CONTAMINANT SCAVENGER HUNT

6-8

SUBJECTS:
Chemistry, Language Arts

TIME:
2 class periods

MATERIALS:
writing supplies
student sheets

OBJECTIVE

The student will do the following:

1. Identify substances and activities within a household that contribute to water pollution.

2. Identify safe cleaning alternatives for commercial cleaning products.

BACKGROUND INFORMATION

Pollutants that come from homes often originate in the kitchen, bathroom, or garage. Some chemicals such as oil, paint thinner, and pesticides often find their way down the drain and into the water system. Household cleansers, such as drain cleaner, oven cleaner, and tarnish remover have caustic chemicals that lower water quality. These products have chemical ingredients that may not be removed during water treatment. A partial solution would be to avoid putting these chemicals directly into water in the first place. Hazardous household wastes can be taken to approved disposal sites.

Fortunately, there are non-toxic alternatives that can be used instead of some household cleansers. Items such as baking soda and vinegar can be used in different combinations to clean different areas of the home. Baking soda can be used in place of a room deodorizer. Boiling water, vinegar, and baking soda can be used with a plunger to take the place of a toxic drain cleaner. Vinegar wiped with newspaper can be used as a window cleaner. Scouring powder can be replaced by baking soda and vinegar. Salt, baking soda, and a piece of aluminum foil in warm water can take the place of a tarnish remover.

<u>Terms</u>

alternative: a chance to choose between two or more possibilities; one of the two or more possible choices.

caution: a warning against danger.

disposal: a disposing of or getting rid of something, as in the disposal of waste material.

pollution prevention: preventing the creation of pollutants or reducing the amount created at the source of generation, as well as protecting natural resources through conservation or increased efficiency in the use of energy, water, or other materials.

ADVANCE PREPARATION

A. Prepare two copies of the “Contaminant Survey” sheet and one copy of the “Alternative Cleaning Products” sheet for each student.

B. Make an overhead of the “House Cutaway.”

PROCEDURE

I. Setting the stage

A. Divide class into teams. Have at least two products per team on hand. Have each student fill out one contaminant survey sheet using the two team products. Have the students work in teams to find the information.

B. Assign a different area of the house to each team: kitchen, garage, garden/yard, bathroom, basement, and laundry room.

C. Displaying the overhead of the house, brainstorm with the class a list of possible products used in each location.

II. Activities

A. Have each team fill in the remaining contaminant survey sheet with the products brainstormed for their area of the house.

B. Have students collect data from their own homes. Explain that some products will not have an entry in each category.

C. Have the students meet in their teams and combine their lists into a master list for their area.

D. Have the students use the “Safe Alternatives to Toxic Home Cleaners” handout to fill in the “Alternative Cleaning Products” sheet for the cleaning products they found.

III. Follow-Up

A. Review data with students:

1. What products did they find?

2. How do we use these products?

3. How do these products affect water? (This may be on the label under the caution statement.)

IV. Extensions

A. Have the students keep track of how many times they use alternative cleaning products.

B. Let the students share this project with their families at home. Encourage them to show their families their home surveys and the list of alternative products that could be used.

C. Have the students watch television advertisements and check the products advertised for environmental or physical safety.

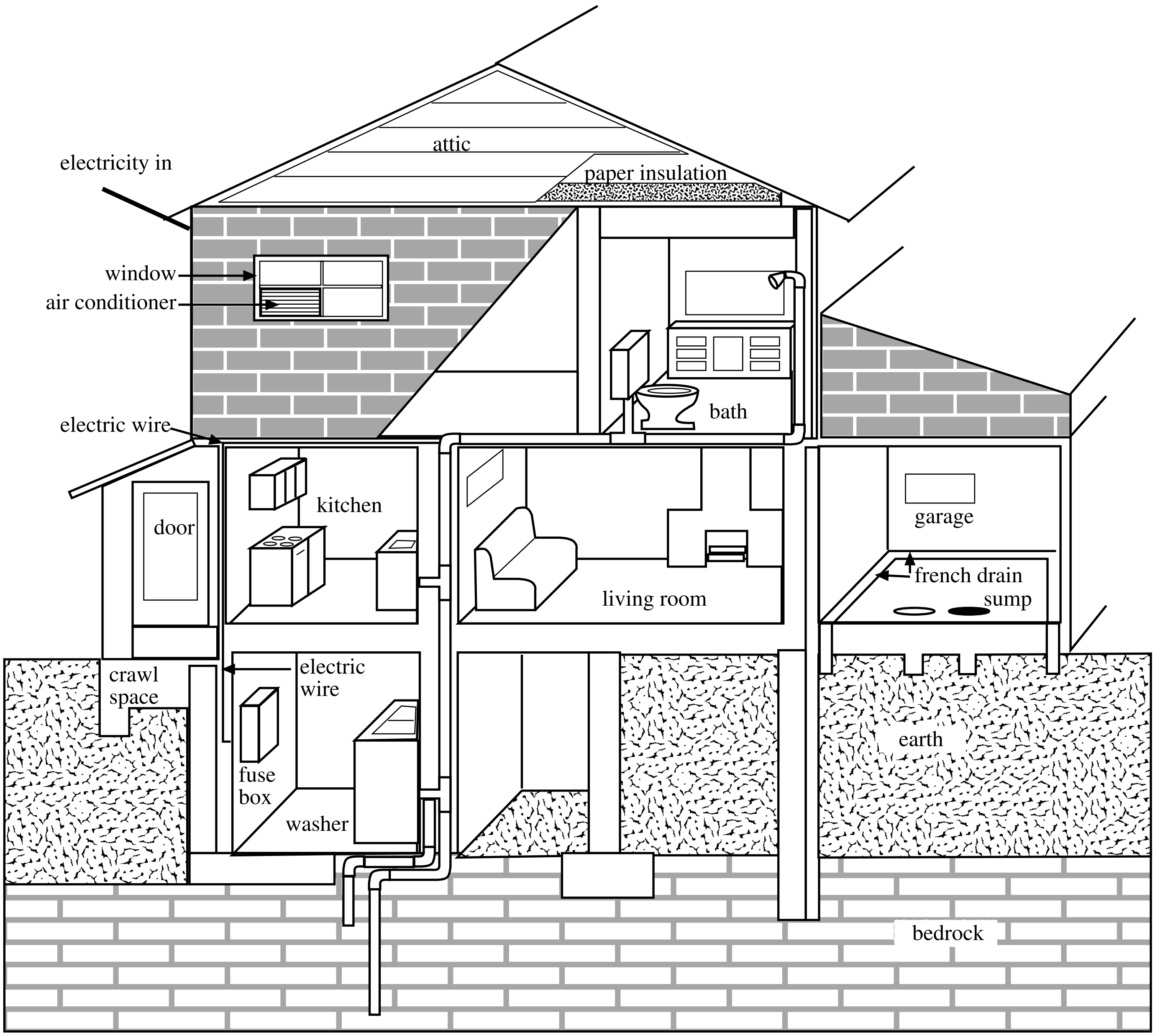
D. Have the students make their own handbooks to take home and refer to as needed.

RESOURCES

Gralla, Preston, How the Environment Works, Ziff-Davis Press, Emeryville, California, 1994.

Household Hazardous Waste Wheel. Available from Legacy, Inc. 800 - 240 - 5115.

Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995. Obtain from Project Wet: Water Education for Teachers, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057 (Fax: 406-994-1919; e-mail: rwwet@msu.oscs.montana.edu).



Directions: Use a colored marker to trace all the possible routes by which radon may enter this home.

STUDENT SHEET

6-8

CONTAMINANT SURVEY

Product Name	Four Main Ingredients	Container Plastic Glass Paper	Caution Statement	First Aid	Disposal Procedure

PRODUCT	***SAFE ALTERNATIVE INGREDIENTS***

SAFE ALTERNATIVES TO TOXIC HOME CLEANERS

The average home in America today has between 10-15 gallons of toxic products. The following is a list of safe alternatives to some of these toxic chemicals used in the home. Please be aware that, although these “home brews” may be friendlier for the environment, this does not mean they are safe for human consumption (even common materials such as vinegar can be harmful if consumed in large quantities). So treat these mixtures with care and keep them out of children’s reach.

DRAIN CLEANER

Dissolve 1 lb. washing soda in 3 gallons of water and pour down the drain. Grind lemon rinds and 1/4 cup borax in garbage disposal and rinse with hot water.
Pour 1/2 cup baking soda into drain and follow with 1/2 cup vinegar or lemon juice (beware of a strong reaction from these two chemicals). Let the mixture sit for 15 minutes before rinsing with hot water.

BEST BET: avoid dumping grease down the drain; instead, pour into soup can, freeze it, and throw it out on garbage day.

APPLIANCE CLEANER

Combine 1 tsp borax, 2 tbsp vinegar, 1/4 tsp liquid soap and 2 cups of very hot water in a spray bottle. Shake gently until everything dissolves; spray the mixture onto appliances and wipe with a rag.

OVEN CLEANER

Sprinkle oven generously with water, sprinkle with baking soda, sprinkle again with water. Let sit overnight and wipe up. If desired, wipe entire oven with liquid soap and rinse thoroughly.
Mix 2 tbsp liquid soap, 2 tsp borax and warm water.

CREAMY SOFT SCRUBBER

Combine 1/2 cup baking soda in a bowl with vegetable-oil-based liquid soap, stirring into a creamy paste. Scoop onto a sponge and wash desired surface. Rinse thoroughly. If a disinfectant is desired, add borax; for heavy washing jobs, add washing soda.

WINDOW CLEANER
Shake up 1 tsp liquid soap, 3 tbsp vinegar and 2 cups water in a spray bottle. Use as you normally would.

LINOLEUM FLOOR CLEANER

Blend 1/2 cup liquid soap, 1/2 cup lemon juice, and 2 gallons warm water. Wash floors as usual.

STAIN REMOVERS

COFFEE STAINS – rub moist salt on the item
RUST STAINS on clothes – lemon, juice, salt, and sunlight
SCORCH MARKS on clothes – use grated onions
INK SPOTS on clothes – cold water, 1 tbsp cream of tartar and 1 tbsp lemon juice
OIL STAINS on clothes – rub white chalk on stain before laundering
PERSPIRATION STAINS on clothes – white vinegar and water
GENERAL SPOTS on clothes – club soda or lemon juice or salt

BATHROOM CLEANERS

MILDEW REMOVER – use equal parts vinegar and salt
TOILET BOWL CLEANER – paste of borax and lemon juice, or just borax, left in toilet overnight and wiped out in the morning
TUB AND TILE CLEANER – combine 1/2 cup baking soda, 1 cup white vinegar, and warm water

POLISHES FOR AROUND THE HOUSE

for CHROME – apple cider vinegar
for SILVER – mix 1 qt. warm water, 1 tbsp baking soda, 1 tbsp salt, and a piece of aluminum foil
for COPPER – lemon juice and salt
for STAINLESS STEEL – mineral oil
for BRASS – worchestershire sauce or vinegar and water

SHOE POLISH

banana peel

INSECT PROBLEMS AT HOME

Ants – red chili powder at point of entry into house
Moths – cedar chips
Fleas on pets – gradually add brewers yeast to pet’s diet
Nematodes in garden – plant marigolds

LIQUID FABRIC SOFTENER

baking soda or borax in the rinse water

RUG & UPHOLSTRY CLEANER

club soda

DECAL REMOVER (ON GLASS)

soak with white vinegar

RUSTY BOLT / NUT REMOVER

carbonated beverage / vinegar

CAUTION

Be judicious using any of these mixtures. Test on a small, hidden area when cleaning clothes, carpets, etc. As indicated earlier, these mixtures can be harmful if ingested or used carelessly.

The easiest and safest way to manage household hazardous waste is not to make it in the first place. Choose less toxic products and products whose processing results in less toxic waste.

INSECT PROBLEMS AT HOME Cont'd

Flies – well-watered pot of basil
Roaches – chopped bay leaves and cucumber skins
Insects on outdoor plants – soapy water on leaves, then rinse; or boil elderberry leaves in water and add a touch of liquid soap to make a spray

DESALINATION / FRESHWATER

6-8

SUBJECTS:
Chemistry, Social Studies

TIME:
2 class periods

MATERIALS:
goggles
washers
scissors
towel
glycerin
glass tubing bent at right angles
shallow pan
ice
water
pan balance
table salt
two 500 mL beakers
1000 mL flask
1-hole rubber stopper
rubber tubing
hot plate cardboard
teacher sheet

OBJECTIVES

The student will do the following:

1. Produce freshwater from saltwater by the process of desalination.

2. Discuss the substances found in ocean water (composition).

3. Discuss why some substances in seawater do not remain in solution for long periods of time.

BACKGROUND INFORMATION

Oceans are physical combinations of different substances. These substances are in the oceans because they were dissolved, given off by volcanoes, or were weathered off. Seawater is a well-mixed solution of dissolved salts in water. Sodium and chloride combine to form common salt. Sodium and chloride ions together account for 86 percent of the salt ions present in seawater. Sulfate, magnesium, calcium and potassium ions together make up the next 13 percent of salt ions present. Other elements such as iodine are present in trace concentrations and are measured at less that one part per million.

