

Mammalian Dive Response Laboratory Investigation Teacher Guide



New England
Aquarium

Protecting the blue planet

Overview

Modeling the Marine Mammal Dive Response is a high school-level laboratory lesson designed to enhance students' understanding of biological concepts such as cellular respiration, cell biology, animal physiology, and adaptations. During this activity, students analyze how their heart rate changes as they hold their breath underwater to model the **mammalian dive response**. Through accessory lessons, students can learn about **Weddell seals** and how their adaptations have connections to human health. Students will use what they learn about marine mammal physiology to better their understanding of cellular respiration. This lesson also has extension components that allow students to design and test their own hypotheses and analyze their data using statistical tests.

Objectives

- The PowerPoint lesson provided on the NEAq website is designed to introduce the Weddell seal and give students context for complex topics such as cellular respiration (glycolysis, Krebs cycle, electron transport chain). This lesson is designed to complement a high school biology textbook and existing teacher lessons.
- The lab is a guided inquiry-based activity to help students understand the adaptations of marine mammals with a focus on the Weddell seal. This laboratory lesson highlights the mammalian dive response while incorporating physiological responses in terms of cellular respiration.
- Additional resources have been compiled to help students study for these concepts. These resources include a Blendspace page with video resources on cellular respiration, Quizlet online flashcards, and MCAS biology test prep that can be used in class or for homework study tools. See the appendix for these resources.

Students will understand:

- Mammalian dive response
- Weddell seal adaptations
- A real-world context for cellular respiration

Students will be able to:

- Interpret data
- Relate physiological structures to cellular respiration in mammals
- Take a pulse
- In extension:
 - Use statistical test to show scientific significance
 - Design independent experiments

Skills

Critical thinking, MS Excel data analysis, data collection and analysis, measuring heart rate

Components of Lessons

Lesson 1

Weddell Seal Biology PowerPoint

- Background information
- Video and article links (homework or class discussion)
- Embedded questions and answers

Lesson 2

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Teacher sheets with answer keys

Student sheets:

- Pre-lab questions
- Procedure
- Data sheets and Excel files
- Post-lab questions

Procedure

Students should follow the procedure as indicated on the Student Sheet-Procedure section.

Extensions:

Inquiry

Prompt students with the following question: **What triggers the dive response in mammals?** Students can then develop their own hypotheses and design their own experiments. Students should use their heart rate as the indicator although body and skin temperature can also be used as an indicator if you have the means to measure it.

Your school's maintenance department may have an infrared laser temperature reader, which can read skin surface temperature. Encourage students to always measure before and after heart rates and to manipulate one variable at a time. Students should be given 30 to 40 minutes to come up with testable hypotheses and preliminary procedures and data collection.

Examples:

- Breathing through a snorkel in the air and in the cold water bath to test if the water is the trigger
- Submerging face in room-temperature water and then cold water to see if the temperature of the water is a trigger
- Holding breath in air while slumped over, as if face was in the pan to test body/neck position

Analyze and Conclude

Depending on time and background information, you can have students enter the class data into MS Excel or other data entry program. From there, students can use formulas to calculate the mean, median, and standard deviation of their data; interpret any outliers; and graph the raw data.

Students can then analyze their data using a student's t-test or class data using a Chi Square analysis to draw statistical conclusions on the mammalian dive response.

Statistical Tests

Use a [student's paired t-test](#) to compare before and after heart rates in Data Table 2.

http://psc.dss.ucdavis.edu/sommerb/sommerdemo/stat_inf/tutorials/tcorrhand.htm

Evaluate whether the difference was significant or not.

Use a [Chi Square](#) analysis to compare the entire class average (Data Tables 3 and 4) heart rates before and after submerging. <http://math.hws.edu/javamath/ryan/ChiSquare.html>

You can also use the [online calculator](#) at <http://graphpad.com/quickcalcs/chisquared1.cfm>

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References

"Buys Laboratory." *Buys Laboratory*. Buys Laboratory, 2015. Web. 30 June 2016. <<http://buyslab.mgh.harvard.edu/antarctica/project/>>.

