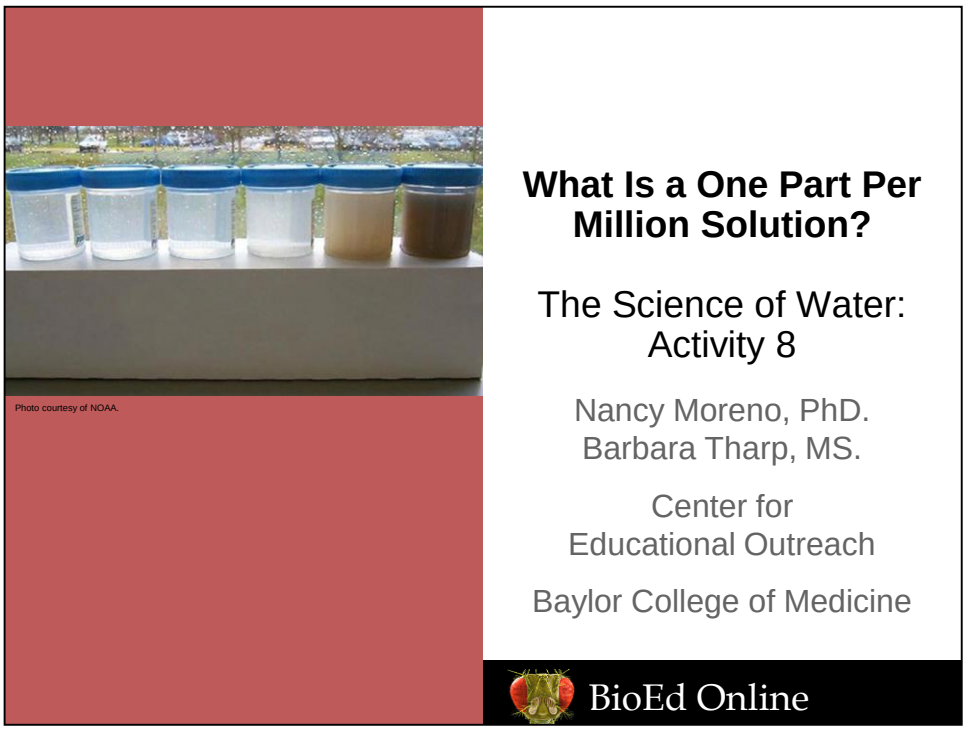

What Is a One Part Per Million Solution?

**Previously entitled, "Pollution Dilution"*

This activity's objectives are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Life Science. Students will learn that substances dissolved in water can be present in very tiny quantities (parts per million) that are not visible to the eye. Reviewing fractions by factors of ten will help to facilitate student understanding the concept of parts per million.

Concept

⑩ Substances dissolved in water can be present in very tiny amounts that are not visible to the eye.

Reference

Moreno N., and B. Tharp. (2011). *The Science of Water Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-61-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Image Reference

Photo courtesy of NOAA. http://www.noaa.gov/

Key Words
lesson, experiment, water, ppm, one part per million, one part per million solution, solutions, concentrations, harmful chemicals, pollution, water pollution,

Materials

Have students work in groups of four. Place materials for groups on plastic trays, and set trays in a central location for Materials Managers to pick up.

Number six portion-size cups 1 through 6 (one set per group). Alternately, use commercially available chemistry trays or cut the bottoms of plastic egg cartons in half to create chemistry trays with six wells.

Materials per Student Group

- 6 2-oz portion cups, (numbered 1 through 6)
- 2 9-oz clear plastic cups
- 2 pipettes or droppers
- Plastic tray
- Small bottle of blue or red food coloring
- Water

Materials per Student

•Copy of “What Does One in a Million Look Like?” page

Reference

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Image Reference

Photo by JP Denk © Baylor College of Medicine.

Key Words

materials list, materials needed,

What Is a One Part Per Million Solution? © Baylor College of Medicine.

