Garbology

GRADE LEVELS: Grades 4th-8th

CONCEPTS:

According to the EPA , in 2006, Americans produced 251 million tons of trash. 80 million tons, or 32% of the trash came from packing and containers. Of the total trash, only 32% of the volume was recycled. All of this trash adds up and presents many problems. One of those issues is where to put the trash. Landfill space is running out and landfills present ecological problems to the community surrounding them.

The Model T Ford provides an example of rethinking trash and packaging. The box that the car was shipped in was to later be used as the floorboards inside the car. This workshop will address the amount of waste we produce, alternatives to throwing items in the rubbish bin, and a look at redesigning a common packaging scheme.

OBJECTIVES:

Students Participants will explore the impact their trash has on the population and the earth. Students will practice sorting household garbage. Students will then be given the opportunity to redesign the packaging for a common childhood experience—the kid's meal.

ACADEMIC CONTENT STANDARDS:

- Science: Understanding Technology 5.1, 6.2
- Science: Physical Sciences: 4.2, 4.3
- Science: Earth and Space Sciences: 5.5
- Science: Science and Technology: 5.1, 5.2, 5.3, 6.2

VOCABULARY/KEY WORDS:

Recycling: Process that turns used materials into new products in order to prevent waste and the use of other valuable resources. Recycling also results in the conservation of energy and the reduction of pollution.
Reduce: To cut back on the amount of items used or the number of times
Reuse: The use of an item again in its original form for the same or different purpose.

EXTENSIONS AT COSI:

Gadgets:

- At the entrance to Gadgets check out the gear chairs. Can you think of another example of using discarded objects in a different way than that for which they were created?
- Sign up and participate in a Take Apart Gadgets Café. Ask the gadgeteers where the computers come from and what will happen to them after COSI is finished with them.
- Go to the Gadgets TV theatre in the back of Gadgets. Watch at least two of the videos on how different objects are manufactured/made.

1st Floor Hallway:

- Go to the Trashformation Exhibit. Take the quiz and watch the video to learn more about how you can reduce waste in a landfill.

The COSI Challenge Center:

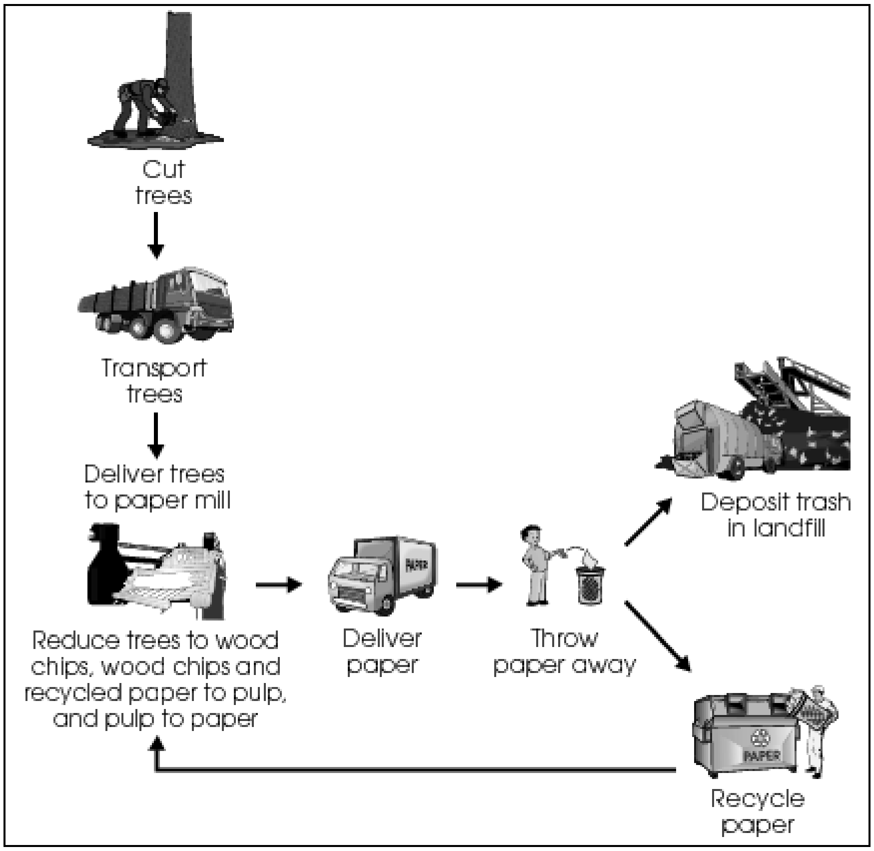
- Participate in the COSI Challenge Center. Take a look at the items you are using. What was their original purpose?