"Coma." *PBS. NOVA Teachers*, Apr. 2004. Web. 30 June 2016. <http://www.pbs.org/wgbh/nova/education/activities/2411_coma.html>.

CosplayerProductions. "Stig Severinsen Can Hold His Breath For 22 Minutes." *YouTube*. YouTube, 13 Apr. 2014. Web. 30 June 2016. <<https://www.youtube.com/watch?v=GI8-Ta2ujnw>>.

Eck, David, and Jim Ryan. "The Chi Square Statistic." *Chi Square Statistics*. Hobart and William Smith Colleges, n.d. Web. 30 June 2016. <<http://math.hws.edu/javamath/ryan/ChiSquare.html>>.

"GraphPad QuickCalcs: Chi Square Calculator." *GraphPad QuickCalcs: Chi Square Calculator*. GraphPad, 2016. Web. 30 June 2016. <<http://graphpad.com/quickcalcs/chisquared1.cfm>>.

Jee, Jane J. "How Diving Mammals Stay Underwater for So Long." *National Geographic*. National Geographic Society, 15 June 2013. Web. 30 June 2016. <<http://news.nationalgeographic.com/news/2013/06/130614-diving-mammal-myoglobin-oxygen-ocean-science/>>.

Laskowski, Edward R., MD. "Fitness." *Heart Rate: What's Normal?* Mayo Clinic, 2016. Web. 30 June 2016. <<http://www.mayoclinic.org/healthy-lifestyle/fitness/expert-answers/heart-rate/faq-20057979>>.

"The Mammalian Diving Reflex." *DUJS Online*. Dartmouth Undergraduate Journal of Science, 11 Mar. 2012. Web. 30 June 2016. <<http://dujs.dartmouth.edu/2012/03/the-mammalian-diving-reflex/#.V3VBKZMrKxl>>.

"Methods Manual: T-test, Hand Calculation." *Methods Manual: T-test, Hand Calculation*. University of California Davis, n.d. Web. 30 June 2016. <http://psc.dss.ucdavis.edu/sommerb/sommerdemo/stat_inf/tutorials/tcorrhand.htm>.

Nestor, James. "Your Body's Amazing Reaction to Water." *Ideas.TED.com*. TED, 25 June 2014. Web. 30 June 2016. <http://ideas.ted.com/science_of_freediving/>.

Rennie, John. "How the Dive Reflex Extends Breath-Holding." *Scientific American*. Scientific American, a division of Nature America, Inc., 22 Mar. 2012. Web. 30 June 2016. <<http://www.scientificamerican.com/article/breath-holding-dive-reflex-extends/>>.

Roth, Stephen. "Why Does Lactic Acid Build Up in Muscles? And Why Does It Cause Soreness?" *Scientific American*. Scientific American, a division of Nature America, Inc., 23 Jan. 2006. Web. 30 June 2016. <<http://www.scientificamerican.com/article/why-does-lactic-acid-buil/>>.

Stechmann, Jesper. "Mammalian Dive Reflex - Heartrate." *YouTube*. YouTube, 17 Apr. 2015. Web. 30 June 2016. <<https://www.youtube.com/watch?v=00RKH6NRMqc>>.

WeddellSealScience. "Introduction to Weddell Seals." *YouTube*. YouTube, 28 Oct. 2010. Web. 30 June 2016. <https://www.youtube.com/watch?v=Vo__ds7LgpE>.

© World Health Organization, 2011. All Rights Reser, comp. "Using the Pulse Oximeter." *Using the Pulse Oximeter* (n.d.): n. pag. 2011. Web. 30 June 2016. <http://www.who.int/patientsafety/safesurgery/pulse_oximetry/who_ps_pulse_oxymetry_tutorial2_advanced_en.pdf>.