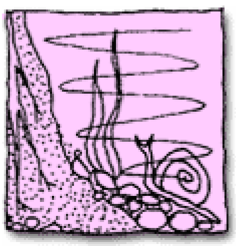
BOTTLE BIOLOGY

SEE IT, TOUCH IT, SMELL IT, TASTE IT...

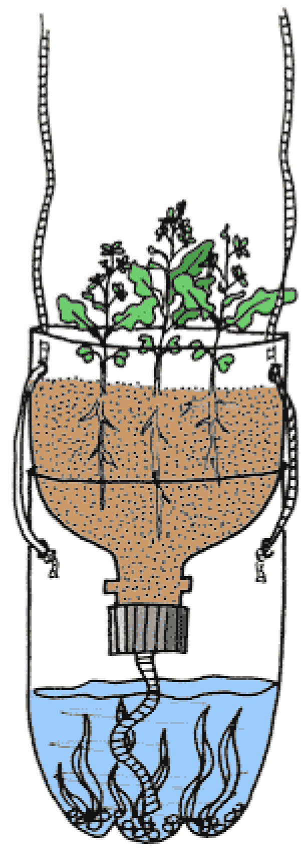
| INTRO | BASICS | TOOL BOX | BUILDING BLOCKS | LINKS | INVESTIGATIONS

| BOTTLE COLUMNS | HANGING BOTTLES | HOME |

# TerrAqua Column - What is the Land-Water Connection?



What common substance falls from the atmosphere, flows through our bodies, runs through the soil beneath our feet, collects in puddles and lakes, then vaporizes back into the atmosphere in a never-ending cycle?



Water, as it cycles between land, ocean and atmosphere, forms the major link between the terrestrial world (involving anything living on the earth) and the aquatic world (involving anything living on or in the water).

Water drips off rooftops, flows over roads, off your toothbrush, and down the drain, percolates through the soils of fields and forests and eventually finds its way into rivers, lakes and oceans.

During its journey, water will pick up leaf litter, soil, nutrients, agricultural chemicals, road salts and gasoline from cars, all of which have profound impacts on life in aquatic systems. Water can also be filtered or purified as it percolates through soil.

The TerrAqua Column provides you with a model to explore the link between land and water. The model has three basic components: soil, water and plants.

By varying the treatment of just one of these components you can explore how one variable can affect the whole system. How does salt affect the growth of plants? How does adding fertilizer to the soil affect algal growth in the water chamber? What type of soil best purifies water?

Experimentation with the TerrAqua Column is practically unlimited. You can define a question, and then design your experiment to explore it.


**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.

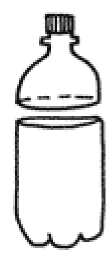
## Build a TerrAqua Investigation Column *(option 1)*

***Build Option 1*** | ***Build Option 2***

### Option 1

***Materials***

- One 2-liter soda bottle
- One bottle cap
- Tool Box
- Wicking material-fabric interfacing or cotton string
- Water, soil and plants

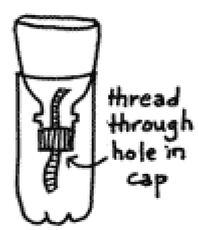


***Bottle #1***

**Step 1** – Remove label from the 2-liter bottle. Cut bottle 1 cm below shoulder.

**Step 2** – Poke or drill a 1 cm hole in bottle cap.


**Step 3** – Thread a thoroughly wet wick strip through bottle top, invert top, and set into base. Wick should reach bottom of reservoir and thread loosely through cap.




**Step 4** – Fill reservoir with water. Add soil and plants to top chamber. To be effective, the wick should run up into soil, not be plastered along a side of the bottle. For better drainage, place a layer of gravel, sand or vermiculite in the bottom of the soil unit.

