How Can We Find Out What Is in Water?

from *The Science of Water Teacher's Guide* and for *Mystery of the Muddled Marsh*

Written by
Nancy P. Moreno, Ph.D.
Barbara Z. Tharp, M.S.
Judith H. Dresden, M.S.

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The activities described in this book are intended for school-age children under direct supervision of adults. The authors and Baylor College of Medicine cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text.

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Authors: Nancy P. Moreno, Ph.D., Barbara Z. Tharp, M.S., and Judith H. Dresden, M.S.
Editors: James P. Denk, M.A., and Paula H. Cutler, B.S.
Designer: Martha S. Young, B.F.A.

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BCM
Baylor College of Medicine

Center for Educational Outreach
Baylor College of Medicine
One Baylor Plaza, BCM411
Houston, Texas 77030
713-798-8200 | 800-798-8244 | edoutreach@bcm.edu
www.bcm.edu/edoutreach | www.bioedonline.org | www.k8science.org

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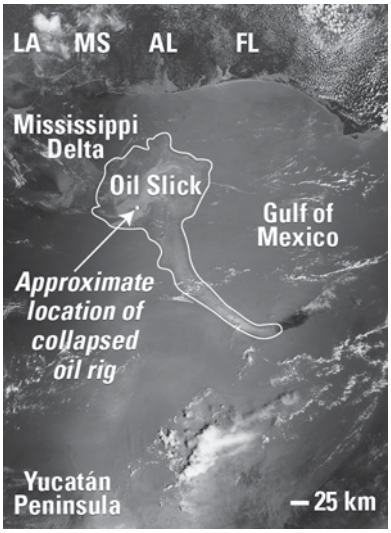
Water Pollution and Health

Environment and Health Basics

All the water on Earth ultimately forms a single, immense system. Oceans, wetlands, streams, lakes and underground water supplies all are linked through drainage patterns in watersheds and through the endless cycling of water on our planet. Because water sources are connected, pollutants travel from part of one ecosystem to another. Eventually, the contaminants can affect very distant ecosystems and populations. Water pollutants can be divided into several major categories, all of which impact human health and well-being.

- **Nutrients.** These can come from chemical sources (fertilizers or detergents) or can be biological in origin (sewage or manure). Nutrients usually are carried into water sources by rainwater. They cause excessive growth of water plants and algae, which can clog navigable waterways and consume oxygen (needed by other organisms such as fish) when they decompose. These changes cause the decline of important lakes and wetlands, and can affect the quality of drinking water. In groundwater, fertilizers can make water from wells unsafe to drink.
- **Soil and sand from plowed fields, construction sites, logging sites, urban lands and areas being strip-mined.** These sediments make lakes, wetlands and streams more shallow, limiting the use of waterways for transportation and decreasing the quality of wildlife habitats. Washed-off soil also can be a source of excess nutrients.
- **Disease-causing organisms.** Bacteria, viruses and single-celled parasites can enter water supplies from inadequately treated sewage, storm water drainage, septic systems, livestock pens, and boats that dump human wastes. These organisms cause diseases such as dysentery and typhoid, and skin and respiratory illnesses.
- **Metals (such as mercury and lead) and toxic chemicals (such as those found in pesticides, herbicides, cleaning solvents, plastics and petroleum derivatives).** These substances can be poisonous to humans and wildlife. Metals and many manufactured chemicals persist in the environment. They build up in the bodies of fish and other animals, and can find their way into groundwater, making it unsafe to drink.
- **Heat.** Warm water discharged from power plants (where water is used for cooling) can drastically alter aquatic ecosystems. Changes in water temperature can affect the quantity of oxygen in the water and can make some organisms more susceptible to disease, parasites and toxic chemicals.

Most sources of water pollution are spread over large areas. Water from rain and irrigation collects pollutants as it washes over the land or sinks into the soil. This type of pollution, which is not attributable to a single location, generally is called non-point source pollution. It is much more difficult to monitor and to control than point source pollution—which is discharged at a single place (such as from a factory or waste treatment plant, or a chemical spill).



A large patch of oil visible near the site of the *Deepwater Horizon* rig collapse and oil spill on May 17, 2010. A long ribbon of oil stretches far to the southeast, entering the loop current, a stream of fast moving water that circulates around the Gulf of Mexico before bending around Florida and up the Atlantic coast.

Source: NASA Earth Observatory.

WATERSHEDS

An area of land that catches rain and snow and drains into a marsh, river, lake, groundwater or other body of water is called a watershed. Watersheds come in all sizes, and they form based on water drainage patterns. Within watersheds, water always flows downhill—so any activity that changes characteristics of water upstream will affect water quality downstream. Homes, farms, cities, fields and forests all can be part of the same watershed.

Satellite image courtesy of NASA Earth Observatory.

How Can We Find Out What Is in Water?

Environment and Health

CONCEPTS

- Many different substances can be dissolved in water at the same time.

OVERVIEW

Students use simple paper chromatography to investigate a mystery liquid.

