ACTIVITY 12

WHEN THE HEAT'S ON

WHAT IS THE EFFECT OF TEMPERATURE ON THE RATE AT WHICH "COLD-BLOODED" ORGANISMS THAT LIVE IN WATER USE OXYGEN?

SCIENCE SKILLS:
- measuring
- organizing
- inferring.
- experimenting
- communicating

CONCEPTS:
- The temperature of the environment has a direct effect on the rate of oxygen use by "cold- blooded" living things.
- The warmer the environment is, the more oxygen "cold-blooded" organisms use.

MATH AND MECHANICAL SKILLS PRACTICED:
- use of dissolved oxygen test kits
- use of a thermometer
- averaging numbers

SAMPLE OBJECTIVES:
- Students will be able to interpret experimental data about the effect of temperature on the rate at which plants use oxygen.

INTRODUCTION:
This experiment spans two days of class. It can easily be set up during the first and completed during the second. Data analysis may take additional class time.

This activity examines the relationship between temperature and dissolved oxygen usage (respiration rate) in "cold-blooded" ectothermic organisms, which include plants as well as most animals except birds and mammals. If you have enough jars, this experiment can be done at the same time as Activity 11. All that is required is one more jar and set of plants per group and a cold place to leave them overnight. These instructions are written as a separate experiment.

MATERIALS:

For each group (minimum two groups):
- four quart or pint glass jars with wide screw tops; must all be the same size to compare results
- one big bunch of freshwater plants (*Elodea*, also called *Anacharis*, is the kind most commonly available from biological supply houses and pet shops); need six 6 inch strands per quart
- aged tap water at room temperature
- two brown paper grocery bags

Shared by class:
- dissolved oxygen test kits
- turkey baster or large syringe (see Recipes)
- refrigerator or ice chest

LESSON PLAN:

BEFORE CLASS: Set the water out ahead of time so that the chlorine will dissipate. When you use plants to test the effect of temperature on rates of oxygen usage, you avoid the possibility of hurting animals. The same kind of work could be done with any cold-blooded organisms living entirely in water, but aquatic animals may be very sensitive to temperature changes. Your results will depend to some extent on the temperature at which the plants have been maintained over the preceding weeks. They will be better if the plants have been in a warm (75°F) aquarium for several weeks. Also, make sure you use a yard of *Elodea* per quart or half that per pint.

DURING CLASS:

METHODS: Briefly review the results of the previous exercise in which students proved that things living in water used oxygen from the water. Do the students think that the temperature of the water might have an affect how fast plants and animals use oxygen?

Have the students ever heard an animal referred to as cold-blooded? Warm-blooded? Have them write what they think these terms mean. There are some very strange misconceptions about these words. Discuss what they mean. Does a turtle sitting in the sun by a pond on a hot summer day really have cold blood? No, it might be very warm to the touch. It can be more active when warm. Can you name some animals that move slower when it is cold outside? Flies, crickets, frogs are possible answers. Introduce the term ectothermic which comes from roots that meam warmth from outside.

Plants are ectothermic too. Would cold-blooded be a good name for them? No, since they do not have blood. Their rate of oxygen use (which is a measure of respiration) is temperature dependent just like the rates of fish and frogs. Could we set up an experiment to test the effect of temperature on the rate that plants use oxygen?

This experiment is similar to Activity 11 in design. Set it up the first day. Test the dissolved oxygen in the aged water and record the amount. Each group should have four jars full of water. Two are controls and will have no plants. The other two will have aquatic plants. The hard part is to get similar amounts of plant material in each jar. If you use Elodea, measure them, putting the same total length in each jar.

Try to make sure that the pieces have the same general health as well as length. Seal the jars and put them in paper grocery bags for darkness. Pick two different temperatures. One of them might be in a refrigerator or in an ice chest or outside on a cold (but not freezing) night and the other at room temperature. Each group of students will have two jars at room temperature and two in the cold. Leave overnight. If your classroom is allowed to get very cold at night, put the jars in an ice chest with a gallon jug of very hot water when you leave.

The following class day, test the dissolved oxygen level in each jar. Record the temperature of the water in each jug after the oxygen sample is taken. Calculate the difference between the test and the control at each temperature: control - test = oxygen used by the plants

RESULTS:

At which temperature was the most oxygen used? There should be a higher rate of use at higher temperatures. Why did we use a control at each temperature? Because temperature could have an effect on dissolved oxygen too, and we wanted to eliminate that as a cause of our results.

CONCLUSIONS:

Environmental temperatures have an effect on the rate at which ectothermic organisms use oxygen. Generally, the warmer the environment, the higher the oxygen usage.

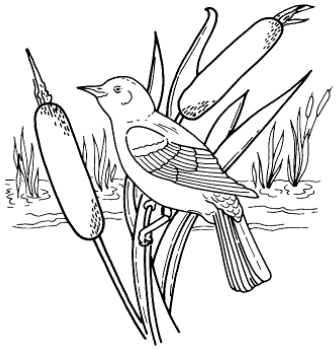
USING YOUR CLASSROOM AQUARIUM:

Add the Elodea to your aquarium.

Discuss with your students whether or not there are any warm-blooded animals in your aquarium. Can they name any warm-blooded animals that do live in fresh water? Beavers and river otters are two that come to mind.

EXTENSIONS:

1. Discuss the problems animals living in a small pond might have on a very hot day. In a crowded pond, they might exhaust the supply of oxygen. When would the problem be the worst? At the end of the night, because the plants would be using oxygen all night, but not making any with photosynthesis.



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Name Possible answers

Write what you think the word "cold-blooded" means: I think that this means that an animal has blood that is cold all the time just like I am warm all the time so I'm warm-blooded. But then how can plants be cold-blooded?

Note: You will get many such misconceptions here.

What question are you trying to answer by doing this experiment?

Do plants use more or less oxygen when they are warm versus cold?

The original amount of dissolved oxygen in the water was 9.4 ppm
Record the results of your experiment here:

temperature **dissolved oxygen in ppm**

	beginning	after 24 hrs	difference
cold plants temp. 5°C	9.4	5.2	- 4.2
warm plants temp. 25°C	9.4	1.8	- 7.6

Record the results for your class here:

-0.2 -0.4
+0.4 -0.2
-0.2 +0.2
-0.2 -0.2
-0.2 -0.6
-4.2 -7.6
-4.6 -8.4
-5.0 -7.8
-4.4 -7.4
-18.2 -31.2
4.5 7.8

difference in dissolved oxygen in ppm

	1	2	3	4	5	6	average
cold plants	-4.2	-4.6	-5.0	-4.4			-4.5
warm plants	-7.6	-8.4	-7.8	-7.4			-7.8

Based on the class results, what conclusion can you draw about plants' use of oxygen in the dark as it relates to temperature? Higher temperatures cause the plants to use more oxygen. Our teacher says plants are cold-blooded so higher temperature may make cold-blooded organisms use more oxygen.

Why do you think you added all the class results together and took an average fo your results? Because one group might make a mistake Also, the same thing has to happen over and over before it can be taken as a fact.