**Hold Your Breath!**

*What triggers the mammalian dive response in humans?*

**Goals and Objectives:**

In this lab, you will design and conduct your own experiments to determine which factors trigger the mammalian dive response in humans.

**What is the dive response?**

The **mammalian dive response** (also known as the *mammalian dive reflex*) is: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
The dive response is characterized by **three** major physiological responses:

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. *Definition*: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   *How might this help a diving mammal?* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. *Definition*: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   *How might this help a diving mammal?* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Definition: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   *How might this help a diving mammal?* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**The Lab**

**Materials**

* Dishpan or tub with cold water (15°C)
* Thermometer for water baths (needs Celsius units)
* Ice
* Stopwatch or timer
* Infrared Thermal Sensor
* Towels

**Procedure**

**Part 1**. **Demonstrating the Dive Response**

* 1. Fill a tub with cold water (15°C) and use the thermometer to record water temperature (in °C). Get the temperature as close to 15°C as possible.
  2. **Control Phase**: The subject should sit with his/her face out of the water and breathe normally.
     1. Record the subject’s resting heart rate: place two fingers (do not use thumbs!) over either the radial (wrist) or carotid (neck) arteries and count the number of beats in 5 seconds. Multiply this number by 12 to find the subject’s heart rate in beats per minute (bpm). Record the heart rate in the data table.
     2. Use the infrared thermal sensor to record skin temperature (in °C) at a peripheral location (e.g., the palm of the hand).
     3. Use the infrared thermal sensor to record skin temperature (in °C) at a “core” location (e.g., the belly or back).
  3. **Simulated Dive Phase**: The subject should take a deep breath, then submerge his/her face in the water to the level of the temples, and remain in that position for 30 seconds. The simulated diving sessions could potentially be dangerous if subjects do not know how to gauge their own breath-holding limits under water. *If the subject shows any signs of discomfort, stop the dive immediately.*
     1. During the last 5 seconds of the dive, record the subject’s “diving” heart rate by again placing two fingers over either the radial or carotid arteries and by counting the number of beats in 5 seconds. From this number, calculate and record the subject’s heart rate in beats per minute (bpm).
     2. Record skin temperature at the peripheral location (in °C).
     3. Record skin temperature at the core location (in °C).
  4. Repeat steps 2 and 3 twice more to get three total trials. You can have the same person do the “dive” all three times, or you can use multiple subjects.

Data for Part 1 – Demonstrating the Response

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Subject Name | Control Heart Rate (bpm) | Control Peripheral Skin Temp (°C) | Control Core Skin Temp (°C) | Dive Heart Rate (bpm) | Dive Peripheral Skin Temp (°C) | Dive Core Skin Temp (°C) |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

**Look at your data for Part 1**

What was the average control heart rate? \_\_\_\_\_\_\_ bpm

What was the average dive heart rate? \_\_\_\_\_\_\_ bpm

Was there a difference? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What was the average control peripheral skin temperature? \_\_\_\_\_\_\_ °C

What was the average dive peripheral skin temperature? \_\_\_\_\_\_\_ °C

Was there a difference? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What was the average control core skin temperature? \_\_\_\_\_\_\_ °C

What was the average dive core skin temperature? \_\_\_\_\_\_\_ °C

Was there a difference? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 2. Identifying Factors that Trigger the Dive Response**

You and your group will now conduct *your own experiments* to determine which factors trigger the dive response in humans.

To keep things simple, focus only on **bradycardia** as an indicator of the dive response in your experiments.

Think carefully about the conditions in which the subject already did the dive. How cold was the water? How long did the subject hold his/her breath? What was the position of the subject’s body?

Before you begin the experiment, make some predictions. What factor(s) do you think will trigger the dive response in humans? Do you think one factor is more important than others for triggering dive response?

**Be creative! Brainstorm a few factors you would like to test and list them here:**

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

One good starting point could be to test whether it makes a difference if the subject holds his/her breath in air versus in cold water. You should conduct three or more experiments to test three different triggers. Test a single factor with each experiment, and have three replicate trials per experiment. In other words, only one thing should differ between the control and the experimental condition, so that you can interpret your data clearly.

**Before you begin your experiments, your teacher must approve them. This is for your safety.**

Data for Part 2 – Experiments

**Experiment 1**

Factor to test: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Experimental conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Trial Number | Control Heart Rate (bpm) | Experimental Heart Rate (bpm) |
|  |  |  |
|  |  |  |
|  |  |  |

**Experiment 2**

Factor to test: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Experimental conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Trial Number | Control Heart Rate (bpm) | Experimental Heart Rate (bpm) |
|  |  |  |
|  |  |  |
|  |  |  |

**Experiment 3**

Factor to test: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Experimental conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Trial Number | Control Heart Rate (bpm) | Experimental Heart Rate (bpm) |
|  |  |  |
|  |  |  |
|  |  |  |

**Analysis**

Draw separate bar graphs to depict the results of each of your experiments. Each bar graph should show how the average heart rate of your subject(s) differed between control and experimental conditions. Be sure to label your axes and give the graph a title that indicates what the experiment tested (Ex. “The Effects of Water Temperature on Triggering the Mammalian Dive Response”)

**Bar Graph for Experiment 1**

**Bar Graph for Experiment 2**

**Bar Graph for Experiment 3**

**Conclusion**

Based on this lab activity, can you identify the key factors that trigger the mammalian dive response?

The factors are: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_