overhead fluorescent)

- ▶ **Dump and Sort Method:**

- Prepare fresh bedding as described earlier.
- Empty the contents of your container onto the plastic sheet.
- Add fresh bedding to the container.
- Position the light source over the casting pile. The worms will move down into the castings.
- Carefully pick the castings from the pile in layers, working toward the bottom center of the pile. Place castings in a separate container.
- Continue this procedure until there is only a small pile of castings with worms beneath it.
- Add this pile and worms to the fresh bedding in your worm container.
- Use the harvested castings for a classroom horticulture project.

- ▶ **Split Harvesting Method:**

If the above method seems like too much trouble, you can simply add 2/3 of the castings (worms and all) directly to your garden. Add the remaining 1/3 to your fresh bedding. This will inoculate the bedding and provide some worms to get you going again, but it depletes your worm population for a while.

LET'S EAT

Suggested foods for your worm family.

Apples	Artichokes	Bananas	Beans	Beets
Bran	Bread	Broccoli	Cabbage	Cake
Cantaloupe	Carrots	Celery	Cereal	Corn
Coffee Grounds*	Coffee Filters	Corn Meal	Cucumber	Eggs
Egg Shells	Grapes	Grits	Honeydew	Kiwi
Lettuce	Molasses	Oatmeal	Onions	Pears
Pasta	Pancakes	Papaya	Peas	Pie
Peaches	Pizza	Potatoes	Raisins	Rice
Spinach	Tea Bags*	Tomatoes	Turnips	
Waffles	Watermelon	Zucchini		

*Acidic Foods: Feed in small quantities only, may produce odors and attract undesirable insects.

DO NOT FEED: Heavily salted foods: Salted peanuts, potato chips, etc. . . .
Manure from dogs, cats, or horses. They may contain wormers or antibiotics that will kill your worms. Animal feeds: They may also contain antibiotics.

