# Activity 2-3
# Secret Services

**AT A GLANCE**

Perform simulations that demonstrate some of the important ecosystem services that biodiversity provides.

**OBJECTIVES**

Perform a series of simulations that demonstrate ecosystem services. Identify and discuss the services illustrated in the simulations.

**SUBJECTS**

science

**SKILLS**

organizing (manipulating materials), interpreting (identifying cause and effect, inferring, making models), presenting (demonstrating, explaining), citizenship (working in a group)

**LINKS TO *ILLINOIS BIODIVERSITY BASICS* CONCEPTUAL FRAMEWORK**

genetic/species/ecological diversity

**VOCABULARY**

atmosphere, evaporation, heavy metals, impurity, mineral, pesticides, photosynthesis, sediment, toxic substance, transpiration, wetland

**TIME**

two class periods

**MATERIALS**

**station #1:** clear funnel or clear plastic soda bottle with the bottom cut off and the label removed; clear plastic cup, tall jar or flask; cotton balls or toilet paper; activated charcoal; sand; potting soil; water

**station #2:** fresh celery stalks with leaves; a jar or beaker; red or blue food coloring; water; paring knife; magnifying glass

**station #3:** several sponges; a doormat or a piece of artificial turf; two flat sheets of wood or plastic similar in size to the doormat; two shallow aluminum trays; soil; two containers of water; props to tilt the models

**station #4:** two large, clear-plastic cups; a six-inch square piece of waxed paper; geranium plant leaf with stem; cobalt chloride paper (available from science supply catalogs); petroleum jelly; paper clip; tape; water

**station #5:** large bowl; water; measuring cup; tablespoon; baking soda; drinking glass; lamp; water plant such as *Elodea* or *Anacharis* (available from stores that sell live fishes)

copy of "The Secret's Out!" for each student

**CORRELATION TO COMMON CORE STANDARDS AND NEXT GENERATION SCIENCE STANDARDS**

science: MS-LS2-5

Ecosystems and the variety of species within them provide many important services that help make life possible or at least more livable. These services are happening all the time—they are so common that we often don't notice them or think about how important they are. This activity is a series of five simulations that illustrate a variety of these services. (More advanced students can try to develop their own simulations after learning more about ecosystem services.)

## BEFORE YOU BEGIN

There are a number of ways you can use this activity with your students. We suggest that students be grouped into five secret service teams. Assign each team the task of setting up and testing one of the simulations on Day 1. On Day 2, have each team present its secret service simulation to the class. After watching each presentation, students will use the handout "The Secret's Out!" to identify the ecosystem service being demonstrated in the simulations.

You will need to arrange stations for each team's simulation. Put a copy of the directions and the necessary materials at each station. Label each of the five stations. Also make one copy of "The Secret's Out!" for each student. (Please note that Station #2 is shorter than the others, yet it still requires two days. It can be combined with Station #3. Stations #2 and #3 require some preparation ahead of time. Stations #1, #4 and #5 require activated charcoal, cobalt chloride paper and *Elodea*, respectively. Activated charcoal and *Elodea* can be found in most pet stores that sell fishes. Cobalt chloride paper can be ordered through science supply catalogues.)

## WHAT TO DO

1. **Day 1: Setting the stage.**
   Divide your class into five teams and assign one team to each station. Explain that the students will be working together to complete a simulation. Each team will be responsible for a different simulation. Students should not discuss their simulation with other members of the class. The simulations illustrate various ways that ecosystems provide important services for us and the environment. Identify the five stations around the room.

When they arrive at a station, all the members of the team should read the directions completely before setting up the simulation. Students should then set up and run their simulation. Tell them that on Day 2, each team will run its simulation for the class. Each team should discuss the expected outcome of the simulation. Each member of the team should also answer the questions listed under "Think About It."

Note: Remind the students that after they try their simulation, they have to get it ready for the next day, so they might have to dry their equipment and/or supplies or replace some of the parts. Stations #2, #4 and #5 require 24 hours to complete. Let the students at these three stations know that they will not need to run the simulation again on Day 2 but that they'll have to explain what they did on Day 1.

2. **Day 2: Presenting the simulations and matching the analogies.**
Distribute the "The Secret's Out!" page to each student. Explain to the students that each team will have a few minutes to explain their simulation to the class. Ask each team to briefly review its procedures, perform the simulation (or explain the results of an overnight simulation) and discuss the results. Students should provide information to the class that answers the "What Happened?" and "Think About It" sections on their handout. After watching each presentation, have the students use "The Secret's Out!" page to identify the ecosystem service being demonstrated in the simulation. Discuss student responses. (*Answers: A—2, B—3, C—1, D—5, E—4*)

3. **Review and summarize.**
When all the teams have completed their presentations, review and summarize the different ways ecosystems provide important services to people and to the planet. The list should include flood control, water filtering and purification, erosion control, oxygen production and climate control.

## WRAPPING IT UP

**Assessment**

1. Use the last step of the activity ("What to Do," Step #3) as the assessment. Encourage students to include on each list how the service is conducted in the "real" world and to give local, regional or state examples of where the ecosystem services are taking place (e.g., local marsh, Shawnee National Forest, Volo Bog State Natural Area).

2. Students may keep a lab manual and make a report for each station. Lab reports should include an overview of the simulation, a description of what happened and an analysis of the secret service that was simulated.

**Portfolio**

The lab reports for each station from Assessment #2 can be placed in the portfolio.

**Extensions**

1. Identify places in your community where the ecosystem services that you simulated are occurring.

2. Have students propose or create simulations that model other ecosystem services.

3. Identify species that perform these ecosystem functions.

4. Ask each student to illustrate one or two ecosystem services through sculpture, photography or another art form. The student can use words to clarify points, but words should not be the focus of the illustration.

## Resources

Bernstein, Leonard, Winkler, Alan and Linda Zierdt-Warshaw. 1995. *Environmental science: ecology and human impact.* Addison-Wesley Publishing Company, Inc., Menlo Park, California. 452 pp.