SCIENCE, HEALTH & MATH SKILLS

- Measuring
- Predicting
- Making observations
- Drawing conclusions

TIME

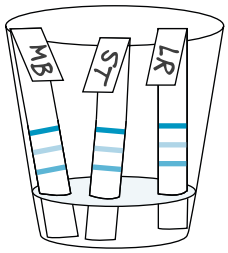
Preparation: 10 minutes
Class: 30 minutes

MATERIALS

- Cup, 9-oz clear plastic
- Red, green and blue food coloring (see SETUP)
- Water

Each group will need:

- Round basket-type coffee filters (1–2 per group)
- Beaker, 250-mL (or 9-oz clear plastic cup)
- 2 pairs of scissors
- 2 rulers
- Water



Students observe the bands of color that appear on filter paper strips.

Note: This activity works best if the strips are not pressed against the sides of the beaker or cup.

Small amounts of many different substances can be dissolved in water at the same time. Many of these materials are not visible or distinguishable when they are mixed together in water. In this activity, students will use a simple separation technique to detect the presence of several different food dyes in water.

The technique, called chromatography, takes advantage of the "sticky" qualities of water, which help it travel up a piece of filter paper. When this happens, the water molecules are attracted to charged regions on the paper's cellulose molecules. As water moves up the paper, it carries other molecules (such as the food coloring used here). Different molecules will move up the paper at different rates, based on their sizes and degrees of attraction to the water molecules. As a result, the different substances (food coloring dyes in this case) will form separate bands or spots on the filter paper.

Unit Links

Mystery of the Muddled Marsh
Science boxes, pp. 17 and 24

Explorations
Riff and Rosie Talk to Ms. Linda Holman, p. 7

SETUP

Before beginning the activity, prepare a "mystery liquid" by adding 10–15 drops each of red, blue and green food coloring to about one cup of water.

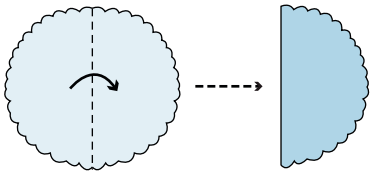
Set the materials out in a central area for the Materials Managers to pick up. Have students conduct this activity in groups of four.

PROCEDURE

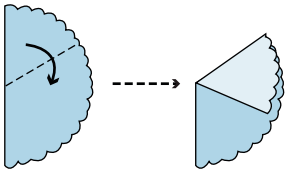
1. Show the mystery liquid to the students. Ask, *Can you tell what's in this liquid?* Explain that each student is going to be a detective and investigate the mystery liquid.
2. Students will need to prepare a test strip of filter paper. Give each group 1–2 basket-type coffee filters. Have the students smooth the filters so that they lie as a flat circle. Each student should cut a strip of filter paper 2 cm wide by 10 cm long.
3. Give each group a 250-mL beaker (or 9-oz clear cup) with about 1 cm of the mystery liquid in the bottom. Tell students they will put the tips of the paper strips into the mystery liquid. Ask them to predict what might happen.
4. Have each student write his or her initials in pencil or permanent ink at the top of his or her filter paper strip. Then have students place the strips in the liquid and gently fold the top of the strips over the side of the beaker so that the strips stay upright (see illustration, left sidebar).

How to Make a Paper Snowflake

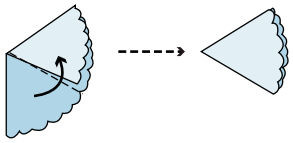
1. Fold a flattened coffee filter in half.



2. Fold approximately one-third of the folded filter toward the center.

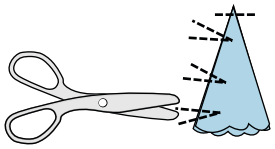


3. Fold the remaining third toward the center to create a triangular shape.



4. Fold the small triangle in half.

5. Cut a pointed tip and other designs on the solid side of the triangle.



6. Open the snowflake.

5. Have the students observe their strips for 5–10 minutes. As the color begins to rise up the strips, ask, *What is happening to the mystery liquid?*
6. Once the liquid in the strips has risen to about 2 cm from the top of the beaker, have students carefully remove their strips and lay them on pieces of paper towel to dry. Instruct students to observe the colors. Ask, *How many colors are on your strips? Which colors?* Let each student report which colors appeared on his or her strip. (Usually three bands will form: blue at the top, followed by yellow or green, followed by red at the base.) Ask, *What does this result tell us about the mystery liquid? How many substances were mixed together to make the liquid?*
7. The strips may be preserved in a notebook or displayed in class after they are dry. Encourage students to extend their findings to other situations. Ask, *Since several different substances were mixed together in the mystery liquid, do you think that other types of liquids can be mixtures of different materials?*

The word "chromatography" comes from the Greek words *khroma* (color) and *graphein* (to write).

VARIATIONS

- After conducting the activity with filter paper strips, let students fold and cut snowflakes out of coffee filters. You may wish to copy and distribute "How to Make a Paper Snowflake" (see box, above). Set the folded snowflakes in the beakers, with the tips in the mystery liquid, to color the snowflakes in rainbow patterns.