Science Unit: *Animal Growth and Changes*
Lesson 2: *How Does Temperature Affect Animals?*

School Year: 2012/2013

Developed for: Hastings Elementary School, Vancouver School District

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Grade level: Presented to grade 2/3; appropriate for grades 1 – 7 with age appropriate modifications

Duration of lesson: 1 hour and 20 minutes

Notes: Brine shrimp (*Artemia*) can be used in place of *Gammarus*. Brine shrimp eggs are easier to get as they can be purchased at most pet food stores and are easy to hatch and grow into adults. This requires several weeks of advance planning. The main difference between the two organisms is that brine shrimp live in saltwater while *Gammarus* live in freshwater. The *Gammarus* used in this experiment were graciously donated by the Biology 140 program at the University of British Columbia. Live *Gammarus* can also easily be obtained from a local pond.

Objectives

1. Explore how temperature affects ectothermic organisms.
2. Gain experience using the scientific method.
3. Practice making and recording observations.

Background Information

Ectothermic organisms cannot regulate their body temperature and thus their internal temperature varies with that of their environment. Some examples of ectothermic animals include insects, fish, amphibians and reptiles. Conversely, endothermic organisms are able to maintain their body temperature despite fluctuations in the temperature of the surrounding environment; this is because they can generate heat through internal processes.

The body temperature of aquatic animals such as *Gammarus* and *Artemia* depends directly on the temperature of the surrounding water. This is biologically important because temperature affects the rate of chemical reactions, including those that occur inside living organisms. In general, higher temperatures increase reaction rates while lower temperatures decrease reaction rates. Consequently, the metabolic rate of ectothermic animals will increase as their environmental temperature becomes warmer resulting in increases in biological processes such as heart rate, breathing rate and digestion. (This is one reason why reptiles can be seen basking in the sun after eating, they are trying to increase their body temperature to aid digestion.) In addition to increasing heart rate, warmer temperatures will also increase the contraction rate of other muscles allowing animals to be more active and move more quickly. In this lesson students will do an experiment to determine how water temperature affects the movement of an ectothermic, aquatic animal.

Vocabulary

Ectothermic animal: An animal that cannot regulate its own body temperature.

Endothermic animal:	An animal that uses internal mechanisms to regulate its body temperature.
Variable:	Anything that can affect the results of your experiment.
Cryoprotectant:	A substance used by some animal that live in cold environments to prevent their blood and other body fluids from freezing.

Materials

- *Gammarus* or other small, motile aquatic invertebrates (1 per student)
- Large plastic pipettes and/or small spoons for transferring organisms
- Overhead transparencies cut into 150mm diameter circles (1 per students)
- 150 mm diameter Petri plates (1 per pair)
- Thread or thin twine
- Masking tape
- Thermometers
- Stopwatch(es)
- 2 small clear vials/jars (for demo)
- Freshwater at 5-10°C
- Water soluble markers
- Syrup or coconut oil (for demo)
- Freshwater at room temperature
- Rulers with mm markings
- Paper towels
- Measuring cup with ml markings
- Tape and scissors (optional)
- Worksheets and pencils
- Document camera (optional)

In the Classroom

Introductory Discussion

1. Today we are going to talk about one of the variable we practiced measuring last week, temperature.
    - Does anyone remember what their body temperature was from last week? (37°C) What about the temperature of the classroom? (22°C)
    - Last week we talked about how people and some other animals are able to control their body temperature and so their body temperature stays the same even in a colder environment…but not all animals are able to do this. Some animals have body temperatures that change when the temperature of their environment changes (ask for examples – insects, lizards, amphibians, crustaceans etc.). These types of animals are called **ectothermic** animals (teacher can write vocabulary on board with definitions). Ectothermic animals cannot regulate their body temperature like we can so their body temperature changes with the environmental temperature.
    - Today we are going to do an experiment to explore how temperature affects ectothermic animals.
    - We are going to use freshwater shrimp, also called *Gammarus*, for our temperature experiment. Gammarus are small freshwater organisms that can be found in lakes, ponds, streams, ditches etc. in BC.
    - Place dish of gammarus on document camera and briefly describe them, or use images on a smartboard.
    - Since freshwater shrimp are ectothermic their body temperature changes when the water temperature changes.

- What happens when the water changes temperature? What about when it gets colder? ***If the water temperature gets colder then their body temperature gets…?*** (ask students to finish the sentence) [colder] How do you think this affects them? [briefly discuss one or two ideas]
- Let's find out!
- Remind students that living organisms need to be treated with respect.
- Students may wish to refer to the *Thinking like a Scientist* handout (introductory activity from this unit).