Environmental Concern, Inc., and The Watercourse. 1995. *WOW! The wonders of wetlands.* Environmental Concern, Inc., and The Watercourse, Bozeman, Montana. 332 pp.

Illinois Department of Natural Resources. 1999. *Biodiversity of Illinois, volume I: aquatic habitats.* Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

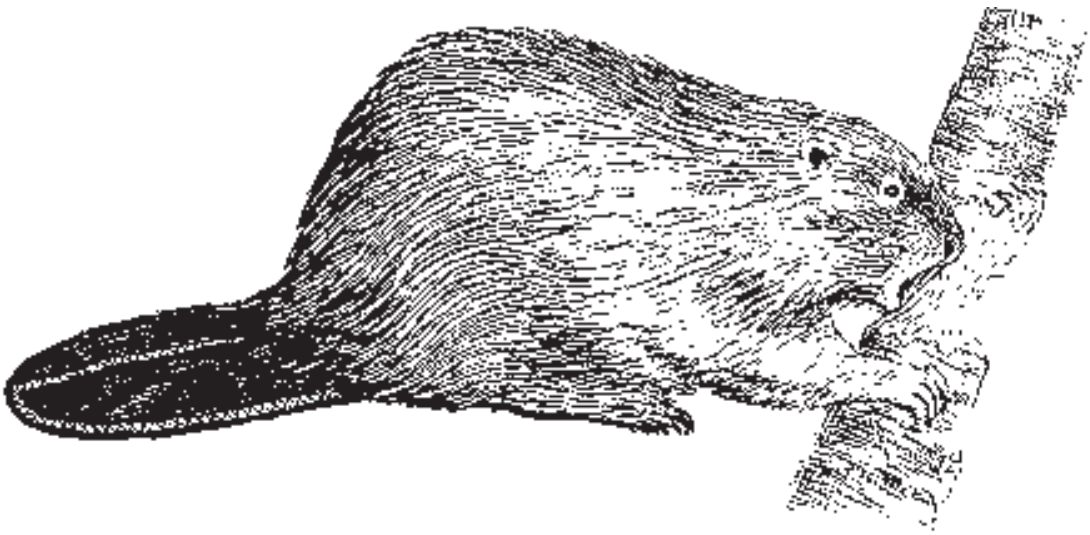
Illinois Department of Natural Resources. 2000. *Biodiversity of Illinois, volume II: woodland habitats.* Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

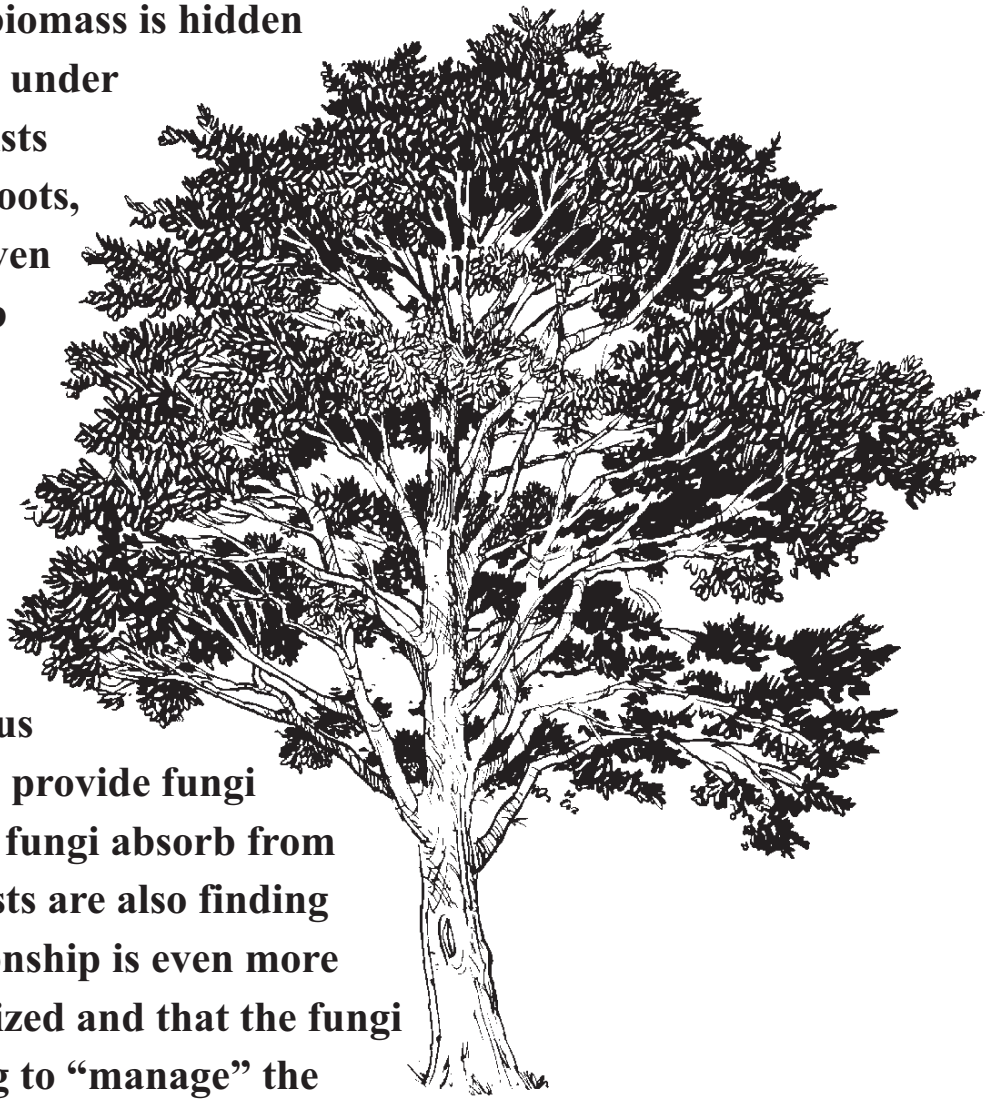
Illinois Department of Natural Resources. 2001. *Biodiversity of Illinois, volume III: prairie and edge habitats.* Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

Oates, Maureen. 1995. *Ecosystems (science is elementary —a science teaching resource publication).* Museum Institute for Teaching Science, Boston. 46 pp.

