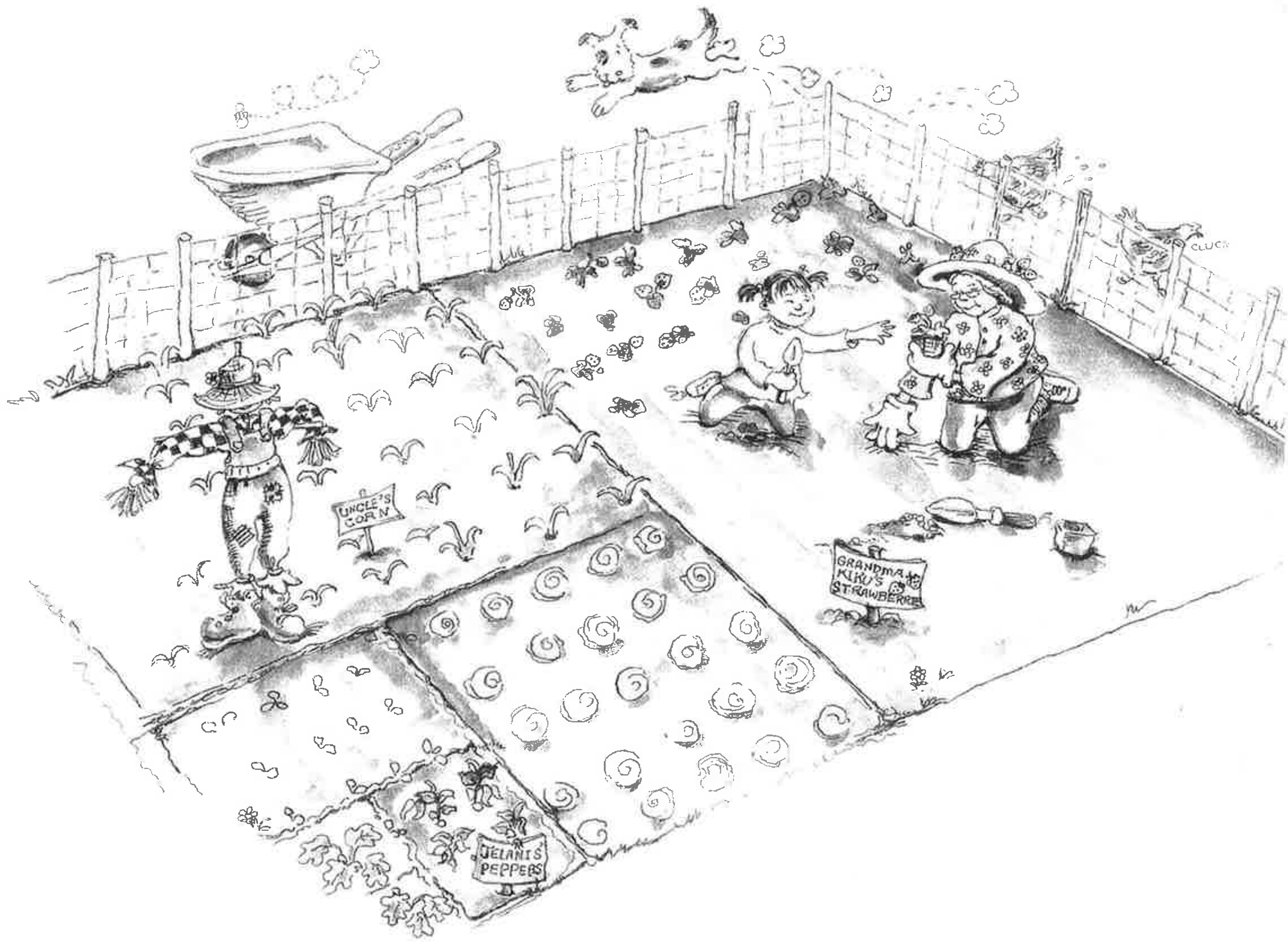
Family Garden

4-6



MATERIALS

two pieces of $8\frac{1}{2}$" by 11" paper of different colors
scissors
Family Garden Record Sheet, page 103

At the Komai annual reunion, Jelani's family gathers for spring planting. Each person brings a favorite vegetable or fruit to plant. They have decided to divide the garden area into sections. The oldest person gets $\frac{1}{2}$ of the whole garden to plant. The next oldest gets $\frac{1}{2}$ of what is left and so on. The family keeps dividing the garden area until everyone has planted something.

Grandmother Kiku, the oldest, chooses strawberries to plant this year. The whole family pitches in to help her, because everyone loves her homemade strawberry ice cream. The next oldest in the family, Uncle Danny, will take half the remaining area to plant corn. He plans to donate his corn to the community food bank.

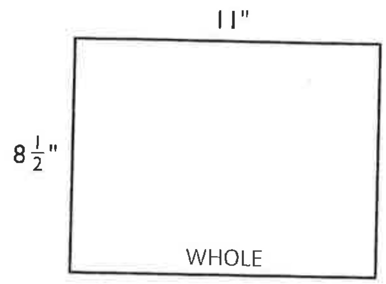
What happens as they continue to divide the garden area? How would you describe what is happening to another person?

This is about
comparing fractions.

How

- Work together and select two pieces of $8\frac{1}{2}$" by 11" paper of different colors to make your garden. One person will cut and one will record, or you can alternate roles.

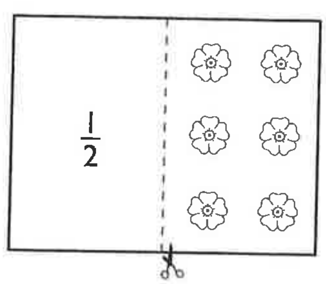
- Before you begin, label 1 piece of paper "1 whole." This will be the template for the whole garden and is where you will place your sections of fruits and vegetables.



THE GARDEN

(do not cut this)

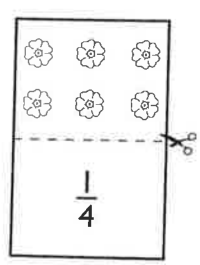
- Take the second piece of paper and fold it in half. Cut along the fold line. Draw your favorite fruit or vegetable on one of the pieces. Put the other piece aside for now.



GARDEN PLOTS

(paper # 2)

- Together figure out the fractional value of the first piece that you cut, and label the fraction on the back of this piece. Now you are ready to place this piece on the garden plot (template).



GARDEN PLOTS

(cut 1/2 again)

MATH CONNECTION

Making a physical model helps us understand the relative values of fractions. Children need to understand and compare the different values of fractions such as $\frac{1}{8}$ and $\frac{1}{4}$. This is especially true when children move to decimal fractions like 0.125 and 0.25. As the denominator (the bottom number of the fraction) increases and the numerator (top number) stays the same, the quantity represented decreases. For example $\frac{1}{45}$ is much smaller than $\frac{1}{4}$.

Family Garden

There are several ways to find the value of a particular fraction. One strategy is to ask how many times this piece will fit on the whole. Your answer becomes the denominator. For example, the largest fractional piece you cut fits on the whole template two times. So the denominator is two, and we write the fraction for the first piece as $\frac{1}{2}$.

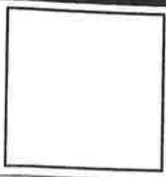
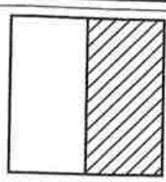
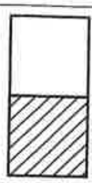
- Take the piece you set aside, and repeat the procedure above, drawing a different fruit or vegetable for this garden section and labeling its fractional value. When you are finished, place this piece in your garden.
- Continue the process until the pieces become too small to handle. Remember to label your garden sections on both sides.
- How many different types of fruits and vegetables were planted? What would happen if you kept dividing the garden?
- Using the record sheet, make a list of the fractional pieces that make up your garden, arranging them from largest to smallest.
- What patterns do you notice? What is the relationship between the denominators and the size of the different pieces?

