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Teacher Notes

Montoring an Aquarium Introduction

In this activity, students will use a pH probe and a light probe to investigate the relationship between diurnal variation in light and the production of carbon dioxide in aquatic plants. The activity is designed to complement a long-term inquiry regarding environmental factors and ecosystems. The activity follows introductory environmental probe activities that explore temperature variation in various habitats ("Environmental Temperatures"), oxygen variation under different temperatures ("Escaping Oxygen"), and an introduction to the pH scale ("Changing pH") by testing lemon juice, baking soda solution, and different types of leaves. In other environmental investigations children have discovered that plants are net consumers of carbon dioxide and that animals produce carbon dioxide. Students may have used either Bromothymol blue or pH paper as an indicator of acidity in water, which in turn is an indicator of carbon dioxide. When carbon dioxide dissolved in water it produces a weak acid, carbonic acid.

The pH and light probes enable students to make a 24-hour study of simultaneous changes pH and light intensity. In a controlled experiment, they will observe the relationship between light intensity and carbon dioxide production by *Elodea* (an aquatic plant). In addition they will be able to observe the impact of the introduction of an animal, a goldfish, to their experimental ecosystem.

The primary goal of this activity is to expand students understanding of the dynamic relationships among several environmental factors. In addition, they will be building toward a more complex understanding of photosynthesis. However, photosynthesis may be beyond the scope of this activity, since this activity focuses on only one aspect of the complex process that also includes energy transformation and chemical change.

Students investigate and observe the factors of an aquatic ecosystem while they are:

- realizing that the number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition.
- understanding that for ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis.
- recognizing that substances often are placed in categories or groups if they react in similar ways, such as an acid or base.
- making explanations and predictions from evidence and drawing logical conclusions.
- identifying variables that can affect the outcome of an experiment. In addition they will learn to identify other variables in an experimental design that must be controlled in order to isolate the affect of one variable.
- gaining skills and confidence in using a scientific measurement tool, light and pH probes, as well as the spreadsheet and graphing capacity of a computer to represent and analyze data.
- learning to value accuracy and precision in scientific investigation.

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Discussion Guide

Initiate a discussion with students about changes they have noticed from day to day or during the day in the aquatic environments that they have set-up in their classroom. The students will probably discuss changes in factors such as appearance, temperature, and acidity of water. Encourage them to discuss relationships and interactions they have observed among environmental factors. Students may have observed interactions among plants and animals. One strategy for recording their ideas about the relationships among environmental factors would be a class concept map.

Introduce the idea that sometimes in order to understand a complex process, scientists sometimes try to isolate components in a controlled experiment. Point on the concept map to the interaction between plants and light. Make a list of the ideas students have about this relationship. Now, point to the gas exchange relationship between plants and animals.

Show the glass a small aquarium with a goldfish and Elodea. Have the students think about how changes in light affect the production of carbon dioxide in plants. Usually, however plants to not live in water all alone. There are animals around. Challenge the students to design an investigation about how light, carbon dioxide production, and animals affect each other? Show and describe the light and pH probes that the students will be able to use in their investigation.

Have the students read and discuss "Thinking About the Question".

After students have had an opportunity to answer these questions develop an experimental procedure in a class brainstorm session. It is suggested that the students set up at least four separate investigations. Four aquariums containing:

- water only
- water and goldfish
- water and *Elodea*
- water, goldfish, and *Elodea*

The students should come to an agreement about controlling variables such as the amount of water, number of goldfish, number of *Elodea* springs, and location of the aquariums. The students will have to use two computers for each aquarium, one for the pH probe and one for the light probe.

Once the experimental procedure has been established have the students go to "Investigation I".

Note: After the 24-hour period, each group should graph their own data. They are then asked to share the combined pH and light data so that it can be entered on other group's spreadsheet. This will provide them the data to graph each aquarium so that data can be compared and analyzed. It is left up to the teacher to determine the method of sharing the data (disk, print out, etc.).

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Additional Teacher Background

Carbon dioxide is more soluble (dissolves more easily) in water than oxygen. In a pond or stream, carbon dioxide enters the water from many different sources, including run-off from local terrain, the atmosphere, and rain. But the major source of carbon dioxide results when aquatic plants and aquatic organisms undergo respiration. If light is available, aquatic plants use the carbon dioxide to produce oxygen through the process of photosynthesis.

When the carbon dioxide becomes soluble, it combines with the water to produce a weak acid called carbonic acid. By observing the pH level for a 24-hour period, you can see the relationship between light and pH in an aquatic environment. If the amount of oxygen is high, generally the carbonic acid level is low in an aquatic environment. When light is present, aquatic plants produce more oxygen than the plants and animals can use. At night, when the light is absent, both the plants and animals use up the excess oxygen and produce carbon dioxide. This creates more carbonic acid at night, causing a decrease in pH. *Remember* , the stronger an acid, the lower the value on the pH scale.

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Monitoring an Aquarium Suggested Timeline

The amount of time you spend on introductory discussions, data collection, and analysis, will determine your overall timeline. The following represents a possible timeline.

- One class period - Introductory Discussion
- One class period - Investigation I: Setting up your aquarium
- One class period - Investigation II:Initial testing of your aquarium
- One class period - Investigation II:Monitoring a day in the life of your aquarium
- One class period - Analysis

Additional days can be used for further investigations.

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