A process called desalination is used to remove salt from the ocean. Distillation is one of the most common methods of desalination. At desalination plants ocean water is heated so water vapor will form. This vapor is then collected and cooled. The end product from this procedure is fresh water. The ocean, therefore, stores freshwater. Desalination is a very expensive process but very much welcomed in areas with limited or no supply of freshwater.

Areas such as Kuwait, Saudi Arabia, Morocco, and the state of Florida have a limited supply of freshwater and an abundant supply of seawater. Some areas, such as Oman and Bahrain, have no access to freshwater. Lack of freshwater is a limiting factor for population and industrial growth. Technology is now being used to convert seawater into freshwater for use in areas with limited or no access to freshwater.

Terms

desalination: the purification of salt or brackish water by removing the dissolved salts.

glycerin: a sweet, thick liquid found in various oils and fats and can be used to moisten or dissolve something.

halite: a white or colorless mineral, sodium chloride or rock salt.

mineral: a naturally occurring substance (as diamond or quartz) that results from processes other than those of plants and animals; a naturally occurring substance (as ore, petroleum, natural gas, or water) obtained usually from the ground for human use.

mixture: two or more substances mixed together in such a way that each remains unchanged (sand and sugar form a mixture).

salinity: an indication of the amount of salt dissolved in water.

ADVANCE PREPARATION

A. Have all equipment ready prior to lab day. Be sure to cut and bend glass tubing so it fits into the holes in the stopper. All glassware needs to be clean.

PROCEDURE

I. Setting the stage

A. Stress that the students should be careful when putting the glass into the stopper and rubber tubing into the glass tubing.

II. Activity

A. Have the students perform or watch as you demonstrate the following:

1. Dissolve 18 g of table salt in a beaker filled with 500 mL of water.
2. Put the solution into the flask. Place the flask on the hot plate. Do not turn the hot plate on.
3. Connect the stopper, glass tubing, and rubber tubing (see diagram). Use the glycerin on the ends of the glass tubing. Using protective gloves or holding the tubing with a towel, gently slide the glass into the stopper and rubber tubing.
4. Put the stopper into the flask. Make sure the glass tubing is above the solution.
5. Make a small hole in the cardboard. Slide the free end of the rubber tubing through the hole. Do not let the tubing touch the hot plate.
6. Put the cardboard over a beaker and weigh it down with four washers. This will hold it in place.
7. Place the beaker in the shallow pan that is filled with ice.
8. Turn on the hot plate, bringing the solution to a boil. Write down what occurs to the solution in the flask and the beaker.
9. This process will be continued until almost all of the solution is boiled away.
10. Turn off the hot plate and let the beaker cool.

III. Follow-Up

A. Ask the students the following questions, or have them answer the questions in groups.

1. What occurred to the solution in the flask?
2. What occurred inside the beaker?
3. Taste the H_2O inside the beaker. Does the water taste salty?
4. Is anything in the flask? If your answer is yes, identify.
5. Do you still have the same amount of water that you started with? Explain.
6. Look at the sides of the flask and write down what you see.
7. Write a paragraph and explain how desalination produces fresh water.

IV. Extensions

A. Debate the idea of obtaining gold from the oceans.

B. Provide water samples and have students use a test kit to analyze the water. Kits can be obtained from a biological supply catalog.

C. Obtain water from the ocean or Gulf (if available). Place an open container of seawater in the sun, allowing the sun to help the water evaporate more quickly, leaving a salt residue behind. (This can also be used to introduce the activity.)

D. Have students do research on the Nansen bottle or salinometer, then make a model of one of these instruments.

E. Have students research the Gulf War in Kuwait and the surrounding area and discuss what happened to the environment when Hussain blew up the oil wells and the desalination plant.

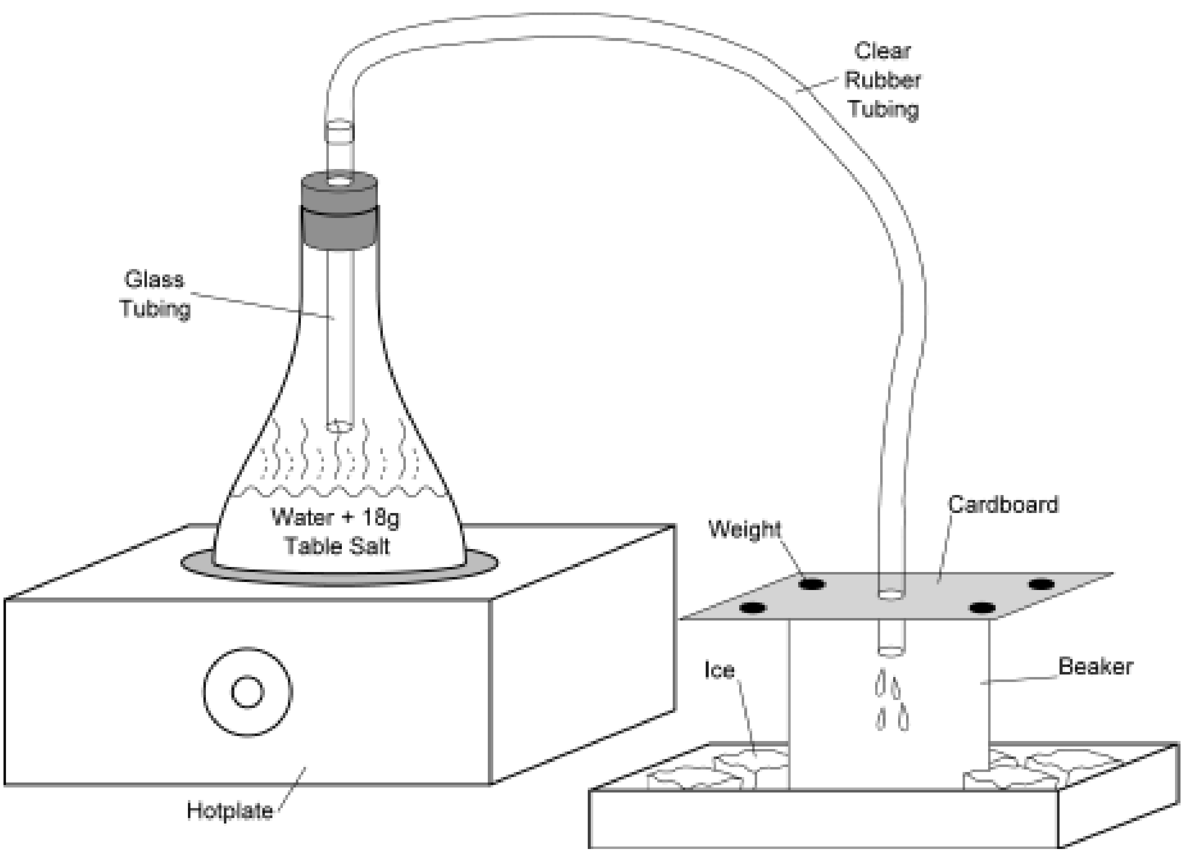
F. Have students calculate the cost of building a desalination plant.

G. Have students research and report on other methods of desalination (e.g., reverse osmosis, ultrafilteration or others) and list the advantages/disadvantages of all methods.

RESOURCES

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Duxbury, Alison B. and Alyn C. Duxbury, Fundamentals of Oceanography, Wm. C. Brown Publishers, Dubuque, Iowa, 1996.


Clear
Rubber
Tubing
Glass
Tubing
Water + 18g
Table Salt
Weight
Cardboard
Ice
Beaker
Hotplate

HOW SOFT OR HARD IS YOUR WATER?

6-8

SUBJECTS:
Chemistry, Geology, Math,

TIME:
50 minutes

MATERIALS:
borax or washing soda
different samples of water
distilled water
second timer
test tubes with stoppers or small bottles with corks or caps
medicine dropper
soap
marking pencil
student sheets

OBJECTIVES

The student will do the following:

1. Test samples of water to determine how a chemical water softener (borax, washing soda) affects water's ability to form suds.

BACKGROUND INFORMATION

Water that contains large amounts of dissolved calcium or magnesium is considered to be "hard." The chemical weathering of rocks containing calcite, dolomite, or ferromagnesium minerals leaching into groundwater supplies or streams is often the source of hard water for home use. Hard water causes several problems in homes.

A reaction occurs when hard water comes in contact with detergents. During this process the calcium ions precipitate the fatty acids from the soap. A form of scum or gelatinous, gray curd forms. The curd forms as calcium ions are removed from the water. This process continues until all of the calcium ions are bound up in the curd. The soap will not lather until all of the calcium ions are bound in the curd. For this reason, households that have hard water must use larger amounts of detergent.

Hard water causes other household problems by precipitating a scaly deposit inside tea kettles, hot water tanks, and hot water pipes. This scaly deposit consists of carbonate salts that, over time, can build up enough to clog an entire hot water piping system in a home. The entire hot water piping system must then be replaced.

"Soft" water carries ions that do not react with the soap and therefore allows lathering. Water softeners are available for home use that replace calcium ions with sodium ions. The sodium ions do not affect lathering or cause scaly deposits to build up. Soft water containing large amounts of sodium may be harmful, however, for persons with salt-free or low-sodium diets. Soft water tends to be significantly more aggressive than hard water and can leach metals from pipes (primarily lead and copper). Some water suppliers add zinc ortho phosphates to the water to reduce its softness and balance its pH to near 7.0.

ADVANCE PREPARATION

A. Make a soap solution by dissolving a walnut-sized piece of soap in 1/2 liter (about 1 pint) of water.

B. Collect samples of water from different places, such as a stream, a river, a lake, a well, a spring, and a faucet. You may also use various brands of bottled water from different locations in the US,

PROCEDURE

I. Setting the stage

A. Place half of each sample in a separate bottle so that each bottle is half full. Place distilled water into one pair of bottles. Label each sample.

II. Activity

A. Have the students follow these steps:

1. Using a medicine dropper, add ten drops of the soap solution to one of the distilled water samples.

2. After closing the bottle, shake for several seconds and lay the bottle on its side. Observe the suds in the bottle.

3. If, at the end of one minute, no suds remain, continue to add the soap solution one drop at a time until some suds remain at the end of one minute.

4. Record on the student sheet the total number of drops of soap solution needed for the water sample to contain suds.

B. Repeat steps 1 - 4 for each of the different samples of water collected. Record the data on the student sheet.

C. Repeat steps 2, 3, and 4 with the other set of samples. Treat each water sample by dissolving a few crystals of either washing soda or borax in each sample before adding the soap solution. This should make the water sample softer but do not announce this to the students, let them figure it out.

III. Follow-Up

A. Have the students answer the following questions:

1. Using the data you recorded in the table under "No Water Softener," which water sample was the softest? Which was the hardest?

2. List all of the samples in order of hardness, beginning with the softest.

3. Why is the method used in this activity a way of determining the relative hardness of water rather than the actual hardness of water?

4. How were the results different when the samples were treated with a water softener?

5. What conclusions can you draw from the results observed when the chemical water softener was added to the samples?

IV. Extension

A. Have the students graph the results of the treatments. (See a sample graph on the student sheet.)

B. Have the students test their water at home.

RESOURCES

McGeary, David and Charles C. Plummer, Physical Geology: Earth Revealed, 2nd Edition, Wm. C. Brown Publishers, Dubuque, Iowa, 1994.

Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995. Obtain from Project Wet: Water Education for Teachers, 201 Culbertson Hall, Montana

HOW SOFT OR HARD IS YOUR WATER?