Washington State Department of Publications Office. 1996. *Discover wetlands.* Washington State Department of Publications Office, Olympia, Washington. 235 pp.

The Watercourse and Western Regional Environmental Education Council. 1995. *Project WET.* The Watercourse and Western Regional Environmental Education Council, Bozeman, Montana. 518 pp.





**Nearly half of a tree's biomass is hidden in a vast tangle of roots under the ground. And scientists have found that these roots, in turn, are usually woven into an even bigger web made of fungi. Fungi and trees have a symbiotic relationship that benefits both. Fungi help trees absorb important nutrients like nitrogen and phosphorus from the soil. And trees provide fungi with carbon, which the fungi absorb from the trees' roots. Scientists are also finding that this tangled relationship is even more complex than they realized and that the fungi may actually be helping to "manage" the forest by giving some trees more nutrients than others.**

*—Adapted from "The Web Below," by Carl Zimmer in Discover, November 1997.*



**CLASSIFIED INFORMATION**

**Do not share this information with other teams!**

*Soil is a mixture of mineral particles, air, water, microorganisms and other organic matter (material derived from living things). The materials that make up soil form layers. Hundreds of years may be required to form just a few inches of soil. Soil helps to purify water by filtering out some of the suspended solids (floating "dirt" particles) as they flow through the different soil layers. The makeup of the soil determines how well it will act as a filter. Soil also helps to remove chemical contaminants such as fertilizers and pesticides. Many minerals in the soil can chemically bond with contaminants, which are then stored in the soil and prevented from flowing into nearby waterways. As a result of chemical reactions, the soil can also help "detoxify" certain chemicals, making them less harmful to living things.*

# STATION 1: DIRTY WATER

## MATERIALS

clear funnel or clear plastic soda bottle with the bottom cut off and the label removed; clear plastic cup; tall jar or flask; cotton balls or toilet paper; activated charcoal; sand; potting soil; water

## WHAT TO DO

1. Pack the funnel approximately one-third full with cotton balls.
2. Place a layer of charcoal on top of the cotton balls. Then place a layer of sand on top of the charcoal.
3. Place the funnel into the jar or flask. The mouth of the jar should be small enough to keep the funnel off the bottom of the jar. (See diagram.)
4. Mix one-fourth cup of potting soil with one-half cup of water in the plastic cup. Then slowly pour the water into the funnel.

## WHAT HAPPENED?

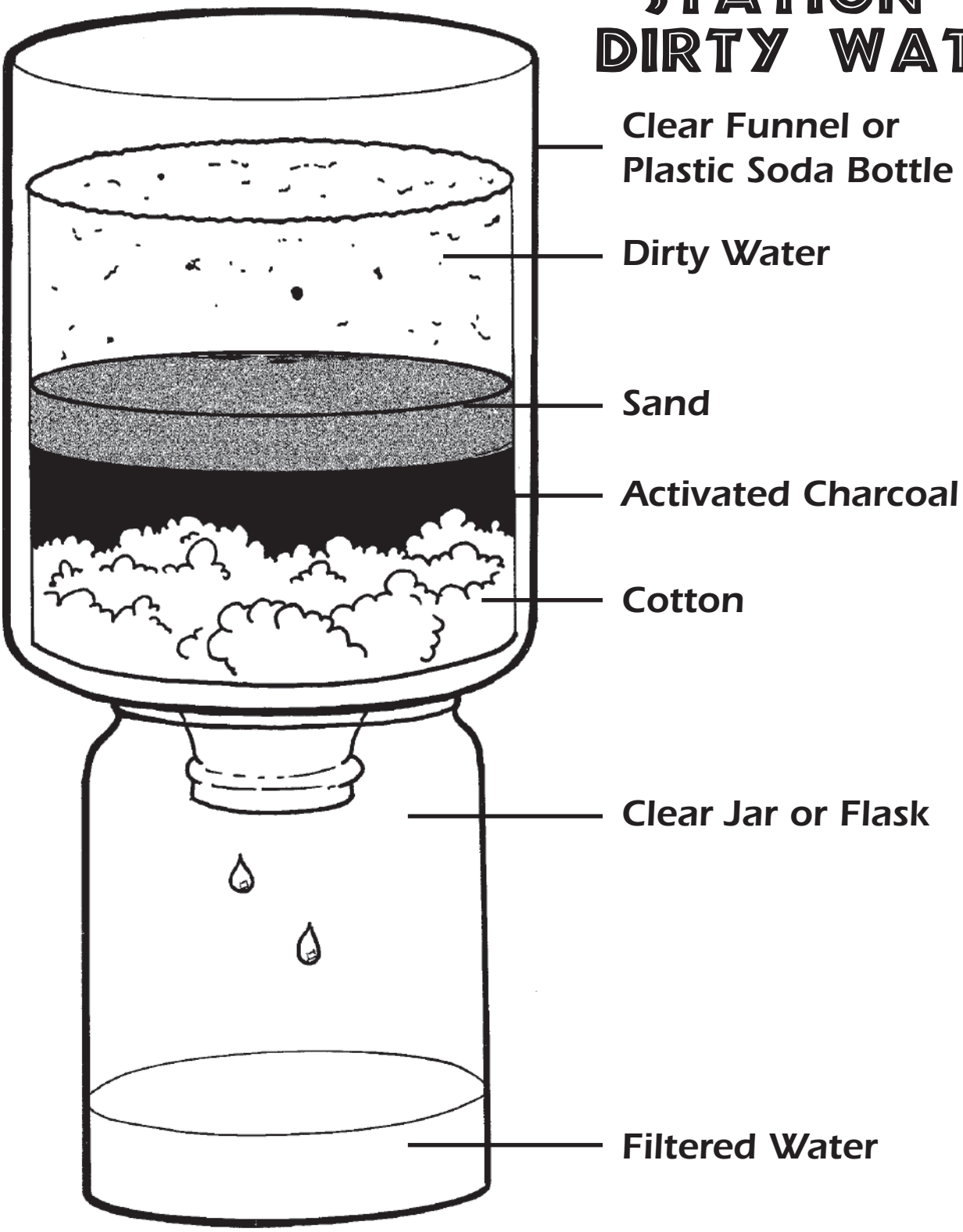
Describe the appearance of the water after filtering and any changes that you can see. Look at the different layers in your funnel. Where did most of the large soil particles get trapped? Where did the fine particles get trapped? What do you observe about your samples?

