Pinniped BODY SHAPE
Does it conserve warmth?

T E A C H E R

Activity Overview

To survive in cold ocean environments an organism's body must be adapted to life under water. A body will cool very quickly when in contact with water. The body shape of an organism is one adaptation that helps to conserve warmth.

Students will learn how a pinniped's body shape is adapted to conserve warmth by simulating pinniped and human body shapes using plastic or latex gloves. Students will use a Temperature Sensor to measure and graph changes in temperature of a pinniped body and a human body when plunged into ice water. The temperature sensors are connected to a TI CBL 2™ or Vernier LabPro and a TI-73 Explorer™.

Conclusion: Pinniped body shape helps conserve warmth by minimizing the surface area in contact with the cold ocean waters.

Activity at a Glance

Grade: 4-9
Subject: Science
Category: Physical Science, Life Science
Topic: Heat, Physical Properties, Animals, Living Things, Adaptation

Time Required

- One 45-minute period

Level of Complexity

- Medium

Materials*

- TI-73 Explorer™
- TI CBL 2™ or Vernier LabPro
- TI-73 DataMate
- 2 Temperature Sensors
- Plastic tub (about 30 cm X 60 cm)
- Ice cubes
- Cold tap water
- Warm tap water
- Stopwatch
- 2 Plastic or latex gloves
- String

TI-73 Explorer™

Temperature Sensor

* This activity has been written for the TI-73 Explorer™ but you can easily substitute the TI-83 or TI-83 Plus. Also see Appendix A for steps on how to transfer DataMate to your graphing device and how to use DataMate for data collection.

JASON

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Concept Background

- The less surface area a body has, the less heat it will lose when under water.
- Animals that live in colder regions generally have rounder body shapes and smaller ears, feet, tails, and noses. These parts increase the surface area and can lose heat rapidly.
- Pinnipeds are big but they are shaped to minimize surface area. They do not have many nooks and crannies that can lose heat.
- Blubber does more than keep pinnipeds warm. It helps to streamline their body shape.
- On land, pinnipeds' lack of mobility has made them vulnerable to hunters and, in frozen regions, to polar bears. Pinnipeds are also sometimes eaten by killer whales just as they are emerging from the surf onto the beach.

Preparation and Classroom Management Tips

- Warm the water for the bodies to a temperature above 40°C
- Create an ice bath that has a temperature below 5°C.
- The starting temperature in the pinniped and human gloves should be very close.
- Adding equal amounts of water to the gloves makes the volume of the *Pinniped* and *Human Body* the same. This is an important variable to control in the experiment.
- The amount of water used is important. Use as much water as possible. However, using too much water will cause water to overflow and spill when tying. If too little water is used, there will not be enough water in the middle of the *Human Body*.
- Students need to be careful not to spill any water when inserting Temperature Sensors and tying off the gloves.
- Caution students to keep the temperature probe in the middle of the gloves and out of the fingers of the human body.
- Latex gloves may be easier to use than plastic because they can expand.
- Caution students not to puncture the gloves with the temperature probes.
- Discuss with students the disadvantage of the pinniped's body shape. They lack mobility when on land making them vulnerable to predators and hunters.
- This activity works well with students working in groups, or as a demonstration.
- The activities *Pinniped Body Shape – Does It Conserve Warmth?*, *How Does Blubber Work?, and Can You Breathe Like a Pinniped?* explore pinniped adaptations. These activities can be set up as stations in your classroom simultaneously. Have students rotate between stations to complete each activity.
- Encourage students to answer the questions in Data Analysis in their journal.

National Education Standards

Science Standard A: Science As Inquiry

Students should understand scientific inquiry and develop abilities necessary to perform it.

Science Standard C: Life Science

Students should develop an understanding about the structure and function of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and the diversity and adaptations of organisms.

Math Standard: Data Analysis & Probability

Students should develop an understanding about how to collect, organize, display, and interpret data.

English Language Arts Standard 3

Students should apply strategy to comprehend, interpret, evaluate, and appreciate text.

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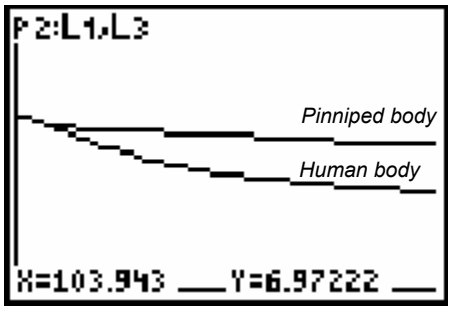
- Create your own student questions for use on your students' TI graphing devices using the Texas Instruments StudyCard applications.