6-8

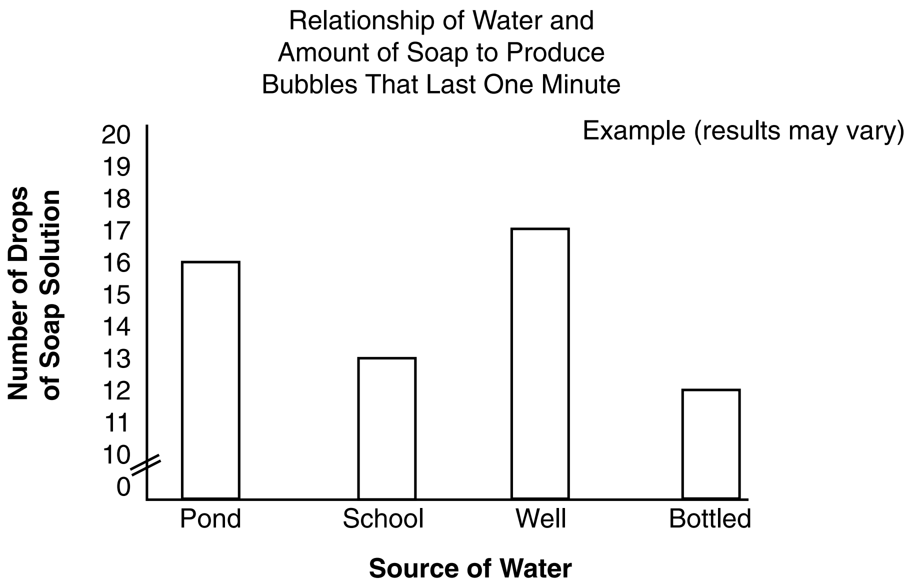
Directions:
1. Fill each test tube or jar half full with sample water and cap it.
2. Label each sample.
3. Using a medicine dropper, add ten drops of the soap solution to the first sample (distilled water).
4. Shake the sample for five seconds, lay it on its side, and observe the suds.
5. Time for one minute. If no suds remain, add more soap one drop at a time until suds remain for one minute.
6. Record the number of drops added to each sample on the table below.
7. Repeat steps 1 – 6 with the same samples. Treat each by dissolving a few crystals of washing soda or borax in each sample before adding the soap solution.

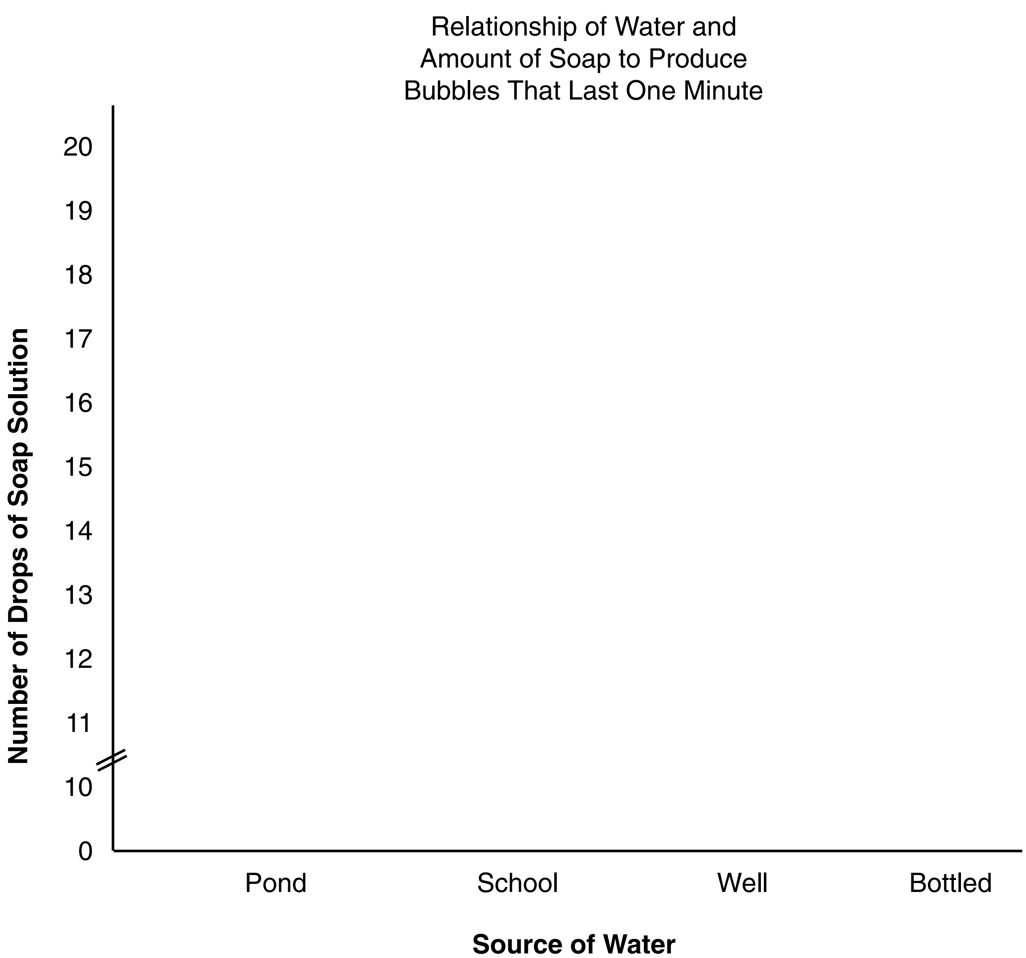
UNTREATED SAMPLES

Sample Type	# Drops of Soap Added	Description of Sample
1. Distilled		
2. Faucet		
3.		
4.		
5.		
6.		

TREATED SAMPLES

Sample Type	# Drops of Soap Added	Description of Sample
1. Distilled		
2. Faucet		
3.		
4.		
5.		
6.		


Relationship of Water and
Amount of Soap to Produce
Bubbles That Last One Minute
Example (results may vary)
Number of Drops of Soap Solution
20
19
18
17
16
15
14
13
12
11
10
0
Pond
School
Well
Bottled
Source of Water


Relationship of Water and
Amount of Soap to Produce
Bubbles That Last One Minute
Number of Drops of Soap Solution
20
19
18
17
16
15
14
13
12
11
10
0
Pond
School
Well
Bottled
Source of Water

HOW TO TREAT POLLUTED WATER

6-8

SUBJECTS:
Chemistry, Earth Science, Health

TIME:
15 minutes preparation
2 days time for biological degradation
1 day aeration time
50 minutes investigation

MATERIALS:
sand
fine gravel
medium gravel
funnel
filter paper
ring stand and ring
aerator or stirrer
goggles for each student
chlorine bleach
large jar
4 large test tubes
test tube rack
two 400 mL beakers
green food coloring
dirt
organic matter
detergent
glass-marking pencil
student sheet

OBJECTIVES

The student will do the following:

1. Demonstrate a method of treating polluted water.

BACKGROUND INFORMATION

Water pollution has increased greatly over the years as the population has grown and development has occurred. Water treatment has also grown. Water is cleaned in nature as it passes through sand and gravel. Drinking water or wastewater treatment plants use metal grating and screens that filter out large debris. Most point sources are treated; nonpoint sources have continued to grow, however. Raw sewage must now be treated before it is allowed to enter our rivers, lakes, and ocean. All water from streams and lakes must be treated or purified again before it can be used as drinking water. The procedures used for treating water in this experiment are similar to the procedures used in water treatment plants.

Polluted water is usually treated in three steps. The first step is pretreatment. The second step is the primary treatment of settling and skimming. Layers of sand and gravel are used for filtration. During this process, solids get trapped in the sand and gravel while the water flows through. The third step is the secondary treatment of aeration and settling. Aeration is the process of stirring or bubbling air through the liquid. Adding oxygen to the water promotes the growth of helpful aerobic bacteria and other microorganisms that can decompose organic material. This process is called biological degradation. Wastewater treatment plants have large aeration tanks and clarifiers that do this procedure. Finally, chlorine is added to the water or other disinfection procedures are used to kill any remaining harmful bacteria.

Terms

aeration: to expose to circulating air.

chlorine: a chemical element, symbol Cl, atomic number 17, atomic weight 35.453; used as a disinfectant in drinking and wastewater treatment processes.

disinfection: the use of chemicals and/or other means to kill potentially harmful microorganisms in water; used in both wastewater and drinking water treatment.

organic material: material derived from organic, or living, things; relating to or containing carbon compounds.

pollution: contaminants in the air, water, or soil that cause harm to human health or the environment.

sewage contamination: the introduction of untreated sewage into a water body.

ultraviolet light: similar to light produced by the sun. Ultraviolet light is produced by special lamps. As organisms are exposed to this light, they are damaged or killed.

ADVANCE PREPARATION

A. Gather all materials before lab session.

B. Do steps 1 and 2 of the activity as a demonstration or have groups of students complete them. Depending on the maturity and skill level of the students, this may be best done as a teacher demonstration.

C. Run off copies of the data table.

PROCEDURE

I. Setting the stage

A. Discuss background information with students.

II. Activity

A. Have the students perform the following procedure:

1. Fill a large glass jar 3/4 full of water. Add some dirty ground-up organic matter such as grass clippings or orange peels, a small amount of detergent, and a few drops of green food coloring.

2. Cap the jar, shake it well, and let the mixture stand in the sun for two days.

B. After the polluted sample has ripened for two days, have the students do the following:

1. Shake the mixture and pour a sample into one of the test tubes. Label this test tube “Before treatment, Sample # 1”

2. Use an aerator from an aquarium to bubble air through the sample in the jar. Allow several hours for aeration; leave the aerator attached overnight. If you do not have an aerator, use a mechanical stirrer or mixer and also leave on overnight.

C. The next day, when aeration is complete, have the students:

1. Pour another sample into a second test tube labeled “Aerated, Sample # 2.”

2. During treatment, fold a piece of filter paper in half twice. Hold three sides and pull out the remaining side to form a cone. Wet the paper with tap water and then insert the cone in a funnel. Mount the funnel on a support.

3. Place a layer of medium gravel, then fine gravel, and finally white sand in the funnel. (A filtration plant does not use filter paper, but the sand trap is several meters deep. The paper replaces several layers of sand.)

4. Pour the remaining aerated liquid through the filter into the beakers. This takes a while and spills easily. Do not allow the liquid to spill over the filter paper. You may have to filter the same liquid several times before you obtain good results.

5. Pour a sample of the filtered water into a third test tube labeled “Filtered, Sample # 3”.

6. With goggles on, pour another sample of the filtered water into a fourth test tube labeled “Chlorinated, Sample # 4.” Add two to three drops of chlorine bleach to the test tube. Mix well until the water is clear.

7. Carefully observe all four test tubes. Write a detailed description of each liquid in the data table on the student sheet. Include the odor of each sample. **Do not taste!**

III. Follow-Up

A. Have students fill in the data table.

B. Ask students the following questions:

1. What changes in the composition of the liquid did you observe after aeration?

2. Did aeration remove any of the odor?

3. What was removed by the sand filter?

4. Did the addition of chlorine cause the water to become clearer?

5. Did the chlorine remove the green color?

6. Did the chlorine have an odor? Was it worse than the wastewater?

IV. Extensions

A. This can also be set up in an aquarium using several layers of sand and gravel. Pour water through as a solution to filter. It is impressive to note how much it takes to filter the color out of the water.

B. Visit a local wastewater treatment plant (always accompanied by an operator or manager).

C. Invite a guest speaker from a wastewater treatment plant to speak with the class about treatment processes, experiences, costs, and benefits to the community and environment.

RESOURCES

Biological Science: An Ecological Approach, 7th edition, BSCS Innovative Science Education, Kendall/Hunt Publishing Company, Dubuque, Iowa, 1992.

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Directions: Fill in the following information for each sample.

Describe Step 1 (Making Solution):
Describe Step 2 (Aeration):
Describe Step 3 (Filtration):
Describe Step 4 (Chlorination):

RECORD OBSERVATIONS OF SAMPLES 1, 2, 3, 4

Sample 1
Sample 2
Sample 3
Sample 4

LEAKY FAUCET

6-8

SUBJECT:
Ecology

TIME:
50 minutes

MATERIALS:
plastic cups
graduated cylinders
water
nail
stop watch or watch with second hand
student sheets

OBJECTIVES

The student will do the following:

1. List how water resources can be managed to meet human needs.
2. Describe how conservation is essential to water resource management.
3. Explain how much water can be wasted by a leaky faucet.

BACKGROUND INFORMATION

Water is a major limiting factor of the environment. Without water life cannot exist. Increasing pressure on water resources and widespread, long-lasting water shortages in many areas exist for three reasons. The first reason is that increases in human populations are putting great demands on natural freshwater sources. The second reason is that there is an unequal distribution of usable freshwater. The final reason is that existing water supplies are becoming more and more polluted, more used, and less available.

Water is not usable in all forms and is not evenly distributed. Only 3 percent of the world's water supply is drinkable. Only .5 percent is reachable. Through careful management and conservation, available water supplies will be able to meet the demands of our increasing population. Practicing conservation is extremely important to everyone. Scientists estimate that 30 - 50 percent of the water supply used in the United States is wasted. Leaky pipes and faucets waste up to 30% of the nation's water. Industries can practice conservation by cleaning and reusing the water needed to make products. Plastic sheets that line irrigation canals can prevent much water from seeping into the ground.

As much as half of the water now being used for domestic purposes can be saved by practicing certain conservation techniques. Water can be saved in the bathroom by using low-volume shower heads, taking shorter showers, stopping leaks, and by using low-volume or waterless toilets. Toilet flushing is the largest domestic water use. Each person uses 50,000 liters (13,000 gallons) of drinking quality water each year to flush toilets. Special water-conserving dishwashers, washing machines, and other appliances that greatly reduce water consumption are available today.