## THINK ABOUT IT

How do you explain the results of the experiment? Why do you think some materials are more effective filters than others? How would you describe the "services" that soils provide? Can you list a local example of this service?

Adapted from *Water Watchers*; used by permission of the Massachusetts Water Resources Authority.

# STATION 1: DIRTY WATER



**Student Page**
Secret Services

**CLASSIFIED INFORMATION**

**Do not share this information with other teams!**

# STATION 2: TREATMENT PLANTS

*Plants have fine "tubes" inside them that carry water from their roots to their leaves. When water contains toxic pollutants (such as pesticides or heavy metals) those pollutants may also be carried up and through the plant. Many wetland plants store toxic materials in their tissues. This doesn't mean that the toxins disappear—usually they are excreted later. But they are released slowly, in small amounts that are less damaging than a large dose of toxins entering a river, lake or pond all at once. When the wetland plants die, the toxins are released back into the water and soil of the wetland where they may be "captured" by other plants or by soil particles. Even though wetland plants can help absorb and alter some toxins, they aren't able to absorb all toxins. Just as there's a limit to how much water a sponge can absorb, there's a limit to what wetland plants can absorb—especially if toxins enter the wetland in large amounts.*

Adapted from *Discover Wetlands* with permission of the Washington State Department of Ecology, Publications Office, Publication Number 88-16, P.O. Box 7600, Olympia, WA 98504.

## MATERIALS

fresh celery stalks with leaves; a jar or beaker; red or blue food coloring; water; paring knife; magnifying glass

## WHAT TO DO

1. Add several drops of food coloring to a water-filled beaker or jar. The food coloring represents pollution from a toxic substance (pesticides, oil or heavy metals, such as mercury, for example).
2. Cut one-half inch from the bottom of a celery stalk and place the stalk in the colored water. Leave overnight. The celery stalk represents plants such as cattails, sedges and grasses that grow in wetlands. The colored water represents the water that flows through the wetland.
3. On the following day, cut the celery stalk into one-inch pieces so that each team member has a piece.
4. Examine the celery closely.

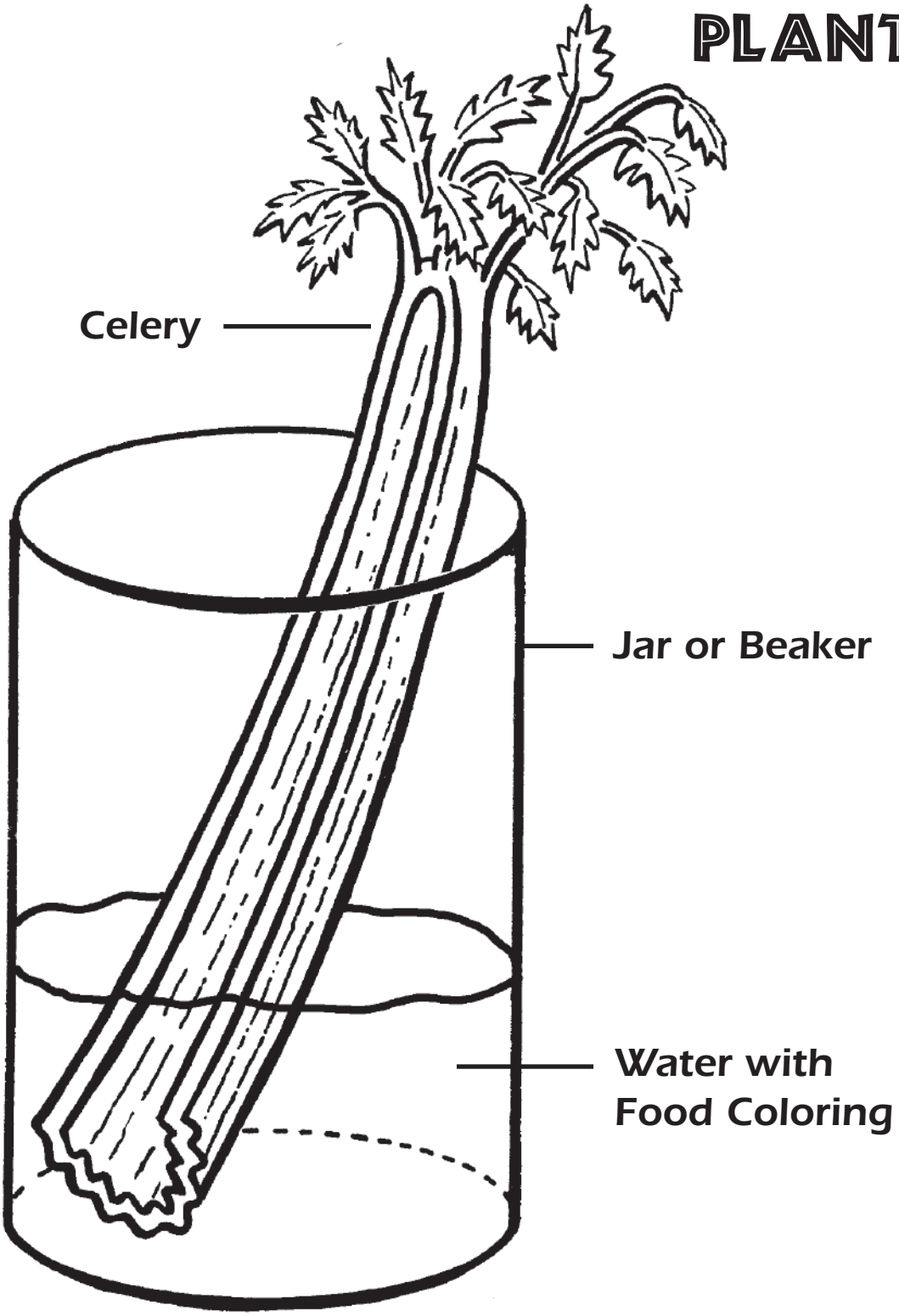
## WHAT HAPPENED?