ADDITIONAL RESOURCES:

For local recycling information:
http://www.swaco.org/
For fun recycling games:
http://www.recyclezone.org.uk/home_fz.aspx
http://www.recycleamerica.com/press/links.asp
http://www.epa.gov/osw/nonhaz/municipal/index.htm
http://www.epa.gov/epawaste/conserve/rrr/index.htm
http://42explore.com/recycle.htm

SAMPLE TEST QUESTIONS:

The diagram below shows the process of how trees are made into paper. It also shows two ways to dispose of used paper.



In your Answer Document, describe two ways that recycling paper conserves Earth's resources. Use the information in the diagram to support your answer. (2 points)

Scientists often work together to solve a problem. Sometimes they work in laboratories. Sometimes they are outside doing fieldwork. The chart provides a list of some careers in science.

Types of Careers in Science

Career	What Do They Study?
Astronomer	Planets, Stars and Space
Botanist	Plant Growth and Development
Chemist	Chemicals and Elements
Ecologist	Ecosystems and Habitats
Paleontologist	Fossilized Remains of Organisms
Physicist	Interactions of Matter and Energy

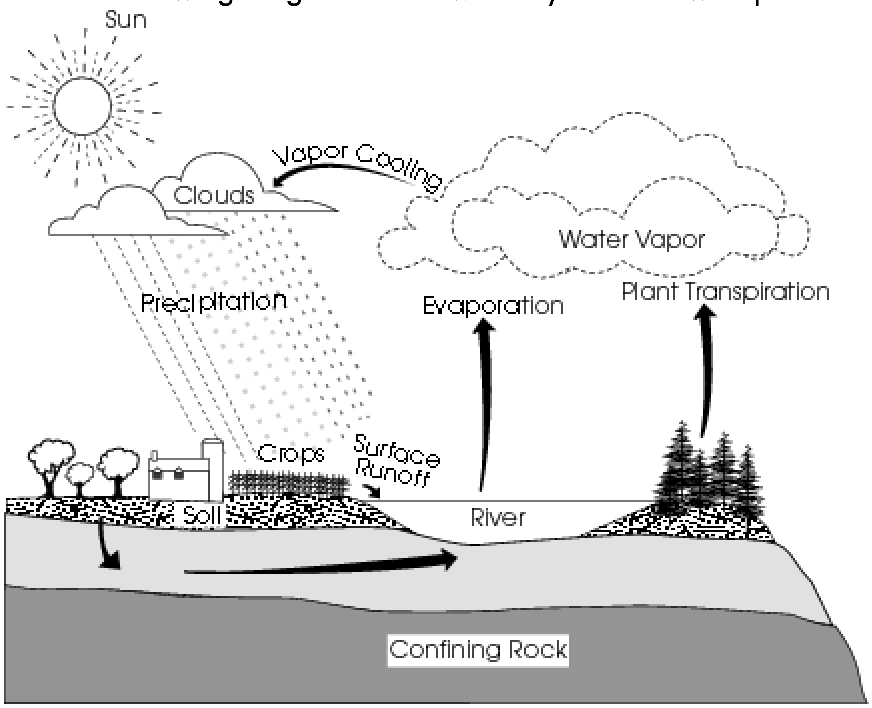
Which scientists might work together to save a polluted wetland?

A. Chemist, botanist and ecologist
B. Astronomer, ecologist and physicist
C. Physicist, paleontologist and chemist
D. Botanist, astronomer and paleontologist

Which organism is a decomposer?

A. Frog
B. Worm
C. Oak tree
D. Grasshopper

E. Use the following diagram of the water cycle to answer question #.



Source: Ohio Department of Natural Resources, Division of Water

Local environmental scientists have collected evidence of the presence of insecticides in the river. Insecticides are used on crops to help prevent damage from insects.