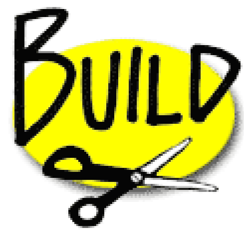

**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.

BOTTLE BIOLOGY
SEE IT, TOUCH IT, SMELL IT, TASTE IT...

| INTRO | BASICS | TOOL BOX | BUILDING BLOCKS | LINKS |
INVESTIGATIONS
| BOTTLE COLUMNS | HANGING BOTTLES | HOME |

# Build a TerrAqua Investigation Column *(option 2)*

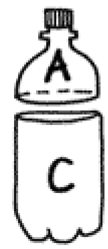
*Build Option 1* | *Build Option 2*




## Option 2

***Materials***

- One 2-liter soda bottle
- One bottle cap
- Tool Box
- Wicking material-fabric interfacing or cotton string
- Water, soil and plants

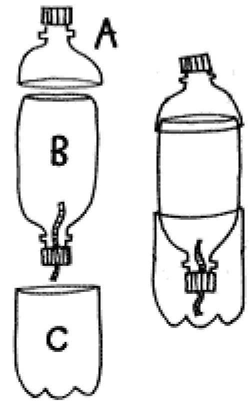



**Step 1** – Remove label from the 2-liter bottle. On bottle #1, cut 2 cm below shoulder to produce component "A," a shallow funnel top and "C" a deep reservoir.

**Step 2** – Poke or drill a 1 cm hole in bottle cap.


**Step 3** – Cut Bottle #2, 1 cm below hip to produce component "B" a deep funnel unit with hip taper.


**Step 4** – Fill reservoir with water. Add soil and plants to top chamber. To be effective, the wick should run up into soil, not be plastered along a side of the bottle. For better drainage, place a layer of gravel, sand or vermiculite in the bottom of the soil unit.





Hang this bottle

**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.

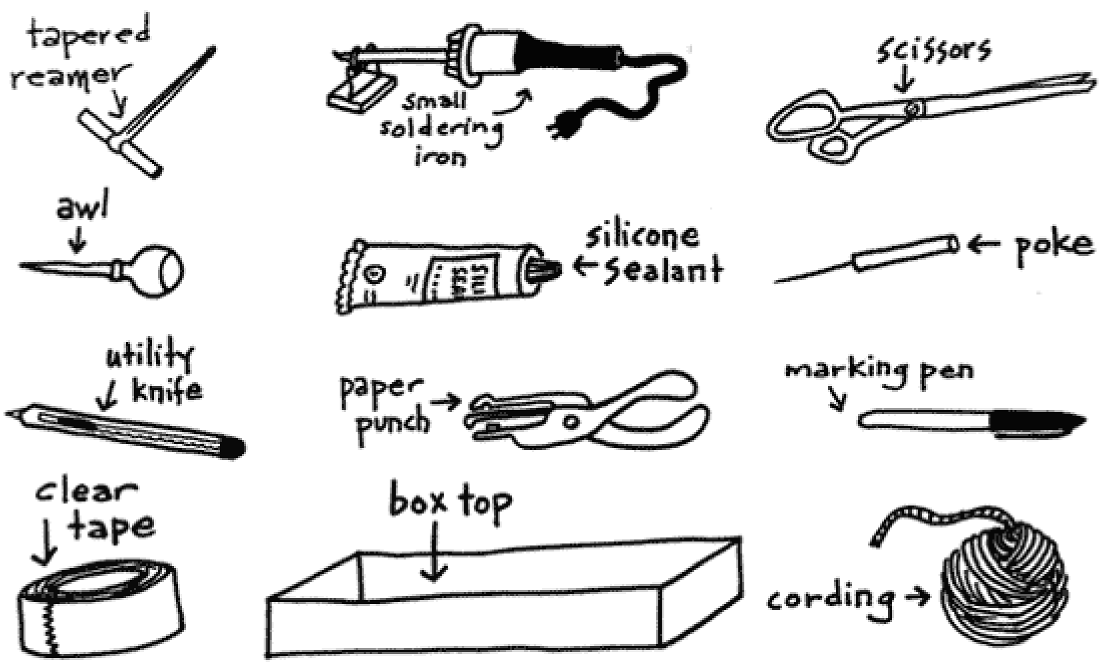
BOTTLE BIOLOGY

SEE IT, TOUCH IT, SMELL IT, TASTE IT...



