KIDS ENVIRONMENTAL LESSON PLANS

This lesson plan developed by:

Increases in CO_2 Creates a More Acidic Ocean

Overview:
A fun activity using your own exhaled breath to visualize how our oceans are becoming more acidic due to increasing carbon dioxide emissions.

Ocean Literacy Principles:

1. The Earth has one big ocean with many features
5. The ocean supports a great diversity of life and ecosystems
6. The ocean and humans are inextricably interconnected
7. The ocean is largely unexplored

Key Concepts:

- Every year one third of carbon dioxide emissions are absorbed by the ocean, causing a decrease in the pH of ocean water. This change in chemistry in our marine waters is called ocean acidification.
- Human activities are contributing to ocean acidification, but there are things we can do to reduce our carbon footprint to stop ocean acidification.

Materials:

- 5 clear glass jars or cups, about 8 oz capacity
- 1 set of measuring cups
- 1 set of measuring spoons
- 1 small pot, about 1 quart capacity
- 1 funnel
- cheesecloth
- safety glasses

Acidic Ocean (cont.)

- 2 cups of finely chopped red cabbage
- drinking straws (not made of plastic, if possible)
- 2 cups of boiling tap water
- baking soda
- white vinegar
- tap water

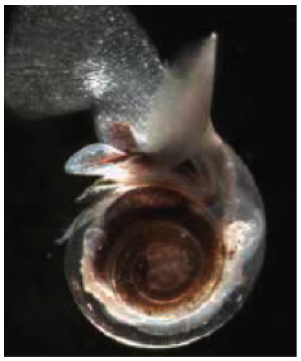
Set-up Prior to Activity:
The red cabbage pH indicator can be made ahead of time (steps 1-2) and stored in the refrigerator until the activity. However, students may want to help make the solution.

Duration:
60-75 minutes (30 minutes if the red cabbage pH indicator is prepared ahead of time)

Physical Activity:
Moderate

Background:
Increased carbon dioxide in the atmosphere is leading to many changes that have serious consequences for Earth's ecosystems, including humans. Climate change is causing ice sheets and glaciers to melt, and sea level rises as the melt water flows into Earth's ocean. Seawater is beginning to contaminate sources of fresh water. Rising sea level is submerging coastal marshes that help protect the shore from severe storms, and bringing structures on land closer to the edge of the ocean. These changes make it more likely that these structures will be damaged by coastal storms, which are expected to increase as additional heat in Earth's atmosphere changes the patterns of winds and precipitation. Heat waves and droughts are also expected to increase, and bring additional threats to human lives.

Increased atmospheric carbon dioxide is also causing serious changes in the chemistry of Earth's ocean. The ocean absorbs about a quarter of the carbon dioxide humans release into the atmosphere every year, and this additional carbon dioxide in seawater is causing Earth's ocean to become more acidic. Scientists use a measurement called pH to describe how acidic or basic a solution is. A pH of 7 is considered neutral. Acidic solutions, such as vinegar or lemon juice, have a pH less than 7. The more acidic a solution is, the lower the pH number. Basic solutions, such as milk or baking soda dissolved in water, have a pH greater than 7.



In addition to other impacts of global climate change, ocean acidification poses potentially serious threats to the health of Earth's ocean and its ecosystems. The impact on individual species is expected to vary. A more acidic environment has a dramatic effect on some species that build calcium carbonate (limestone) shells, such as oysters. When shelled organisms are at risk, the entire food web also is at risk. For example, pteropods are an important food source for salmon. According to some

research reports, a 10 percent drop in pteropod production could result in a 20 percent drop in the mature body weight of pink salmon (*Oncorhynchus gorbuscha*). These impacts are happening right now, and are affecting marine food webs that provide important sources of food for humans as well as ocean species.

Activity:

How It Works:

Red cabbage contains chemicals that change color depending upon pH. These types of chemicals are called pH indicators. In basic solutions, these chemicals from red cabbage are light blue, but they change to pink-purple in acidic solutions. At the beginning of your demonstration, you will put a very small amount of baking soda into the container of tap water to be sure that it is slightly basic (seawater is normally slightly basic, with a pH of about 8.2). So, when you add the red cabbage indicator solution to the container of tap water, the indicator will have a light blue color.

When you exhale, the air from your lungs contains more carbon dioxide than the air in the atmosphere. Blowing through a straw into the container of tap water bubbles carbon dioxide through the liquid. Some of this carbon dioxide dissolves to form a weak acid (carbonic acid). When this happens, the red cabbage indicator changes to a pink-purple color, showing that the pH has changed and the liquid has become more acidic.

Procedure:

1. Put the chopped red cabbage into a small pot, and pour in about 2 cups of boiling water to cover the cabbage. Let the mixture rest for about 30 minutes.
2. Fold the cheesecloth so that it is at least four layers thick, but still covers the opening of the funnel. Strain the cabbage mixture through the cheesecloth into one of the glass jars or plastic cups. You will have some liquid left over in the pot. Save this in case you need it later.
3. Pour about 1/4 cup of tap water into another glass jar or plastic cup. Add 1 tsp of the red cabbage indicator solution to the jar. The solution should have a pale blue color. The pH of tap water varies from place to place, so if the solution is not pale blue, add a pinch of baking soda, and gently swirl the container so that the baking soda dissolves. Repeat if necessary until the solution has a pale blue color.
4. Pour about 1/4 cup of tap water into another glass jar or plastic cup. Add 1 tsp of the red cabbage solution to the jar, then add 1 tsp of white vinegar. The solution should have a pink-purple color.
5. Put about 1/4 tsp of baking soda into another glass jar or plastic cup, fill the container with tap water, and gently swirl the container so that the baking soda dissolves.
6. Pour about 50 ml 1/4 cup of tap water into the last glass jar or plastic cup. Add 1/4 tsp of the baking soda solution from Step 5 solution to the jar, then add 1 tsp of the red cabbage solution to the jar. The solution should have a pale blue color.

Acidic Ocean (cont.)

7. Put on a pair of safety glasses. Blow gently through the straw into the solution prepared in Step 6. Keep blowing for several minutes, until the color of the solution changes from pale blue to pink-purple.

Discussion:
You have just shown how dissolved carbon dioxide can make a solution more acidic! This is what is happening to our ocean because of carbon dioxide that has been added to Earth's atmosphere by human activities.

- What are some human activities that contribute to ocean acidification?
- What would happen if pteropods were no longer able to make their shell?
- What are some other organisms that are directly and/or indirectly impacted by ocean acidification?
- What are some ways we can reduce our carbon footprint to stop ocean acidification?

Additional Resources:
http://coralreef.noaa.gov/education/oa/presentation-videos.html

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