It is estimated that half of all the water used for agriculture is lost. Better farming techniques, such as minimum tillage, use of mulches, and trickle irrigation, can reduce water losses dramatically. Almost half of all water used in electric power plants and other industrial facilities is for cooling. Dry cooling systems may be a useful alternative. Water used for cooling may also be reused for something else.

Term

conservation: planned management of natural resources (such as water) to prevent waste, destruction, or neglect.

ADVANCE PREPARATION

A. Gather materials.

B. Make sure the cups hold enough water to drip for one minute based on the size of the nail hole. The hole should simulate the approximate size of the drip that would come from a leaky faucet.

PROCEDURE

I. Setting the stage

A. If graduated cylinders are not available, make your own by using a larger cup marked off in specific measurements for the graduated cylinder. Be sure the top cup, the “drip cup,” does not slip inside the larger. If it does, use toothpicks placed close to the top to hold the “drip cup” in place.

B. Provide a foam or plastic cup and a nail for each group. You may want to demonstrate to the students how to punch a hole into the bottom of the cup.

C. Explain to the students they will be doing three trials to get an average volume.

II. Activity

A. Fill the cups with water.

B. Set the cup on top of the graduated cylinder.

C. Start timing.

D. Collect water drops in the cylinders for one minute.

E. Measure the water volume collected from each cup.

F. Record the data on the student sheet.

G. Repeat three times.

III. Follow-Up

A. Ask the students the following questions:

1. How does this activity relate to water that is wasted in a leaky kitchen faucet?

2. If you cannot stop the leak right away, what could you do with the water?

B. Have the students compute the volume of water that would be “wasted” from each cup after one hour, one day, one week, one month, and one year.

C. Have the students complete the “Conserve Water at Home” student sheet.

IV. Extensions

A. Observe water use around the house and list ways to conserve.

B. Have students work in teams (cooperative learning) to create posters of ways to conserve water.

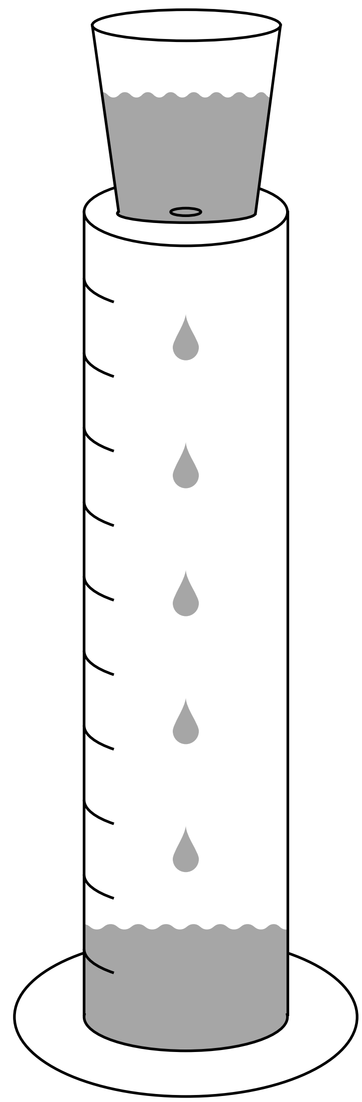
C. Have the students make up their own cartoon strip, which can be shown to the whole school by placing it on a bulletin board.

RESOURCES

Cunningham, William P. and Barbara Woodsworth Saigo, <u>Environmental Science: A Global Concern</u>, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995. Obtain from Project Wet: Water Education for Teachers, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057 (Fax: 406-994-1919; e-mail: rwwet@msu.oscs.montana.edu).

Experiment set-up



Directions:

1. Place the plastic cup on top of the graduated cylinder. Make sure someone holds it the whole time.
2. As soon as the water is poured in the cup, start timing for one minute.
3. At the end of one minute, move the cup off the cylinder. Put your finger over the hole.
4. Record your results.
5. Do three trials.

Trial # 1 – volume of water = _______________

Trial # 2 – volume of water = _______________

Trial # 3 – volume of water = _______________

Total volume _______________

Average volume (divide total by 3) in one minute = _______________

6. Answer the following questions based on your trials:

   a. How does this activity relate to water that is wasted by a leaky faucet?

   b. If you cannot stop the leak right away, what could you do with the water?

   c. Compute the volume of water wasted in the following time periods:

one hour ________

one day ________

one week ________

one month ________

two months ________

one year ________

Use the vertical letters below to write a sentence about conserving water. An example is provided for you.

C ____________________

O ____________________

N ____________________

S ____________________

E ____________________

R ____________________

V ____________________

E ____________________

W ____________________

A ____________________

T ____________________

E ____________________

R ____________________

A ____________________

T AKE SHORTER SHOWERS

H ____________________

O ____________________

M ____________________

E ____________________

LET'S GIVE WATER A TREATMENT

6-8

SUBJECTS:
Art, Biology, Ecology, Health

TIME:
50 minutes

MATERIALS:
pond water
rain water
dirty water (mix dirt and water)
four clear plastic cups labeled A, B, C, and D
small can with holes in bottom
paper towel
sand
microscopes
bottle with eye dropper filled with bleach
slides
goggles for each student
student sheet

OBJECTIVES

The student will do the following:

1. Define potable water.

2. Learn why water is treated for drinking purposes.

BACKGROUND

Sources of water pollution include the home, leaking septic systems, industry, cities, agriculture, logging operations, and mines. Pollutants from these sources eventually get into both surface and groundwater. Water for drinking is taken from both surface and groundwater.

Infectious agents such as bacteria, viruses, and parasites can come from untreated or improperly treated human wastes, farm animal wastes, and food processing factories with inadequate waste treatment facilities. Water runoff from these areas carries pathogens to nearby waterways and water sources. Drinking water must therefore be disinfected during the treatment process to kill these pathogens. Chlorine is the most commonly used water disinfectant. A form of liquid chlorine ($NaOCl$ or $CaOCl_2$) is one of the compounds in bleach.

Hazardous wastes such as household cleansers and paint thinners are often poured down the drain or onto the ground. These household items contain harmful chemicals that cannot always be removed during water treatment, so they should be used as infrequently as possible. Household wastes should be disposed of carefully. Reading the label is often a good way to determine how and where to use and dispose of household chemicals. Heavy rains in cities wash dirt, wastes, and pollutants from city streets into storm drains. Industries and mining operations produce harmful chemicals and sometimes radioactive materials.

The Environmental Protection (EPA) Agency is a federal agency that seeks to protect water quality. For years many people assumed that groundwater could not become polluted. It was thought that water was cleansed as it passed through the soil. Soil can filter water to some extent; however, it cannot remove certain chemicals. In 1988, a survey by the EPA showed that 45 percent of public water systems that were served by groundwater sources were contaminated with industrial solvents, agricultural fertilizers, pesticides, or other synthetic chemicals.

In 1972, Congress passed the Clean Water Act. This important legislation appropriated funds for reducing water pollution. Much of the money has been spent on improving municipal sewage treatment plants.

Terms

landfill: a large, outdoor area for waste disposal; landfills where waste is exposed to the atmosphere (open dumps) are now illegal; in "sanitary" landfills, waste is layered and covered with soil.

pollutant: an impurity (contaminant) that causes an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that may be harmful to or affect the health, survival, or activities of humans or other living organisms.

potable: fit or suitable for drinking, as in potable water.

surface water: precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration, and is stored in streams, lakes, wetlands, reservoirs, and oceans.

ADVANCE PREPARATION

A. Assemble all materials. Check pond water to make sure it has life in it.

B. Use a designated, clean working area.

C. Label glasses A, B, and C.

D. Make copies of the data table.

E. If you do not have enough goggles for all students, do the activity as a teacher demonstration.

PROCEDURE

I. Setting the stage

A. Discuss proper use of microscope.

B. Discuss why water needs to be clean and what health problems can occur if it contains harmful organisms or pollutants.

II. Activity

A. Pour some pond water (A), rain water (B), and “dirty” water (water that has been mixed with soil and shaken) (C) into clear plastic cups. Label each.

B. Have the students observe a drop of pond water under the microscope and draw what they see.

C. Have the students observe a drop of rain water under the microscope and draw what they see.

D. Have the students observe a drop of dirty water under the microscope and draw what they see.

E. Pour dirty water into a can with a paper towel and sand and set the can over a clear cup labeled D.

F. Allow this to stand for 30 minutes.

G. Add several drops of bleach to cup A and have students observe what happens to the organisms after bleach is added. Compare cup A to cups B and C. Even water that appears to be clear must be disinfected with chemicals to make sure it is safe to drink.

H. Treat the water in cups B and C by putting several drops of bleach in each.

I. Stir cup A and compare it with the treated water in cups B and C. Allow the students to look at a sample of each again with a microscope.

J. Have the students observe a sample of the water in cup D under the microscope.

III. Follow-Up

A. Have the students answer the following questions:

1. What did you observe?

2. What is the difference between the water in cups A, B, and C?

3. Is this filtered water clean enough to drink?

4. Is there any use for this water?

5. What do you see in the microscope?

6. What happens to the microorganisms when bleach contacts them?

7. What is potable water?

IV. Extensions

A. Visit a wastewater treatment plant.

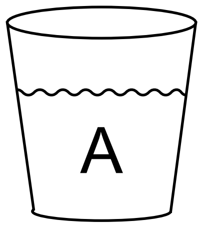
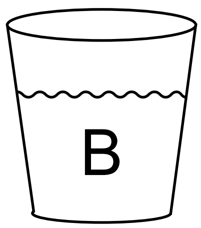
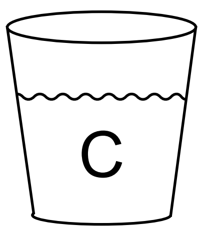
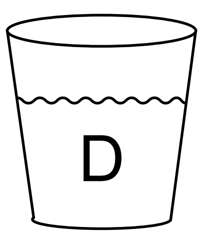
B. Bring in a speaker from an industry such as a paper company that handles treating wastewater.

RESOURCES

Department of 4H and other youth programs, "4H Water Wise Guys," Cooperative Extension Service, April 1992.

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Gralla, Preston, How the Environment Works, Ziff-Davis Press, Emeryville, California, 1994.

Water	1st Observation	2nd Observation
 A Pond		
 B Rain		
 C Dirty		
 D Filtered Dirty		

1. What did you observe in Sample A after you added the bleach?

2. Do you think Sample D is clean enough to drink? Why or why not?

PURIFYING WATER

6-8

SUBJECTS:
Art, Chemistry, Health

TIME:
2 class periods

MATERIALS:
stereomicroscope
petri dish
samples of pond water
laundry bleach
small beaker
medicine dropper
student sheets

OBJECTIVES

The student will do the following:

1. Discuss ways of conserving resources.
2. State what the acronym "EPA" stands for and explain the agency's function.
3. Discuss ways water pollution can be controlled.
4. Describe how laundry bleach can be used to purify water.

BACKGROUND INFORMATION

Water pollution affects our water ecosystems. Freshwater is a renewable resource, but it can become so contaminated by pollution that it is no longer safe for consumption. Water can become polluted by fertilizers, pesticides, and other wastes that have run off land into surface water or leached into groundwater. Poor land use rapidly increases sediment erosion, and pollutants can quickly reach surface water.

In large, rapidly flowing rivers, contaminants are diluted quickly to low concentrations and the aquatic oxygen supply and the waste decomposition is quickly renewed. Sewage is one common water pollutant. When the amount of sewage is large in comparison to the water volume, an overabundance of phytoplankton is produced. The organisms that decompose the phytoplankton use up the available oxygen, so aerobic organisms in the area die. As the water flows downstream, the sewage is diluted and further decomposed, and the oxygen supply increases.

Huge amounts of sediment and surface runoff end up in rivers daily. Runoff from factory waste can include poisonous chemicals such as lead, mercury, alkalis, and chromium, which kill the organisms that decompose organic wastes. Hydroelectric plants discharge hot water into rivers, which changes the light, temperature, and atmospheric gases of the aquatic environment, rendering it intolerable for many organisms. Perpetually warm water may change the type of species living in the area. Humans depending on this water can also have their health affected by these pollutants.

Terms

chlorine: a chemical element, symbol Cl, atomic number 17, atomic weight 35.453; used as a disinfectant in drinking and wastewater treatment processes.

pollution: contaminants in the air, water, or soil that cause harm to human health or the environment.

ADVANCE PREPARATION

A. Set up lab stations with required materials.

B. Collect water samples from a pond, making sure the water contains microscopic organisms.

PROCEDURE

I. Setting the stage

A. Discuss the activity objectives using the background information.

B. Explain to the students they will be doing three treatments to get an average.

II. Activities

A. Place the petri dish on the microscope's stage.

B. Pour the pond water into the petri dish.

C. Have the students observe the movement of the microorganisms.

D. Have the students draw on the student sheet what they see through the microscope and describe the movement of the microorganisms.

