LIFE IN THE COLD: CLIMATE CHALLENGES

Summary

Students study polar bear adaptations to the cold arctic climate. Older students create models of two arctic animals to learn about adaptations for climate based on body form.

Grade Level:

3-5; K-2; 5-8

Time:

one to two class periods.

Subjects:

math, science, language arts

Skills:

analysis, application, classification, problem-solving, critical thinking, comparison, construction

Learning Objectives:

Students will be able to:

- ✔ Identify and explain polar bear adaptations to extreme arctic climate and conditions and extrapolate these adaptations to other cold climate animals.
- ✔ Apply the challenges of the arctic climate, particularly extreme cold, to human adaptation and survival in the arctic.
- ✔ Explain the connection between amount of body covering and change in temperature due to varying climate conditions. (5-8)
- ✔ Calculate a surface area to volume ratio (5-8)

Materials:

- ✔ Picture of a polar bear; ice, bucket, vegetable shortening, zip-lock bags; dress up items (see chart below - one set for the class or multiple sets for small group work); large box, milk crate, or bag.
- ✔ (5-8): scissors, tape, photos or illustrations of the arctic fox, kit fox, jackrabbit, snowshoe hare, lemming, elephant.
- ✔ Copies of student activity sheets for polar bear and lemming.

Materials, continued:

Item	Represents
One down coat *(or other warm coat)*	thick fur
One white sheet or doctor's lab coat	camouflage
One black sweater or T-shirt.	black skin
A pair of extra-large mittens	large paws
Two large pieces of bubble wrap	surface of polar bear feet
A nose-clip	ability to close nostrils under water
A pair of swim goggles	ability to see clearly under water
Tube of petroleum jelly (Vaseline).	oily fur for quick swimming
Binoculars	powerful eyesight
A fish net and butter knife (for safety)	claws/big paws for catching food
A pocket knife (or butter knife, for safety)	sharp teeth
A stick of butter or wet suit	blubber

Include a few "wild card" items, things that are not useful in the arctic and do not apply to a polar bear, such as flip-flops, bathing suit or tank top.

Background

Animal species inhabiting the arctic tundra have evolved special adaptations that enable them to survive in an ecosystem that is dramatically different in the summer than in the winter. Due to the high latitude of the arctic and the tilt of the earth, the arctic experiences light and temperature extremes in a calendar year. Temperatures range from 60° F (50° C) in the winter to 77° F (25° C) in the summer. In Barrow, Alaska, there is a 67-day-long period of darkness beginning November 18, and May 10 starts an 84-day-long period of light.

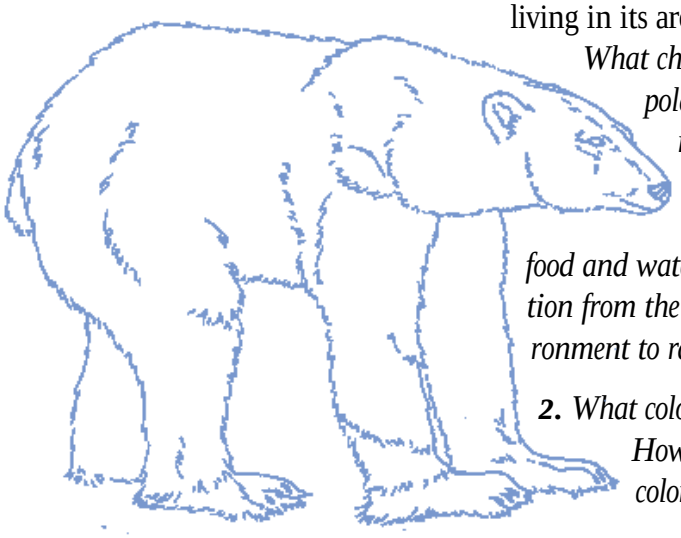
There are many ways arctic species are adapted to their unique habitats. Many species have thick layers of fat and heavy fur coats. Several arctic species change color with the seasons to blend in with the changing ground cover—arctic fox and rock ptarmigan, for example. Some species hibernate, including ground squirrels and grizzly bears. Insects lay eggs in summer when the ground is soft and larvae are adapted to survive freezing temperatures. During the winter, some insects survive by going into a dormant state, called diapause. In this state, they can live despite being nearly frozen, due to naturally occurring antifreeze-like compounds in their bodies.