BUILDING A WORM BOX

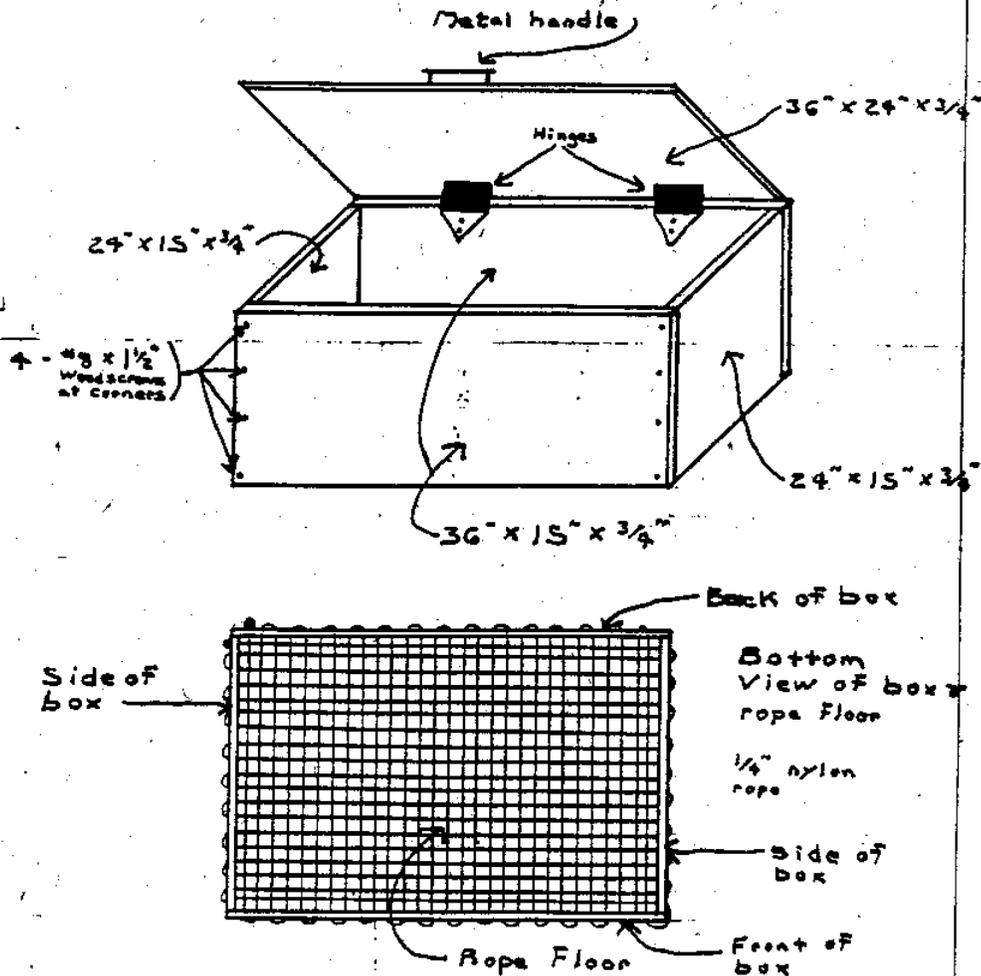
1. A box approximately 2 feet wide by 3 feet long by 15 inches high will be adequate for the average daily food waste from 6 people or approximately 1.5 pounds of food waste per month per 1 square foot of interior surface area of worm bin. Maximum depth of the worm box should be no more than 15 inches. Example: A 2 foot by 3 foot worm bin with 1.5 pounds of worms, would be sufficient for 6 to 9 pounds of food waste per week. See page 2 for pounds of worms per square foot per pounds of food.
2. Materials needed for construction of the box include:
 - a. 2 pieces of 3/4" X 24" X 15" plywood. (front and back walls of worm box)
 - b. 2 pieces of 3/4" X 36" X 15" plywood. (side walls of worm box)
 - c. 1 piece of 3/4" X 24" X 36" plywood. (top cover of worm box)
 - d. 2 metal light duty tee hinges for attaching the top to the worm box
 - e. 1 metal handle for the top.
 - f. 150' of 1/4" nylon braided rope for use in making the nylon floor of the worm box.
 - g. 16 #8 X 1 1/2" woodscrews.
 - h. Woodsealer for sealing the inside of the entire box to prevent rot due to moist conditions.
3. Attach the front and back sheets (a) to the two side sheets (b) with the #8 woodscrews (g) to form a rectangular box.
4. Attach the top sheet (c) to the back sheet with two metal tee hinges (d).
5. Attach the metal handle (e) to the top sheet (c).
6. Drill 3/8" holes along the entire bottom edge of the front, back and side walls of the bottomless box. The holes should be approximately 1" above the bottom edge of the four walls. Holes should also be spaced approximately 1 1/4" to 1 1/2" apart, and no closer than 1" to each of the four corners.
7. Tie a solid knot on one end of the 1/4" nylon rope and begin lacing it from one corner hole on the back sheet to the corner hole on the front sheet then back and forth until all the holes on the front and back sheets are laced together. Then do the same with the holes on the side sheets. When completed the nylon rope bottom should be checkerboard in appearance with spacings between the ropes of approximately 1" to 1 1/4". The rope should be laced tightly to prevent the bottom from sagging when dirt, food and worms are thrown into the worm box.
8. Drill 50 to 60 holes around the upper edge of the side, rear and front sheets to allow air to get to the inside the worm box. These holes should be no larger than 3/8" in diameter so not to allow excessive light into the worm box.
9. Line the nylon bottom of the worm box with strips of finely torn newspaper approximately 1" to 2" deep.
10. Add soil to increase the depth of the material in the box by an additional 2" or 3" and slightly moisten with water.
11. Toss in red wiggler worms and begin feeding them food waste as described on the back of this sheet.
12. Lay several sheets of newspapers on top of the soil/food inside the worm box to prevent fruit flies and other flying bugs from being attracted to the worm box. Change this paper out every two weeks by shredding it up and disposing of it in the worm box.
13. As you feed the worms food, they will come to the surface to eat and slowly the digested material will work to the bottom and fall through the spacings in the nylon ropes. The strips of newspaper in the bottom will eventually degrade allowing this rich organic material to fall out of the bottom. The worms will stay in the box, but from time to time several may fall out through the nylon rope floor. Just throw any wayward worms back into the worm box. If it gets too wet, the moisture will generally evaporate or flow out the bottom through the spacings in the rope.
14. Every 4 to 6 months some of the worms need to be removed so they do not get too crowded. Do this by laying a fine screen on the top layer and lay a small amount of food on top of the screen. The worms will crawl up through the fine screen to get to the food. You can easily harvest them by then picking up the screen and the worms at one time.
15. Allow the remaining worms to continue to grow and multiply before separating again in several months.

