

Diving Physiology Lab
Modified from Dr. William Stark, St. Louis University

INTRODUCTION

In this lab we will examine the human physiological response to conditions that simulate underwater diving (the diving reflex). The diving reflex has been studied extensively in marine mammals such as cetaceans (whales and dolphins), sirenians (manatees), some carnivores (seals, walrus and otters) and seabirds (like penguins!!!)

The diving reflex in mammals is mediated, in part, by receptors of the trigeminal nerve (cranial nerve V) in the face, nose and mouth, which respond to the temperature of the water. In diving mammals and humans, the stimulation of the trigeminal cold receptors in the nasal and pharyngeal passages results in powerful reflex apnea (cessation of breathing). In fact, approximately 30% of human drowning victims do not have water in their lungs because this powerful laryngeal reflex actually prevents breathing.

In this lab we will monitor heart rate (pulse) and blood pressure during a simulated dive. A number of parameters associated with underwater submersion will be varied in an attempt to identify the features of submersion that are important for the diving reflex.

EXPERIMENTAL PROCEDURE

Note: Work in groups of 3 or 4: 1 subject, 1 data recorder / timekeeper and 1 person who will direct and care for the subject. Record all observations, data and graphs in your lab notebook.

Part I.

1. **AT REST.** Place the blood pressure cuff on the subject and ask him/her to sit comfortably in a chair for a couple of minutes. Record your subject's blood pressure and pulse while at rest. Calculate Mean Arterial Pressure (MAP):

$MAP = \text{diastolic pressure} + 1/3 (\text{systolic} - \text{diastolic})$

sample calculation for blood pressure reading of 130 / 65

$$MAP = 65 + 1/3 (130 - 65)$$

$$MAP = 87$$

2. To examine the effect of **dry apnea** (breath-holding, no immersion) on MAP and pulse, the subject should hold his/her breath for 30 - 45 seconds (sitting upright in the chair). Take the pulse and blood pressure readings at the end of the trial (during the last 15 seconds).

3. Here we go... **DIVE.** Immerse the subject's face in water at room temperature (20 °C) for 30 - 45 seconds (based on how the subject performed in #2). The director should tap the subject's back after every 10 seconds to relieve

anxiety. Take BP and pulse readings during the last part of apnea while the subject is still immersed (during the last 15 seconds).

At any time the subject may sit up and end the trial. Remember - this is not an endurance test!!!

4. After the dive, repeat the measurements for **recovery** data (continue to measure recovery every 30 seconds until the subject returns to normal).

Determine the average percent change in pulse and mean arterial pressure: M.A.P for pre-dive period (resting), dry apnea, diving and recovery following a simulated dive.

Sample table:

Subject A	Pulse	% change from rest	MAP	% change from rest
At Rest		xxxxxxxxxxxx		xxxxxxxxxxxx
Dry Apnea				
Dive				
Recovery 30 sec.				
Recovery 60 sec				
Recovery 90 sec				

Part II. Now you will come up with experiments to determine what factor(s) are responsible for the observed dive reflex using a snorkel and water of different temperatures.

Post-Lab

In addition to your summary, include answers to these questions:

1. What is the correct physiological term for the cessation of breathing? Which nerve reports sensations from the face that mediates the diving reflex?
2. What is so unusual about the combination of pulse and pressure changes in diving?
4. What factors were most important in the diving reflex? What effect does temperature have on the diving reflex?
5. What adaptive value do you think the diving reflex has?