Science Safety Considerations

Students always must think about safety when conducting science investigations. This slide may be used to review safety with your class prior to beginning the activity.

Safety first!

•Always school district and school science laboratory safety guidelines.

•Have a clear understanding of the investigation in advance.

•Practice any investigation with which you are not familiar before conducting it with the class.

•Make sure appropriate safety equipment, such as safety goggles, is available.

•Continually monitor the area where the investigation is being conducted.

Safety note: Caution students to be careful when handling food

coloring as it can stain hands, clothes, work surfaces and equipment.

References

1.Dean R., M. Dean, and L. Motz. (2003). *Safety in the Elementary Science Classroom*. National Science Teachers Association.

2.Moreno N., and B. Tharp. (2011). *The Science of Water Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-61-3.

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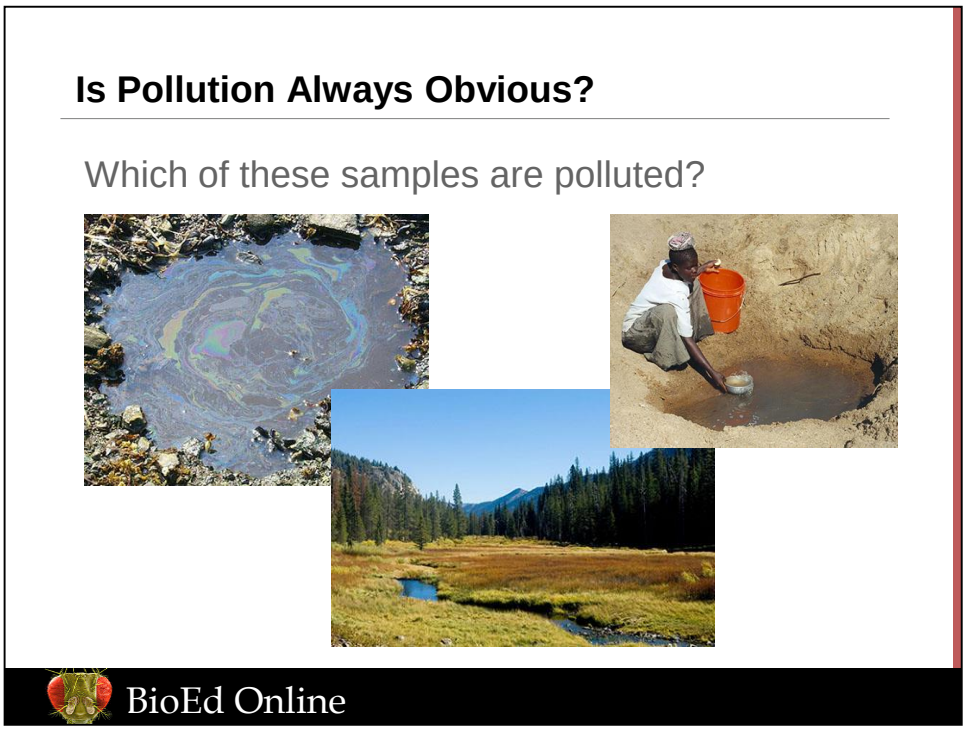
Key Words

science, classroom, safety, lab, laboratory, rules, safety signs,



Is Pollution Always Obvious?

All water on Earth is part of 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 these water sources are connected, pollutants travel from one part of the system to another.

Eventually, pollution in one part of the system can affect ecosystems and populations, both human and wildlife, very far away from the source.

Reference

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Baylor College of Medicine.

Image References

Photo of motor oil in water courtesy of NOAA. http://oceanservice.noaa.gov/education/tutorial_pollution/media/supp_pol04b.html

Photo of a healthy water shed courtesy of the US Environmental Protection Agency. http://water.epa.gov/polwaste/nps/watershed/index.cfm

Photo of Mwamanongu village water supply courtesy of Bob Metcalf, released into the public domain. http://commons.wikimedia.org/wiki/File:Mwamongu_water_source.jpg

Key Words

lesson, experiment, water, ppm, one part per million, one part per million solution, solutions, concentrations, harmful chemicals, pollution, water pollution,

Let's Get Started

Have students follow the instructions on the student sheet, "What Does One in a Million Look Like?" Make sure each student group has the following items.

