Fur vs. Blubber: Which is the better insulator for a marine mammal?

For "warm-blooded" animals like mammals, maintaining body temperature is crucial for survival. This is especially challenging in the ocean, because seawater conducts heat 25 times faster than air – that means animals lose heat 25 times faster in water compared to air at the same temperature! Marine mammals use two different kinds of **insulation** to stay warm in the cold ocean: **fur** and **blubber**. Fur is the insulation used by land mammals, and is also used by polar bears, sea otters, and fur seals in the ocean. Other marine mammals, including manatees and dugongs, whales and dolphins, true seals, sea lions and walrus, use a thick blubber layer to insulate their bodies against the cold water.

The way fur works as an insulator is by **trapping air** among the hairs. It is not actually the fur that provides the insulation, but the trapped air layer that creates a barrier between the animal's skin and the surrounding environment. Sea otters and fur seals have a dense coat of fur, and they often blow air into that fur to trap a layer of air between their skin and the water. Their fur is so thick that no water can reach their skin. This way, their skin stays dry and warm.

Blubber is a continuous layer of **fat tissue**, and it is the fat itself that acts as an insulator. Animals like seals and dolphins have very thick layers of blubber to keep them warm in the coldest waters. Their blubber layers can be many inches thick!

So, which kind of insulation works better? Let's find out! For this activity, a water balloon full of hot water will represent the marine mammal.

Instructions:

Make sure you have a data sheet before you start the activity. You will be recording two temperatures for each "marine mammal" and you will need a place to write them down. Remember that whenever you record a temperature on your data sheet, you should include the units of the measurement. For example, if the temperature of the water is 25 degrees Celsius, you should write "25°C" instead of just "25" (° is the symbol for degrees). This should be labeled on the top of the data table column in Excel, not each individual square. You will not be able to make a graph if the units are included in each square.

Procedure

1. Fill the plastic tub with ice and cold water. Let it chill for approximately five minutes.
(Teacher may have this prepared.)
2. Take the temperature of the ice water with the thermometer and record the temperature on your data sheet.

No Insulation (Control) –

1. Run tap water until it is hot to the touch. Fill a beaker with 50 ml hot water and take the temperature of the water with the thermometer. Record the initial temperature on your data sheet before you dump out the water.
2. Turn off the faucet, place mouth of balloon over faucet. Turn back on the hot water and fill the balloon with the hot water until the balloon has a height of 12 cm.
    (Sometimes it's easier to fill the balloons if you blow them up and deflate them first.)
3. Tie off the top of the balloon.
4. Immerse the balloon in the ice water for 300 seconds. (Make sure it is completely under water!)
5. After 300 seconds, remove the balloon from the ice water.
6. **CAREFULLY** pop the balloon and empty the water in the balloon into a beaker.

7. Using the thermometer, immediately take the temperature of the water in the beaker.
8. Record the final temperature on your data sheet.

Fur Insulation (Sea Otters and Fur Seals)

Fur works as an insulator for marine mammals only when it traps an air layer between the water and the animal's skin. For this part of the activity, we need to place one balloon inside another balloon, and then **fill up the inside balloon with water and the outside balloon with air**. Follow these steps:

1. Using a pencil, insert the ERASER end all the way into the end of the first balloon.
2. Holding the first balloon tight around the pencil, take another balloon and roll it onto the pencil on top of the other balloon. (The second balloon should be tucked inside the first balloon.)
3. Carefully remove the pencil, making sure that you don't accidentally pull the first balloon out of the second balloon.
4. Run tap water until it is hot to the touch. Fill a beaker with 50 ml hot water and take the temperature of the water with the thermometer. Record the initial temperature on your data sheet before you dump out the water.
5. Turn off the faucet, place mouth of both balloons over faucet. Turn back on the hot water and fill the inner balloon with the hot water until the balloon has a height of 12 cm.
   (Sometimes it's easier to fill the balloons if you blow them up and deflate them first.)
6. Tie the top of the inside balloon.
7. Blow up the outside balloon so that the inside water balloon is surrounded by air, about 4 cm.
9. Tie the top of the outside balloon, trying to tie the top of the water balloon in it as well.
10. Immerse the double-balloon in the ice water for 300 seconds. (Make sure it is completely under water!)
11. After 300 seconds, remove the double-balloon from the ice water.
12. Carefully pop **ONLY THE OUTSIDE** balloon and let the air out.
13. **CAREFULLY** pop the inside balloon and empty the water from the balloon into the beaker.
14. Using the thermometer, immediately take the temperature of the water in the beaker.
15. Record the final temperature on your data sheet.

Blubber Insulation (Seals, Sea Lions, Walrus, Dolphins)

Blubber is a thick fat layer that surrounds a marine mammal's body. You need to create a fat layer to surround your water balloon, and vegetable shortening makes a good substitute for blubber. Follow these steps:

1. Take the temperature of the ice water with the thermometer and record the temperature on your data sheet.
2. On a desk or table, lay out a sheet of plastic wrap that's big enough to entirely cover a full balloon.
3. Using gloves, spread approximately 1 cm thick layer of vegetable shortening out on the plastic wrap. Set this aside for now.
4. Run tap water until it is hot to the touch. Fill a beaker with 50 ml hot water and take the temperature of the water with the thermometer. Record the initial temperature on your data sheet before you dump out the water.
5. Fill a balloon with the hot water until the balloon has a height of 12 cm.
6. Tie the top of the balloon.
7. Place the balloon in the center of the plastic wrap and wrap the balloon up in the vegetable shortening. Try to squish the vegetable shortening around until it evenly covers the whole balloon.
8. Immerse the vegetable shortening-covered balloon in the ice water for 300 seconds. (Make sure it is completely under water!)

9. After 300 seconds, remove the balloon from the ice water.
10. Peel the plastic wrap and the vegetable shortening off the balloon and throw it away. It may be messy and slippery – don't drop the balloon!
11. **CAREFULLY** pop the balloon and empty the water from the balloon into the beaker.
12. Using the thermometer, immediately take the temperature of the water in the beaker.
13. Record the final temperature on your data sheet.

NAME:_____ **DATA SHEET**

No Insulation (Control)

Temperature of Ice Water °C	**Initial Temperature of Balloon Water** °C	**Final Temperature of Balloon Water** °C	**Change in Temperature of Balloon Water** °C

Fur Insulation (Sea Otters and Fur Seals)

Temperature of Ice Water °C	**Initial Temperature of Balloon Water** °C	**Final Temperature of Balloon Water** °C	**Change in Temperature of Balloon Water** °C

Blubber Insulation (Seals, Sea Lions, Walrus, Dolphins)

Temperature of Ice Water °C	**Initial Temperature of Balloon Water** °C	**Final Temperature of Balloon Water** °C	**Change in Temperature of Balloon Water** °C

Post Lab Questions

1. Which balloon lost the most heat?

2. What was the best insulator? Use data to support your claim.

3. What do you think would happen if you used a bigger balloon? Would the temperature inside the balloon drop faster or more slowly in the ice water? Why?

4. Based on your answer for 3, do you think it is common for small marine mammals to live in icy Antarctic water? Why or why not?

5. During the investigation, we used vegetable shortening to insulate the water balloon as a blubber layer and we used a second balloon with a layer of air between to insulate the water balloon as fur. Explain one mechanism other than these two features that polar animals may use to stay warm.

6. Design a jacket for a scientist conducting research in Antarctica. Draw and label its layers below and include an explanation of your design using evidence from your collected data, that your design would keep her warm.