Describe what you see. Observe the tubules (tubes that transport the water). Where do you see the colored water? Do you notice anything interesting about the celery leaves? (As you cut through the celery, you should see colored lines in the stalk. The colored lines are the xylem that transports water and minerals to all parts of the plant. Because the xylem distributes water throughout the plant, you should see color at the edge of the leaves. If you look carefully with a magnifying glass, you should also see the veins in the leaves tinted with color.)

## THINK ABOUT IT

Communities are increasingly using wetlands as natural water treatment facilities. How do wetland plants help purify water? Why is the water remaining in the beaker still "polluted"? What do you think happens to the pollutants? Why can't we dump all our waste into wetlands? How does your community treat its wastewater? Where does the water from storm drains in your community go?

# STATION 2: TREATMENT PLANTS



**Student Page**
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# STATION 3: RUNOFF RACE

**CLASSIFIED INFORMATION**

**Do not share this information with other teams!**

As water flows through wetlands, the grasses slow the speed of the water by simply being in the way. When the water slows, particles of soil and other solids are deposited in the grass, making the water clearer. Larger particles usually settle out first and the smallest particles usually travel the farthest. Wetlands help protect streams, lakes, bays and other downstream water bodies from a heavy build-up of sediment. They also help protect many aquatic plants and animals. Muddy water covers filter feeders such as mussels, clogs fish gills, smothers fish eggs, "blinds" aquatic animals that hunt for food by sight and blocks sunlight that aquatic plants need to grow.

## MATERIALS

several sponges; a doormat or a piece of artificial turf; two flat sheets of wood or plastic similar in size to the doormat; two shallow aluminum trays; soil; two containers of water; props to tilt the models

## WHAT TO DO

1. Set up both boards (or sheets of plastic) on a slant. They need to be at the same angle.
2. Place the doormat (or artificial turf) on one of the boards. Then set the trays at the base of each board. (See diagram.) These boards represent wetlands. The board with the doormat represents a healthy wetland filled with plants. The other board represents an unhealthy wetland where the plants have died or have been removed.
3. Fill both water containers with equal amounts of water and soil, then mix.
4. Get a team member to stand behind the high end of each board. Now have each of them pour a container of the soil/water mixture down the board at the same time and at the same rate. This flow represents water entering the wetland as a stream, flowing through the wetland and emptying into a lake (the tray).

## WHAT HAPPENED?

Which wetland had the faster water flow? In which wetland did more soil settle out? (The model with the doormat or artificial turf should have slowed the water down and trapped more of the larger particles, keeping them from settling out into the tray.)

## THINK ABOUT IT

Based on your observations of this model, how do healthy wetlands help provide cleaner water? How could muddy water be harmful to wildlife? Why do scientists recommend natural planting along the edges of streams, rivers, ponds and lakes?

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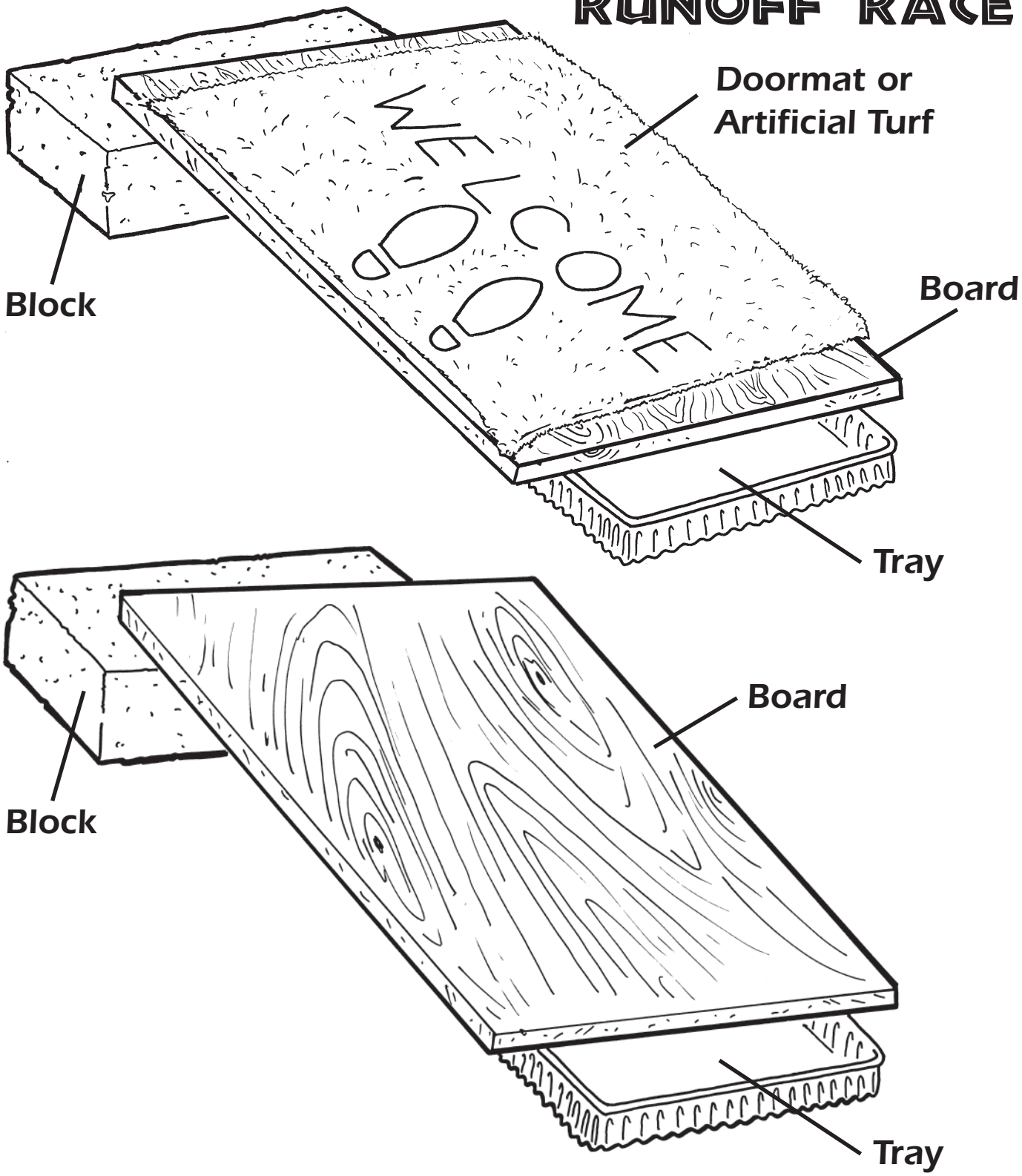
# STATION 3: RUNOFF RACE