## Tool Box

These tools will enable you to construct any of the investigation columns on this site. Some of these items are not critical – you do not need to use a razor to start bottle cuts, for example, or a tapered reamer to enlarge holes – but they can make construction easier.




- **Box top or drawer** to stabilize bottle while making cutting lines
- **Marker, wax pencil or crayon** for drawing cutting lines
- **Cutting blade or utility knife** to start cut
- **Scissors** to cut bottle
- **"Poke," darning needle or diaper pin** to make air holes
- **Awl** to make holes in bottle caps and film cans
- **Tapered reamer** for enlarging holes
- **Paper punch** for making large holes in thin plastic
- **Clear waterproof postal or bookbinding tape** to join columns
- **Silicone sealant** to waterproof joints
- **Clothes line, polyester or nylon craft cording**
- **Small inexpensive electric soldering iron**
- **Hair dryer**
- **Plant Light House**

**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.

BOTTLE BIOLOGY
SEE IT, TOUCH IT, SMELL IT, TASTE IT...

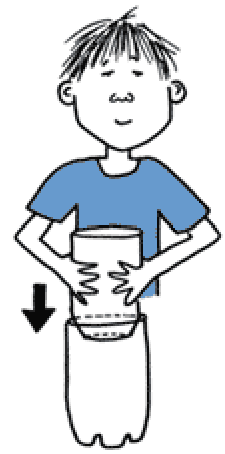
| INTRO | BASICS | TOOL BOX | BUILDING BLOCKS | LINKS |
INVESTIGATIONS
| BOTTLE COLUMNS | HANGING BOTTLES | HOME |

## Bottle Basics

With a pair of scissors and your imagination, you can turn plastic soda bottles into tools for exploring the world.



---



**Anatomy:** The first step in any construction project is to understand your materials. Almost all soda bottles taper at the shoulder and hip. Because of this shape, you can “nest” the tapered ends inside the straight sides of another bottle.

Top of page

---

**Species:** Not all bottles are exactly the same. Some have thinner, gently tapering bodies, while others are wider with rounder shoulders. Bottles that appear the same may vary by a millimeter or two in diameter and this can make a difference. These differences will affect how your bottle constructions fit together. When you are collecting bottles to construct the columns, look for bottles with similar shapes and sizes. One way to guarantee this is to use bottles of the same brand of beverage. Most bottles work equally well in bottle biology constructions. Constructions can also utilize additional common plastic containers such as deli containers, cottage cheese dishes or other similar shaped plastic containers.


Top of page

---

**Bottle care:** Creased and bent bottles have weak spots. Use bottles without dents so your columns are strong and durable. Also, remember that air expands and contracts with temperature changes. If you carry sealed bottles from a warm room to a cold car, your bottles will crumple. When transporting bottles, keep the caps off or loosely attached to allow air exchange.

Top of page

---

**Collecting bottles:** For better or for worse, plastic soda bottles are not difficult to come by. If your plans involve many bottles, however, you may need to organize some type of bottle collection activity. Ask students to bring in bottles. Some teachers use extra credit points or other incentives to encourage students to contribute bottles. Your community recycling center is also an excellent source.


Top of page

---

**Removing labels:** Once you have collected bottles, you will need to remove the labels. Most labels are attached by a heat-sensitive glue. *Resist ripping off the labels, or you may end up with many small pieces of label stuck to the bottle.*


An inexpensive **hair dryer** will remove the label and base from your bottle in a jiffy. Set the hair dryer on **low**. Hold your bottle about 10 cm away from a blowing nozzle, and move it rapidly up and down so that the air warms the seam of the label. Gently pull on an edge of the label until you feel the glue begin to give. *This takes about 4 seconds.*

Bottles are made from **PETE** (polyethylene teraphthalate). This is a generally inert plastic, but it will warp easily if overheated, so keep the bottle moving. Leave the bottle cap on or fill the bottle with water first to prevent warping.

A quieter way to remove the label and base from your bottle is to fill it about 1/4 full with **very warm water** *(49 - 65 degrees C or 120 - 150 degrees F; hotter than this may warp your bottle)*. Cap the bottle in order to retain pressure inside so the bottle doesn't crumple, and tip it on its side to warm the glued seam. After a few seconds tug on a label corner.