Note: Save your garden pieces and template. Use them for the Family Garden Game on page 104.

FAMILY GARDEN

RECORD SHEET

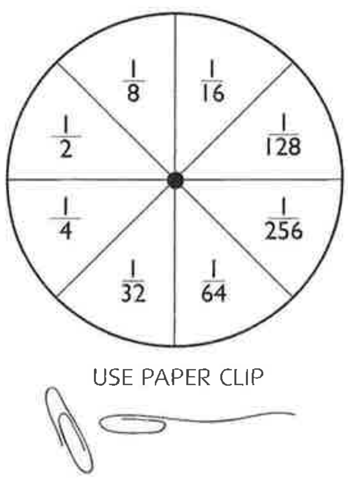
Record what you and your partner do in the following ways:

GARDEN SECTIONS	WHAT HAPPENED	FRACTIONAL VALUE
 *Template does not get cut*	My original whole garden plot	1 whole
	**Example:** I took the second piece of paper and cut it into two equal pieces. I labeled one piece with my favorite fruit and its fractional value on the other side.	$\frac{1}{2}$
		

Family Garden Game

4-6

MATERIALS
paper template and fractional garden pieces from the Family Garden activity
1 spinner, page 105
1 paper clip
1 pen or pencil



In order to play this game, you first need to complete the Family Garden activity on page 100.

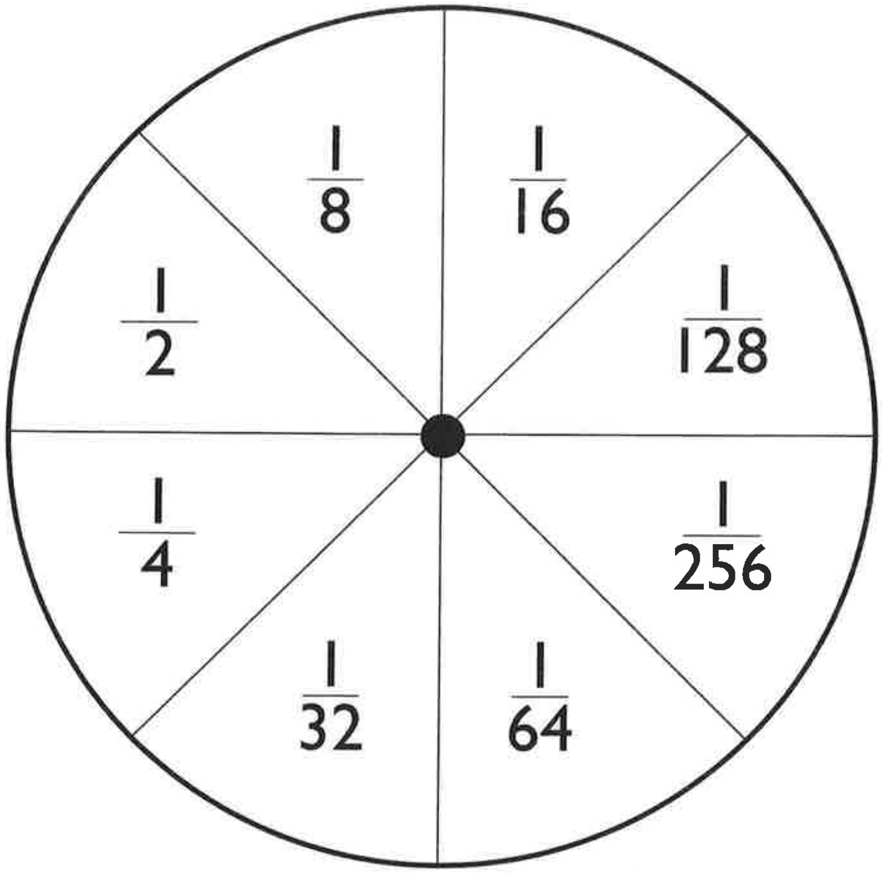
How

- Copy and make the spinner on page 105 for this activity.
- Work with 2-6 players. Each player will need a set of fractional parts and a whole template from the Family Garden activity.
- Take turns using the spinner.
- Take the fractional piece selected by the spinner, and place it on your whole template.
- If you have already used the fractional piece selected, you can spin again 1 time. If you get the same fraction again, then you skip your turn.
- Each person must take five turns. The person with the smallest area uncovered has planted the most garden.
- Play again. Did you cover more area this time?

Here's More

- Start with your template covered with all your fractional pieces.
- Take turns using the spinner.
- Remove the fraction piece indicated by the spinner.
- If you have already used the fractional piece selected, you can spin 1 more time. If you get the same fraction again, then you skip your turn.
- The person with the largest area uncovered on their whole template after 5 turns wins the game.

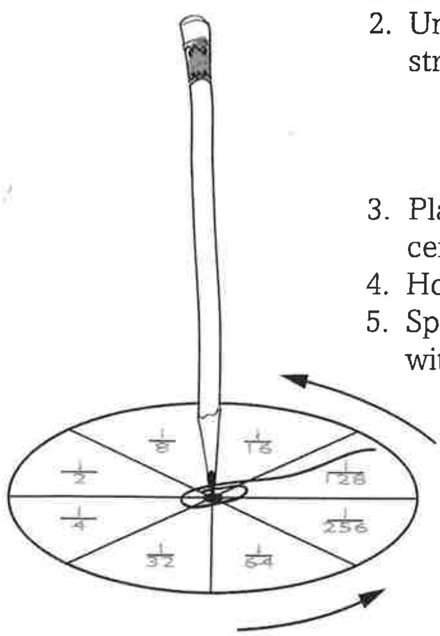
This is about
using probability and comparing fractions.



HOW TO MAKE YOUR SPINNER:

1. Make a copy of the above spinner.
2. Unfold a paper clip so that one edge is pointed straight as shown below.

3. Place the looped end of the paper clip on the center of the spinner.
4. Hold the paper clip in place with a pen or pencil.
5. Spin the paper clip by flicking the pointed end with your finger.



Edible Compost

A favorite way to teach kids about what goes into the compost bin is to make an edible compost. Make sure no one has peanut or other food allergies before starting. **Materials**: 1. cup: (small paper cups ideal to promote recycling and quick decomposition) 2 forks: to eat with and serve as a pitch fork for turning the pile 3. soil: crushed Oreo cookies, chocolate graham crackers or Coco Pebbles 4. brown leaf litter/twigs: Corn Flakes, Wheaties, Rice Crispies and small pretzels 5. green products: green coconut (grass), dried fruit 6. worms: Gummy worms. **The Lesson**: first talk about the bin – everyone grabs a cup to use for their bin. Next talk about starting the bin with a little bit of soil. Add crushed Oreos or Coco Pebbles for soil starter. Then talk about what to add to the bin. Ask the kids what would count as brown things. When they mention twigs, add small pretzel sticks and when they say dead leaves, add Wheaties or Corn Flakes. Next ask what would be some things that would be considered green things. Add green colored coconut for grass clippings and dried fruit bits for food scraps. Now compost needs air so stir with forks or shake the cups up to mix everything together. Real compost also needs water but edible compost doesn't taste very good with water added. (Get a drink of water after you eat your compost). Talk about the critters that come to a compost bin and add a few gummy worms. If you are working with several children, have them sit in small groups of 4 to 6. Have the needed items off to the side in plates or bowls. Have a representative from each group come up and get the materials for their group after talking about it. Have a container for each group to carry the items in and tell them how much of each thing they will need. (Example: add 1 spoonful of coconut for each child in your group.) After every group has their materials, the group representatives can come and take more if there is anything left. Remember, children learn best by doing. Happy Eating!

