



The Effects of Water Temperature Change on Goldfish Physiology and Behavior

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THE EFFECTS OF WATER TEMPERATURE CHANGE ON FISH PHYSIOLOGY AND BEHAVIOR

SUGGESTIONS FOR TEACHERS

Purpose

To determine the effects of water temperature on physiological and behavioral changes in fish.

Objectives

Upon completion of this activity, students will be able to:

1. Design an experiment to measure the effects of changing water temperature on fish respiration (guided with teacher, with set parameters).
2. Design a second experiment examining the relationship between water temperature and another approved physiological or behavioral variable
3. Create a poster to be displayed in a poster session communicating the results of the experiment in a manner that is appropriate for the audience
4. Conduct an experiment demonstrating proper maintenance and care of live animals

Note: Teachers can choose to do either part 1, 2, or both, depending on the level and needs of your students.

Materials

Class: A functioning aquatic environment

Two large beakers or bowls, one with heated aquarium water and one with chilled water.

Several thermometers for the warm and cold water baths and testing beakers/cups

Several beakers (must be cleaned without soap) or clear plastic cups

Individual groups:

Two fish per group (rough estimate)

A timing device

All of the above materials will be needed for Part 2, plus whatever is deemed appropriate for each groups' experiment. For behavioral studies, additional (temporary) fish tanks may need to be set up.

Preparation and Procedures

Part 1: (Guided) The Effect of Water Temperature on Fish Respiration.

Students should be familiar with proper care and maintenance of the fish prior to beginning the lab. Students should also know the difference between temperature maintenance in warm- versus cold-blooded organisms. Fish respiration can be clearly seen either by watching a fish's mouth or gill movement. Students will count the number of respirations while placing the fish in cups using water of varying temperatures.

The class will collectively determine a hypothesis and the procedures for the question of "how does water temperature affect fish respiration?" Break students up into groups of four with the Part 1 Student Data Sheet. Students will need to plan the procedures for the experiment.

The parameters for the experiment include the following:

- all fish must stay alive
- each fish can stay out of water for a maximum of 30 seconds
- each fish must have at least 4 minutes of recovery time in its normal water temperature before it is used again in another student's data
- water temperatures can range from 60 to 85 degrees F, depending on the species of fish - know the temperature limits of your fish!

The Water System:

Students must devise a system so that fish are not out of the water for more than the 30 second limit, and that the same fish is not used repeatedly over a small space of time, violating the recovery time rule. Most likely fish will have to be isolated in beakers (or other cups) and time recorded on the beaker so adequate recovery is ensured for each fish. Keeping them isolated also allows you to number and identify each fish. Hot and cold sources of water will need to be established. Using only water from the tank, warm the water on a hot plate and set up a cold water bath in separate beakers. For the testing environments, mix either some hot or cold water in with regular tank water in a cup or beaker and note the temperature prior to introducing the fish to the new temperature.

After 15-30 minutes of group discussion, review procedural ideas and together pick and choose ideas to formulate the best plan. There are many possibilities for the exact procedures to this lab. Let students assist in deciding which procedures will contribute best to a successful experiment. Make sure a control is included and discuss confounding variables. Begin writing a class poster together, with question, hypothesis and procedures. The poster can be used as a referent during the experiment and for future lab activities.

During the experiment, students should work in pairs to collect and record data. It can be difficult to count respirations and is therefore important that students are patient and calm. Agitation in the room can affect respirations and behavior. All data should be noted on the Part 1 Student Data Sheet. Students can pick set temperatures, such as 65, 75 and 80 degrees F or collect data at a full range of temperatures. If the latter is chosen, a line graph would be most appropriate to determine if there is any relationship between the temperature and breathing. At the completion of the data collection, a data chart and line graph can be completed on an overhead projector with all data points. Finish the class poster with the chart, line graph, conclusion, sources of error and ways to improve the lab.

Part 2: The Effect of Water Temperature on Physiological or Behavioral Changes in Fish

All of the previous parameters stated in Part 1 should be followed in Part 2. In this part students choose their own dependent variable to be measured against changes in water temperature. Possible ideas include changes in feeding behavior, movement in the tank, interaction with other fish, fin movement, changes in circulation or any other feasible ideas posed by the students. If a student chooses to examine changes in circulation, data will be qualitative and not quantitative. Blood movement can be clearly seen in the tail vessels when the tail is spread out under a light microscope, but there is no measurable pulse. Blood movement is continuous. The fish will need to be wrapped in water-soaked gauze and partially immersed in a petri dish with the tail exposed and spread out under the lens. All ideas need to be written up in the Student Proposal Sheet and approved prior to any experimentation.

In groups of two (depending on class size), students will collect data for their experiments and complete their Data Sheets. At the completion, each group must design and make a poster to be presented at a poster session to share information gained through the experiments. Students should follow the grading rubric used in Part 1.

Safety

Students should demonstrate and abide by all regular safety policies established in the classroom.

Regarding the use of the fish, all procedures designed in parts 1 and 2 must receive approval from the teacher. See reference 6 for instructions to establish and maintain your fish tank. See reference 5 for protocol for proper care and use of live animals for laboratory purposes.

Questions to Ask

1. How do warm- versus cold-blooded animals maintain temperature homeostasis?
2. Predict how human respiration changes with severe temperature changes. Research your answer (vital signs and hypothermia).
3. What are some adaptations that allow fish to benefit from a water environment?
4. How does fish circulation compare with human circulation?
5. Compare different adaptations for the bottom and top dwellers in your tank (if you keep a variety of fishes).
6. Why is it important for the experiment and the fish to have the “recovery time” during which they are allowed to return to their normal water temperature?
7. Why do the fish require a constant supply of fresh water over their gills?
8. What other variables could be affecting your fish in Part 2 of the experiment?
9. What is the purpose of the control in this experiment?

