ANATOMY AND PHYSIOLOGY

15. **Go with the flow!**

Objective: Students will demonstrate heat transfer in a countercurrent system, and explain the importance of conduction in heat-energy transfer.

Level: 4-7

Background: Thermodynamics is the science of energy, and its basic principles are that heat flows and that cold is an absence of heat. Heat energy can be transferred in a variety of ways, including conduction, convection and radiation. The countercurrent flow in the blood vessels in whale flippers and flukes is an example of conduction. Warm blood in arteries passes by the veins where heat is transferred and returned to the central core of the body. This activity will duplicate the whale's countercurrent heat exchange system.

Materials: two sections of thin plastic tubing - each approximately 1.5 metres long, two funnels, hot and cold water in containers, two buckets, two thermometers.

Procedure:

1) Get two four-litre (one-gallon) containers. Fill one with hot water and one with cold water. Measure the temperature of each.
2) Keeping the tubes separate, use the funnel to pour the water from each container through its own tube. Make sure that the end of the tube is placed in its respective bucket.
3) Measure the temperature of the hot water as it exits the tube. There should be a minimal amount of change in temperature from start to finish for both the hot and the cold water (heat loss or gain from the environment).
4) Twist the two tubes together. Make sure the respective ends are placed in the correct bucket - cold tube in cold bucket, hot tube in hot bucket.
5) Repeat steps 1 and 2.
6) Measure the temperature of the water as it exits. The cold water should have gained some heat from the hot water. This is an example of how the whale can bring heat back into its core. The hot water will have cooled off significantly. This demonstrates how heat can be dissipated to cool off an animal.
7) Optional: Try the experiment with tubes of different thicknesses. A thicker tube provides more insulation and less heat transfer.