**Student Page**
Secret Services

# STATION 4: NATURAL CLIMATE CONTROL

**CLASSIFIED INFORMATION**

**Do not share this information with other teams!**

Water is necessary for life on earth. In the water cycle, water moves from the oceans to the atmosphere, to the land, through lakes, streams and rivers back to the ocean. Living things also take part in the water cycle. Plants absorb water through their roots and release water into the atmosphere through their leaves in a process called transpiration. Transpiration is the evaporation of water through tiny openings in the leaves. When the water evaporates, any impurities that might be in it stay behind in the plant. In this way water entering the atmosphere is purified. Water released into the atmosphere also contributes to the formation of clouds. In ecosystems, plants play an important role in determining the amount of water entering the atmosphere, which has a great effect on the climate in an area.

## MATERIALS

two large, clear-plastic cups; six-inch square piece of waxed paper; geranium plant leaf with stem; cobalt chloride paper (available from science supply catalogs); petroleum jelly; paper clip; tape; water

## WHAT TO DO

1. Place a drop of water on a piece of cobalt chloride paper. Observe the change in color. Cobalt chloride paper is used to detect the presence of water.
2. Fill one of the cups with water and apply petroleum jelly to the rim.
3. Straighten the paper clip and use one end of it to poke a small hole in the center of the square of waxed paper.
4. Insert the geranium leaf stem through the hole in the waxed paper square. Apply petroleum jelly around the stem where it emerges from the waxed paper. Apply enough petroleum jelly to cover any extra space in the hole and make an airtight seal.
5. Position the leaf and waxed paper combination directly over the water-filled cup. Gently press down on the waxed paper around the rim so the waxed paper is held in place by the petroleum jelly. The stem should be in the water.
6. Tape a piece of cobalt chloride paper to the inside bottom of the other cup. Apply petroleum jelly around the rim of the cup.
7. Invert the cup with the cobalt chloride paper over the geranium leaf setup. Gently press the cups together. Do not allow the leaf to touch the cobalt chloride paper.
8. Observe the setup for five minutes. Pay particular attention to the color of the cobalt chloride paper. Leave the setup undisturbed for 24 hours.
9. On the following day make your final observations about the cobalt chloride paper.