- Six 2-oz. cups (numbered 1–6)
- One 9-oz cup of clean tap water
- One empty cup (for cleaning pipettes)
- Two pipettes (one for use with food coloring, one for use with water only)

Students should begin by placing one drop of food coloring into Cup 1. (With younger students, you may elect to place a drop of food coloring into the cup for each group.) Using a clean pipette, students then should add 9 drops of water to Cup 1. Ask, *How many drops of food coloring did you add to the cup? How many drops are in the cup all together* (food coloring and water)*?*

Instruct students to use a pipette to collect one drop of the mixture from Cup 1 and place it in Cup 2. Next, have them add nine drops of water to Cup 2. Be sure they use a clean dropper/pipette for the water. In between steps, students should clean their droppers by rinsing them with tap water and squirting the excess into the empty cup. Each group should repeat this procedure, using one drop from the previous cup and mixing it with nine drops of water until all six cups are filled.

When groups have completed their solutions for all six cups, have them observe the colors of the solution in each cup. Ask, *What happened to the color of the water in each cup? In which cup(s) does the color seem to disappear?* and *Does this mean that there isn't any food coloring in the water?*

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Let's Talk About It

Review the fractions represented on the worksheet, What Does One in a Million Look Like? Make sure that students understand the concentration in Cup 6 is one part in one million. Each of cups 2–6 holds a solution that is 10 times more diluted that the solution in the preceding cup. Ask, *Is there another way that we could make a mixture with one part in one million?* Of course, we could add one drop of food coloring to 999,999 drops of water.

Hold up a glass of tap water. Ask students, *Could our drinking water contain tiny amounts of other substances?* Follow up by asking, *What might those tiny things be?* Possible answers could include: minerals, microorganisms (germs), or chemicals. Ask, *Are all of these things harmful?*

Help students to understand that almost no water, except in a laboratory, is completely pure. Although it may look clear and clean, water often contains many types of chemical and biological materials. Most of these are harmless, especially in tiny quantities. In fact, even

water that comes from crystal clear wilderness sources, or “natural” spring water sold in stores, contains dissolved minerals and other substances.

Point out, though, that some pollutants can be harmful to humans (for example, heavy metals like lead and mercury, pesticides, and some industrial chemicals), even in tiny amounts measurable only in parts per million or parts per billion. Mention that certain city, county, state and federal agencies test drinking water for potentially harmful chemicals, and that the Environmental Agency (EPA) sets limits for acceptable amounts of potentially harmful chemicals in drinking water. Ask students, *Why is it important to test our drinking water?*

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Key Words

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The Science of Water Pollution and Health

- All water supplies form one large system, linked by the water cycle.
- Pollutants can travel from one water supply to another.
- Common water pollutants include the following.
  - Nutrients
  - Soil and sand
  - Disease-causing organisms
  - Metals and toxic chemicals
  - Heat

BioEd Online

The Science of Water Pollution and Health

All the water on Earth is part of 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 are transferred from one part of the system to another. Over time, contaminants can reach and impact ecosystems and human/plant/animal populations very far from their points of origin. Water pollutants can be divided into several major categories, all of which impact human health and well-being.

• **Nutrients** can come from chemical sources (fertilizers or detergents) or can be biological in origin (sewage or manure). They usually are carried into water sources by rainwater. Nutrients cause excessive growth of water plants and algae, which can clog navigable waterways and consume oxygen needed by other organisms, such as fish. The introduction of excess nutrients can damage lakes and wetlands, and can affect drinking water quality as well. Fertilizers also can impact groundwater and make water from wells unsafe to drink.