According to the diagram, how might this insecticide have reached the river?

A. Transpiration
B. Precipitation
C. Condensation
D. Surface runoff

Garbology Pre Visit Activities

Symbol Search

Key Words/Concepts:
Recycling

Objectives: Students will identify household products that are recyclable and explore the different types of recyclable plastics.

Materials:
Several household products
Symbol Search handout sheet

Procedures:
1. With an adult, search for products with one of the seven recycling symbols shown on the worksheet.
2. Write the name of the product below the matching symbol on the worksheet.
3. Make observations about the types of products found under each symbol.
4. Be sure to bring your worksheet to your COSI workshop.

Possible Interactive Questions:
- Where on the products did you typically find the symbol?
- What types of items around your home did not have the recycling symbols?
- What do you think the numbers on the symbol mean?
- What do the different letters on the symbols represent?

What Happened/What's Going On:
Plastic was introduced to the world in 1862 by Alexander Parkes at London's Great International Exhibit. The original material, called Parkesine, was a celluose derived material that could be easily molded when heated. Parkesine would retain the molded shape when it

cooled. The malleability of this material and others like it led this group of synthetic materials to be called plastic, after the greek word *plastikos,* or “fit to be molded”.[1]

Today, in many developed countries, plastic is ubiquitous. Every year, the United States of America produces enough plastic film to shrink wrap the entire state of Texas.[2] Bottled water, candy bars, DVD’s and CD’s are just a few examples of products that are packaged in plastic.

Let’s examine the use of plastic in water bottles. Plastic is formed by using the resource of petroleum, the same resource used to fuel automobiles. Every year, it takes over 1.5 million tons of barrels of oil to manufacture a year’s supply of water bottles. That is enough petroleum to fuel 100,000 cars. In 2006, Americans drank an average of 167 bottles of water each. Twenty-three percent of these water bottles were recycled. That means that Americans sent 38 billion water bottles to landfills in 2006 alone. Once these water bottles reach the landfills it takes 700 years before a water bottle begins to decompose.

Academic Content standards:
Science, Earth and Space Sciences, 5.5, 5.6
Science, Science and Technology, 5.1, 6.2

[1] Bellis, Mary. "The History of Plastics". 12/05/08 <http://inventors.about.com/od/pstartinventions/a/plastics.htm>.
[2] "Plastic Facts". University of Purdue. 12/05/08 <http://www.purdue.edu/envirosoft/housewaste/src/plastic.htm>.

Symbol Search

Directions: With adult supervision, explore your house looking for the recycling symbols below on household objects. When you find one of the symbols on an object, write the name of the product below the symbol. Be sure to bring sheet to the Garbology Worksheet at COSI.

1 PETE	2 HDPE	3 PVC	4 LDPE	5 PP	6 PS	7 OTHER

COSI Center of Science and Industry

Wrap It Up!

Lesson developed by the Southwest Environmental Health Sciences Center, University of Arizona

Key Words/Concepts:
Garbage
Waste
Packaging
Reduction

Objectives: Students will examine the role of product packaging and resource waste.

Materials:
6-7 unique brands of chewing gum with unique packaging
Scale
Calculators

Procedures:

1. Record the different brands of gum and their prices in the appropriate columns of the handout.
2. Find the total mass of your group's package (gum + packaging). This may be printed on the package; if not, use a balance or scale.
3. Record the printed gum mass. This may not be present; use balance if necessary.
4. Calculate the mass of the packaging:
   Total mass – gum mass = packaging mass
5. Unwrap all of the gum in your package. Measure the mass of gum. Record actual gum mass.
6. Measure the packaging mass. Record actual packaging mass.
7. Calculate and record the packaging percentage of the total mass:
   $$\frac{\text{Actual gum mass}}{\text{Total packaging mass}} \times 100$$
8. Calculate and record the cost per gram of gum:
   $$\frac{\text{Price}}{\text{actual gum mass}} \times 100$$
9. Graph the percentage of packaging on the bar graph on the handout. Get the information from the other groups and complete your bar graph.