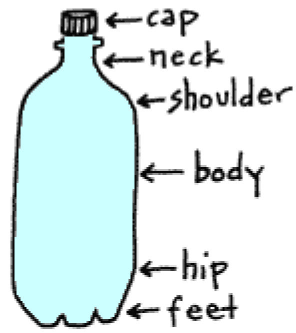

**Glue** is often left on the bottle after the label is removed. If this offends your aesthetic sensibilities, rub a small amount of peanut butter onto the glue. As you rub, the oil in the peanut butter causes the glue to ball up so it can be pulled off (no kidding, crunchy works best). If you are really into the clean bottle look, wash your bottles with soap and warm water and dry them – they'll shine!

Top of page

---

**Cutting bottles:** There are only so many ways you can cut a bottle; above the shoulder, below the shoulder, above the hip and below the hip, and only so many things you can do with each piece you create.

The easiest way to cut a bottle is to cut along a marked line with scissors. Once you have decided where to cut a bottle, place it on its side in the corner of an empty drawer, tray, or box — shallow




cardboard flats and computer printer paper box tops work well. Brace the bottom of the bottle against a corner of the box. Rest a pen or wax pencil against the edge of the box, so the tip rests against the bottle where you want your cutting line. Slowly turn the bottle. Two people make this job easy.

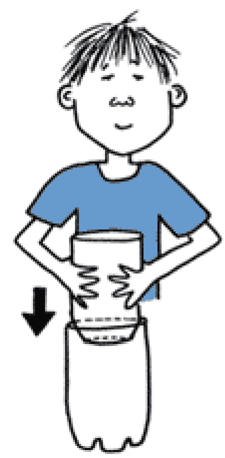
We use **erasable felt tip pens** or wax pencils to make cutting lines because they don't smear and can be easily removed. Make sure your bottle is dry before marking. If you want lines that last, use a permanent marker.

**Draw all of your cutting lines first** (it's hard to do once the bottles have been cut), and then use a cutting blade to begin the bottle cuts. You only need a cut big enough to insert the top arm of a scissors. You will make a smoother cut with the top arm of the scissors inside the bottle, so insert the top arm into your initial cut and snip around, following your cutting line. Don't worry about ragged edges; they are easy to snip away with scissors once the bottle is in pieces.

Basic bottle cuts...

Top of page

---



**Building Blocks*:** Step-by-step bottle constructions specific to each Column Investigation. Bottle Biology investigations can and should go beyond this book. Just like Legos™ or Tinker Toys™, Bottle Biology Building Blocks can be combined in an infinite variety of ways. Each possible combination is helpful for exploring different concepts.

*Building Blocks concept has been adapted from the Families Understanding Nature Project (F.U.N.) by Heather Putnam, 2002

Top of page

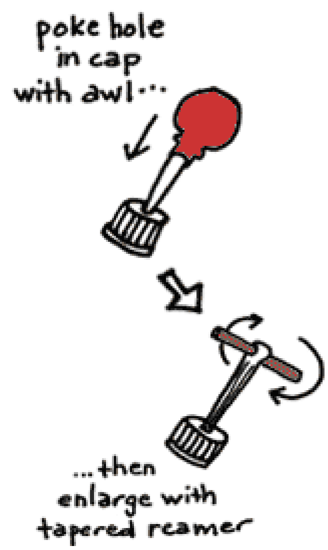
---

**Making holes:** The size, shape and number of air holes you put in a bottle column is part of your experiment – there's no wrong way to do it. Keep in mind, however, that with the Decomposition Columns, you will most likely want holes small enough to keep fruit flies and other insects inside the bottle and out of your classroom. You will want adequate ventilation for plants, insects and other life, so make four or five "stars" of holes (see picture) – but keep them small.

A **poke** is a needle, pin, or nail, with the blunt end stuck into a wooden handle. **Diaper pins, safety pins, upholstery needles and compass points** all work as well.