E. Add one drop of bleach. Have the students observe and describe what happened to the microorganisms.

F. Continue adding one drop of bleach at a time. Continue this until all movement has stopped.

G. Repeat steps B – F three times, filling in the information on the student sheet.

III. Follow-Up

A. Ask students the following questions after they have completed the student sheet:

1. What do you conclude from your three treatments?

2. What other methods could be used to purify water?

B. Have the students use the steps in the scientific method to write up the lab activity (problem, procedure, data, conclusion).

IV. Extensions

A. Call a water treatment facility and ask what is done to purify the drinking water. Find out what is added, when, and how much.

B. Take a field trip to a water treatment facility.

C. Write a letter to your regional Environmental Protection Agency office (there are 10), state environmental agencies, or local organizations concerned with water protection. Request information on topics such as water quality, water testing, and water regulations. (See Resources chapter for addresses.)

RESOURCES

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Gralla, Preston, How the Environment Works, Ziff-Davis Press, Emeryville, California, 1994.

BSCS Innovative Science Education, Biological Science: An Ecological Perspective, Teacher's Edition, Kendall Hunt Publishing Co., Dubuque, Iowa, 1992.

Trial #
Drawing

Describe what you observed.

Approximate # of microorganisms moving ________

no bleach

Describe what you observed.

Approximate # of microorganisms moving ________

1 drop

Describe what you observed.

Approximate # of microorganisms moving ________

2 drops

Describe what you observed.

Approximate # of microorganisms moving ________

3 drops

Supply the following information based on your three treatments.

Directions: Count the approximate number of microorganisms that were moving during each of the treatments.

	Treatment #1	Treatment #2	Treatment #3	Total 1, 2, 3	Average (divide total by 3)
no bleach (no treatment)					
1 drop					
2 drops					
3 drops					

Answer the following questions based on your investigation:

1. What is the effect of adding bleach to pond water?

2. How does the amount of bleach affect the microorganisms?

3. What other methods could be used to purify water?

WATER TREATMENT PLANTS

6-8

SUBJECTS:
Biology, Botany, Health

TIME:
Teacher set-up one day ahead, then 30 minutes for demonstration and discussion.

MATERIALS:
celery stalks
2 beakers (jars may be used)
food coloring
water
knife
teacher sheet
student sheet

OBJECTIVES

The student will do the following:

1. Describe how plants remove pollutants from water.
2. Discuss the limitation of plants' ability to remove pollutants from water when overburdened with pollutants from the land.

BACKGROUND INFORMATION

Many people fail to realize that plants are essential to the health of our water supply. Wetlands and their plants are an increasingly popular alternative for filtering wastewater from homes, factories, schools, and businesses. Plants growing in a wetland filter pollutants out of runoff, rainwater, and wastewater before it enters bodies of water.

The tangle of leaves, stems, and roots in a densely vegetated wetland trap trash and particles of sediment. These remain in the wetland, while the cleaner water moves away. As water moves through a wetland, plants also take up toxic pollutants and nutrients. Nutrients are used by the plant for metabolism and growth while other substances are stored in the tissues of the plant.

In a natural system, plants are fairly efficient at keeping the system in balance even when there is a naturally occurring flow from upstream. However, when human activities in the water and on land add nutrients, sediment, and toxic pollutants, plants cannot clean everything. We must be careful that our activities will not send pollutants into the water. We also must maintain and even add to the wetlands that help keep out those pollutants that we miss or cannot control.

Many pollutants run off of the land from construction sites, highways, streets, and the communities in which we live. Sometimes ponds or ditches are built to filter runoff from these sites. These ponds are ditches, which are often planted with wetland plants to aid in the filtering. Rain and runoff also rest a bit here before moving on. This means that many of the pollutants, especially soil particles, settle to the bottom while the cleaner water drains off from the top. These ponds or ditches are called storm water management ponds.

Natural and constructed wetlands are now being used for sewage treatment in some areas. One city in California transformed a 160 acre garbage dump into a series of ponds and marshes. The sewage is first pumped into the holding ponds where it undergoes the settling process. Bacteria and fungi digest the organic solids that have settled out. Effluent from the holding ponds then passes through the marshes where water is filtered and cleansed by aquatic plants.

<u>Terms</u>

nutrient: an element (or compound thereof), such as nitrogen, phosphorus, and potassium, that is necessary for plant growth.

pollutant: an impurity (contaminant) that causes an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that may be harmful to or affect the health, survival, or activities of humans or other living organisms.

storm water runoff: surface water runoff that flows into storm sewers.

ADVANCE PREPARATION

A. The activity may be done in groups or as a demonstration. Prepare the demonstration one day before the lesson. Repeat these steps in front of the class to show how the demonstration was prepared.

B. Place one set up of celery in the refrigerator to note whether any differences are noted in the chilled plant.

PROCEDURE

I. Setting the stage

A. Prepare a solution in a beaker by adding several drops of food coloring to water. Explain that the food coloring represents pollution by a toxic substance (a pesticide, for example). Students may come up with other examples.

B. Ask students to imagine water flowing through a wetland that has many plants. Tell students that the stalks of celery are similar to plants growing in a wetland, such as sedges, cattails, and grasses.

II. Activity

A. Cut off the bottom half inch of the celery stalks and place them in the water overnight. Over time the colored water will travel by capillary action up the stalk. This will be a visible demonstration of how plants can absorb pollutants with the water they “drink.”

B. The colored water may or may not be visible on the outside of the stalk. Cut off one-inch pieces of the celery and hand them to the students to study closely. They will see colored dots on the cross section, which are water-filled channels in the celery.

III. Follow-Up

A. Ask the following questions or have students answer them in groups:

1. How do wetland plants help to purify water? (They purify water by taking up pollutants from it.)

2. Why is the water remaining in the beaker still polluted? (Plants can only do so much. As new, hopefully clean, water flows into the system, the pollutants will be somewhat diluted and the water a bit less polluted. If the water continues to flow on to other parts of the wetland, other plants will continue to remove pollutants. Wetland soil also helps to filter out some pollutants.)

3. Where does the water go after uptake into the plant? (It is transpired out through the stomata in the plants’ leaves and usually evaporates.)

4. What happens to the pollutants? (Some are used in the plants’ metabolic processes, some are transformed into less harmful substances, while others are stored in the plants’ tissues and could be re-released into the environment if the plants die.)

5. Why can’t we simply dump all of our waste into wetlands? (Wetlands can only do so much, so many pollutants still end up in the water. Too many pollutants will harm or destroy a wetland. The best solution is to reduce the pollution.)

IV. Extensions

A. Have the students check their neighborhoods and other places undergoing construction to observe the areas after a rainstorm.

B. Have the students write a plan for how they would control pollutants if they owned a large plant nursery.

C. If the neighborhood has a storm water management pond, ask the students to observe it. Many are located near large shopping centers and parking lots. Ask the students to observe the pond on a dry day and on a day after a heavy rain.

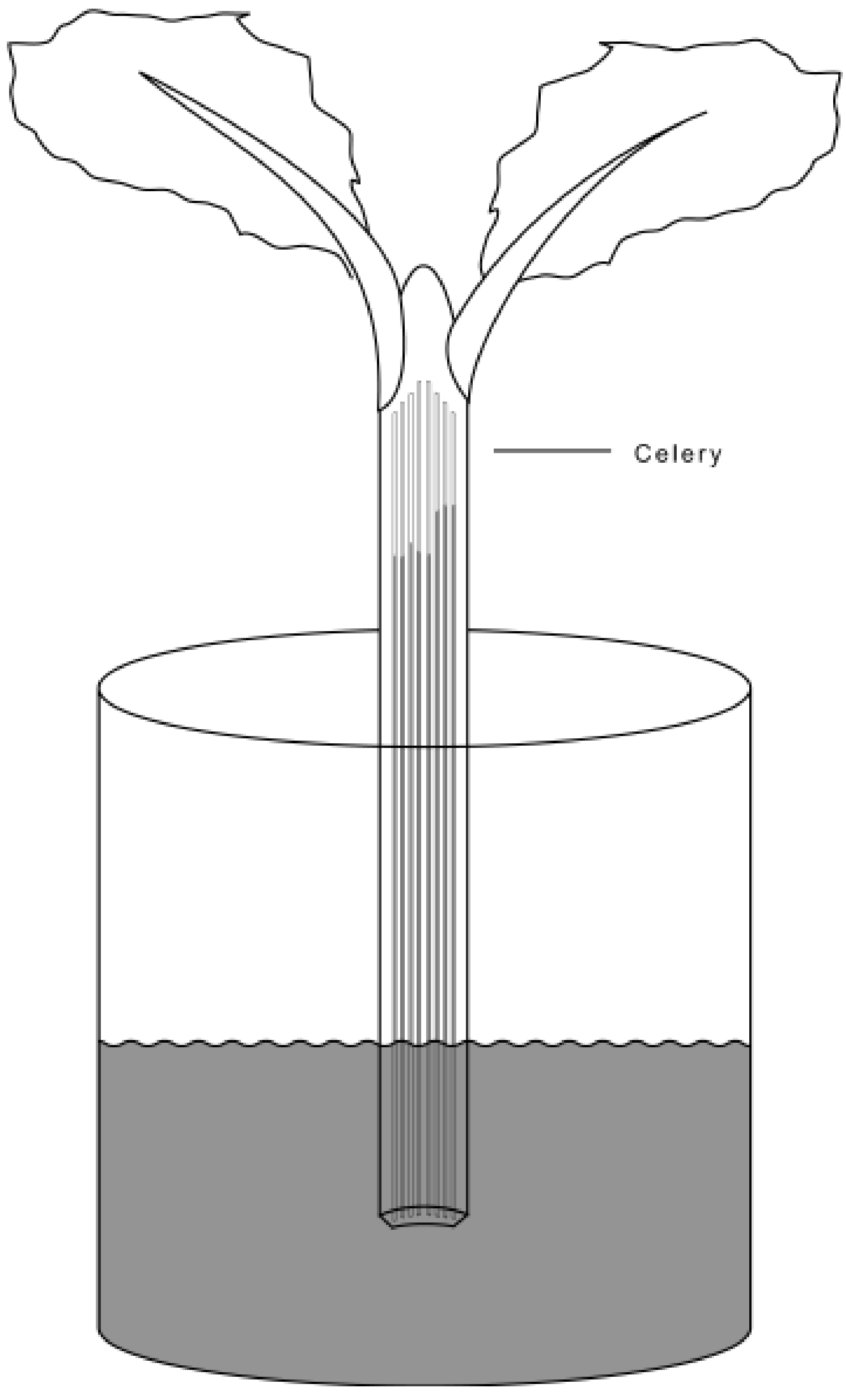
RESOURCES

"Treatment Plants," Discover Wetlands.

WOW!: The Wonder of Wetlands.

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Dennison, Mark S. and James F. Berry, Wetlands: Guide to Science, Law, and Technology, Noyes Publications, Park Ridge, New Jersey, 1993.


Celery

1. How do wetlands help to purify water?

2. Why is the water remaining in the beaker still polluted?

3. Where does the water go after uptake into the plant?

4. What happens to the pollutants?

5. Why can't we simply dump all of our waste into wetlands?

PURIFICATION OF WATER

6-8

SUBJECTS:
Ecology, Chemistry, Health

TIME:
50 - 90 minutes

MATERIALS:
photographs or posters of water and wastewater treatment plants
list of steps involved in water and wastewater treatment plants
local map
student sheets

OBJECTIVES

The student will do the following:

1. Identify the reasons for purifying water for communities.
2. Describe the water treatment processes that occur at a water filtration and treatment plant.
3. Describe the wastewater treatment processes that occur at a municipal wastewater treatment facility.
4. Compare the municipal system's water purification system to the ways water is purified in nature.
5. Discuss the advantages and disadvantages of chlorinated water.

BACKGROUND INFORMATION

Rivers and lakes are sources of water for municipal areas. Water samples collected from these water sources often look cloudy. Samples can look clear and still contain invisible sources of pollution. Rivers and lakes must be monitored for contamination and other sources of pollution.

Water that enters the municipal water supply has to be cleaned before it can be used and must also be cleaned after it is used. Thus, the water is both precleaned and post-cleaned. Precleaning takes place at a water treatment plant, and post-cleaning takes place at a wastewater treatment plant.

In some areas of the country, raw or insufficiently treated wastewater threatens the purity of the water resources. Poorly treated wastewater may contain harmful levels of bacteria and chemicals that can jeopardize human life.

Municipal water systems are responsible for cleaning the water before it is used. The water treatment system includes standardized steps for the treatment of the water before it is allowed to enter the homes of individual citizens.

The following steps are included in a water treatment filtration system:

1. Screening removes large objects from the water.
2. Pre-chlorination adds chlorine to kill disease causing organisms.
3. Flocculation adds alum and lime to remove suspended particles by trapping them in a jelly-like suspension formed from the added particles.
4. Settling allows trapped particles and solids to settle to the bottom.
5. Sand filtration allows sand to act as a natural filter, removing nearly all suspended material.
6. Post-chlorination adjusts the chlorine to maintain long-term action to kill disease-causing organisms.
7. Other treatments, such as fluoridation, pH adjustment, and further aeration, can be optional steps.