Possible Interactive Questions:

- What types of materials are used in the packaging of the gum?
- Are any of the materials recyclable? If not, are the materials waste or can they be reused?
- Did higher cost relate to more packaging?
- Why do we need packaging?
- Does the packaging affect which gum you buy?

Extension:

Have the students rethink the gum packaging and challenge them to design a new way to package the gum that is less wasteful and more cost effective.

What Happened/What's Going On:

The manner in which the products we buy are packaged is very important in regards to garbage. According to the Southwest Health Sciences Center, the packaging of products represents 35% of all solid waste. Looked at from a different angle, one out of every 11 dollars spent by consumers pays for the packaging of a product. When a consumer buys a product like a frozen dinner, they are not only buying the food but also the cardboard box, tray and plastic covering in which the food is packaged. That consumer pays once more for the package when they pay for it to be disposed of in a landfill.

You can reduce the amount you spend on packaging by following these helpful tips provided by the University of Florida's Institute of Food and Agricultural Sciences:[3]

1.) When practical, buy in bulk: Products packaged in bulk produce less waste and cost less. For example, examine the difference between a 48 ounce jar of applesauce and 48 ounces worth of applesauce packaged in six smaller plastic containers.
2.) Choose reusable or recyclable packages: Familiarize yourself with your local recycling program. Purchase products that come in packages that can be recycled in this program.
3.) Avoid excess packaging: You greatly reduce the amount of packaging that is purchased and turned into waste by choosing to buy whole fruits and vegetables. When pre-cut and packaged vegetables are bought, the consumer pays on average 45 percent more.
4.) Pay for the product, not the package: Often identical products can be packaged in different ways. For example, instead of traditional toothpaste packaging, some toothpaste is packaged in new pump style packaging. The toothpaste costs the same but overall the complete pump package is more expensive and contains less toothpaste.

Academic Content Standards

Science, Earth and Space Sciences, 5.5, 5.6
Science, Science and Technology, 5.1, 6.2

Name ____________________

WRAP IT UP!

Activity Created by the Southwest Environmental Health Sciences Center, University of Arizona

Record your pack's brand name and packaging in the table below.

Brand Name of Package	Price of Package

Pick one pack of gum and complete the following directions.

Find the total mass of your group's package (gum + packaging). This may be printed on the package; if not, use a balance or scale.

Mass of Package = ____________________

Record the printed gum mass. This may not be present; use balance if necessary.

Mass of Gum = ______________________

Calculate the mass of the packaging: Total mass – gum mass = packaging mass

_________ — ___________ = __________

Unwrap all of the gum in your package. Measure the mass of gum.

Actual Gum Mass = ____________________

Measure the packaging mass. Record.

Actual Packaging Mass = ________________

Calculate and record the packaging percentage of the total mass:

$\frac{\text{Actual gum mass}}{\text{Total packaging mass}} \times 100$

Percentage of Total Mass = _______________

Calculate and record the cost per gram of gum:

$\frac{\text{Price}}{\text{Actual gum mass}} \times 100$

Cost Per Gram of Gum = _________________

Packaging Percentage of Total Mass

Brand

Graph it Up!

Bears in the Air

Bears in the Air was designed by Facing the Future.org, a non-profit education organization based out of Seattle, WA.

Objectives: Students will experience how mental models can limit our success and keep us from reaching our goals. Students will also redesign a system to accomplish a shared goal and discuss how this activity models real-world systems and explore possible redesigns of those systems.

Materials:

- Stuffed bear or easy and safe-to-throw-and-catch object.
- Watch with a second hand
- Large, clear area in the classroom for the students to stand in a circle

Procedures:

1. Arrange students so they are standing shoulder-to-shoulder in a circle. Stand in the circle with them and show them the stuffed bear or other object.
2. Tell students they are going to play a game in which they toss the bear around the circle. Tell them there are only 2 rules to the game: 1) Everyone must touch the bear and (2) They must touch it in the same sequence each time.
3. Have everyone hold their hands out in front so they ready to catch the bear.
4. Gently toss the bear to someone across the circle.
5. Have that person toss the bear to someone else and drop his or her hands after tossing. The last person tosses the bear back to you.
6. Practice once so they are comfortable with the sequence.
7. Now tell them you are going to time the activity to see how fast they can do it. You will need to either time it yourself or designate a student for that job ahead of time.
8. Run the activity and time it. After the first timed run-through, tell students that you are sure they can do it much faster. Run and time the activity a few more times, telling them after each run-through that they can do it even faster. Most likely they will be able to do it faster in the beginning by tossing faster; however, once they reach a certain level of success, they will not get any faster without a system redesign. In fact, they may even get slower if they get sloppy and toss the bear outside the circle or drop it in their attempt to get faster. This

part of the activity models the concept of "limits to success."