-over->

FOOD WASTE FOR EARTH WORMS

- | | |
|------------------|-----------------------|
| Apples | Grits |
| Apples Peels | Lemon Peels |
| Baked Beans | Lettuce |
| Banana Peels | Molasses |
| Biscuits | Newspapers (shredded) |
| Cabbage | Oatmeal |
| Cake | Onion Peels |
| Celery | Pancakes |
| Cereal | Pears |
| Cheese | Pineapple |
| Coffee Grinds | Pineapple Rind |
| Corn Bread | Pizza Crust |
| Cream Cheese | Potatoes |
| Cream of Wheat | Potato Peels |
| Cucumber | Potato Salad |
| Deviled Eggs | Tea Bags |
| Egg Shells | Tomatoes |
| Grapefruit Peels | Turnip Leaves |

/ Do not add bones, meats or oil to the worm box.





Objectives

Students will be able to: 1) identify materials needed in the composting process; 2) identify problems that may arise in composting; and 3) list ways to use compost.

Method

Students will work cooperatively to create a composting system, solve composting problems, and use resulting compost in and around the school and home.

Materials

a plastic tub or empty fish tank with a lid, samples of various types of soil (sand, silt, loam, clay), soil from outdoors, container of water, spray bottle, thermometer, a small hand shovel, work gloves (optional), copy of "Compost Pile Troubleshooting" (included at the end of this lesson) posted in the classroom, organic matter such as kitchen or yard wastes (some or all of the following):

high in nitrogen:	high in carbon:
coffee grounds	hay or straw
egg & nut shells	leaves
grass clippings	ashes
manure (or fertilizer)	sawdust & wood chips
	shredded paper
	weeds & other garden wastes

Vocabulary

aeration, compost, microbes, organic, porosity

Procedure

1. Background: Composting is a biological process during which organic materials, such as grass and leaves, are broken down by microbes into a soil-

TURN OVER A NEW LEAF

like product. It is a form of recycling, a natural way of improving the texture and porosity of soil.

Tiny living things do much of the work of breaking down organic materials to form compost. These tiny workers, called microbes or microorganisms, include such things as bacteria and fungi. Animals living in the soil help microorganisms break down organic materials. Worms and pill bugs are examples of soil animals that help change organic wastes into compost.

As microorganisms and soil animals turn organic materials into compost, they use the organic materials as food. The organic materials provide nutrients for growth and activity. Eventually, these nutrients are returned to the soil, to be used again by trees, grass, and other plants. This is nature's way of recycling.

By composting at school or home you can return organic wastes to the environment as valuable resources for other living things.

2. Show students samples of different soil types (sand, silt, loam, clay). Discuss good soil and poor soil. Introduce the term COMPOSTING. Explain that composting is a way to improve the physical properties of soil (texture and aeration). Composting is a natural (biological) process during which organic material, such as leaves, grass and selected kitchen wastes, are turned into a soil-like product. Yard and kitchen waste is often thrown away and buried in a landfill. Composting can transform yard and kitchen waste into a rich, organic soil additive.



- For composting without the addition of soil animals, such as earthworms, a plastic tub or empty fish tank will serve as the composting site. Tell the students that they will be building a small compost pile in the classroom to learn about the process first-hand. The classroom model will contain only yard wastes and **selected food wastes**. It will also use only microorganisms found naturally in soil used from the outdoors; other soil animals will not be specifically added to this composting model, although, some may be present in the soil used as "cover."
- Prepare the compost materials. Have students bring in chopped up yard wastes including leaves, grass, hedge clippings, and weeds. The smaller that waste is chopped up, the faster it will break down into compost. The mixture should contain a combination of materials high in nitrogen and high in carbon.

high in nitrogen:

coffee grounds
egg & nut shells
grass clippings
manure (or fertilizer)

high in carbon:

hay or straw
leaves
ashes
sawdust & wood chips
shredded paper
weeds & other
garden wastes

- Build the compost pile by following these steps:
 - Put a layer of coarse materials (sticks, small brush, larger pieces of bark) on the bottom of the container to create a way for water to drain and air to circulate.
 - Mix the chopped yard wastes together; the more variety of materials, the better. Lay a one to two inch layer on top of the bottom layer.
 - Cover organic wastes with a one inch layer of soil.
 - Adjust the moisture in your compost pile. Add straw or sawdust to soggy materials. If the pile is too dry, add water using a spray bottle. The

materials should be damp to the touch, but not so wet that water comes out when you squeeze it. (Refer to "Compost Pile Troubleshooting" as needed.)