"COMPOST, BECAUSE A RIND IS A TERRIBLE THING TO WASTE."

Soda Bottle Terrarium

OBJECTIVE: To observe how a terrestrial ecosystem works

Get It Together

- 2 clear 2-liter bottles (for each group of students)
- sharp scissors
- ruler
- "Life in a Bottle" lab sheet (pages 48–49)

Fizzy Science

An *ecosystem* is a naturally functioning system that includes a community of living things and all the other environmental components that allow those organisms to carry out their life processes. Included in the ecosystem are many *abiotic* (not produced by living organisms) factors–such as water, oxygen, carbon dioxide, soil, and nutrients. One way to understand how an ecosystem functions is to make a model of one, like a *terrarium.* The word *terrarium* comes from the Latin word *terra*, which means "earth." A typical terrarium contains soil, plants, and a host of other living things, ranging from insects and snails to worms and microbes. Terrariums can be either open or closed systems. In an open terrarium, air is free to circulate in and out of the system and moisture is added regularly to sustain the various life processes. In a closed system, moisture is added at the beginning when the terrarium is first set up but then the system is sealed and allowed to run on its own.

Before You Start

Remove the labels from all bottles. Cut off the tops so that half of the bottles are 23-centimeter (9-in.) cylinders and half are 15-centimeter (6-in.) cylinders.

What to Do

1. Tell students that they are going to create their own little world! They will be building a mini-ecosystem, complete with all of the natural factors needed to keep it going.
2. Ask: What does the word *ecosystem* mean? *(An ecosystem is a part of the environment that includes living things and all the factors that they need to survive.)*
3. Challenge the class to brainstorm all the things that make up a typical forest ecosystem, such as soil, plants, trees, insects, air, and water. List their responses on the board.
4. Explain that even though some of these factors may seem less important than others, they all play a role in keeping an ecosystem going. Sometimes just a change in one small factor can have an enormous effect on an entire ecosystem. Since it's difficult to study large-scale ecosystems in nature, scientists often create model ecosystems that allow them to test different factors.
5. Explain that one way to model an ecosystem is to build a terrarium, which is like an aquarium, but has soil and plants instead of water. Hand out copies of the "Life in a Bottle" lab sheet and invite students to construct their own ecosystem in a bottle.

Name ______________________ Date ______________________

Life in a Bottle

How does a terrarium model an ecosystem?

❶ In this activity you are going to build a simple terrarium, which is really a mini ecosystem in a bottle. During your investigation, you will be able to control different factors to see how they impact different organisms living in your ecosystem.

❷ Take the shorter of the two soda-bottle cylinders and fill it with about $7\frac{1}{2}$ centimeters (3 in.) of moist garden topsoil. Sprinkle $\frac{1}{4}$ cup of wild birdseed or grass seed on the soil and then add another $2\frac{1}{2}$ centimeters (1 in.) of soil on top of the seed. Spray the top of the soil with water until it just starts to form little puddles.

You'll Need

- clear 2-liter bottle with top cut off 15 cm from the bottom
- clear 2-liter bottle with top cut off 23 cm from the bottom
- $\frac{1}{2}$ liter garden topsoil
- $\frac{1}{4}$ cup wild birdseed or grass seed
- water
- plant mister or spray bottle
- sunny windowsill

❸ Take the taller soda bottle cylinder and turn it upside down over the one with the soil in it. The large cylinder should be a little narrower than the shorter one. Slip the open end of the tall cylinder into the short cylinder and push it down until it fits tight.

❹ Observe the terrarium from the side. What do you see happening to the water that you sprayed on top of the soil? What part of the environment does the water represent?

____

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❺ Place the terrarium on a sunny windowsill. Check it each day for seven days and note any changes that you see in the system on the chart below:

Day	Observations
1	
2	

Day	Observations
4	
5	
6	
7	

❻ Once your ecosystem has become established and the plants are growing, you can begin testing different conditions. Here are some of the variables that you can test:

- **Population size:** What would happen if you added more seeds to the soil?
- **Population variation:** What would happen if you added animals, such as insects and worms, to the terrarium?
- **Temperature:** What would happen if you placed the terrarium in a cool spot?
- **Sunlight:** What would happen if you placed it in the dark?
- **Water:** What would happen if you added more water or took the top off so it will dry out?
- **Acid rain:** What would happen if you added a teaspoon of vinegar or lemon juice to the water?

Think About It: How do terrariums help scientists determine what factors impact the health of an ecosystem?

Soda Bottle Bug Habitat

OBJECTIVE: To observe the behavior and life cycle of isopods

Get It Together

- clear 2-liter soda bottle with cap (for each group of students)
- several pill bugs (purchased or collected in the wild)
- magnifiers
- paper plates
- "Pill Bug Palace" lab sheet (page 51)

Fizzy Science

Isopods are fascinating creatures that belong to the class *Crustacea.* One of the most common isopods is the pill bug, which is not really a bug at all. Although often confused with insects, pill bugs (as all isopods) are more closely related to crabs. Pill bugs can be found in moist soils, usually under rocks or decaying logs. They are about $1\frac{1}{4}$ centimeters ($\frac{1}{2}$ inch) long and have a flattened body. They breathe through gills and have seven pairs of legs. Their most striking feature is the armor-like plates that cover their bodies. When threatened, pill bugs roll up into a ball, making it hard for birds and other animals to eat them. The life span of a typical pill bug is about two years but they can live up to five years. They are decomposers, feeding mostly on decaying plant and animal matter. In captivity, pill bugs feed on fruit and potatoes.

Before You Start

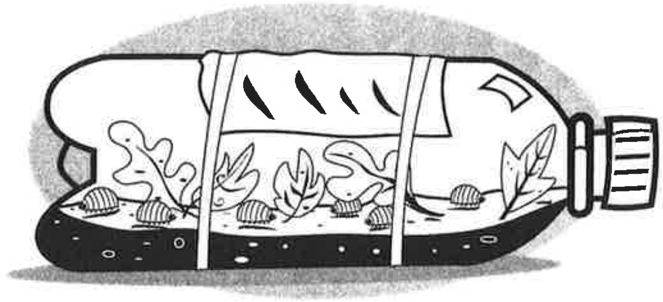
Remove the labels from all soda bottles. If possible, organize a class field trip to collect pill bugs. They are commonly found under rocks and rotting wood and around building foundations where it is dark and damp. Or you can order them from a science supply house. Store the pill bugs in a soda bottle with some moist soil. Punch small holes in the bottle to let air in.

What to Do

1. Divide the class into small groups and give each group a set of magnifiers and a paper plate. Call on a representative from each group to come forward with the paper plate. Give each group some soil with several pill bugs. Explain that the creatures are called *isopods*, which means "similar feet." Their common name is pill bug.
2. Have students use the magnifiers to carefully observe the creatures and then make a list of their physical characteristics, including the number of legs, number of body segments, presence of wings or antennae, and so on.
3. With the class's input, list the pill bug's physical characteristics on the board. Ask: What group of animals do you think pill bugs belong to? *(Crustaceans)*
4. Explain that even though pill bugs look like insects–and they have the word "bug" in their name–isopods really belong to a class of animals called crustaceans. Ask students to name some other crustaceans. *(Crabs, lobsters, shrimp)*
5. Hand out copies of the "Pill Bug Palace" lab sheet, inviting students to construct their own pill-bug habitat.