Polar bears are a well-known arctic species, living year-round in one of the harshest environments imaginable for large mammals, without a period of dormancy. In fact, the word "arctic" is derived from the Greek word *arctos*, for bear. Like all arctic animals, polar bears have evolved a number of adaptations to deal with the extreme cold of the arctic environment. These helpful characteristics include a highly specialized fur coat. The longer, outer coat of "guard" hairs stick together when wet to form a waterproof barrier. Furthermore, the fur is white to camouflage the bear from its prey, and polar bears have broad paws for walking on ice and paddling in water. They have a sleek shape for efficient swimming motion, and have very sensitive noses and sharp teeth to help with catching and eating their favorite prey—seals. Like many larger arctic animals, polar bears have a thick layer of blubber beneath their fur. The blubber acts as a food store, and insulates bears from the cold.

Have you ever noticed that most year-round tundra residents have compact bodies and short limbs? These are adaptations to conserve heat. Surface area-to-volume ratios are a mathematical way to

proportionally compare objects that are different sizes and shapes. They explain how much skin (surface area) an animal has relative to its total body volume. For example, we know just by looking at them that a lemming (a small mouse-sized mammal of the tundra, related to a vole) is much smaller than a polar bear. But which species loses body heat more easily? The relative heat loss of these species can be compared by using a surface area to volume ratio, which your students will calculate in this activity. The higher the surface area to volume ratio, the more heat an animal can lose. Desert animals tend to have high surface area to volume ratios so their bodies can lose as much heat as possible. arctic animals, on the other hand, tend to have low surface area to volume ratios, so they can retain as much heat as possible.

POLAR BEAR



If your students have difficulty grasping this concept, you may want to use the example of the elephant, which lives in very hot areas. An elephant's large ears, which have a very high surface area, function like built-in air conditioners. As air flows over the blood vessels near the skin surface, heat from the elephant's ears is transferred to the atmosphere, releasing heat and cooling the elephant's body. The more surface over which air can flow, the more heat the elephant is able to lose.

Preparation

Gather all "polar bear" items and place them into a large box, crate, or bag.

Procedure

1. Show the class a picture of a polar bear. Ask students to think about the polar bear living in its arctic habitat. *What challenges does a polar bear face, living in such a cold place? How does a polar bear get food and water, shelter, protection from the cold, a safe environment to raise cubs?*

2. *What color is a polar bear? How does this coloration help them to survive in the arctic?* Point out to your students that an animal's fur may be a different color from its skin. Using the polar bear or another arctic species as an example, discuss strategies used and adaptations that are helpful in dealing with and surviving the extreme cold. For example, several species have hollow hairs to trap air and provide insulation, including polar bears, arctic fox, and caribou/reindeer. Show illustrations of these animals. Point out to your students that all of these characteristics are adaptations. *What is an adaptation?* An adaptation is a physical feature or behavioral trait that helps an animal to survive in its habitat.

3. Ask students, *If you moved to the arctic to live, what do you think you would need to survive? How would you have to adapt to survive the challenges of the arctic?*

4. Have your students imagine they are going to visit the arctic for at least one week. Ask for two volunteers —one to be the arctic explorer, and the other to be his/her assistant. Explain that the arctic explorer will be dressed in attire appropriate for exploration. The assistant will help dress the explorer.

5. Give the assistant the box/bag full of items. Tell the students that the box contains many of the items they might want to bring on a journey to the cold north. You can suggest that not all of the items may be suitable, if you have included "wild cards."

6. Have students take turns suggesting what the arctic explorer will need. As they identify items, the assistant can reach into the box to see if she/he can find it, and if so, place the item on the visitor in the appropriate place.