- Maintain the compost pile until the compost is "done." Using a small shovel, mix or turn the pile weekly. This adds air and mixes up the different wastes, preventing the compost from getting smelly.

The compost is "done" when it is crumbly not sticky, dark in color but not black, and smells earthy but not rotten. Your compost pile may be "done" in one or two months.

- Heat is produced within the compost pile due to chemical reactions. In compost piles larger than one cubic yard, temperatures reach 140° to 160° Fahrenheit (32° to 60° Celsius) in the center. These high temperatures sterilize the compost. Have students monitor the temperature of the classroom compost pile as a way of tracking progress. How high did temperatures get? The pile will settle down from its original height. This is a good sign that it is composting properly.

- Discuss the qualities of a good compost pile:
 - A good compost pile is kept moist but not soggy.
 - A good compost pile has enough oxygen. Good compost piles are aerated by stirring regularly.
 - A good compost pile has a good mix of organic ingredients.
 - A good compost pile contains nitrogenous material. Nitrogen is required by the decomposing organisms. Most compost piles use manure as the nitrogen source, fertilizer may be substituted.
- Have students brainstorm a list of suggested uses for the finished compost. Be sure to include the following:
 - Spread compost on a garden in the spring before turning the soil for planting;



- Place or bury compost in a garden between plant rows. The plant roots will grow into the compost and take up nutrients;
- Use compost as mulch for shrubs, trees, and plants;
- When transplanting house plants, add compost to the soil;
- Do not use compost to sprout tender seeds. The seeds may be killed by a fungus in the compost that causes damping off disease.

Assessment

Have students describe materials that are used in composting and why.

Have students illustrate the layers in a compost pile and label them.

Have students list possible uses for compost.

Enrichment

Encourage students to set up compost piles at home.

At home, students should choose a level spot about three feet square that is preferably out of direct sunlight or receives equal amounts of sunlight and shade

during the day. Following are different methods that can be used to prepare a compost pile at home:

- Use no enclosure at all. Simply pile the materials up, keeping them in a fairly dense heap;
- Assemble wooden stakes and chicken wire into a simple round enclosure for the pile;
- Construct a wooden compost bin (use old lumber, if you have any);
- Fashion a three-sided enclosure by placing cinder blocks on top of each other. Leave the front open.

Select the proper materials. Some things belong in a compost pile, and some do not. In general, do not compost materials containing animal fat. (Many heavily-populated or urban areas have regulations against piling and storing food wastes; these rules may also apply to adding food wastes to a compost pile. Less populated areas may not be under such constraints.)

Do Compost:

leaves and grass
small garden clippings
wood ashes
bark
peanut and nut shells
weeds

Do Not Compost:

meat and fish
bones
dairy products
vegetable oils/fats
poultry
plastics or
synthetic fibers



Compost Pile Troubleshooting

Symptom	Problem	How to Fix It
pile is wet and smells like a mixture of rancid butter, vinegar, and rotten eggs	<ul style="list-style-type: none">• not enough air• or too much nitrogen• or too wet	<ul style="list-style-type: none">• turn pile• add straw, sawdust or wood chips• turn pile and add straw, sawdust or wood chips; provide drainage
pile doesn't heat up	<ul style="list-style-type: none">• pile is too small• or pile is too dry	<ul style="list-style-type: none">• make pile larger• add water
pile is damp and sweet smelling but will not heat up	<ul style="list-style-type: none">• not enough nitrogen	<ul style="list-style-type: none">• add grass clippings or other sources of nitrogen
center is dry and contains tough materials	<ul style="list-style-type: none">• not enough water	<ul style="list-style-type: none">• add water and turn pile
pile is attracting animals	<ul style="list-style-type: none">• meat and other animal products have been added	<ul style="list-style-type: none">• keep meat and other animal products out of the pile;• enclose pile in a 1/4" hardware cloth

Adapted from: Demonstrating Home Composting, University of Michigan. Used with permission.