9. If the students ask if they can do the activity differently, just repeat the 2 rules above.
10. Continue until students figure out how to redesign the system to achieve the desired goal. There are several redesigns that will accomplish the task much faster, such as standing next to each other and passing the bear along the line, or lining their hands up vertically in the correct order and cascading the bear down the vertical line.

Possible Interactive Questions:

What happened the first few times through?
Did you succeed in doing it faster? Why?
Was there anyone who thought about other ways of doing it but did not speak up?
What kept that person from offering a solution?
Did anyone offer a solution that was ignored? Why was their solution ignored?
What were the assumptions in the activity and how did these assumptions limit your ability to achieve your goal.

Extension:

Have students choose a "system" that they think is not working well. This could be something going on at home, in their school, in their community, or in the larger world. Have them analyze and write about the system using the Bears in the Air activity as a model.

Academic Content standards:

Science, Earth and Space Sciences, 5.5, 5.6
Science, Science and Technology, 5.1, 6.2

Garbology Post Visit Activities

The Recycling Conservation Calculator

Key Words/Concepts:
Recycle
Conservation
Energy

Objectives: Students will calculate the amount of energy they save by recycling paper, plastic, glass, and aluminum materials over the span of a week.

Materials:
Recycling Conservation Calculator handout. (Copy worksheet if you would like to track several weeks)

Procedures:

1. You can recycle many paper, plastic, glass, and aluminum objects. Recycle these items whenever you get the chance.
2. Record all items that you recycle during a week. Tally these recyclables on the handout.
3. At the end of the week, count the number of tallies under each of the four recyclable columns.
4. Use your recycling totals to complete the math problem for each type of recyclable object.
5. Examine how much energy you saved just by recycling.

Possible Interactive Questions:

- What types of items can be recycled?
- Did you find it easy or difficult to recycle during the week? What made it easy for you to recycle? What could be some potential challenges that keep somebody from being able to recycle?
- What are the benefits of recycling?
- What are the potential consequences of not recycling?

What Happened/What's Going On:

Every day the average American discards 4.6 pounds of trash. This trash piles up over time in landfills across the country. The saturation of these landfills with trash puts constraints and pressure not only on the immediate area surrounding the landfill but it also has important effects nationally and globally. For example, one Styrofoam cup takes fifty years to completely decompose. Tin cans that are disposed of in a landfill can take 450 years to decompose and plastic rings will never decompose.[4] These landfills emit methane into the atmosphere. According to the Environmental Protection Agency, in 2006 landfills were the second largest human related methane emitters, totaling 23 percent of total methane emissions.[5]

By recycling glass, plastic, aluminum, and paper products, we not only relieve pressure on landfills and cut back on methane emissions but also save energy and resources. When products are recycled, new resources do not need to be obtained for new products. For every glass bottle that is recycled, enough energy is saved to power a compact fluorescent light bulb for 20 hours. A recycled aluminum soda can will save enough energy to power a television for three hours. [6]

Academic Content standards:

Science, Earth and Space Sciences, 5.5, 5.6
Science, Science and Technology, 5.1, 6.2

[4] "National Recycling Coalition: Why It is Important". National Recycling Coalition. 11/20/2008 <http://www.nrc-recycle.org/whyitsimportant.aspx>.
[5] "Landfill Methane Outreach Program". Environmental Protection Agency. 11/20/2008 <http://www.epa.gov/lmop/overview.htm#methane>.
[6] "National Recycling Coalition". National Recycling Coalition. 11/20/2008 <http://www.nrc-recycle.org/americarecycles.aspx>.