• **Soil and sand** from plowed fields, construction zones, logging sites and strip mines can fill up lakes, wetlands and streams, thereby making these waterways more shallow, which limits their use for transportation and damages wildlife habitats. Topsoil lost to erosion also can be a

source of excess nutrients.

- **Disease causing organisms**, such as 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, as well as 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) can be poisonous to humans, plants and wildlife. Metals and many manufactured chemicals persist in the environment. Metals and manufactured chemicals can remain in the environment for many years**.** They build up in the bodies of fish and other animals, making them unsafe to eat. These toxins also can pollute groundwater, making it unhealthy to drink.

- **Heat.** Warm water discharged from power plants (which use water for cooling) can drastically alter aquatic ecosystems. Changes in water temperature can alter the amount of oxygen in the water and make some organisms more susceptive to disease, parasites and toxic chemicals.

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

Reference

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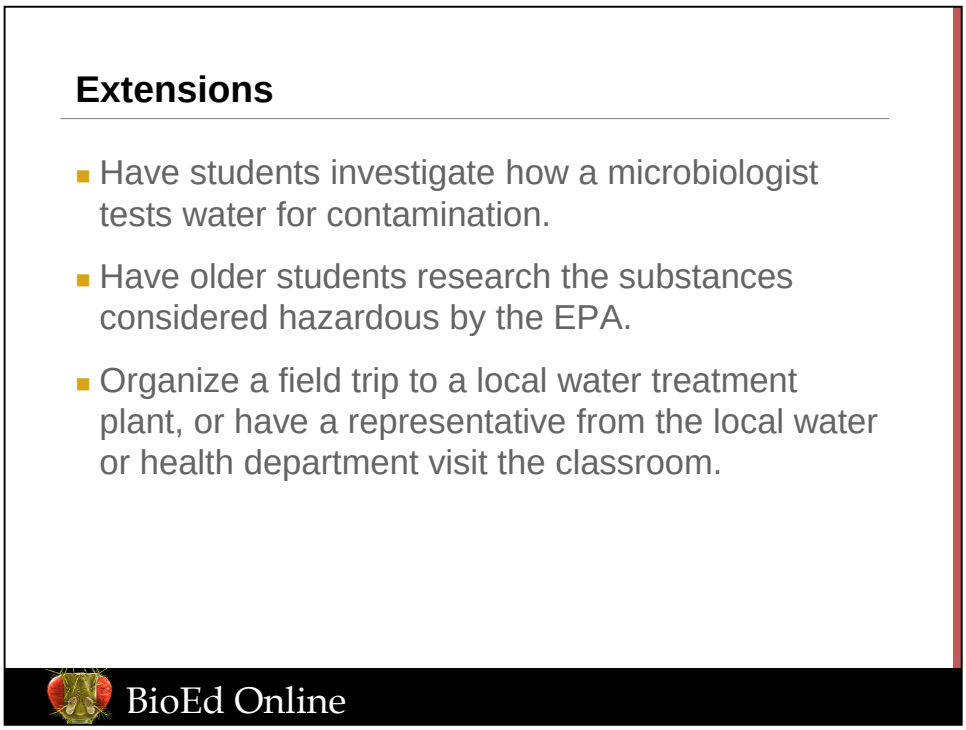
What Is a One Part Per Million Solution? © Baylor College of Medicine.



Extensions

The Safe Water Drinking Act of 1974 requires the EPA to set and enforce standards of safety for drinking water in the United States. Have older students check resources in the library or on the Internet to identify the substances considered hazardous by the EPA, and at which concentrations.

Water treatment plants typically pass water though a complex filtering process to remove suspended particles, and to add chlorine to kill disease-causing organisms. Sometimes, water also is sprayed into the air to help evaporate certain chemicals and improve its taste and smell. Organize a class visit to your municipal water treatment plant, or have a representative from the local water or health department visit your classroom.

Reference

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