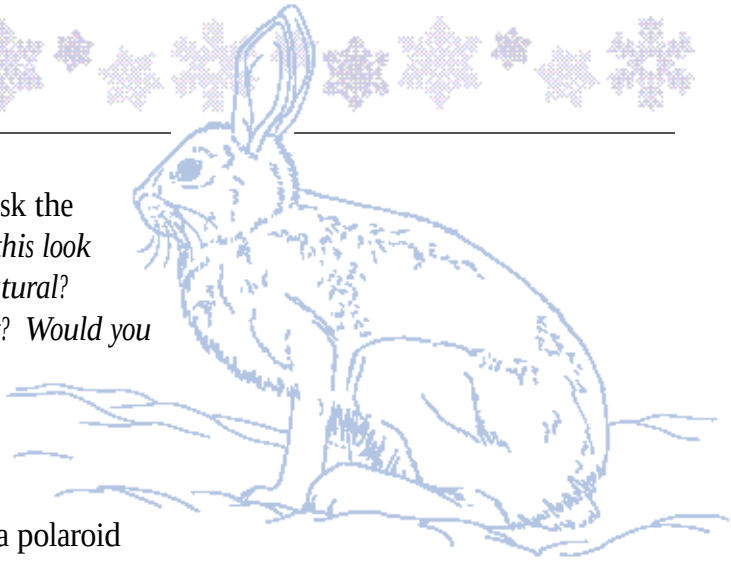
7. As each item is pulled from the box and put on the explorer, have the person who suggested it, or others in the class, explain what challenge that item helps to meet in the arctic cold. For example, if a student suggests a warm coat, they should explain that the coat would help to keep the person warm and retain body heat.

8. As further items are suggested, you may need to help the class along with questions. For example, *How about eating? How will the explorer find food? How will they catch the food?*

9. When all of the items are on the explorer, have the class take a good look. Ask the students, *Does this look comfortable? Natural? Why or why not? Would you want to be responsible for taking all of this gear along with you?* Take a polaroid photo if a camera is available. Explain that the polar bear actually has all of these adaptations built into its body.

10. Have the assistant remove the items from the explorer volunteer one by one. As each item is taken off, write its name on the board. Have students identify which polar bear adaptation corresponds to each one, and write the adaptation next to the human item on the board. When all have been identified, have students look at the list. *What does it tell them?*

11. Discuss the fact that it takes thousands of years for animals to develop special adaptations to their particular ecosystem, through the process of **natural selection**. Ask students, *How would relatively sudden changes in the ecosystem, global warming, for example affect a species and its abilities to survive in a given ecosystem?*



SNOWSHOE HARE

Modifications for Younger Students (K-2)

Assemble all the dress-up items in a box or bag and remove them one at a time to show the students. Ask them, *How would a polar bear use this? Does a polar bear wear a warm "coat?" Mittens? How could a warm coat be useful in the cold? What do you need when you are cold?*

Modifications for Older Students (5-8)

Compare the photos (or illustrations) provided of the arctic fox and kit fox, and/or of a jackrabbit and a snowshoe hare. All of these animals live in North America, but in very different ecosystems, and they have very different habitat requirements. *Which do you think lives in the desert? Which lives in the arctic? Why?*

LEMMING

Think of a lemming, which looks like a big mole, compared with a polar bear. *Which animal is more likely to lose body heat? Why?*

Surface area-to-volume ratios are measurements used to realistically compare things of different sizes. We know a polar bear is much larger than a lemming, but what if you were to make a really large lemming, or a really small polar bear? Comparing their skin and body sizes using a ratio allows us to make useful comparisons. Looking at an animal's surface area to volume ratio can tell us what kind of climate it is adapted to, and why it has some of the adaptations it has.

Look at the polar bear and lemming worksheets. The animals have grids overlaid to better enable students to calculate the surface area and volume of each. Have students calculate the body size of the lemming and of the polar bear, using the dimensions provided. The surface area is the sum of the length x width of each piece (you can use 2 pieces for the purpose of this activity, or estimate the surface area of the front and back of the animal.) (Area = l x w)

Next, calculate the volume, the insides of each animal. The volume is the sum of the length x width x height for each piece (estimate width). (V = l x w x h)

Divide the surface area by the volume for each animal. Compare your answers. A larger number means the animal gives off or loses more heat. *Why? Is the result what you expected? Which animal should be more efficient at retaining its heat?*

How might climate change affect these species? In addition to their adaptations to cold temperatures, polar bears use floating pack ice for seal hunting and for denning areas. *What causes climate change?* One cause is the combustion of fossil fuels, such as petroleum. Burning fossil fuels releases gases (such as Carbon Dioxide) into the atmosphere. These gases allow radiation from the sun to enter earth's atmosphere, but they do not allow all of that radiation to escape back into space. The consequence is a global temperature increase over time, which is called the greenhouse affect.