For needle pokes, you needn't cut off the eye of the needle. For large nail poke handles, you may want to use a small dowel, and will need to drill a hole just a bit smaller than the nail into one end of the dowel in which to insert the cut end of the nail.


**Hot pokes or soldering irons** are useful for creating larger holes or making holes near the neck or base of the bottle where the plastic is thicker. Very large holes can be made by heating the open end of a pyrex test tube in a gas torch or Bunsen burner and pushing the tube through the bottle. Obviously, burns are a hazard of this technique. Also, plastic smokes a bit as it melts, so an entire class using hot pokes can create a real stink. Be sure you let the pokes cool off in a safe place.




A **woodworking awl** is quite effective at making small holes in bottles and bottle caps. If an awl is pushed all the way through a surface, it will create a hole several millimeters wide, enough for fruit flies to pass through. Awls are particularly sharp, so place a piece of wood underneath whatever you are poking and watch your fingers.

A **tapered reamer**, available at the hardware store, is excellent for enlarging holes. Normally used for creating holes in sheet metal, it will easily make a hole in plastic up to 1 cm in diameter. Since the reamer has a blunt tip, begin your hole with an awl or poke.

A **paper punch** will easily penetrate a soda bottle or film can. Different punches create different sized and shaped holes. Since the holes are quite large, punches are not recommended for investigations that you want to keep moisture or small insects from either entering or existing the investigation.

If you are preparing materials for many students, a **drill press** is the most efficient tool if you have access to one. Regular spiral fluted drill bits work well, and sharp "brad" pointed bits will wander less on the surface of the plastic as you start your hole. For holes larger than 1 cm, flat wood bits with spurs on the blade tips work best.

Pieces of old hosiery or no-see-um tent netting, plastic window screening or nylon bridal veil material will keep out even the smallest flies and can be used to cover window bottles. Use double-sided sticky tape to attach netting by surrounding the hole with tape and pressing on an appropriately sized piece of netting. Alternately, 5-minute epoxy glues work well.

Top of page

---

**Joining bottles:** Tape is the best material for joining bottles and will help columns survive handling in the classroom. However, not all tape is created equal.

**Tapes** that are clear, waterproof, and wide (about 5 cm) work well. For a large number of constructions, you may want to buy a dispenser. The best tape we have used (and the most expensive) is **bookbinding tape**. We use it for making demonstration constructions.

**Silicone sealant** such as bathtub or aquarium sealant is required for the Terraqua Column to produce waterproof joints, since even a waterproof tape will eventually leak. Silicone sets over a 24-hour period and is slippery when fresh. Fix the joint to be sealed with several small pieces of tape, which you can remove after the seal has solidified. Buy your sealant in a tube with a nozzle that you can fit as far into the joint as possible. This will give you a strong and watertight seal. Be sure to keep the silicone bead thin, 2-3 mm in diameter, so it sets in 24 hours. Also note that the chemicals used in silicone sealant are a health hazard. Use the stuff in a ventilated area.

Top of page

---

**Hanging Bottles:** Hanging bottles will have gravity working for you rather than against you. By hanging your bottle investigations with nylon cording or macrame string, each component is individually accessible, securely threaded together and stabilized with cording. Once the bottles are hanging they will not fall over and they will take up less table space.

