**Mammalian Diving Response Lab**

**Introduction:**

In order to deliver oxygen to their tissues, every mammal must breathe air. Those animals that must dive in order to survive, like marine mammals (seals, sea lions, whales, dolphins, etc.), have evolved ways to conserve oxygen during dives.

When humans dive, they display some of the same characteristics as marine mammals (and for that matter, even rats). During a dive, a human’s brain will work to shut off blood flow to the unnecessary organs – the organs it doesn’t need at that moment. Blood flow to the kidneys, stomach, and even muscles will be dramatically lowered so that oxygen is conserved for the heart and brain. As a result, the heart can get away with beating less so that it doesn’t consume much oxygen.

**Purpose**

You will first demonstrate whether the mammalian diving response works in humans. You will then develop hypotheses to test what triggers the response: Is it the water? Is it the breath-holding? Is it temperature alone? Is it a combination of all of these?

By the end of this experiment, you will:

* Successfully demonstrate whether the mammalian diving response occurs in humans.
* Create a hypothesis as to what triggers the mammalian diving response.
* Using controlled experiments, determine whether your hypothesis is correct.
* Understand why the mammalian diving response is important in an evolutionary context.

**Pre-lab Questions**

1. What is a mammal? What does a mammal need in order to survive? How can a mammal compensate if it doesn’t have access to any of those?
2. When you exercise, does your heart rate increase or decrease? Do you consciously have control over how fast your heart beats”
3. Have you ever jumped into a pool of cold water? If you have, were you able to stay underwater very long?

**Materials**

* 1 plastic bin per group.
* 1 towel per student (paper towels will, of course, will suffice).
* Tap water
* Ice
* 1 thermometer per group
* If measuring pulse manually: 1 stopwatch per group

**Procedure**

**PartI.**

To determine an individual’s heart rate, find the radial pulse using these instructions:

1. With the individual’s palm facing upwards, use the middle and index finger to follow the base of the thumb about ~2.5 cm (~1 inch) past the wrist.
2. Find the “groove” between the radius (the forearm bone on the same side of the thumb) and the tendon which runs parallel to the radius (Figure 1).
3. Press gently, sliding the two fingers up and down along the groove until a pulse is felt.
4. The most accurate way to determine heart rate is to count the number of beats felt at the radial pulse for 60 seconds (If you count 74 beats in 60 seconds, the individual’s heart rate is 74 beats per minute). It is also acceptable, though less accurate, to measure for 30 seconds and multiply by 2 or measure for 15 seconds and multiply by 4 (If you count 37 beats in 30 seconds, the individual’s heart rate is ~74 beats per minute. If you count 18 beats in 15 seconds, the individual’s heart rate is ~72 beats per minute.).



Figure . Approximate location of radial pulse.

Once you know how to measure heart rate, you may move on to the next steps.

1. Get into groups of no more than 4 students, with at least one student in each group willing to put their face (up to the level of their temples) in cold water. The student who is willing to put their face in cold water is called the “diver.”
2. Assign one group member to be in charge of the stopwatch. This person will be the “timer.” He or she is responsible for timing the experiment. It might also be nice of this person to tap the diver every 10 seconds so that the diver knows how long they’ve been underwater.
3. The other two group members are responsible for working with the timer to measure the diver’s pulse and record it on the data sheet below.
4. Fill a plastic bin about 1/2way full with tap water and adjust the temperature to 10-15 °C, using ice and/or warm water to compensate. Remember, you want your diver to be able to submerge their face in the tub comfortably!
5. At this point, the diver is not underwater, but is resting with his/her elbows on the table and their head hanging over the table.
6. Working in your assigned roles, find the diver’s pulse and get ready to count.
7. Start counting pulses. Record the number of pulses you feel during 2 15-second intervals (0:00-0:15 and 0:15 to 0:30). See the data table below.
8. Multiply the number of pulses you felt in each 15-second interval by 4 to determine heart rate in beats per minute during these 2 intervals (Remember: multiplying the number of pulses you feel in 15 seconds by 4 gives the person’s heart rate per 60 seconds). You should also average the 2 intervals to determine heart rate over the entire 30-second period.
9. After a short break, the diver should immerse his/her face in the cold water up to temple-level. Students assigned to measure pulses/record data should immediately begin measuring the pulse as discussed in step 8.
10. Students should again multiply the data from the 2 15-second intervals by 4 to determine heart rate in beats per minute. Again, students should find the average heart rate across the 30-second period as well.
11. Which average heart rate is lower, the individual’s rate while they were breathing air or while they were underwater?
12. Take a 5 minute break, then repeat the entire procedure to ensure accuracy. You might also want to switch the order of experiments around. In other words, you might want to measure the heart rate while the person is submerged *first* and then when they’re breathing air *second.*
13. Repeat step 12 until you run out of time.
14. You will put your data into Excel to see if there is a significant difference between groups. To do this look at the TTest Excel tutorial for help!!

**Part II.**

1. Now that you’ve demonstrated that the mammalian dive reflex does, indeed, occur in humans, come up with a hypothesis that describes what triggers it. Is it the cold that triggers it? Cold water? Just water? Is it holding your breath? Holding your breath under water? Holding your breath under cold water?
2. You have several tools available for testing your hypothesis: snorkels, face masks, and ice packs (cold packs and room-temperature packs). Design an experiment using these tools to determine what causes the response to “turn on.” Remember, you can only change one variable at a time.