## WHAT HAPPENED?

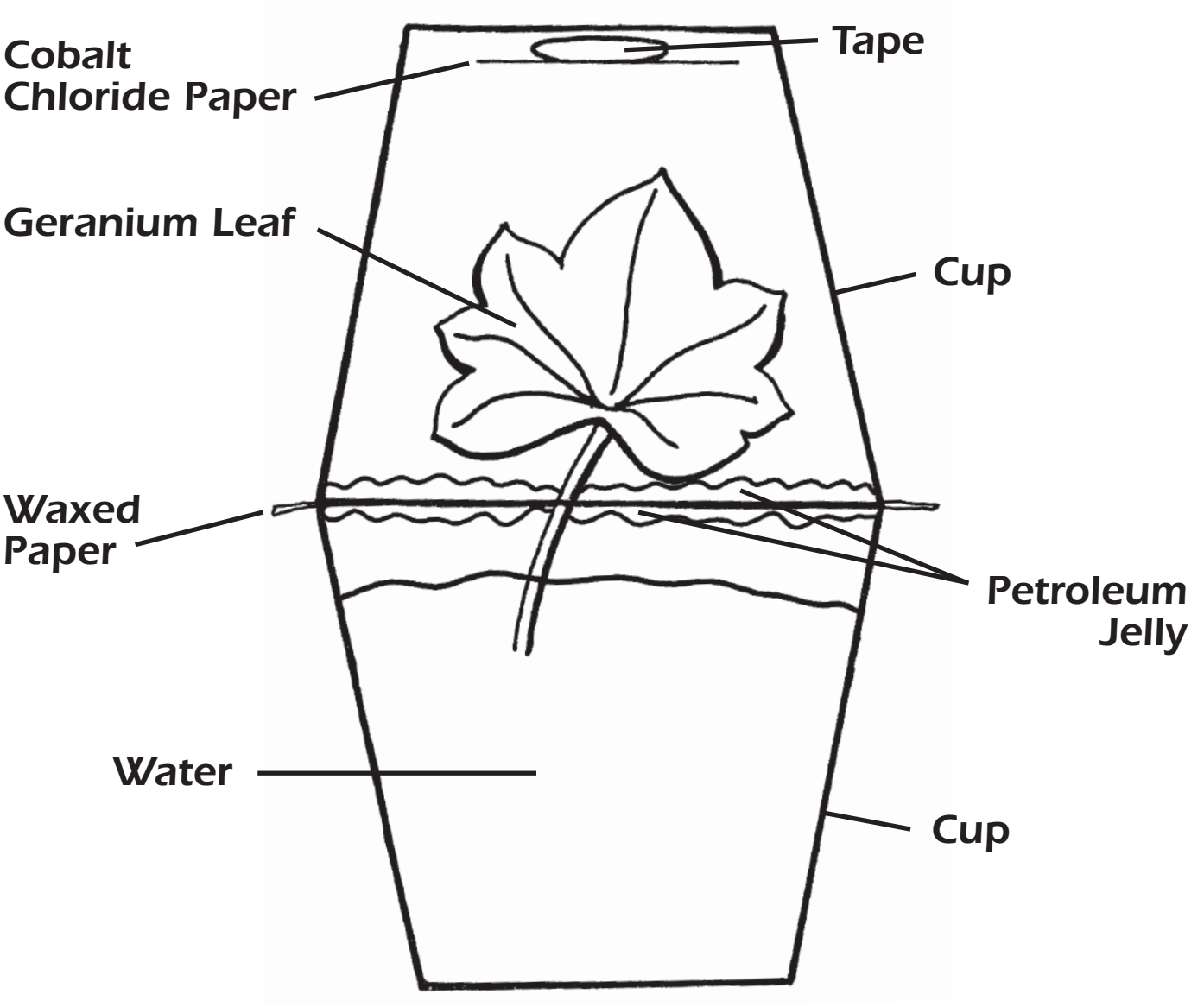
How do you explain the change in color of the cobalt chloride paper? (As the water made its way through the stem and leaf, it entered into the air of the second cup.

# STATION 4: NATURAL CLIMATE CONTROL

Because cobalt chloride paper turns pink in the presence of water vapor, the cobalt chloride paper changed color.)

### THINK ABOUT IT

Using the results of the demonstration, what role do you think plants play in the water cycle? How do plants affect local climates? Describe the differences in climate between two Illinois ecosystems (e.g. forest, prairie, wetland, etc.). Do you think the climate would be different in a community with many trees compared to a community with few trees?



**Student Page**
Secret Services

# STATION 5: PRODUCING OXYGEN

**CLASSIFIED INFORMATION**

**Do not share this information with other teams!**

*Green plants, like animals, need food. But unlike animals, plants make their own food through a process called photosynthesis. Photosynthesis uses carbon dioxide ($CO_2$), water ($H_2O$) and energy from the sun to produce food and oxygen. Common indoor plants used in homes and offices may help to fight the rising levels of indoor air pollution. Scientists are finding plants to be useful in absorbing potentially harmful gases and cleaning the air inside modern buildings.*

## MATERIALS

large bowl; water; measuring cup; tablespoon; baking soda; drinking glass; lamp; water plant such as *Elodea* or *Anacharis* (available from stores that sell live fishes)

## WHAT TO DO

1. Using a measuring cup, fill a bowl with fresh water. Write down the number of cups of water used.
2. Mix in one tablespoon of baking soda for every two cups of water. (Baking soda is also known as bicarbonate of soda. It contains carbon and in this experiment it will provide the $CO_2$ that a plant needs in order to create its own food—to photosynthesize.)
3. Place a water plant, such as *Elodea*, inside a drinking glass. Add enough water to fill up half the glass.
4. Lower the glass sideways into the bowl of water until the glass fills with water and no air bubbles are left in the glass. Then turn the glass upside down in the bowl without letting in air. The top of the glass should rest on the bottom of the bowl.
5. Set up a light near the bowl and aim the light toward one side of the glass.
6. Leave the light on the plant overnight.
7. Observe the plant and the glass of water the next day.