2. Description of science experiment/activity:
   - Students will do an experiment to determine how temperature affects the activity level of gammarus, an aquatic invertebrate. They will use the distance that gammarus swims in a set time period as a measure of its activity.
   - Students will place a piece of clear acetate (overhead transparency) over the lid of their Petri dish and use a water soluble marker to trace their gammarus' movement over a 3 minute period.
   - Students will then lay a piece of thread along their line and measure the length of the thread (in mm) with a ruler to determine how far their gammarus swam. Younger students will skip this step and instead simply compare the tracings made at the two different temperatures.
   - The above procedures will be repeated for each replicate.
   - Each replicate should be done on separate transparencies or with a different colored marker so that comparisons can be made.
3. Processes of science that the students will focus on: Students will focus on making and recording measurements.
4. Safety guidelines:
   - Treat living animals with respect.
   - Wash hands after the lesson and before eating.
   - Be careful not to drop the thermometers or let them roll off the desk as they can break.

Science Experiment

<u>Experiment Title</u>: How does temperature affect aquatic organisms?

<u>Purpose of Experiment</u>: To determine how water temperature affects the activity level of aquatic invertebrates.

<u>Experimental Treatments</u>: Water temperature

Test treatment 1	Warm water: (approximately) 20°C – room temperature
Test treatment 2	Cold water: (approximately) 5-10°C,

<u>Prediction or Hypothesis:</u> I think gammarus will swim farther in ________ water. Students will fill in the blank with either warm or cold based on their own personal prediction.

<u>Methods and Instructions:</u>
Set-up prior to experiment: Heat/cool jars of freshwater to the desired test temperatures. Similarly one group of gammarus should be acclimated to each test temperature. Note that if tap water is used it should be left out in an open container for several days prior to use to allow the chlorine to dissipate. A better

option is to collect pond water when the gammarus are collected. To save time, if enough Petri dishes are available, one gammarus can be placed into each Petri dish ahead of time.

Brief description of how students will work in groups or pairs: Students will work in pairs to conduct this experiment. The results from all pairs will be pooled as a class.

1. Each pair will receive one gammarus in a large Petri dish (150 mm diameter) with a lid. The dish will initially be filled with room temperature seawater.
2. Follow the detailed instructions on the worksheet.
3. Students will be given a 3-5 minutes to observe their gammarus and record how it moves (on their worksheet).
4. Use the document camera to demonstrate how students will make their measurements: Students will place a piece of clear acetate (overhead transparency) over the lid of their Petri dish and use a water soluble marker to trace gammarus' movement over a 3 minute period. Small pieces of masking tape can be used to help hold the transparency in place. [OPTIONAL] Students will use thin twine or thread to determine the length of their line and then measure the length of the thread (in mm) with a ruler. Have students practice tracing gammarus' movement with their finger for a few seconds. [Younger students can simply compare the tracings made at each temperature]
5. Discuss some of the variables that must be controlled for in this experiment (write on board) and have students record them on their worksheets.
6. Have students record which team member will conduct which replicate on their worksheets (teacher can decide or can flip a coin).
7. Have students measure and record the temperature of the water prior to each replicate.
8. For younger students, the scientist or teacher will act as the timekeeper and the class will conduct their replicates simultaneously. For older students the partner not performing the measurements can act as the timekeeper.
9. Both students will conduct their warm replicates before measuring the length of the organism's path. The student can use two different transparencies or use two different colors of marker.
10. Once both warm replicates have been completed older students can use the thread and their rulers to determine the path length. They may wish to use small pieces of tape to help hold the thread in place. While students are doing this, the scientist can collect the organisms and prepare the cold replicates. Younger students can skip this step and just visually compare their warm and cold tracings.
11. Each Petri dish will have the same amount of cold water poured into it and a new test organism (from the cold acclimated group) placed into it.
12. Students will repeat the measurements in cold water as above.
13. Younger students will compare the two tracings they made and decide if the gammarus swam further in warm or cold water. The teacher or scientist can make a tally of each student's results on the board. For older students who want to measure the distance swam, the teacher or scientist can record the measurements of the class as a whole and graph them (scatterplot).

Closure Discussion

1. What results did your team of scientists find? Have students raise their hands in turn if their team's results indicated more activity (i.e. farther distance swam) in cold water or warm water.

2. Discuss why everyone did not find the same results (variation in organism's behaviour – may have been frightened, hungry, tired etc.). Remind students this is why we do replicates, especially when we work with living organisms. Relate it back to the height experiment in Lesson 1.
3. Why do you think ectothermic organisms are less active at low temperature? What happens to you when you get cold? Has anyone ever jumped into a really cold lake or river? How did you feel? Was it easy or hard to swim? How long did you stay in?
4. Why does cold make us move slower or want to move slower?
5. Let's think about how cold affects things. Does anyone store syrup in their fridge? What happens to it when it gets cold and you try to pour it? (Thick and slow moving). What about when it gets hot? (Thin and runny)
6. DEMO: Demonstrate the above concept with two small jars/vials – one with cold syrup/corn syrup/coconut oil (from fridge or on ice) and one in your pocket at body temperature. Discuss how this can affect how an organism functions.
7. Why do you think gammarus swam farther in warm water? (Record answers on worksheet)
8. How do you think ectothermic animals live at REALLY cold temperatures? What about an animal like the Antarctic midge (show picture on document camera if available) The Antarctic midge is a type of wingless fly that lives in Antarctica. It is only 7mm in length as an adult. Grab your rulers and see how big that is. This insect lives in Antarctica, the coldest place on earth where the temperature ranges from -50°C to -3°C during the winter months. How in the world does it survive in Antarctica? Is that cold enough to freeze animals (colder than your freezer with frozen meat and ice cubes). Can an animal live/move if it is frozen? Discuss how some animals use **cryoprotectants** to prevent their blood and other body fluids from freezing. See extension activity.
9. Remind students that they may see gammarus on the upcoming pond fieldtrip.