Name ______________________ Date ______________________

Pill Bug Palace



What are isopods? How do they behave?

You'll Need

- clear 2-liter soda bottle with cap
- sharp scissors
- 15-by-10-cm sheet clear plastic wrap
- 2 large rubber bands
- 1 liter forest soil (or humus or topsoil from garden center)
- dead leaves
- 3 or 4 pill bugs
- sunny windowsill or desk lamp
- apple, raw potato, and other types of food
- spray bottle with water

1. Turn the 2-liter bottle on its side. Using sharp scissors, carefully cut a small rectangular opening (about 10 by 5 centimeters) on one side of the bottle.

2. With the bottle still lying on its side, fill the bottom of the bottle with moist organic soil to a depth of about 5 centimeters (2 in.), making sure to keep the opening facing up. Spread the soil evenly along the bottom. Place three or four pill bugs into the soil and add a few dead leaves.

3. Stretch a piece of clear plastic wrap over the opening and hold it in place with two rubber bands. Your habitat is complete and ready for observation.

4. Observe the pill bugs in their new home. Where do they go? Why?

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5. Place the habitat on a sunny windowsill or under a bright light. How do the pill bugs react?

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6. Cut up a piece of apple or raw potato and place it in the habitat. How do the pill bugs react? How do they eat? Try other types of food like carrots, bananas, and so on. What is their favorite food?

____

____

7. To stay healthy, pill bugs need to be fed and kept moist every few days. Use a spray bottle to thoroughly soak the top of the soil.

Think About It: What characteristics do pill bugs share with insects and worms? How are they similar to other crustaceans?

Soda Bottle Greenhouse

OBJECTIVE: To investigate if the color of light affects the growth of plants

Get It Together

- clear 2-liter soda bottle (for each group of students)
- green 2-liter soda bottle (for each group of students)
- sharp scissors
- ruler
- lima beans or grass seeds
- soil
- small plastic cups
- flashlight
- "Growing Green" lab sheet (pages 53–54)

Fizzy Science

To grow, most plants need water, air, nutrients from soil or water, and light. Plants get their energy directly from light. During a process called *photosynthesis*, they use light energy to manufacture simple sugars from water and carbon dioxide. Without light, most plants would die. But not all light is created equally. Sunlight, which most plants rely on, is a full-spectrum light source. It consists of a wide range of different wavelengths of light energy. You can see these different wavelengths when you look at a rainbow. Other light sources, such as incandescent or fluorescent bulbs, frequently are missing some wavelengths of light. As a result, indoor plants that get their energy from an artificial lamp or from sunlight passing through a tinted window (which filters out certain wavelengths) are often stunted.

Before You Start

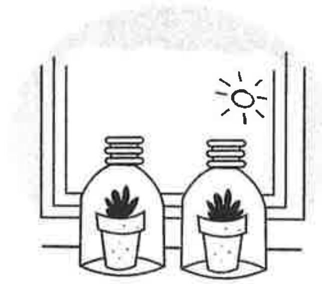
Cut the bottoms off all the bottles, about 25 centimeters (10 in.) from the top. Remove all labels. Before beginning the activity, you may want to grow lima beans or grass seeds in small plastic cups for students to use. Or, you can purchase seedlings from a local garden center.

What to Do

1. Ask students: What do plants need to grow? *(Water, soil, air, light)* Explain that unlike animals that get their energy from eating other things, plants use sunlight to make their own food through a process called *photosynthesis.*
2. Ask: Have you ever noticed that indoor plants sometimes don't do as well as the same plants grown outside? While many factors could cause plants to grow poorly, one problem is that sometimes light passing through a window is filtered by the glass.
3. Darken the room. Turn on a flashlight, directing it toward a wall to make a spot of light. Next, shine the light through the clear plastic bottle. There should be little change in the spot of light.
4. Hold up the green bottle and ask: What will happen to the light as it passes through the green bottle? *(The light will have a greenish tint.)*
5. Explain that the green plastic blocks all the colors of light except for green. Ask: Do you think a plant will grow the same way under green light as under white light? Hand out copies of the "Growing Green" lab sheet and invite students to find out!

Name ______________________ Date ______________________

Growing Green



How does green light affect the growth of plants?

❶ In this activity, you are going to investigate if the color of light affects a plant's growth. You will need about two weeks to complete your observations.

❷ Place your two plant samples side-by-side on a sunny windowsill or under a grow lamp. Use the marker to label one pot "Green" and the other "Clear."

❸ Carefully observe the two plants. Use the ruler to measure the height of each plant and the width of its leaves. Record your observations for each plant below:

Clear: ______________________

____

Green: ______________________

____

You'll Need

- clear 2-liter bottle with bottom cut off 25 cm from the top
- green 2-liter bottle with bottom cut off 25 cm from the top
- 2 small potted plants of the same variety that can fit inside the bottles
- permanent felt-tip marker
- ruler
- sunny windowsill or grow light
- water

❹ Water each plant with the same amount of water. You will be conducting a *controlled experiment*, which means that all conditions for both plants will be the same except for one. Why is it important for the two plants to be as similar as possible in every way?

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❺ Cover the plant labeled "Green" with the green soda bottle cylinder and the plant labeled "Clear" with the clear soda bottle cylinder. Leave the caps off the bottles. Check the plants each day over a 14-day period, remembering to water them every few days so they don't dry out. Record your observations below:

Day	Green	Clear
1		
2		
3		

Day	Green	Clear
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

❻ Based on your observations, did the different-colored lights have any impact on the plants' growth? In what way?

____

____

Think About It: Do you think all plants would react the same way in this experiment? How might you check your hypothesis?

Transpiration Bottle

OBJECTIVE: To observe how transpiration works in plants

Get It Together

- 2 clear 2-liter bottles (for each group of students)
- sharp scissors
- ruler
- lima beans or grass seeds
- soil
- small plastic cups
- fresh green tree leaves
- magnifiers
- "You're All Wet!" lab sheet (page 56)

Fizzy Science

Most plants need to be watered regularly to stay healthy. Water is used in photosynthesis to make food for the plant. It also transports minerals, nutrients, and food throughout the plant. Most of the water that a plant takes in at its roots is lost back out through its leaves in a process called *transpiration*. Transpiration helps keep a plant cool and helps concentrate essential elements inside the plant tissue. The underside of a leaf has tiny openings called *stomata*, which allow gases to pass in and out of the plant. This is where most transpiration takes place. The topside of a leaf has no openings and is often covered with a thick waxy layer called the *cuticle*. This layer prevents too much transpiration from taking place. Many times when the sun is shining brightly and the stomata are open, water loss can be significant. During evening hours, the stomata close so plants can recharge.

Before You Start

Cut off the bottle tops so that half of the bottles become 10-centimeter (4-in.) tall cylinders and half become 23-centimeter (9-in.) tall cylinders. Before the activity, you may want to grow some lima beans or grass seeds in small plastic cups for students to use. Or, you can purchase seedlings from a local garden center.

What to Do

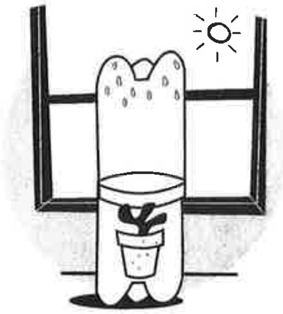
❶ Ask students: Why do plants need water to grow? *(Water is important for making food and for transporting nutrients in the plant.)* Explain that water also helps keep plants cool. On hot days, water evaporates off the leaves in a process called *transpiration*.