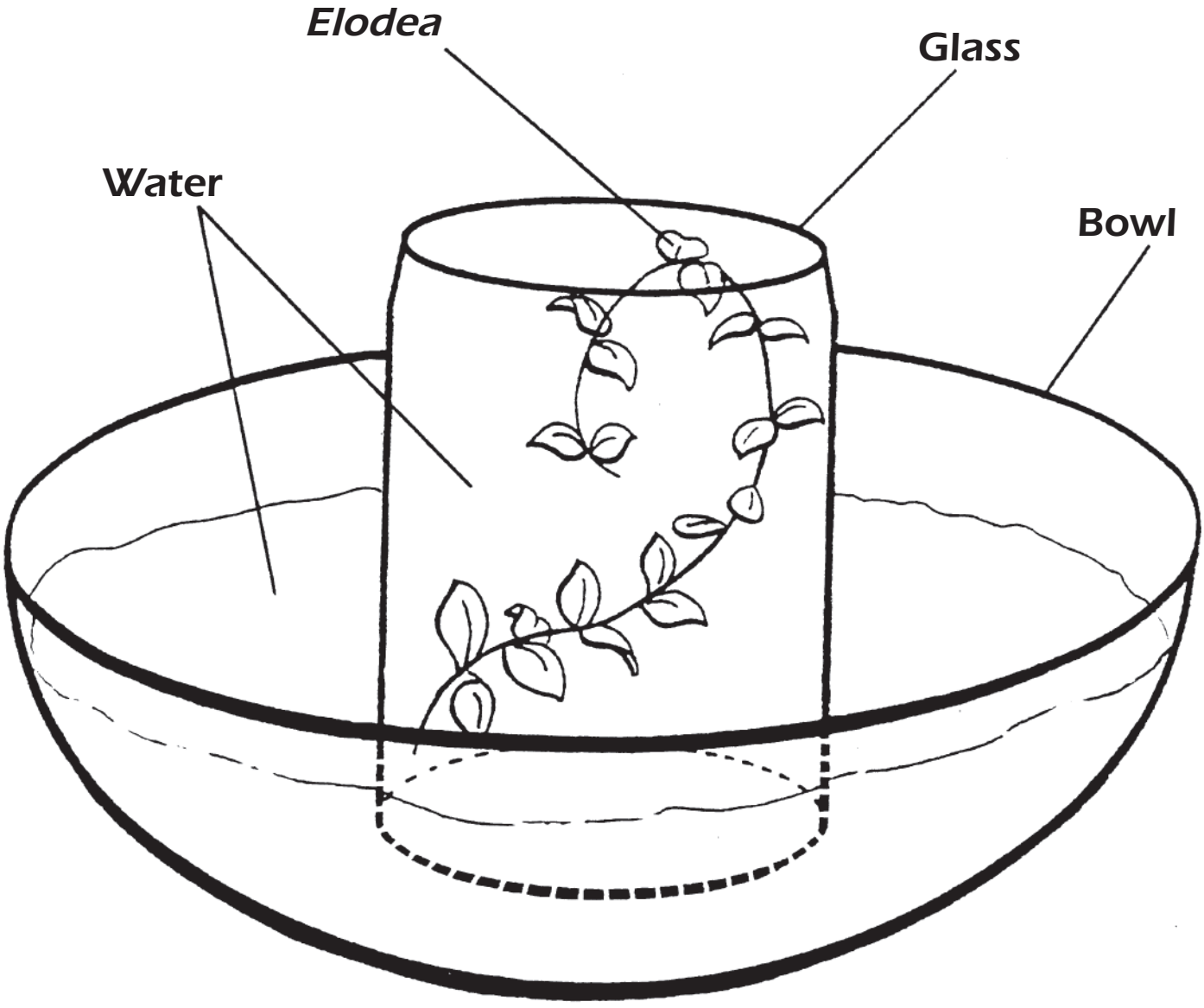
## WHAT HAPPENED?

What formed the next day? Why? (You should see a bubble the next day. The light stimulates photosynthesis in the plant. As a plant goes through photosynthesis to make food, it releases oxygen. Since oxygen is lighter than water, it rises to the top and is trapped by the glass. After 24 hours, enough oxygen has gathered to form a bubble.)

## THINK ABOUT IT

How do you explain the results you see? Why might a city planning board be interested in planting trees in their community, or the people in an office building be interested in having house plants? Using the results of the demonstration, what role do you think plants play in all ecosystems? What other factors are necessary for the process of photosynthesis?

# STATION 5: PRODUCING OXYGEN



## Student Page
# Secret Services (continued)


### Match the number of the station to the ecosystem service that is described here.

**A**_____Plants have fine "tubes" inside them that carry water from their roots to their leaves. When water contains toxic pollutants (such as pesticides or heavy metals) those pollutants may also be carried up and through the plant. Many wetland plants store toxic materials in their tissues. This doesn't mean that the toxins disappear—usually they are excreted later. But they are released slowly, in small amounts that are less damaging than a large dose of toxins entering a river, lake or pond all at once. When the wetland plants die, the toxins are released back into the water and soil of the wetland where they may be "captured" by other plants or by soil particles. Even though wetland plants can help absorb and alter some toxins, they aren't able to absorb all toxins. Just as there's a limit to how much water a sponge can absorb, there's a limit to what wetland plants can absorb—especially if toxins enter the wetland in large amounts.

**B**_____As water flows through wetlands, the grasses slow the speed of the water by simply being in the way. When the water slows, particles of soil and other solids are deposited in the grass, making the water clearer. Larger particles usually settle out first, and the smallest particles usually travel the farthest. Wetlands help protect streams, lakes, bays and other downstream water bodies from a heavy build-up of sediment. They also help protect many aquatic plants and animals. Muddy water covers filter feeders such as mussels, clogs fish gills, smothers fish eggs, "blinds" aquatic animals that hunt for food by sight and blocks sunlight that aquatic plants need to grow.

**C**_____ Soil is a mixture of mineral particles, air, water, microorganisms and other organic matter (material derived from living things). The materials that make up soil form layers. Hundreds of years may be required to form just a few inches of soil. Soil helps to purify water by filtering out some of the suspended solids (floating "dirt" particles) as they flow through the different soil layers. The makeup of the soil determines how well it will act as a filter. Soil also helps to remove chemical contaminants such as fertilizers and pesticides. Many minerals in the soil can chemically bond with contaminants, which are then stored in the soil and prevented from flowing into nearby waterways. As a result of chemical reactions, the soil can also help "detoxify" certain chemicals, making them less harmful to living things.

**D**_____Green plants, like animals, need food. But unlike animals, plants make their own food through a process called photosynthesis. Photosynthesis uses carbon dioxide ($CO_2$), water ($H_2O$) and energy from the sun to produce food and oxygen. Common indoor plants used in homes and offices may help to fight the rising levels of indoor air pollution. Scientists are finding plants to be useful in absorbing potentially harmful gases and cleaning the air inside modern buildings.

**E**_____Water is necessary for life on earth. Through the water cycle, water moves from the oceans, to the atmosphere, to the land and back to the ocean. Living things also take part in the water cycle. Plants absorb water through their roots and release water into the atmosphere through their leaves in a process called transpiration. Transpiration is the evaporation of water through tiny openings in the leaves. When the water evaporates, any impurities that might be in it stay behind in the plant. In this way water entering the atmosphere is purified. Water released into the atmosphere also contributes to the formation of clouds. In ecosystems, plants play an important role in determining the amount of water entering the atmosphere, which has a great affect on the climate in an area.