Data Analysis



Sample graph

1 Q. Draw a sketch of the graph created by your graphing device. Label *Pinniped Body* the curve that represents the temperature for the Pinniped glove. Label *Human Body* the curve that represents the temperature for the human glove. *(Note: P1 represents the sensor connected to CH1 and P2 represents the sensor connected to CH2).*

A. *Answers will vary. The students should sketch a graph similar to the sample graph above.*

2 Q. By observing your graph how does the temperature in the *Pinniped Body* change during the four-minute period?

A. *The temperature in the Pinniped Body decreases slightly. It decreases slower than the temperature in the Human Body.*

3 Q. By observing your graph how does the temperature in the *Human Body* change during the four-minute period?

A. *The temperature in the Human Body decreases significantly. The decrease in temperature in the Human Body is greater than the decrease in temperature in the Pinniped Body.*

4 Q. Copy Table 1 into your journal.

5 Q. Record the temperature of each glove at the beginning of the experiment in Column A of the table (x = 0).

A. *Answers will vary.*

6 Q. Record the temperature of each glove at the end of the experiment in Column B of the table (x = 240).

A. *Answers will vary.*

Vocabulary

Adaptation A physical feature or ability, developed over many generations, that helps a species survive in its environment.

Carnivore A flesh-eating animal.

Double migration Two annual round trips made by the northern elephant seal between its feeding grounds in the north Pacific and the Channel Islands.

Molt To shed the skin, fur, or feathers periodically. Northern elephant seals are said to do "radical molting" because their skin comes off in sheets.

Otariid Any of approximately 14 species of pinnipeds, including the California sea lion, that have outer ear flaps and hind flippers that can be rotated underneath the body.

Phocid Any of approximately 19 species of pinnipeds known as "true seals," including the northern elephant seal. Phocids do not have extended earflaps. They do not use their flippers for moving on land. Instead they wriggle from side to side or hunch their bodies like caterpillars.

Pinniped A walrus, sea lion, or seal.

Surface area A measure of the number of square units needed to cover the surface of the object.

Taxonomy The science of classification and categorization of living things. Linnean taxonomy categorizes all plants and animals into the following seven subgroupings, each more specific than the one before: kingdom, phylum, class, order, family, genus, species.

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7 Q. Find the change in temperature by subtracting Column B from Column A (A-B). Record the change in temperature for each glove in Table 1.

A. *Answers will vary.*

8 Q. Which body shape had the greatest change in temperature?

A. The Human Body had the greatest change in temperature.

9 Q. Which body shape had the least change in temperature?

A. The Pinniped Body had the least change in temperature.

10 Q. A body shape with nooks and crannies will have a greater surface area than a body shape that does not have nooks and crannies. Which body shape had a greater surface area, *Pinniped Body* or *Human Body*? Explain.

A. The Human Body has more nooks and crannies and therefore it has a greater surface area.

11 Q. Knowing that you added equal amounts of water to both gloves, what caused the different rates of cooling in the *Pinniped Body* and *Human Body?*

A. *Since equal amounts of water were added, the volume of the two bodies was the same. Differences in surface area resulted to a greater temperature drop in the Human Body than the Pinniped Body. Therefore, the Human body cooled faster than the Pinniped Body. The surface of the Pinniped Body has less surface area and conserves warmth better than the Human Body.*

12 Q. Human bodies have arms and legs while pinniped bodies lack these body parts. Explain how this adaptation helps keeps a pinniped warm?

A. *Arms and legs increase the surface area of a body. A body with less surface area will conserve more heat when in contact with cold water.*

13 Q. If the experiment was an hour long rather than 4 minutes long, what do you think would have happened to the temperature of the ice water, the *Pinniped Body*, and the *Human Body*?

A. *The temperature of the ice water would increase. The Pinniped Body and Human Body temperatures will also increase. Given enough time, the water temperature, Pinniped Body temperature, and Human Body temperature would be equal.*

14 Q. Based on your data, which will keep your hands warmer, gloves or mittens? Explain.

A. Mittens will keep your hands warmer because there is less surface area in contact with the cold air.