Where To Go From Here

Part 2 is a natural continuation of Part 1 in this activity. If a teacher chooses to use Part 1 only of the lab, it can be integrated into either a physiology or adaptation unit. If it is included with an adaptation unit, students can play an active role in setting up the tank and choosing an appropriate mix of fish which can share a common space. If it is used as part of a physiology unit, the principles and parameters for designing an experiment with fish or other live animals (including humans) can be used again pertaining to other body systems. Students may have other questions related to the aquatic environment, such as preferred light conditions in the tank. Any logical ideas or questions could be used for an experiment. The grading rubric can be used for any lab throughout the year.

References and Resources

1. <http://www.marinebiology.org/fish/htm> ("Fish: A Quick Course on Ichthyology")
2. <http://www.faradic.com/~ranma/fish.htm> ("Fish of the Shore")
3. <http://www.belmont.edu/Science/Biology/Bio112/27-Fishes.html>
4. <http://www.msccserver.cox.miami.edu/msc111/Smith4.htm>
5. National Research Council: Institute of Laboratory Animal Resources Commission of Life Sciences (1996) Guide for the Care and Use of Laboratory Animals: National Academy Press, Washington, D.C.
6. Sweeney, Mary Ellen (1995) Aquariums For Your New Pet: T.F.H. Publications, Neptune, N.J.

Suggestions for Assessment

Part 1 Assessment:

Each group will be required to fill out the Student Data Sheet. After each group has completed its Data Sheet, the class will collectively prepare one poster, which includes all data, averaged where appropriate. Back in the original groups, students can determine the class grade using the lab scoring rubric. The teacher can choose to discuss variations in grades and/or average the grades students determined.

Part 2 Assessment:

Each group will produce a poster showing the results of its experiment. It should follow the grading rubric and include all parts. This poster will be presented to the other groups, or any other audience.

STUDENT DATA SHEET

PART 1: TEMPERATURE AND RESPIRATION

Goal: Your group is to brainstorm ideas for how to carry out an experiment to measure the effect of temperature changes on fish respiration. A fish's number of respirations per minute can be seen easily counted by watching its mouth or gill movement.

Group Members:

Parameters for Temperature and Circulation

- all fish must stay alive
- each fish can stay out of the water for a maximum of 30 seconds
- each fish must have at least four minutes of recovery time in its normal water temperature before it is used again in another student's data
- water temperatures can range from 60 to 85 degrees F.

Hypothesis

What do you think will happen?

Why? (Use your information about temperature homeostasis for warm- and cold-blooded animals)

Materials Needed

Ideas for Procedures (each group)

How will you keep track of individual fish?

How will you change the temperature of the water?

How will you ensure the fish get 4 minutes of rest between trials?

Summarize all of your procedures, from start to finish:

Agreed Upon Procedures After Class Discussion

Data and Observations

Fish Number	Water Temp.	Respirations	Observations

How will your graph be organized to clearly show the data?

Analysis/Conclusion (address your hypothesis)

Presentation:

Your group will make a poster describing all aspects of this experiment. It must include an introduction, hypothesis, procedures, data and results, conclusion and sources of error/improvements.

STUDENT DATA SHEET

PART 2: PROPOSAL FORM FOR INDEPENDENT RESEARCH

Goal: In this experiment, you will test the effects of water temperature on some other variable of your choice. The water temperature is your independent variable and the other behavioral or physiological change you choose will be the dependent variable. What effects do you think water temperature might have on the fish?

Group Members:

Parameters for Care of the Fish:

- all fish must stay alive
 - each fish can stay out of the water for a maximum of 30 seconds
 - each fish must have at least four minutes of recovery time in its normal water temperature before it is used again in another student's data
 - water temperatures can range from 60 to 85 degrees F.
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1. What is your research question?

2. What is your hypothesis?

3. What resources do you have to support your hypothesis? (Attach relevant research)

4. What materials will you need?

5. What are your tentative procedures?

6. Do you have a control? Explain how you will include a control in your experiment?

7. Approved _____
Not approved _____

Comments:

PART 2 STUDENT DATA SHEET

Question:

Design an organized method to collect and display your data (chart):

Plan what type of visual summary (graph) will best show your results. Draw a quick sketch of what will be on the x- and y-axes, (labeled with units) as well as the graph title:

Assessment:

Your group will make a poster describing the answer to your research question. It should include a purpose, hypothesis, materials, procedures, data/ results, conclusion and sources of error/improvements. Follow the grading rubric to know exactly what is expected.

EXPERIMENTAL DESIGN GRADING RUBRIC

AREA	CRITERIA FOR ASSESSMENT	POSS. PTS	PTS EARNED	COMMENTS
Problem	Clearly stated Stated as a question	5		
Background Research	Research attached Research properly referenced Research addresses the question Research leads to a hypothesis	10		
Hypothesis	Hypothesis is stated Hypothesis answers problem Research supports hypothesis	5		
Experimental Design	Lists materials, proper amounts Procedure written clearly; can replicate Procedure in logical order Identifies variables Includes repetitions if applicable	20		
Data Recorded	Variables are labeled Measurements use appropriate units Chart/table logical and organized	10		
Data Display	Graph is properly labeled Graph contains a key All data is represented Relationships are shown clearly Appropriate choice of graph type Scale on graph in equal intervals	10		
Analysis/ Conclusion	Data support the conclusion Conclusion addresses hypothesis Analysis is logical Includes possible sources of error Includes ways to improve design	20		
Presentation	Poster is neat and logical Visuals are clearly displayed All members participate with poster All members participate in presentation Shows planning and organization	20		

