

**Effects of Temperature on Organisms**

**Time:** 2 class periods

**National Benchmarks:** Benchmarks 5A: Diversity of Life; 5D Interdependence of Life; 5E: Flow of Matter and Energy; 9B:Symbolic Relationships; 9D:Uncertainty; 12B:Computation and Estimation; 12D:Communication Skills; 12E:Critical-Response Skills.

**National Science Content Standards:** *Science as Inquiry: A; Life Science: C:* Biological Evolution; The Interdependence of Organisms; Matter, Energy, and Organization in Living Systems; *Science and Technology: E:* Abilities of Technological Design; Understandings about Science and Technology; *Science in Personal and Social Perspectives: F:* Population Growth; Natural Resources: Environmental Quality; Natural and Human-induced Hazards; Science and Technology in Local, National, and Global Challenges

**New York State Standards:** 1, 2, 3, 4, 5, 6, 7

**Objective:** Students will know how temperature affects an aquatic organism, and be able to graph results of an experiment looking at this change.

**Lesson Outline:**

1. Students will discuss what they know about global warming.
2. The teacher will set up a yeast and temperature demonstration.
3. Students will design an experiment to test the effects of different temperatures on a species of zooplankton.
4. Students will graph their results and discuss the implications as a class.
5. Students will observe the effects of different temperatures on the respiration of yeast.

**Materials:**

As a class:

- six plastic soda bottles
- six containers to hold the bottles
- six balloons, each filled with 1 teaspoon of yeast and 2 teaspoons of sugar
- water
- ice
- hot plate or other means of obtaining hot water
- thermometers

For each group:

- Daphnia magna* live specimens (each group should have access to 4-5 organisms)
- hot plate
- beakers
- water
- thermometer
- microscope and depression slides
- timer
- ice

**Engage:** Ask students what they know about global warming, and answer questions as appropriate. Brainstorm ways in which global warming might affect different species, including people. Ask students to think about the impacts of increased temperature on an aquatic species.

As a class, you will set up the yeast and temperature demonstration. To do this, fill each plastic water bottle about a third of the way with warm tap water. Place each water bottle in an appropriate water bath: it is recommended to do three temperatures (room temperature, ice water, and hot water) and a replicate of each. Then, take each of the six filled balloons and secure them over the top of the bottle. Invert the balloon and swirl it with the water inside of the bottle so that the yeast and sugar mix well. Allow the bottles to stand in their water baths for the rest of the period, examining them every 5-10 minutes and observing the change in size of the balloons. The balloons will fill with carbon dioxide from the respiration of the yeast.

**Explore:** Students will receive the materials above and will design an experiment to determine the effects of temperature on the heart rate of an aquatic organism (*Daphnia magna*). They should test at least two different temperatures and a control. Students should ask you for approval of their experimental procedure before conducting the experiment. Some students may increase the temperature above that which the *Daphnia* can survive (about 40 C); decide ahead of time with your students if they are comfortable with this possibility.

**Explain:** Temperature affects the metabolism of *Daphnia* since they are cold-blooded; consequently their body temperature will be the same as the temperature of the water they are floating in. The chemical reactions that occur in the cells of *Daphnia* are dependent on certain enzymes, or proteins, to help the reactions proceed. As you increase the temperature of the water, the metabolism of the *Daphnia* increases as well, because chemical reactions occur faster at higher temperatures. This means that the heart rate will speed up in order to provide oxygen to the cells as the metabolism increases. However, at 40 degrees Celsius, the enzymes break down, and the chemical reactions can no longer occur, so metabolism stops and the *Daphnia* dies. In its natural environment, *Daphnia* does not ever experience temperatures of 40 degrees, so this is unlikely to occur. However, they do experience changes in temperature in their natural environment, and their metabolism does increase or decrease as the temperature changes.

Temperature affects other organisms as well, and although you can measure stress on a larger animal, it would be unethical to test extreme temperatures. Discuss with students what might happen to other animals in a warmer ecosystem, beyond the effects on heart rate. What might happen to phytoplankton or zooplankton populations? Ask students to think about how growth rate increases with temperature, and whether there is an upper limit to what both plants and animals can tolerate. What about the animals that depend on these species? This lesson leads well into Lesson #3, "Long-term temperature changes in the Hudson River".

**Extend:** Students could also test the effects of temperatures on a plant, such as lettuce seeds, and measure the root hair growth of those that have germinated.

**Evaluate:** Students should create a graph of their results and discuss it with the class.

**Comments:**