Building Bio-Reactors

Goals

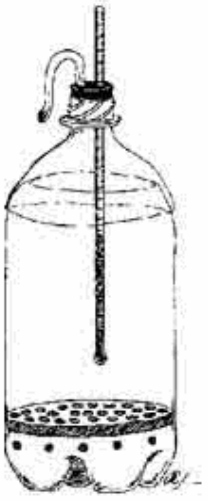
To demonstrate the importance composting has on the environment and us through hands on experiments. To determine best methods of composting.

[top]

Objectives

- Students will be able to describe the process of composting.
- Students will be able to design and construct their own pop bottle bio-reactors.

[top]



Materials (per group)

- 2-liter pop bottle
- 750 g yogurt container
- Styrofoam plate or tray
- Nail for making holes
- Duct tape or clear packaging tape
- Wooden skewers
- Insulation materials such as sheets of fibreglass or foam rubber, or Styrofoam
- Fine-meshed screen to cover top of soda bottle and air holes in bottom half
- Thermometer that will be long enough to reach down into the centre 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
- Utility knife

[top]

Lesson Summary

Class length one hour.

A description of the importance of composting and the methods used to achieve the best composting results should precede the construction of the bio-reactors.

Composting is the controlled decomposition of organic matter. This life cycle depends on the continued replenishment of soils that are depleted each time a crop is harvested. Perhaps the most important and most depleted portion of our soil is humus, which is partially decomposed organic matter.

Geological humus is produced as the plant material that grows on the soil dies and decomposes. When we harvest the crop leaving no fresh organic matter to replenish the humus there are two ways of rebuilding the fertility of the soil. The soil can be left idle for several years allowing it to rebuild naturally or humus can be applied to the soil from an external source.

The following basic principles need to be followed while building a compost pile so a good quality of compost can be made:

- AIR - Composting microbes (fungi bacteria, etc.) are aerobic -- they can't do their work well unless they are provided with air. Without air, anaerobic (non-air needing) microbes take over the pile. They do cause slow decomposition, but tend to smell like putrefying garbage!
- WATER - Ideally, your pile should be as moist as a wrung-out sponge to fit the needs of compost microbes. At this moisture level, there is a thin film of water coating every particle in the pile, making it very easy for microbes to live and disperse themselves throughout the pile.
- FOOD - A good mix of browns and greens is the best nutritional balance for the microbes. Browns are dry and dead plant materials such as straw, dry brown weeds, autumn leaves, and wood chips or sawdust. These items are a source of energy for the compost microbes. Greens are fresh (and often green) plant materials such as green weeds from the garden, kitchen fruit and vegetable scraps, green leaves, coffee grounds and

tea bags, fresh horse manure, etc. These can be thought of as a protein source for the billions of multiplying microbes.

[top]

How to build the bio-reactor

****Depending on the age of the students or the time slotted for the class, the cutting can be done before hand. ****

1. Using a utility knife or sharp-pointed scissors cut the top off the pop bottle just below the shoulder and cut the yogurt container approximately 3 - 5 inches from the top. By placing the top part of the yogurt container over the shoulder of the pop bottle, the top of the pop bottle will fit snugly onto the container.
2. Trace a circle the diameter of the pop bottle on a styrofoam plate or tray and cut it out, forming a piece that fits snugly inside the pop bottle. The circle should sit roughly 4 - 5 inches up from the bottom of the bottle. Break a wooden skewer in half and insert pieces through the holes in the bottom of the container so the styrofoam circle will have a support to sit on. Use a nail to punch holes through the styrofoam for aeration.
3. Make air holes in the sides of the pop bottle in the area below the level of the styrofoam that you made. This can be done 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.
4. Fill the bioreactor with the mixture you wish to compost.

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

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, and then drain off excess water. 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.

5. Put the top piece of the soda bottle back on and seal it in place with tape.
6. Cover the top hole with a piece of nylon stocking rubber banded into place. Alternatively, if you are worried about potential odours 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.
7. 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.
8. Insulate the bioreactor by wrapping it in aluminium foil, shiny side in, and then rubber foam. Make sure not to block the ventilation holes. (Because these pop 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.)
9. Record the initial temperature of each bioreactor and then take a reading after a couple of days. Chart the data to see if there is an increase in temperature.