

Experiment HH-5: The Diving Reflex

Background

Some air-breathing animals have developed physiological and biochemical mechanisms that allow them to survive while submerged underwater for long periods of time. Animals, like sperm whales and some species of amphibians and reptiles, utilize oxygen in a more efficient manner.

Even though different species have different diving capacities, the solutions to the problems associated with diving are similar. Animals can extend diving time by: using stored oxygen; decreasing oxygen consumption; using anaerobic metabolism; and, using aquatic respiration, if possible.

A prominent method for an animal to conserve oxygen while diving is known as selective peripheral vasoconstriction. This method insures that oxygen is delivered to organs with the highest priority need for oxygen, like the brain, heart, and adrenal glands. The remaining organs subsist on local stores of oxygen or use anaerobic metabolism. Since the vasoconstriction that takes place in this method causes an increase in peripheral resistance, the normal level of blood pressure in the animal is maintained by a reduction its cardiac output. The reduction in cardiac output is usually attained through a decrease in heart rate (bradycardia).

Bradycardia and selective vasoconstriction are methods of oxygen conservation commonly exhibited by diving vertebrates like alligators, birds, seals, and whales. Though humans exhibit a diving reflex, this reflex does not contribute to the long term survival of persons submerged in cold water.

Submersion hypothermia consists of the person drowning in cold water which cools his core simultaneously with the cold water he is submerged in cooling his skin. Young, skinny individuals survive being drowned in cold water for up to an hour due to the rapid drop in core temp.

The dive reflex generally does not last any more than 2-3 minutes and therefore plays a minor role in the survival of young people drowned in cold water. Adults do not survive for any long period of time drowned in cold water.

The history behind the explanation of the dive reflex saving drowned children is due to Dr. Martin Niemeroff who pioneered saving drowned students. Unfortunately, his explanation on why these individuals survived was not supported by any research.

In this experiment, students will determine their normal heart rates while resting, holding their breath, and holding their breath as they submerge their faces in cool water.