Recycling Conservation Calculator

Goal: Recycling is also a great way to save energy. Over a span of one week keep track of the amount of glass, paper, plastic, and aluminum you recycle. At the end of the week, convert your recyclable materials into conserved energy using the chart below. Good luck!

Recyclables for the Week of ____________

	 Glass Bottles	 Newspapers	 Plastic Bottles	 Aluminum Cans
Tally				

Use the chart below to figure out the many ways you conserved resources in the past week by recycling.*

# of 	______	x 20	=	____ hours of energy for a compact fluorescent light bulb.	
# of 	______	x 1	=	____ trees saved.	
# of 	______	x 10.4	=	____ shirts made from the fiber of the plastic bottles.	
# of 	______	x 3	=	____ hours of energy need to power a television.	

* Numbers provided by the National Recycling Coalition

Composting Bioreactor

Activity was designed by the Cornell Waste Management Institute

Key Words/Concepts:

Food waste
Composting
Decomposition

Objectives: Students will create a soda bottle bioreactor. Once completed students can use the bioreactors to design and carry out individualized research projects, comparing variables such as reactor design, moisture content, and nutrient ratios of mixtures to be composted.

Materials:

- Two 2-liter or 3-liter soda bottles
- One smaller container, about 5-cm high, that fits inside the soda bottle
- One Styrofoam plate or tray
- Drill or nail for making holes (For Teacher Use Only)
- Duct tape or clear packing tape
- Utility Knife (For Teacher Use Only)
- Insulation materials such as sheets of fiberglass or foam rubber, or Styrofoam peanuts
- Fine-meshed screen or fabric large enough to cover top of soda bottle and air holes in bottom half
- Thermometer that will fit into the top of the soda bottle and be long enough to reach down into the center of the compost
- Chopped vegetable scraps such as lettuce leaves, carrot or potato peelings, and apple cores, or garden wastes such as weeds or grass clippings
- Bulking agent such as wood shavings or 1-2 cm pieces of paper egg cartons, cardboard, or wood
- Optional: Hollow tubing to provide ventilation

Procedures:

1. Using a utility knife or sharp-pointed scissors, cut the top off one soda bottle just below the shoulder and the other just above the shoulder. Using the larger pieces of the two bottles, you will now have a top from one that fits snugly over the bottom from the other.
2. Place a smaller container (roughly 4-5 cm high) upside down into the bottom of the soda bottle. This will form a stand to support the tray that will hold the compost. You

can use any plastic container that will fit inside the bottle and provide adequate support for the Styrofoam stand and overlying compost.

3. The next step is to make a Styrofoam circle. Trace a circle the diameter of the soda bottle on a Styrofoam plate or try to cut it out, forming a piece that fits snugly inside the soda bottle. Use a nail to punch holes through the Styrofoam for aeration.
4. Assemble the bottom of your bioreactor by placing the stand into the soda bottle, then resting the Styrofoam circle on top of the stand. Make a mark on your bottle to indicate where the Styrofoam circle sits. Above this point is where the compost will be, and below it is where you want to make air holes.
5. Make air holes in the sides of the soda bottle in the area below the mark that you made. This can be done with a drill or by carefully heating a nail and using it to melt holes through the plastic. Avoid making holes in the very bottom of the bottle unless you plan to use a tray underneath to collect whatever leachate may be generated during composting. Reassemble the bioreactor pieces, making sure that you have provided sufficient air holes to allow air to enter the bottle and flow up through the stand and Styrofoam circle.
6. Fill the bioreactor with the mixture you wish to compost. A variety of materials will work, but in general you want a bulking agent to provide air flow plus some vegetable scraps to provide food for the microbes (see following table for some possibilities).