The following steps are included in a wastewater treatment system:

1. Preliminary Treatment: Screening is when large objects are removed; smaller objects are ground into even smaller pieces, and sand and dirt are allowed to settle out.

2. Primary Treatment: Primary settling happens when floating grease and scum are skimmed and heavier organic solids settle out.

3. Secondary Treatment: Aeration tanks add air and allow bacteria to digest organic substances. Sometimes rock or plastic media filters are used to grow bacteria that consume organisms in the wastewater.

4. Final settling is when bacteria settle out of the wastewater and are removed to a solids treatment process for stabilization. The stabilized solids, called biosolids, are then suitable for disposal on cropland, in landfills, or for other beneficial uses, such as compost.

5. Disinfection or chlorination means that additional chlorine is added to kill disease-causing organisms. Chlorine can be harmful to humans in large amounts. Chlorine can react with water and produce harmful substances such as chloroform which is carcinogenic. Other popular means of disinfection include ultaviolet irradiation that uses ultraviolet rays to kill harmful bacteria.

6. Optional treatments include controlling water pH by using carbon dioxide to form carbonic acid. Carbonic acid can neutralize alkaline compounds. Heavy metal ions and phosphate ions can also be removed by precipitation.

7. Advanced treatment processes also remove toxins such as ammonia.

Terms

carcinogen: cancer-causing agent.

chlorination: water disinfection by chlorine gas or hypochlorite.

flocculation: the process of forming aggregated or compound masses of particles, such as a cloud or a precipitate.

purification: the process of making pure, free from anything that debases, pollutes, or contaminates.

settling: the process of a substance, such as heavy organic solids or sediment, sinking.

sewage contamination: the introduction of untreated sewage into a water body.

wastewater: water that has been used for domestic or industrial purposes.

ADVANCE PREPARATION

A. Research the water treatment and wastewater treatment plants in your area.

B. Display diagrams of water and wastewater treatment plants on bulletin boards.

C. Make duplicate copies of the steps in water and wastewater treatment.

PROCEDURE

I. Setting the stage

A. Locate the water treatment and wastewater treatment plants in your area on a local map.

B. Discuss the water supply that provides the water for the water treatment plants.

C. Compare the number of students in the class who use water from a water treatment plant with the number who have private wells.

II. Activities

A. List the steps involved in purification of a municipal water supply and explain what happens at each step.

B. Ask the students to draw and label the activities involved in each of the steps.

C. Have the students speculate regarding what might happen if a step was not included.

D. List the steps involved in the treatment of wastewater at a wastewater treatment plant.

E. Ask the students to draw and label the activities involved in each of the steps.

F. Have the students speculate regarding what might happen if a step was not included.

G. Have the students research the amount of chlorine added to the water at each treatment facility. Discuss as a class the possible effects of over-chlorinating.

H. Discuss alternative methods of disinfection.

I. Have the students compare their drawings and descriptions to the wall diagrams.

III. Follow-Up

A. Ask students to research the optional steps used by water treatment facilities in local and surrounding communities. Discuss which optional steps can be detrimental to people or to the environment.

B. Discuss the possible hazards of using well water rather than water from a water treatment facility.

IV. Extensions

A. Take a field trip to the local water treatment and wastewater treatment plants.

B. Secure a speaker from a local, state or federal environmental agency, the local utility company, or an environmental consulting firm to discuss each person's responsibility in protecting our surface waters.

C. Develop a clean water monitoring group to collect data from local rivers and streams.

RESOURCE

American Chemical Society, ChemCom: Chemistry in the Community, Kendall Hunt Publishing Company, Dubuque, Iowa, 1993.

The following steps are included in a water treatment filtration system:

1. Screening — removal of large objects from the water.

2. Pre-chlorination — addition of chlorine to kill disease-causing organisms

3. Flocculation — addition of alum and lime to remove suspended particles by trapping them in a jelly-like suspension formed from the added particles

4. Settling — trapped particles and solids are allowed to settle to the bottom

5. Sand filtration — sand acts as a natural filter, removes nearly all suspended material

6. Post-chlorination — adjustment of the chlorine to maintain long-term action to kill disease-causing organisms

7. Other treatments — fluoridation, pH adjustment, and further aeration can be optional steps

The following steps are included in a wastewater treatment system:

Step 1 – Preliminary Treatment:

1. Screening — large objects are removed; smaller objects are ground into even smaller pieces, and sand and dirt are allowed to settle out.

Step 2 – Primary Treatment:

2. Primary settling — floating grease and scum are skimmed and solids settle out.

Step 3 – Secondary Treatment:

3. Aeration — aeration tanks add air and allow bacteria to digest organic substances.
4. Final settling — sludge continues to settle out, and it is aerated, chlorinated, and dried for incineration or for dumping in landfills.
5. Disinfection/chlorination — additional chlorine is added to kill disease-causing organisms. Other disinfection processes include ultraviolet irradiation.
6. Optional treatments — water pH can be controlled by using carbon dioxide to form carbonic acid. Carbonic acid can neutralize alkaline compounds. Heavy metal ions and phosphate ions can also be removed by precipitation.

BACTERIA IN WATER

SUBJECTS:
Art, Health, Math, Microbiology

TIME:
50 minutes

MATERIALS:
water samples from various sources
bacterial plates
collecting bottles
petri dishes with prepared media
pipette or medicine dropper
gloves
biology text
safety goggles
teacher sheet showing types of bacteria
student sheets

OBJECTIVES

The student will do the following:

1. Inoculate petri dishes with water samples.

2. Observe and record the growth of bacterial colonies.

BACKGROUND INFORMATION

Seventy-one percent of the Earth is covered by water. Only three percent of this water is considered to be freshwater. Freshwater is water that contains less than 0.5 parts per thousand dissolved salts. Ninety-nine percent of the freshwater is either locked up in ice or snow or buried in groundwater aquifers. Lakes, rivers, and other surface freshwater bodies make up only about 0.01 percent of all the water in the world.

Freshwater is a major limiting factor for both biological systems and human societies. Growing world human populations are continuing to place great demands on freshwater supplies. Water shortages are resulting from rising demand, unequal distribution of usable freshwater, and increasing pollution of existing water supplies.

The presence of coliform bacteria in water is a sign that the water has been contaminated. Water quality control personnel monitor water for the presence of coliform bacteria. Coliform bacteria live in the colon or intestine humans and other animals.

ADVANCE PREPARATION

A. This activity will be used in conjunction with a unit on pollution of the environment. Students should have reviewed the basic types of bacteria as indicators of pollution and possible sources of contamination by domestic or agricultural sewage.

B. Because this unit follows microscope use and microorganisms, the students should be familiar with lab techniques. This activity will allow students to directly observe standard lab procedures in determining the pollution level of an area's water bodies.

PROCEDURE

I. Setting the stage

A. Assign groups of four to six students.

B. Distribute three water samples to each group.

C. Prepare the petri dishes by labeling them with the group number and date. **Note: Safety goggles should be worn during this lab.**

II. Activity

A. Students will use a pipette or medicine dropper to inoculate each dish with water from a different source.

B. Have the students tape the dishes (to avoid leakage or exposure) and put them in a cool, dark place.

C. Ask the students to observe the cultures and identify and count the colonies daily for one week. Have them compile and graph the data so comparisons with other groups can be made. Reference books and lab manuals should be available to help with identification.

D. After one week, the teacher should destroy the cultures by pouring household bleach into each dish and then incinerating it. Instruct the students regarding the reasons for careful handling.

III. Follow-Up

A. Evaluate each group's lab techniques during the setting up and observations of the cultures.

B. Evaluate the graphs and data collected during the activity.

C. Students will write answers to the following questions:

1. Explain which culture demonstrated the most types of colonies.

2. Discuss the possible health hazards associated with bacterial pollution.

3. Describe the appearance of bacteria, either from your culture plates or from reference books.

IV. Extensions

A. Identify possible sources of bacterial contamination.

B. Conduct other water parameter tests to determine if pH, nitrates, and phosphates have any correlation to the colony counts.

C. Take a field trip to local water and/or sewage treatment plants.

D. Invite a water quality expert to speak to the class.

RESOURCES

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Project Wet: Curriculum and Activity Guide, Western Regional Environmental Education Council, 1995. Available Through Project Wet: Water Education for Teachers, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057 (Fax: 406-994-1919; e-mail: rwwet@msu.oscs.montana.edu).

Directions: Number each petri dish and inoculate with a different water sample. Record your observations each day for a week, and then graph your results.

Dish # 1 Water Source ____

Day 1

Day 2

Day 3

Day 4

Day 5

Directions: Number each petri dish and inoculate with a different water sample. Record your observations each day for a week, and then graph your results.

Dish # 2 Water Source ____

Day 1

Day 2

Day 3

Day 4

Day 5

Directions: Number each petri dish and inoculate with a different water sample. Record your observations each day for a week, and then graph your results.

Dish # 3 Water Source ____

Day 1

Day 2

Day 3

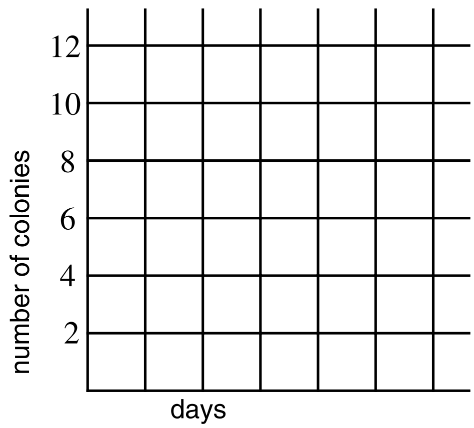
Day 4

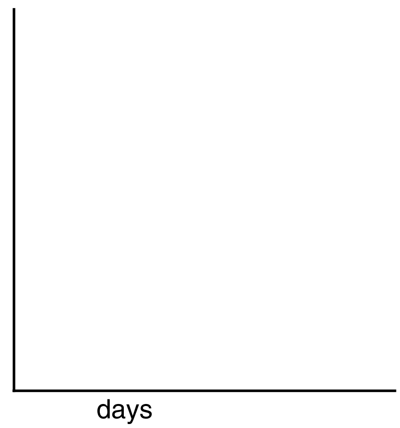
Day 5

Graph your results. Make sure you title your graph and label the x (horizontal) and y (vertical) axes. The first is done.

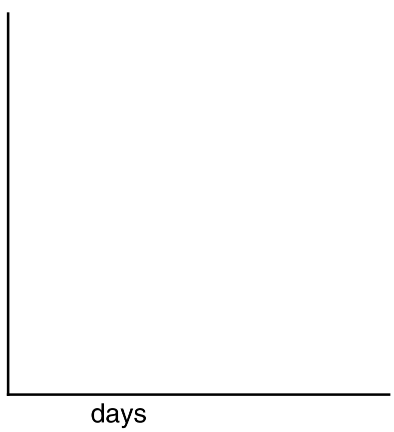
Number of colonies in _________________ water.