Extensions

✔ A related activity is an experiential introduction to blubber. Ask the class, *In addition to polar bears, which arctic animals rely on blubber for insulation?* (for example, whales and seals) Prepare a bucket of cold, icy water (and make sure you have zip-lock bags and vegetable shortening ready). Have students take turns putting one hand into a zip-lock bag and then into the water, feeling through the bag how cold the water is (they should keep their hand inside the zip-lock bag, and not get their hand wet). Next, each student, one at a time, should put their hand into a zip-lock bag that contains one to two cups of vegetable shortening (e.g. Crisco) in it. Then they put the bag (with their hand in the shortening) into the icy water and determine if they feel any difference in temperature. They can get an idea of how the blubber of many arctic creatures provides insulation against the cold.

✔ Have students develop a way to construct models of polar bears and lemmings so they can more accurately measure

surface area and volume and demonstrate what they have learned about the surface area to volume ratio.

✔ *How have your own local species adapted to the climate in your area? Have students choose a schoolyard species to investigate. What are its adaptations to climate? How do they help it survive?*

Assessment

✔ (K-2): Have students draw pictures of polar bears and label different parts with the ways they help the polar bear survive in the cold.

✔ (3-8): Have students draw pictures of polar bears and label different parts with the ways they help the polar bear to survive in the cold. Have students choose and research a different arctic animal and identify its adaptations to survive the cold (many arctic animals are listed in Activity 6). Compare these adaptations with those of the polar bear. What are the similarities and differences they discover? Using available resources, including their local library and the world wide web, students can conduct research about their selected species, concurrently with the activities in this guide. As they learn new concepts throughout the activities, they can apply these concepts to the information they obtain through research.

✔ After completing activities, they should be able to provide the following information: where it lives (draw this on a map, including any other features that affect this species such as a city along its migration path), the climate it prefers, its body form (making inferences about how form follows function), special adaptations it has to live in the arctic ecosystem, how it fits into a food chain or food web, whether it migrates and why, how it is affected by interactions with people or development, and ways that life or habitat can be improved for the species. At the completion of the curriculum, allow students to present their findings to the class, using posters or props if desired.