❷ Pass around the leaf samples and magnifiers. Have students examine both sides of the leaf closely. Ask: How does the topside of the leaf compare to the bottom? *(The topside is smooth, darker, and feels a little waxy; the bottom feels rough and has little holes.)*

❸ Explain that leaves on most plants are designed to minimize water loss. Point out the tiny openings at the bottom of the leaves. Explain that they are called *stomata* and are like the pores in skin, where much water comes out.

❹ Ask: Why would it be bad for the stomata to be on the topside of the leaves? *(If the openings were in direct sunlight, the plant would lose too much water and die.)* Hand out copies of the "You're All Wet!" lab sheet and invite students to investigate transpiration.

Name ________________________ Date ____________________



You're All Wet!

What factors affect transpiration in plants?

You'll Need

- clear 2-liter soda bottle with top cut off 10 cm from the bottom
- clear 2-liter soda bottle with top cut off 23 cm from the bottom
- small potted plant
- paper towel
- large cardboard box or big brown paper bag
- sunny windowsill or grow light
- watch or clock

1. Make sure your plant is watered well. Place the plant inside the shorter soda bottle cylinder. Take the taller cylinder and turn it upside down over the first. Slip the tapered end of the taller cylinder inside the shorter one and push them together so they fit snugly together. Why do you think the two cylinders must fit together tightly?

2. Place the bottle with the plant on a sunny windowsill or under a grow light. Let it stand in the light for about 30 minutes. Observe the inside of the bottle and record what you see. Why do you think this is happening?

3. Next, take the two cylinders apart and dry the inside of the bottles with a paper towel. Replace the plant in the bottles as you did in step 1. Cover the plant with a large cardboard box or brown paper bag and move it from the windowsill to simulate nighttime. Predict: What will happen to the moisture level in the bottle this time? Why do you think so?

4. After 30 minutes, remove the covering from the plant and observe the inside of the bottle. How does the inside of the bottle compare with the way the bottle looked in step 2? Why do you think this is so?

5. Based on your experiments, when would you say that plants transpire the most? How does this help or hurt them?

Think About It: Do you think that all plants transpire at the same rate? How might you design an experiment to check your hypothesis?

Colored Leaves

OBJECTIVE: To discover how xylem works in plants

Get It Together

- clear 1-liter soda bottle (for each group of students)
- sharp scissors
- ruler
- cross-sectional piece of a tree trunk showing the rings (or photo)
- carrots
- magnifiers
- plastic knives
- "Leaf of a Different Color" lab sheet (page 58)

Fizzy Science

Most plants would be in big trouble if not for their stems! Stems transport water, food, and nutrients throughout the plants. Inside the stem are two distinct passageways that allow these critical substances to circulate around the plant. The first channel is called the *xylem*, which carries water and dissolved minerals from the roots up to the leaves. In woody plants, like trees, the xylem tissue is quite strong and provides most of the support for the plant. In perennials, a new layer of xylem grows each year, so if you cut across the stem, you can see each successive layer as a set of growth rings. The second transport channel is called *phloem*, which carries food in the form of sugars from the leaves to the rest of the plant.

Before You Start

Cut the tops off all the bottles, about 15 centimeter (6 in.) from the bottom. Contact your local parks department to try and get a cross-section of a tree trunk. Or find a photo of one.

What to Do

1. Tell students: *In humans and animals, blood flows through veins and arteries to each organ. Do plants have blood vessels too?* Explain that instead of blood vessels, plants have special cells that act like pipelines, allowing water and nutrients to flow around the plant.
2. Divide the class into small groups and pass around the carrots, plastic knives, and magnifiers. Ask: What part of the plant is the carrot? *(Root)* Have students cut across the carrot and observe the pattern inside. Ask: What shape do you see inside the carrot? *(An inner circle of tissue)* Explain that this inner circle is called the *xylem*, and it's the passageway through which water gets from the roots to the rest of the plant.
3. Pass around the tree cross section or a photo of one. Ask: What part of a plant is a tree trunk? *(Stem)* What shapes do you see in the trees? *(Rings)*
4. Explain that tree rings are also xylem. Each year, woody plants grow a new layer of xylem right under the bark and the old layer dies. By counting the layers of xylem, you can tell a tree's age. Non-woody plants also have xylem running through their stems.
5. Hand out copies of the "Leaf of a Different Color" lab sheet and invite students to find a plant stem's xylem.

Name ______________________ Date ____________________

Leaf of a Different Color

How do plants transport water inside them?

You'll Need

- clear 1-liter soda bottle with top cut off 15 cm from the bottom
- red food coloring
- water
- 2 fresh stalks of celery with leaves still attached
- plastic knife
- magnifier
- sunny windowsill or grow light
- watch or clock

❶ Take a stalk of celery and examine it carefully on the outside. With a plastic knife, cut across the stalk near the bottom and examine the inside of the stem, too. What part of the stem do you think transports the water? Record your observations below:

____

____

❷ Put a few drops of red food coloring in the soda bottle cylinder then fill it halfway with water. Cut across the bottom of the second celery stalk and place both stalks in the cylinder, with their leaves sticking out the top.

❸ Place the cylinder on a sunny windowsill or under a grow light and wait about 15 minutes. Predict: What changes will you see in the plants?

____

____

❹ After 15 minutes, remove one of the celery stalks and, with the knife, cut across the stem about 2½ centimeters (1 in.) from the bottom. Look at the bottom of the stem and describe what you see:

____

____

❺ Based on your observations, what part of the stem is the xylem? How do you know?

____

____

❻ Leave the second stalk of celery in water overnight. Based on your observation of the stem, what do you think will happen to the leaves? Write your prediction. Then record your observations the next day:

____

____

Think About It: How might you use this technique to identify the xylem tissue in other plants?

Soda Bottle Composters

OBJECTIVE: To explore how nutrients are recycled in nature

Get It Together

- 4 clear 2-liter soda bottles (for each group of students)
- sharp scissors
- ruler
- magnifiers
- small paper plates
- plastic spoons
- 2 to 3 liters of natural topsoil
- "Let It Rot" lab sheet (pages 63–64)

Fizzy Science

If you've ever taken a close-up look at natural forest soil, you know we live in a rotten world! While most soils are composed of minerals weathered from rocks, it's the organic matter derived from rotting plants and animals that really make soil productive. In a natural system, nutrients continuously get recycled through a process called *decomposition*. As organic material, such as leaf litter, collect on the forest floor, a whole host of organisms breaks it down into simpler compounds. Decomposition is a critical part of all natural ecosystems. Without it, the next generation of *producers* (plants) and *consumers* (animals) would lack many of the essential elements they need to carry out their life cycles. The organisms that are responsible for decomposition are called *decomposers*, and they come in many shapes and sizes. They include microscopic organisms, like bacteria and fungi, as well as insects, worms, snails, and even larger animals. Like all living things, *decomposers* have certain needs, like water and air. Temperature also plays a big role in decomposition, which happens mostly in spring and summer, when the soil is fairly warm. While some decomposers can work at temperatures below freezing, decomposition generally comes to a standstill during the winter months.

Before You Start

Remove the labels from all bottles. Each group of students will need two sets of compost chambers, with each chamber made up of two bottles. Use scissors to cut the tops off so that half of the bottles are 10 centimeters (4 in.) tall and half are 23 centimeters (9 in.) tall. The taller cylinder should be cut off at the point just above where the top of the bottle begins to narrow. If you have a wooded area near your school, you may want to do the first part of the activity in the field. That way, students can see the actual environment associated with natural decomposition in the soil. If this is not possible, gather soil samples, leaf litter, and grass clippings in advance.