References

1. <http://www.units.muohio.edu/cryolab/education/antarcticbestiary_terrestrial.htm> Antarctic Bestiary, Terrestrial Animals. [Information of Belgica Antarctica] Accessed January 31, 2013.
2. <http://antarcticsun.usap.gov/science/contentHandler.cfm?id=2018> Peter Rejeck. The Antarctic Sun, Not much bugs Belgica. Website hosted by the United States Antarctic Program [Information on Belgica Antarctica.] Accessed April 1, 2013.

Extension of Lesson Plan

How do cryoprotectants work?

Cryoprotectants increase the osmolarity of blood and other body fluids, lowering the freezing point. This is the same way that antifreeze works in a car's radiator. Animals as diverse as insects, frogs and fish, have been shown to use cryoprotectants to increase their ability to live at cold temperatures. Cryoprotectants used by animals include sugars (glucose, sucrose), alcohols (glycerol, sorbitol, ethylene glycol) and proteins.

Student can do a simple experiment at home to see a demonstration of cryoprotection in action:

Materials:

- Water
- 1 tbsp salt
- Small bowl or glass

- Spoon
- An empty ice cube tray
- Measuring cup (1/4 cup)
- Freezer

Pour ¼ cup of water into a cup and add 1 tbsp of salt. Use the spoon to stir it really well until all the salt dissolves. Pour the resulting mixture into one section of an empty ice cube tray. Fill another section with plain water. Place the ice cube tray in the freezer and check the consistency of each cube every 20-30 minutes.

Alternatively the teacher or scientist can prepare a demonstration in advance by freezing plain water in one ice cube tray and water mixed with a clear alcohol (such as vodka) in another tray. This is a better example as the alcohol and water cube will stay slushy indefinitely, even after a prolonged time in the freezer. The consistency of the two cubes can be easily compared. For a more detailed demo a series of cubes can be made with increasingly greater proportions of alcohol until such time as the mixture remains liquid when frozen overnight.

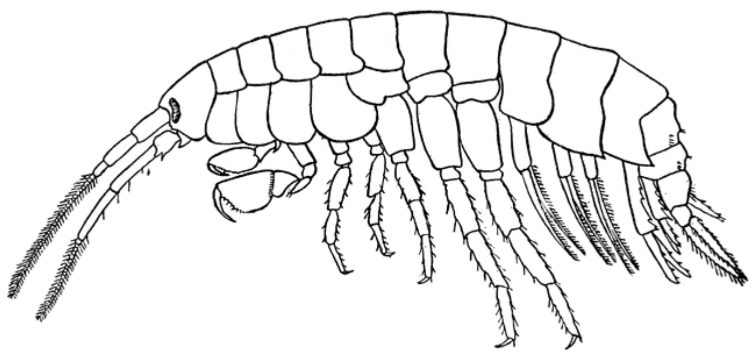
Scientist Name:___________________________

Date:_______________________________

HOW DOES TEMPERATURE AFFECT ANIMALS?

Study Animal

freshwater shrimp (gammarus)



Credit: FCIT http://etc.usf.edu/clipart/

Describe how gammarus moves:

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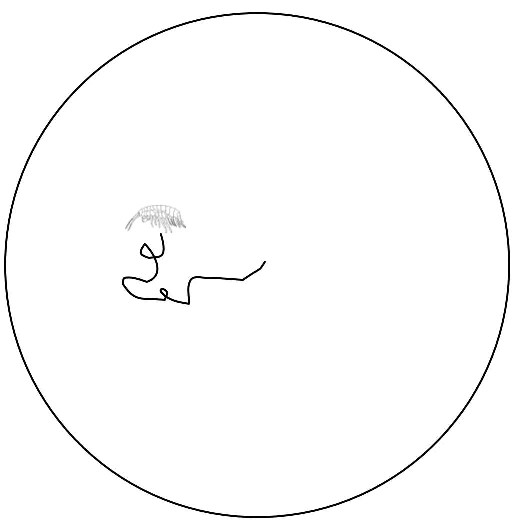
Question: Does water temperature affect how far gammarus swims?

Hypotheses: I think gammarus will swim farther in ____________________ water.

Experiment:



List some of the **variables** in your experiment.

Circle the variable you are testing.

Temperature__________________________

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____

____

Record the distance gammarus swims at each temperature

Replicate	Scientist's Name	Temperature	Distance (mm)
Warm 1			
Warm 2			
Cold 1			
Cold 2			

Conclusions

Based on your results, does gammarus swim farther in cold water or warm water?

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Based on the results of the whole class, does gammarus swim farther in cold water or warm water?

____

What are some reasons why gammarus might swim farther in ____________ water?

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