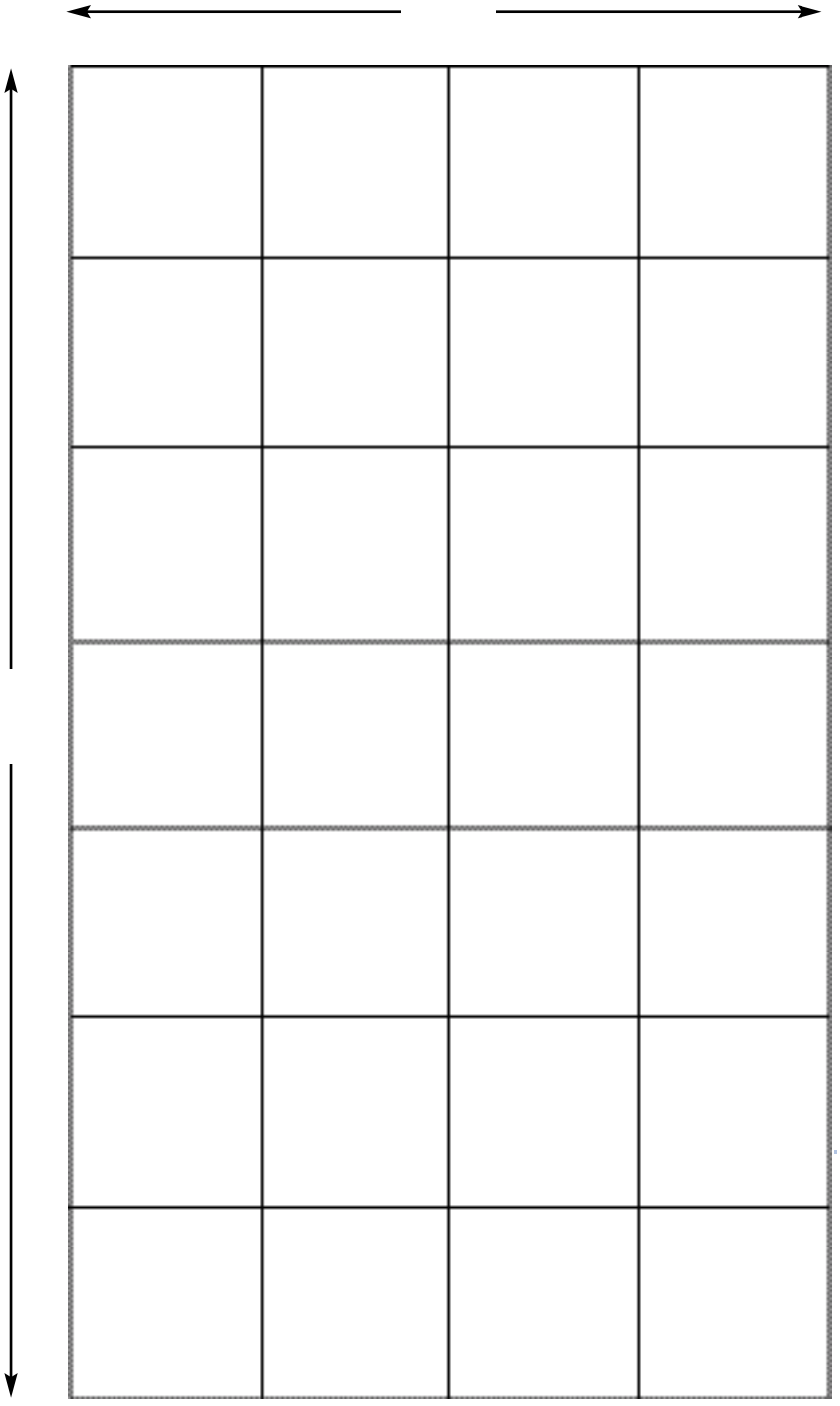
✔ Students can also consider local climate challenges and think of an animal that lives near their school and its needs for food, water and shelter. How does the local species meet its habitat challenges?

✔ (5-8): Work in small groups to apply the concept of surface area to volume ratio to one of your local species, or the arctic species the student has chosen to study. W*hat is the size of your selected species? How long are its legs or arms, and how big are its ears? Is the species adapted to retain or give off heat? How? What adaptations does the animal have that serve to increase or decrease its surface area to give off or retain heat?*

HUMPBACK WHALE

WORKSHEET

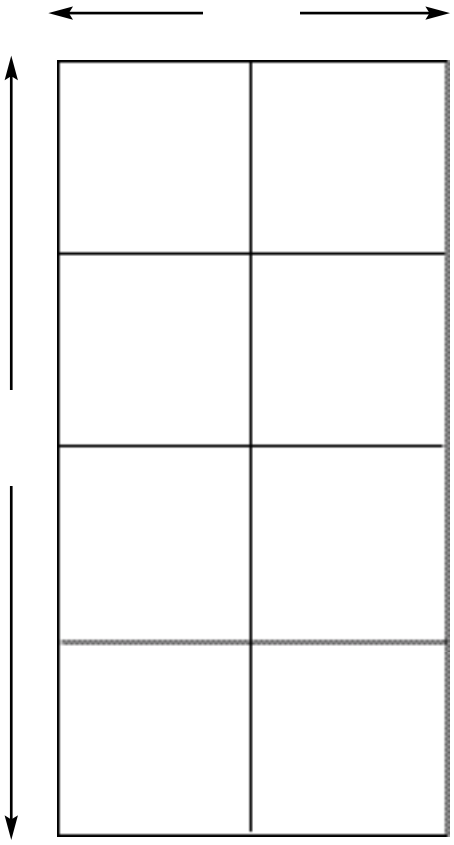
POLAR BEAR



1 inch = 1 foot

WORKSHEET

LEMMING



Actual Size