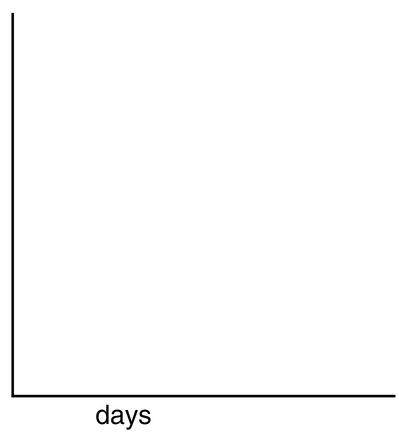
#1



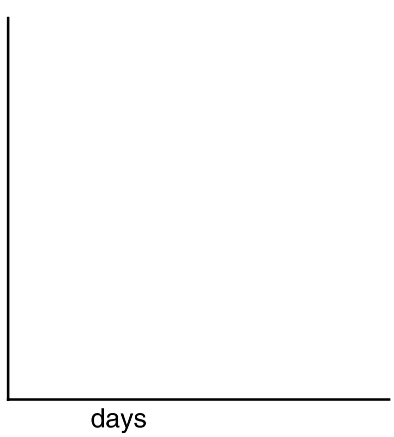


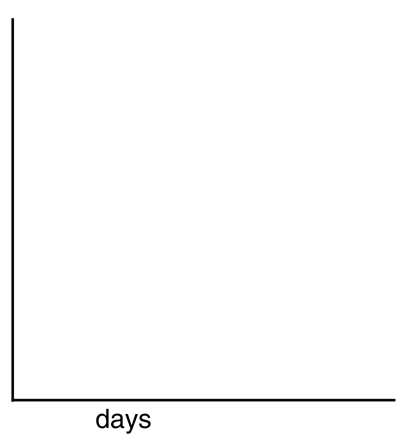
#2

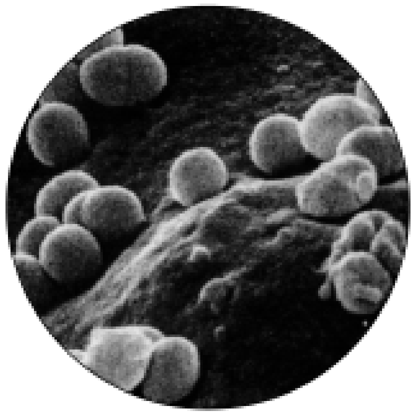




#3

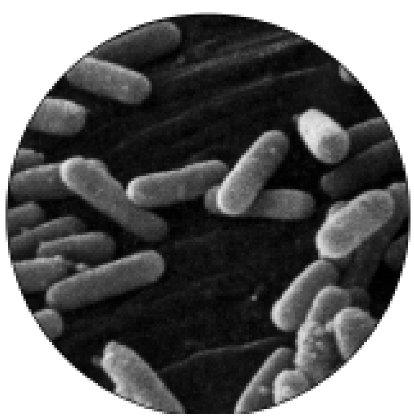






COCCI

SPIRILLA



ROD

INDICATING INSECTS

6-8

SUBJECTS:
Biology, Ecology

TIME:
2 class periods

MATERIALS:
swiftly moving stream
fine netting (2 feet X 10 feet)
jars (one per student)
insect field guides
white sheet
student sheets

OBJECTIVES

The student will do the following:

1. Compile a table of the different kinds and quantities of insects found in a shallow stream.

2. Create a classification system for the insects found.

3. Appraise the quality of the water based on the insects found.

BACKGROUND INFORMATION

Healthy streams contain entire communities of plants, animals, and other organisms which interact with one another and their environment. Producers such as cyanobacteria, diatoms, and water mosses grow on the stones at the edge or on the bottom of the brook. These producers provide food and shelter to aquatic insects. The insects in turn provide food for the small fish inhabiting the brook.

Any physical, biological, or chemical change in water quality that adversely affects living organisms is considered to be pollution. Water pollution affects all the living things of a stream. Some organisms are resistant to certain types of pollutants. Others, however, are less resistant and are vulnerable to the adverse effects of water pollution.

Water quality researchers often sample insect populations to monitor changes in stream conditions. The insects are monitored over time to assess the cumulative effects of environmental stressors such as pollutants. Environmental degradation resulting from pollution will likely decrease the diversity of insects found by eliminating those that are less tolerant to unfavorable conditions. Insects such as the mayfly, stonefly, and caddis fly larvae are sensitive or intolerant to changes in stream conditions brought about by pollutants. Some of these are able to leave for more favorable habitats. Some, however, are either killed by the pollutants or are no longer able to reproduce. Other organisms such as dragonflies, damselflies, and nymphs are called facultative organisms. These organisms prefer good stream quality but can survive polluted conditions.

ADVANCE PREPARATION

A. Have students bring in an empty, average-sized jar.

B. Locate a swiftly moving stream that is at least 3-4 inches deep, but not deeper than approximately 12 inches.

C. Obtain a fine netting that will not allow small insects to pass through.

D. Obtain several insect field guides.

PROCEDURE

I. Setting the stage

A. Explain the relationships between insects and water quality.

B. Discuss the best locations in a stream to collect the insects.

C. Make sure students know how to classify.

II. Activity

A. Select a stream to be tested and bring all the required materials.

B. Locate an area of the stream that has a swiftly moving current. Have the students observe and record the kinds of insects found on the surface of the water.

C. Stretch the netting across the stream perpendicular to the current. Secure the bottom of the net along the bottom of the stream with larger rocks and pebbles. Hold the top of the net above the surface of the water.

D. Have a few students stand about 10-15 feet upstream and disturb the water by shuffling their feet on the bottom, being sure to kick up both large and small rocks.

E. After this disturbed water has passed the point of the netting, have the students quickly pick the bottom of the netting up out of the water without letting the top part of the netting drop into the water.

F. Place the netting on a white sheet on the banks of the stream so that the insects can be observed. Have the students record the kinds and quantities of insects present in a data table.

G. The students should now compare the types of insects found on the surface of the water to the types collected.

H. After separating and observing the insects, place the insects in jars for further observations.

III. Follow-Up

A. Have the students create a classification system of the insects found. Then have them use an insect guide to identify the type of insects found and check the accuracy of their classification system.

B. Use field guides to identify the relationship between the kinds of insects and the indication their presence has on water quality. Write a brief paper on the water quality of the stream tested.

C. Have the students prepare several graphs of the types and quantity of insects found in the stream.

IV. Extensions

A. Have the students identify the various larvae found and the insects into which they will develop.

B. Research the physical characteristics of the insects found at the surface of the water and the adaptations they have made to live there.

C. Invite a limnologist to class to talk about the relationship between insects and water quality.

RESOURCES

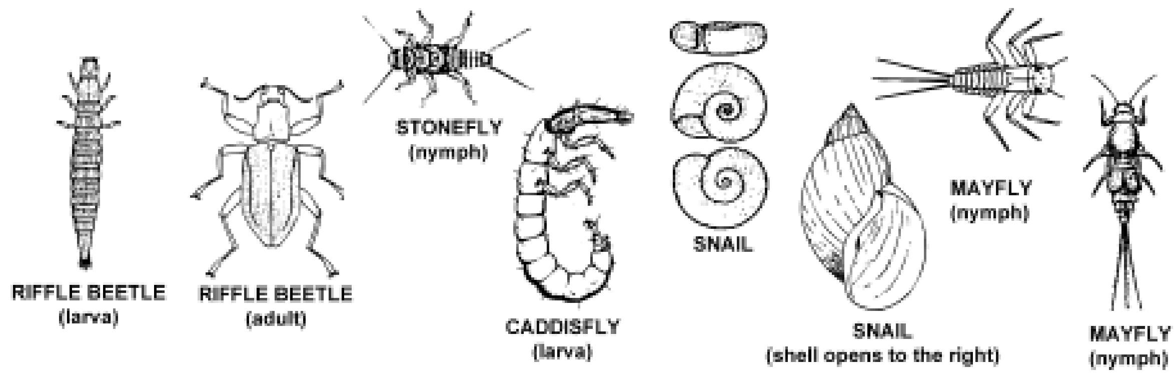
Biological Science: An Ecological Approach, Kendall/Hunt Publishing Company, Dubuque, Iowa,1992.

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

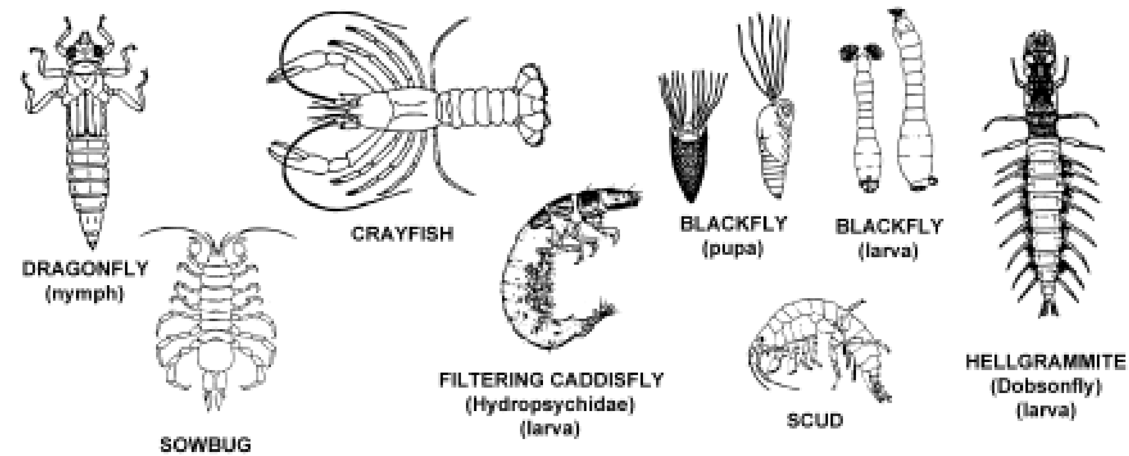
Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995.

MACROINVERTEBRATE GROUPS
Beginner's Protocol PICTURE KEY

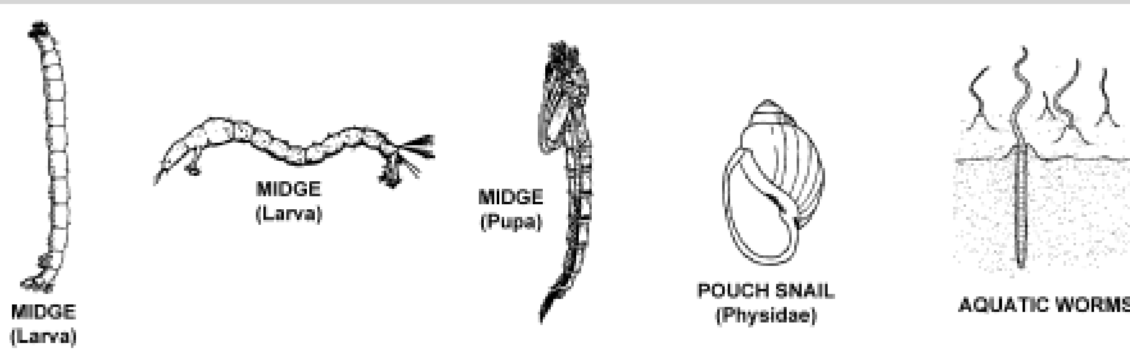
GROUP 1 *These organisms are generally pollution intolerant. Their dominance generally signifies **Excellent-Good Water Quality.***



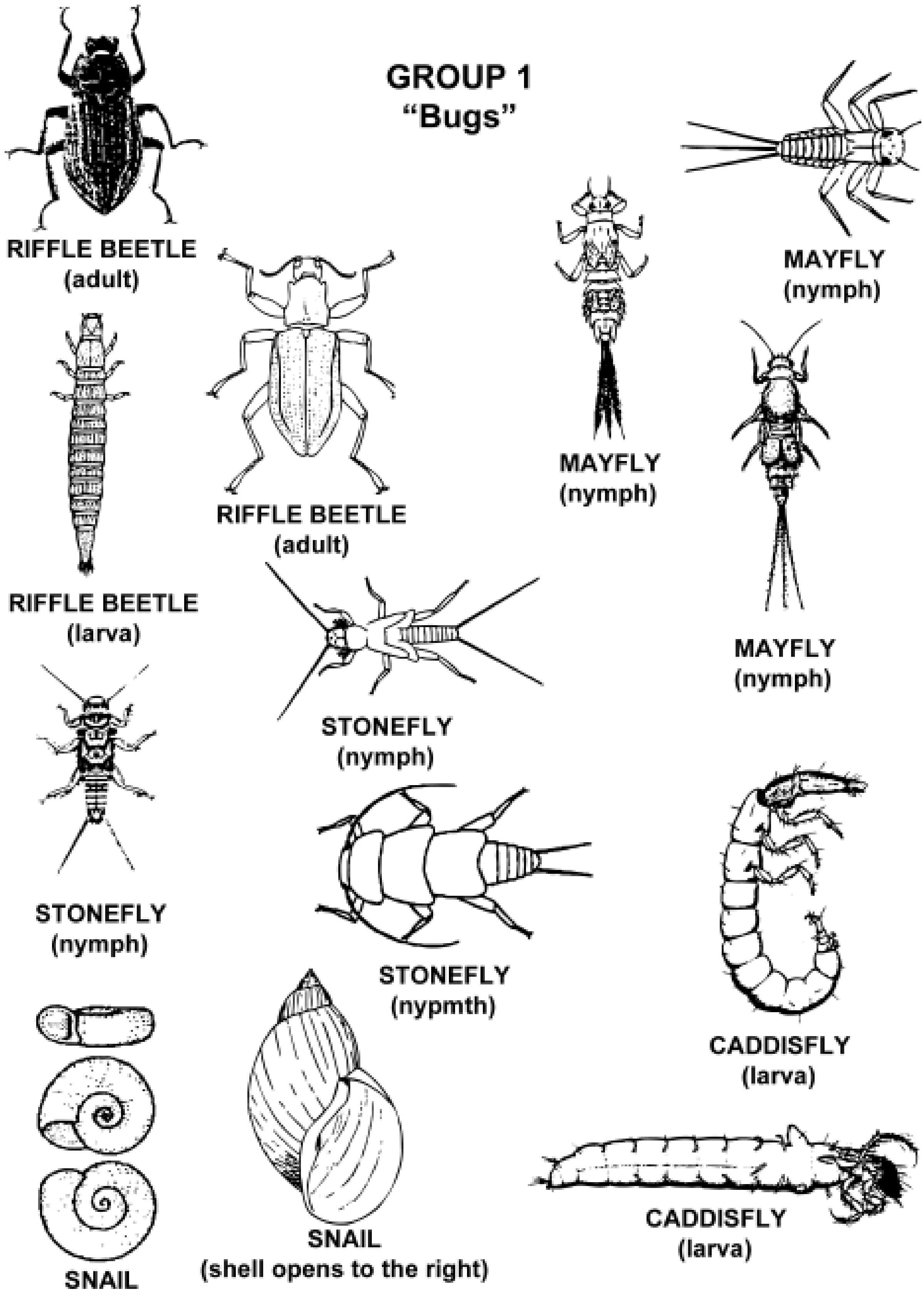
GROUP 2 *These organisms exist in a **Wide Range** of water quality conditions.*