Top of page

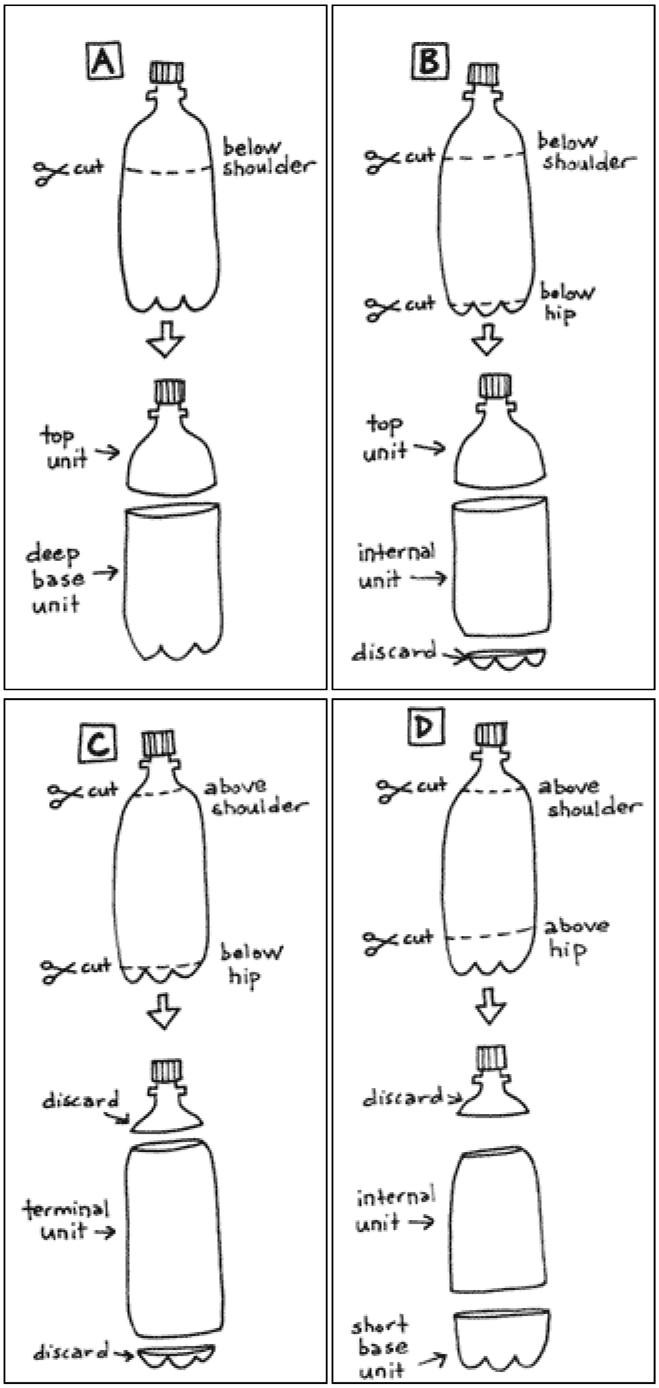
**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.

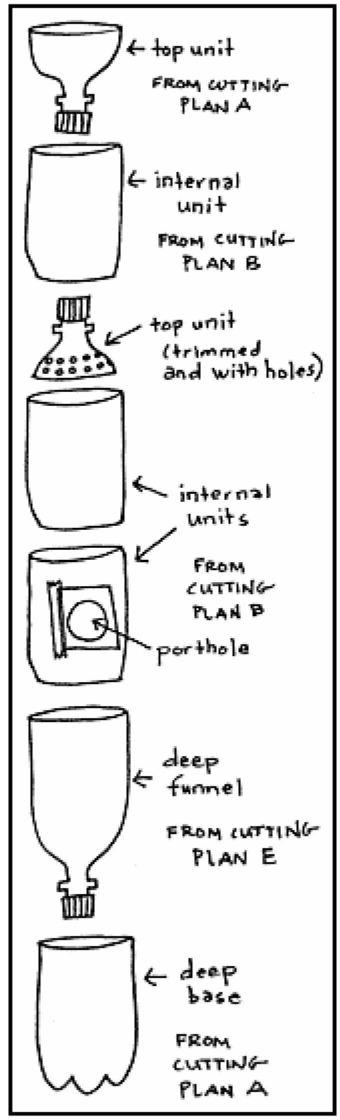
BOTTLE BIOLOGY
SEE IT, TOUCH IT, SMELL IT, TASTE IT...