Bulking Agents	Food for the Microbes
wood shavings	lettuce scraps
small wood chips	carrot peelings
newspaper strips	apple cores
pieces of paper egg cartons	bread crusts
chopped straw	banana peels
	weeds
	grass clippings

7. In these mini-bioreactors, composting proceeds best if the bulking agent and food scraps are cut or chopped into roughly 1-2 cm pieces. Soak the bulking agent in water until thoroughly moist, then drain off excess water.
8. Mix roughly equal amounts of bulking agent and food scraps, then fill your reactor. Remember that you want air to be able to diffuse through the pores in the compost, so make sure to keep your mix light and fluffy and do not pack it down.
9. Put the top piece of the soda bottle back on and seal it in place with tape.
10. Cover the top hole with a piece of screen or nylon stocking, rubber banded into place. Alternatively, if you are worried about potential odors you can ventilate your bioreactor using rubber tubing out the top. Simply use the screw-on soda bottle cover with a hole drilled through it for a piece of rubber tubing, which leads out the window or into a ventilation hood.

11. If you want to eliminate the possibility of flies becoming a problem, you can cover all air holes with a piece of nylon stocking or other fine-meshed fabric. 11. Insulate the bioreactor, making sure not to block the ventilation holes. (Because these soda bottle bioreactors are much smaller than the typical compost pile, they will work best if insulated to retain the heat that is generated during decomposition.) You can experiment with various types and amounts of insulation.
12. Now you are ready to watch the compost process at work! You can chart the daily progress of your compost by taking temperature readings, inserting a thermometer down into the compost through the top of the soda bottle. Using temperature charts, you can compare variables such as the types of compostable materials, moisture levels, amounts of air flow, and insulation systems.
13. Because the bottles are so small, you may not end up with a product that looks as finished as the compost from larger piles or bioreactors. You should find, though, that the volume shrinks by 1/2 to 2/3 and that the original materials are no longer recognizable. You can let the compost age in the soda bottles for several months, or transfer it to other containers for curing while starting up a new batch of compost in the soda bottles.

Extension:

Have students design and carry out an experiment with their new bioreactors. They should pick one variable and observe how the change in that variable affects the composting.

What Happened/What's Going On:

Food can also be recycled through the process of composting. Composting is the decomposition or breaking down of once living plant or animal life. Once composted, the organic material will look like an earthy, dark, crumbly substance. Composting can be very valuable in the reduction of waste. According to the Environmental Protection Agency, 23 percent of waste in the United States comes from yard trimmings and discarded food.

Examine the chart below provided by the EPA to see what is appropriate to compost. [7]

What to Compost - The IN List

- Animal manure
- Cardboard rolls
- Clean paper
- Coffee grounds and filters
- Cotton rags
- Dryer and vacuum cleaner lint
- Eggshells
- Fireplace ashes

[7] "Basic Information". Environmental Protection Agency. 12/05/08 <http://www.epa.gov/epawaste/conserve/rrr/composting/basic.htm>.

- Fruits and vegetables
- Grass clippings
- Hair and fur
- Hay and straw
- Houseplants
- Leaves
- Nut shells
- Sawdust
- Shredded newspaper
- Tea bags
- Wood chips
- Wool rags
- Yard trimmings

What Not to Compost - The OUT List

Leave Out/Reason Why

- Black walnut tree leaves or twigs
  - Releases substances that might be harmful to plants
- Coal or charcoal ash
  - Might contain substances harmful to plants
- Dairy products (e.g., butter, egg yolks, milk, sour cream, yogurt)
  - Create odor problems and attract pests such as rodents and flies
- Diseased or insect-ridden plants
  - Diseases or insects might survive and be transferred back to other plants
- Fats, grease, lard, or oils
  - Create odor problems and attract pests such as rodents and flies
- Meat or fish bones and scraps
  - Create odor problems and attract pests such as rodents and flies
- Pet wastes (e.g., dog or cat feces, soiled cat litter)
  - Might contain parasites, bacteria, germs, pathogens, and viruses harmful to humans
- Yard trimmings treated with chemical pesticides
  - Might kill beneficial composting organisms

Academic Content standards:

Science, Earth and Space Sciences, 5.5, 5.6
Science, Science and Technology, 5.1, 6.2

Online Resources:

Recycle City: http://www.epa.gov/recyclecity/mainmap.htm
The Conversionator: http://www.nrc-recycle.org/theconversionator/shell.html

SWACO: Solid Waste Authority of Central Ohio
http://www.swaco.org/SmartKids/Presentations.aspx
Ohio Department of Natural Resources:
http://ohiodnr.com/tabid/15382/Default.aspx

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