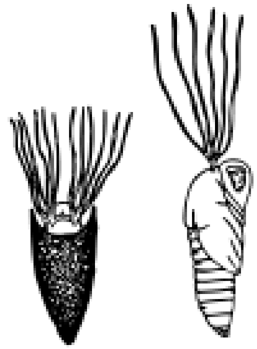
GROUP 3 *These organisms are generally tolerant of pollution. Their dominance generally signifies **Fair-Poor Water Quality.***



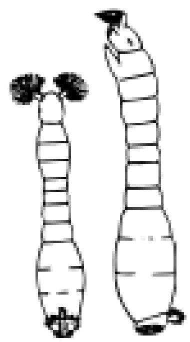
STUDENT SHEET
INDICATING INSECTS
6-8



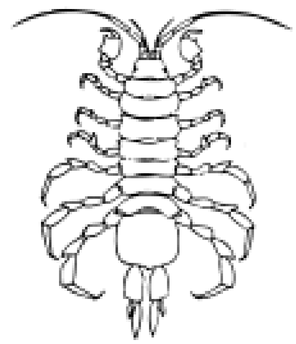
GROUP 2
"Bugs"



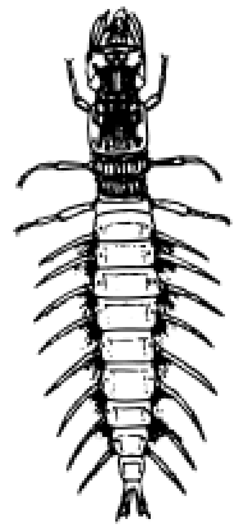
BLACKFLY
(pupa)



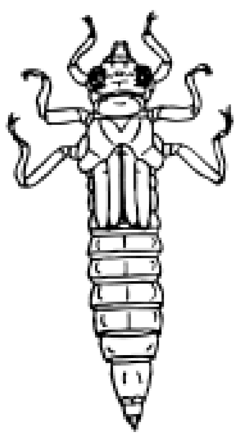
BLACKFLY
(larva)



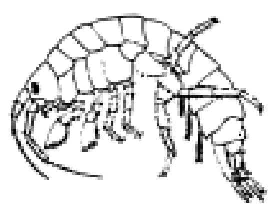
SOWBUG



HELLGRAMMITE
(Dobsonfly)
(larva)

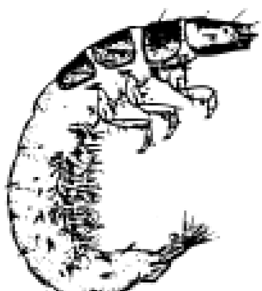


DRAGONFLY
(nymph)

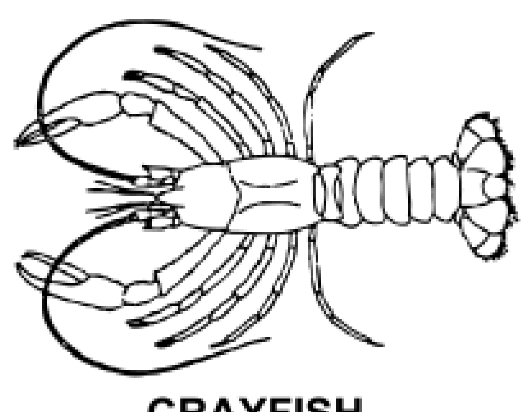


SCUD

SNIPE FLY
(larva)

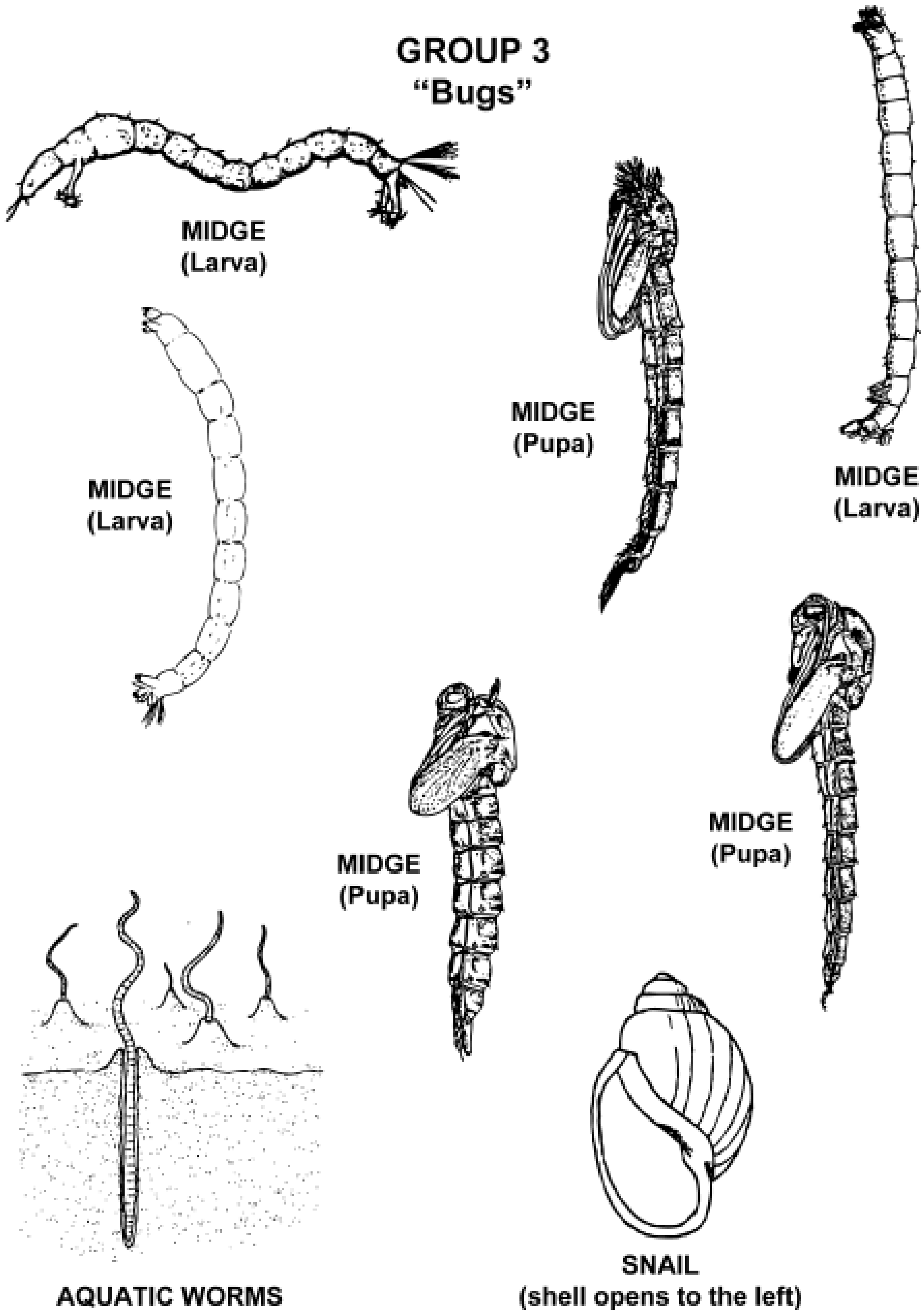


FILTERING CADDISFLY
(Hydropsychidae)
(larva)



CRAYFISH

GROUP 3
“Bugs”


MIDGE
(Larva)
MIDGE
(Larva)
MIDGE
(Pupa)
MIDGE
(Larva)
MIDGE
(Pupa)
MIDGE
(Pupa)
AQUATIC WORMS
SNAIL
(shell opens to the left)

WATER POLLUTION SOLUTIONS

6-8

SUBJECTS:
Art, Chemistry, Language Arts

TIME:
50 minutes

MATERIALS:
scissors
index cards
glue
paper
old magazines
camera and film (optional)
copier (optional)

OBJECTIVES

The student will do the following:

1. Define water pollution.
2. List ways water is polluted.
3. List different kinds of chemicals that can cause water pollution.
4. List ways water pollution can be prevented.
5. Develop various activities to help promote clean water awareness.

BACKGROUND INFORMATION

Water pollution has been attributed to three main causes: human population growth, industrialization, and natural resources development. About one quarter of America's water supply is measurably polluted. Many developing countries have essentially no unpolluted water.

The best solution to water pollution is prevention. If we want to have healthy water, we must create less pollution. Farmers, municipal authorities, industrialists, governments, and the general public must all clean up their activities to reduce pollution.

Individuals can do many things to help clean up our water supply. A good place to start is the home. The main source of water pollutants that come from homes originate in the kitchen, bathroom, or garage. Some chemicals, such as oil, paint thinner, and pesticides, often find their way down the drain and into our water systems. Household cleansers such as drain cleaner, oven cleaner, and tarnish remover have caustic chemicals that lower water quality. These products have chemical ingredients that may not be removed during water treatment. A partial solution would be to avoid putting these chemicals directly into water in the first place. Hazardous household wastes can be taken to approved disposal sites.

Individuals can also influence political leaders to pass laws that prohibit or decrease water pollution. Other ways to decrease water pollution include decreasing water runoff from surfaces in the neighborhood, disposing of hazardous materials properly, and using biological controls instead of toxic pesticides in the home and garden.

<u>Terms</u>

impurity: something that, when mixed into something else, makes that mixture unclean or lowers the quality.

pollutant: an impurity (contaminant) that causes an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that may be harmful to or affect the health, survival, or activities of humans or other living organisms.

water pollution: the act of making water impure or the state of water being impure.

ADVANCE PREPARATION

A. Gather all of the materials that you will need for the following activities.

PROCEDURE

I. Setting the stage

A. Show the students various pictures illustrating water pollution.

B. Ask the students to describe the situations in each picture.

C. Tell the students about the pictures and relate them to water pollution.

II. Activity

A. Divide the class into groups and ask them to choose one of the activities below to draw attention to water pollution solutions.

1. Pollution Solution Cartoon

    a. The students are responsible for writing a cartoon story depicting characters who are trying to save the Earth's water from pollution.

2. Pollution Solution Book Marks

    a. The students can make their own book marks. The pictures on the book marks describes a solution to pollution.

3. Pollution Solution Rap Song

    a. The students can make up a song that is based on a solution to water pollution.

4. Pollution Solution Flash Cards

    a. The students can cut out, copy, or draw some pictures from magazines that show water contamination problems. Better yet, they can take their own pictures.

    b. The pictures can be placed in chronological order: the students will arrange the pictures and explain how what is happening in one picture can cause what they see in other pictures.

5. Pollution Solution Video

    a. The students can write and film a short video on water pollution. It should be no more than 2-3 minutes and be modeled after a public-service announcement.

III. Follow-Up

A. The students can research local and regional areas that have had problems with water pollution. Examples are the Thames River in London, England; the Hudson River in New York; Chesapeake Bay in Maryland; the Everglades in Florida; the Mississippi River near New Orleans; and many others.

B. Students can research individual incidents of water pollution, such as Love Canal; the Exxon Valdez tanker spill; Times Beach, Missouri; the North Carolina hog waste problem; or other local events.

IV. Extensions

A. The class can invite a spokesperson from the EPA to come in and talk about current trends in preventing water pollution.

B. The class can conduct a survey of the area in which they live to determine the extent of water pollution and suggest ways to prevent further pollution.

RESOURCES

DeVito, Alfred and Krockover, Gerald, Creative Sciencing. Scott, Foresman and Co., Glenview, IL, 1991.

Marine Pollution: http://www.panda.org/research/facts/fct_marine.html

Maton, A., Ecology: Earth's Natural Resources. Prentice Hall Science, NJ, 1991.

Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995. Available through Project Wet: Water Education for Teachers, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057 (Fax: 406-994-1919; e-mail rwwet@msu.oscs.montana.edu).

Sund, Robert, Accent on Science. Charles E. Merrill Publishing Co., Columbus, OH, 1983.

Water Pollution: http://www.fcn.org/fcn/ecosystem/water_po.html

Water Education Federation brochure on Household Contaminants. Available through http://www.wef.org.