What to Do

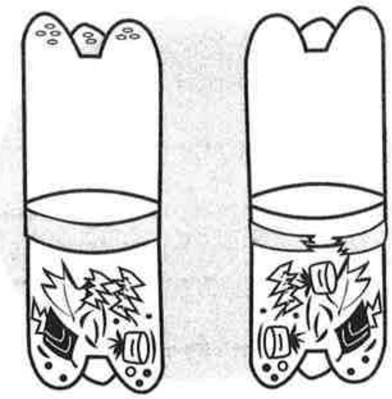
1. Ask students if they have ever taken a close-up look at natural soil. Ask: What kind of stuff is in natural soil? *(Rocks, leaves, twigs, bugs, and so on)* Explain that even though many people take dirt for granted, natural soil is really a very complex environment.
2. Divide the class into small groups and give each group a paper plate, a plastic spoon, and magnifiers. Place a large scoop of soil on each plate and ask students to list what they see in the soil.

Soda Bottle Composters

(continued)

3. After a few minutes, invite students to call out what they've found as you list the various soil components on the board. Point out that if they look at the list closely, most of the components can be broken down into two main groups–*organic materials* (living and dead things, like leaves, roots, and insects) and *inorganic materials* (small rocks and grains of mineral).
4. Ask: How does the organic part of soil change over time? *(They eventually decompose or break down.)* Explain that decomposition is an important process because, without it, there would be no nutrients in the soil for the next generation of plants and animals to use. Soil houses many different types of organisms that help break down organic materials. Most of the time you don't see decomposition at work in soil because it is hidden from view.
5. Hand out copies of the "Let It Rot" lab sheet and invite students to investigate what factors aid in the decomposition process.

Let It Rot



What conditions promote decomposition in nature?

❶ Fill each of the two short soda bottle cylinders with a mixture of leaves, grass clippings, vegetable scraps, and shredded newspaper, up to about 2½ centimeters (1 in.) from the top. Spray the mixture in one bottle with water until it is very damp. Leave the other mixture dry.

You'll Need

- 2 clear 2-liter soda bottles with top cut off 10 cm from the bottom
- 2 clear 2-liter soda bottles with top cut off 23 cm from the bottom
- thumbtack or pushpin
- shredded newspaper, old leaves, grass clippings, and/or vegetable scraps
- spray bottle or plant mister
- cellophane tape

❷ Take one of the taller soda bottle cylinders and turn it upside down over one of the smaller ones. Slip the tapered end of the taller cylinder inside the shorter one and push them together so they fit snugly together. Repeat the same procedure with the second cylinder. Why do you think the two cylinders must fit together tightly?

____

____

❸ Using a pushpin or thumbtack, punch about 15 small holes into the top cylinder of the compost chamber with the wet mixture. Do not put any holes in the other compost chamber–instead, use tape to seal the connection where the two cylinders join together.

❹ Based on how you constructed the two compost chambers, what are the two main environmental differences between the two organic mixtures?

____

❺ Predict: What changes do you expect to see in each bottle over time? Write your predictions here:

____

____

❻ Carefully observe each bottle for the next seven days and record your observations on the chart below. If the bottle with the holes begins to dry out, take it apart and spray more water in it.

Day	Wet Bottle	Dry Bottle
1		

Day	Wet Bottle	Dry Bottle
2		
3		
4		
5		
6		
7		

7. Based on your observations, under what conditions does natural decomposition work best?

Think About It: What other environmental factors might affect the speed of decomposition? How might you test them?

When is the end a beginning?

Decomposition Column

The U.S. generates 190 million tons of solid waste a year — enough to fill a bumper-to-bumper convoy of garbage trucks halfway to the moon. So why aren't we up to our necks in garbage?

The key to staying on top of the garbage heap is recycling, by people and nature. People are just beginning to recycle some of the metal, glass and plastic that fill up a quarter of America's garbage pails.

Nature recycles garbage all the time, and this recycling is essential to the availability of nutrients for living things. Nature's recyclers are tiny bacteria and fungi, which break down plant and animal waste, making nutrients available for other living things in the process. This is known as decomposition.

Decomposition involves a whole community of large and small organisms that serve as food for each other, clean up each other's debris, control each other's populations and convert materials to forms that others can use. The bacteria and fungi that initiate the recycling process, for example, become food for other microbes, earthworms, snails, slugs, flies, beetles and mites, all of which in turn feed larger insects and birds.

You can think of the Decomposition Column as a miniature compost pile or landfill, or as leaf litter on a forest floor. Through the sides of the bottle you can observe different substances decompose and explore how moisture, air, temperature and light affect the process.

Many landfills seal garbage in the earth, excluding air and moisture. How might this affect decomposition? Will a foam cup *ever* rot? What happens to a fruit pie, or tea bag? Which do you think decomposes faster, banana peels or leaves? If you add layers of soil to the column, how might they affect the decomposition process? What would you like to watch decompose?

CONNECTIONS

microbial ecology, decomposition, food chains, carbon and nitrogen cycles, recycling, landfills. Scientific process skills — observing, predicting, asking questions, recording data, describing.

BUILD

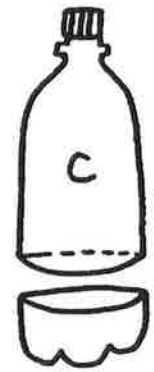
DECOMPOSITION COLUMN

MATERIALS:

- three 2-liter soda bottles
- one bottle cap
- Bottle Biology Tool Kit (p. 2)
- kitchen scraps, leaves, newspapers ... you decide!

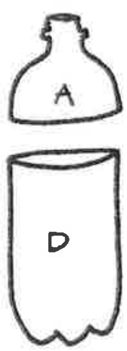
1. Remove labels from three 2-liter bottles (see p. 3).

4. Cut bottom off Bottle #3, 1 to 2 cm above hip, so cylinder has a straight end.



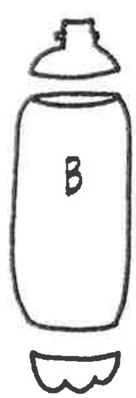
Bottle #3

2. Cut top off Bottle #1 2 to 3 cm below shoulder so that cylinder has straight sides.



Bottle #1

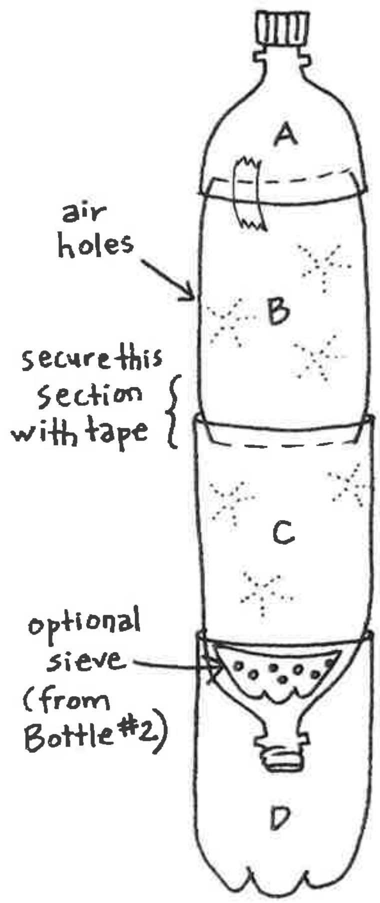
3. Cut top off Bottle #2 2 to 3 cm above shoulder. Cut bottom off 2 to 3 cm below hip. The resulting cylinder will have two tapered ends.



Bottle #2

5. Invert "C" and stack into base "D." Stack "B" and tape middle seam securely. Poke air holes. Add top "A" with a piece of tape for a hinge to the bottle column.