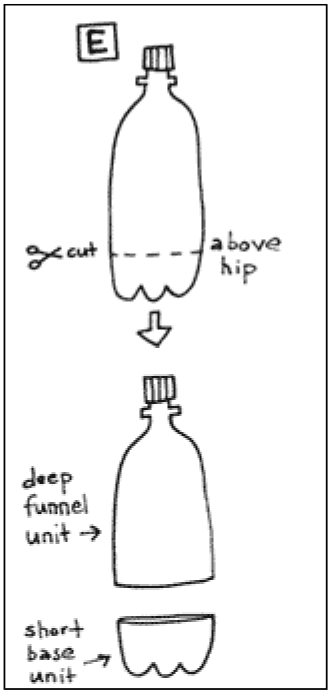


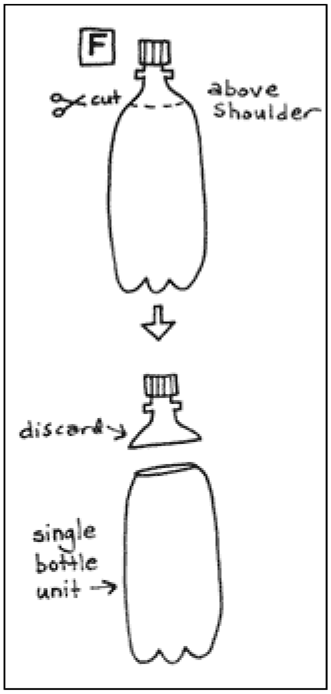
## Building Blocks

Bottles A-F illustrate six different cutting plans using the four basic bottle cuts. The construction on the right is a model for creating your own bottle constructions using these simple methods.






- **Bottle Anatomy**
- **Hanging Building Blocks**

**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.

BOTTLE BIOLOGY

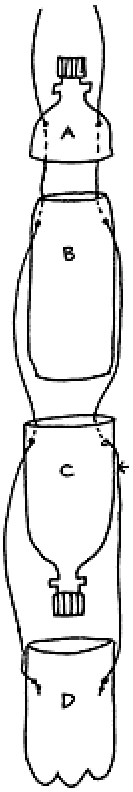
SEE IT, TOUCH IT, SMELL IT, TASTE IT...

| INTRO | BASICS | TOOL BOX | BUILDING BLOCKS | LINKS |
INVESTIGATIONS
| BOTTLE COLUMNS | HANGING BOTTLES | HOME |

## Hanging Bottle Investigations

### Hang Your Decomposition Column


Click here for instructions for filling and building a Decomposition Column.




**Step 1 -** Cut two, 3-foot lengths of cording and fuse the fiber ends with heat from a flame or hot nail.

**Step 2 -** Using a soldering iron or hot nail, melt pairs of 4 mm diameter holes opposite each other on the seams of bottle components "A," "B," "C" and "D" as in the drawing.

**Step 3 -** Tie a simple knot in one end of each cord, then thread each cord through the hole in the rim of "D," from the inside to the outside the knot will be on the inside of the reservoir unit "D." Continue threading the cords from the outside of unit "C" to the inside to the outside of the base of "B," then work inside through the holes just below the hip (top) of "B,"

**Step 4 -** Thread the cords from the inside of column top unit "A," then tie the ends of cords together with a square knot.

Hang your bottle on a hook and it is ready for loading.

---

### Hang your TerrAqua Column

Click here for instructions for filling and building a TerrAqua Column.

**Step 1 -** Cut two, 3-foot lengths of cording and fuse the fiber ends with heat from a flame or hot nail.

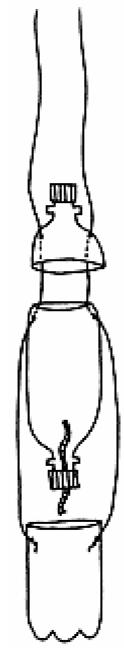
**Step 2 -** Using a soldering iron or hot nail, melt pairs of 4 mm diameter holes opposite each other on the seams of bottle components "A," "B" and "C" as indicated in the drawing.

**Step 3 -** Tie a simple knot in one end of each 3-ft cord. Thread each cord from inside of section "C" so knot is inside reservoir.

**Step 4 -** Thread each cord from outside of "B" to the inside of the deep funnel "C."

**Step 5 -** Thread each cord end from the inside of component "A" to the outside of the top funnel unit. Tie the two ends in a square knot and hang.

Your TerrAqua Column is ready to be filled.



**Bottle Biology**, an instructional materials development program, was funded by a grant from the National Science Foundation administered by the University of Wisconsin-Madison.