6. Poke air holes in column. *Optional: poke hole in cap.*



HANG hang this bottle (see p. 88)

Choosing ingredients: Decomposition Column ingredients can include leaves, grass and plant clippings, kitchen scraps, newspapers, animal manure and soil. If you are interested in how fast things decay, try building two identical columns, but fill them with leaves from two different species of trees. Try adding fertilizer to your column, or water from a pond or river. How do you suppose differences in temperature, light or moisture will affect the decomposition process?

The time it takes: You'll begin to see mold and other evidence of decomposition within the first few days after filling your column.

Two or three months is plenty of time to see soft **organic** material such as leaves, fruits, vegetables and grain products decompose dramatically. (The term organic applies to something that is derived directly from a living organism.) Bark, newspapers and wood chips all take longer to decompose, though they still undergo interesting changes in two to three months.

How wet?: Keep your column moist in order to observe more rapid decomposition. Avoid flooding your column or it will become waterlogged. This can create an **anaerobic** environment, or one completely lacking oxygen, in which certain microbes create particularly vigorous odors.

Using your nose: Odor is a by-product of decomposition, and can tell you a lot about the materials in your columns. Odors may be strong at first, but can mellow and become musty with time. Classrooms full of odorous Decomposition Columns, however, have been known to try the patience of colleagues and building supervisors. The strongest odors arise from animal products such as meat and dairy products. Grapefruit rinds and grass cuttings can also produce strong odors. Why is this so? If you use food scraps, mix in plant matter such as leaves, twigs and dried grass to temper odors. Layering soil on top of contents also lessens the odor.

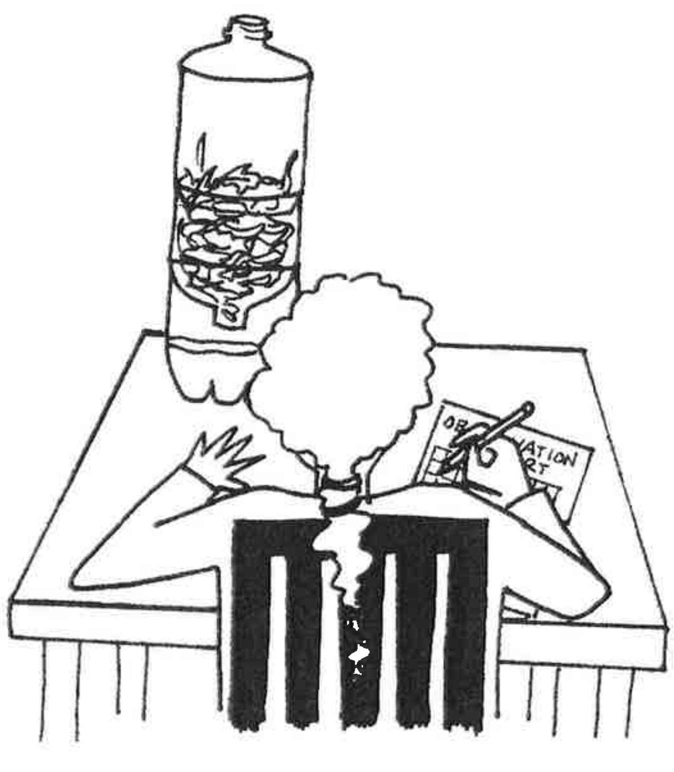
Increasing the number and size of air holes in your column will increase air exchange. How do you think this will affect decomposition? Keep holes small so fruit flies stay inside.

If your classroom fruit fly population booms anyway, make a Fruit Fly Trap! (p. 50). See Bottle Basics (p. 7), for more information on making holes.

Recording data: Once you've decided how to fill your column, carefully observe what you put inside. In a notebook, describe the color, texture, smell and shape of everything you put in the bottle. Weigh everything before it goes into the column (see the Bottle Balance, p. 115).

Schedule column checks for at least once a week to record changes. Note changes in the column contents' height, color, shape, texture and odor. Hold a ruler next to the column to record changes in the height of the contents. Insert a thermometer from the top of the column to determine temperature changes. Can you figure out the rate of change? You can also test the pH of the leachate (the solution that drips through the column) or use it in a bioassay (p. 95). See p. 28 for more on pH.

Is anything moving?: Look for the appearance of any "critters," such as flies, beetles, slugs, millipedes, or snails. Decomposition Columns offer good opportunities for observation and description. Try using photographs or drawings to record changes. Write a story about what is going on in your column. What do you predict will happen during decomposition?



"On Top"

All this new stuff goes on
top
turn it over turn it over
wait and water down.
From the dark bottom
turn it inside out
let it spread through, sift
down,
even.
Watch it sprout.

A mind like compost.

Gary Snyder, Axe Handles
1983

EXPLORE

Rot Race: A decomposition experiment

Soil or no soil?: Build two Decomposition Columns. Weigh out equal quantities of leaves from the same tree. Fill both columns loosely, but mix about 125 cc (half a cup) of garden soil in one. (You can also experiment with grass or other plant material.)

Pour equal amounts of pond or rainwater (200 to 400 ml or 1 to 2 cups) into each column and wait several hours for the water to soak through. Add enough, in equal amounts, so that about 125 ml (half a cup) drips into the bottom reservoir. Schedule one of these "rainstorms" to occur in the column every few days, pouring the drained water back through the column. Which leaf column decomposes faster, and why?

Jim Leidel's 6th-grade students in Madison, WI build Decomposition Columns and try to model natural systems. Some students, for example, pour vinegar solutions through their columns in order to model acid rainfall. Vinegar solutions are also poured through limestone and granitic gravel buffers in order to imitate what might be occurring in eastern U.S. lakes. Levels of pH are measured and compared.

In the past, Jim's students tested solutions of their own choosing, among which were tomato juice and sugar water.

What Is All That Rot?

A bit on the microbiology of decomposition

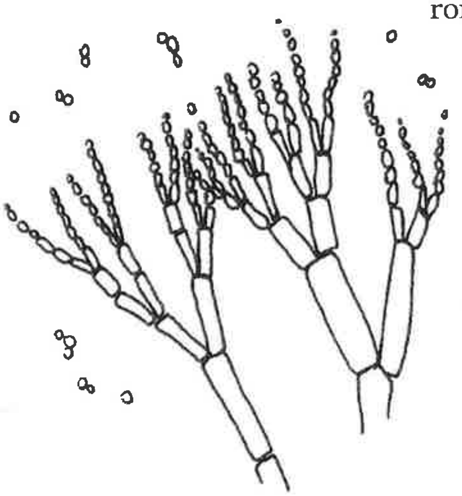
Decomposition can be thought of as a parade of many very tiny creatures. How decomposition proceeds in your column depends on which bacteria and fungi inhabit it, what ingredients you have put inside, and environmental factors such as light, temperature and moisture.

amoeba

The first decomposing organisms that go to work attack the most available food molecules, such as sugars, carbohydrates and proteins. As they grow, these first bacteria and fungi also change the environment. For example, they produce heat, change the pH and consume oxygen. You will see these changes in your column as plant parts become dark and slimy.

As they change their own environment, these organisms can create conditions that favor competing microbes. The biological definition of **succession** is the replacement of one type of organism by another, often caused by environmental changes wrought by the first organism.

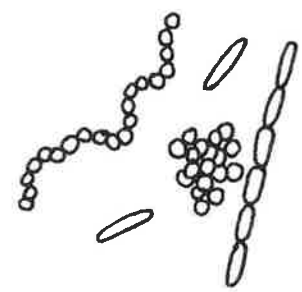
fungi



In your Decomposition Column, for example, one type of bacteria might flourish, changing the pH and raising the temperature of the column in the process. These new conditions may be favorable for a more heat tolerant type of bacteria, which will take over the original bacteria.

A Decomposition Column will show you the dynamic process of decay: strange white fuzz may appear and cover your column for a few days before suddenly disappearing to be replaced by a dark fuzz that climbs up one side. You might see something orange and slimy moving slowly along a rotting twig. You may also observe nonmicrobial life such as fruit flies, mites and millipedes.

bacteria



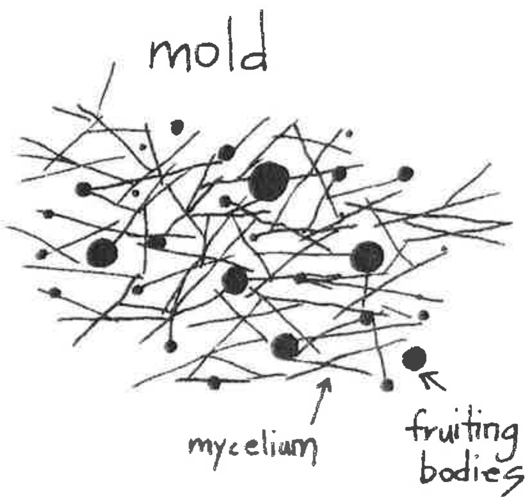
Bacteria, fungi, algae, protozoa and other organisms that live on dead or decaying matter are collectively known as **saprophytes**.

Saprophytes often secrete enzymes onto material they want to eat. Enzymes are biochemicals, responsible for all kinds of chemical reactions including the breakdown of matter into digestible parts for the decomposers. A crumbling log lying on the forest floor, for example, shows the work of enzymes made by saprophytes.

Bacteria are the most numerous of the decomposers. Good soil may have 100 to 1,000 million bacteria per gram. You may see bacterial colonies as round spots, ranging from white, to cream, to brown in color.

There are many types of bacteria. You might identify one type by its odor. These bacteria, called **actinomycetes**, live in the soil and are responsible for that fresh, earthy smell that accompanies newly plowed soil, or a long awaited summer rain.

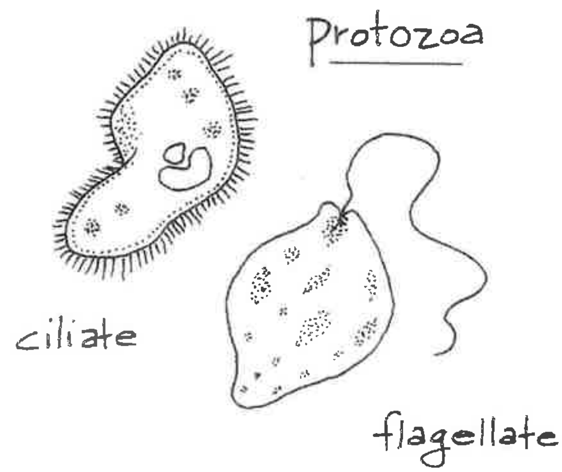
Fungi might appear in your column as a fuzzy blanket of mold covering some delectable rotting thing. Mold fungi form mazes of tiny threads called **mycelium**. If you look closely, you may see tiny dots along the threads. These dots are fruiting bodies, which release fungal spores. A particularly common mold, *Rhizopus*, has a cottony appearance with black dots, and often shows up on bread, fruits and other food.



Slime molds are organisms that move, feeding on microorganisms such as bacteria. They are often brightly colored and have the appearance and consistency of pudding. Slime molds often move toward light, leaving snail-like tracks behind, and producing numerous tiny fruiting bodies, some resembling tiny mushrooms.

Algae might show up in your column as a green tinge on the soil surface or on a moist twig. You have probably seen algae, like **Spirogyra**, growing on the banks of a river, a lake, or perhaps the sides of a fish tank, or as seaweed in the ocean.

Protozoans are another organism with a role in the decomposition drama. These single-celled organisms, such as amoebas, vary widely in size, shape and the manner in which they move. You might see protozoa swimming if you mix a little water with some decomposing material and examine it under a microscope.



Although much of the action takes place on a microscopic scale, decomposition is an exciting process even to the naked eye. By studying your Decomposition Column you can get a sense of the great diversity and activity of microbial life. Bacteria, fungi, algae and protozoa may be small but they are responsible for a great deal of change.

Note: Some of these organisms can only be seen with a microscope

Plant a Tree

Never underestimate the power of a tree! Besides giving us an amazing array of paper and wood products, trees provide a host of other benefits – from shading our backyards to assisting in the maintenance of the global climate. Students can express their appreciation of trees by planning and carrying out their own tree-planting project.

Activity 6

Levels
Grades 1-8

Subjects
Science, Social Studies

Concepts
- Organisms are interdependent: they all depend on nonliving components of the Earth.
- Altering the environment affects all life forms-including humans-and the interrelationships that link them.
- Resource management technologies interact and influence environmental quality; the acquisition, extraction and transportation of natural resources; all life forms; and each other.

Skills
Researching, Defining Problems, Formulating Questions, Making Decisions, Evaluating

Technology Connections
Internet Resources, Digital/Video Cameras, Presentation Software

Materials
Paper and pencils, copies of "Plant a Tree" student page
Optional: *Billy B Sings About Trees* CD

Time Considerations
Preparation: 60 minutes
Activity: Two to five 50-minute periods

OBJECTIVES

- Students will identify ways that urban trees enrich our lives.
- Students will determine how people care for urban trees and identify areas in the community that would benefit from having more trees.
- Students will organize and execute a class tree-planting project in a local area.

ASSESSMENT OPPORTUNITY

- Have your students put together an information booklet that other groups could use to plan, execute, and publicize a community tree-planting project. Teams of students can work on different sections of the booklet such as the benefits of tree planting, selecting a site in your community, getting permission and advice for planting on a site, finding volunteer help and funding, determining what species to plant, planting and caring for the trees, and arranging for publicity. Students can include photos, diagrams, drawings, and videos.

BACKGROUND

Trees are invaluable assets to our communities. They give us flowers, fall colors, and lovely scents. They provide homes for birds, squirrels, butterflies, and other wildlife. Their branches create beautiful shapes that soften the urban landscape and even hold tree houses. They shade and cool our streets and buildings and insulate home from cold winds. They contribute to a community's sense of place.

Trees, particularly those planted in urban or residential areas:
- Help settle out, trap, and hold small particles (dust, ash, smoke) that can damage lungs
- Absorb sulfur dioxide and other pollutants
- Store carbon, helping to reduce atmospheric carbon dioxide
- Hold soil with roots, preventing erosion
- Provide homes and food for birds and other animals
- Serve as a windbreak, keeping buildings warmer
- Provide shade, keeping buildings cooler
- Muffle traffic noise
- Provide beauty and enjoyment

By planting a tree, students can contribute positively to their neighborhood and community. As the founder of TreePeople in Los Angeles writes, "When we plant and care for trees, alone or together, we begin to build an internal place of peace, beauty, safety, joy, simplicity, caring, and satisfaction. The results encourage us to take on larger challenges. After a while, we discover that we've established a richer inner and outer world for ourselves, our families, our neighborhoods, our cities, and our world."

GETTING READY

Find out which agencies or organizations are responsible for tree planting and maintenance in your community. Parks departments, urban forestry departments, and independent garden clubs are possibilities. Students can write to those agencies or organizations for tree-planting information.

DOING THE ACTIVITY

1. Ask students to name some areas in the community (such as along city streets and in other public areas, including the school grounds) where trees have been planted. Then have them work in small groups to list the benefits trees provide to people and wildlife in those areas.

2. Use the groups' lists to develop a class list, and add any other benefits you can think of (see Background). Have everyone make a copy of the list.