# Extreme Animal Adaptations (BIO 490S)

Duke University, Fall 2016

Instructor: Laura Bagge
Office: 301 Biological Sciences
E-mail: laura.bagge@duke.edu
Office hours: by appointment.

**Course description**

How does a warm-blooded whale make an ocean dive to over 3,300 feet deep that lasts over 2 hours? How does a desert-dwelling rodent deal with a lack of water? How does a shrimp that is larger than a human hand camouflage itself by making its entire body and all of its organs see-through? These are just a few of the numerous questions that we will cover in this class. The overarching theme of the topics we will cover in this course can be described as "extreme adaptations" or "physiological extremes." We will explore interesting and significant adaptations to the typical physiological body plans that students often learn about in an introductory biology or physiology class. By studying adaptations, the class approach is different than most other organismal diversity classes, where the focus tends to be on either a particular animal group or the entire tree of life. Because we are dealing with biological systems, none of these processes operate in isolation, and thus many topics will involve integration of several different aspects of physiology and metabolism. Throughout, the course hopes to develop students to:

1) appreciate and understand the diversity of animal adaptations.
2) critically read, process, and critique primary literature.

The course is designed for either sophomore/ junior students interested in focusing their studies on animal behavior or physiology or for senior students in other biological or related fields.

**Course format**

Two 75 minute periods a week (3:05-4:20 Tues/Thursday).
The course will be set up so that each week will focus on one area of "extreme physiology" that will be represented by a paper from the primary literature.

In the first class each week, we will learn about the basic physiological principles involved in that topic area, and how the basic patterns of physiology have been modified in certain animals. This class period will prominently feature multimedia and group activities. The second class period each week will be a student-led discussion in which an individual student or student group will present the topic's main paper (required reading for all class members) to the class, and then will provide evidence from other papers to support or refute the conclusions from the main paper.
Each student will also write a critique of one paper of their choosing from the primary literature in an area of physiology that is different than the one in which they presented. More details related to how to write this critique are posted on Sakai.

**Assignments**
*Weekly readings from the primary literature
*Leading of one discussion session
*One midterm and one final exam
*One final paper critique (4-6 pages)

**Grading**
10% participation – attendance, active participation
15% questions and notes from readings
15% midterm I (October 5th)
20% leading of one discussion section
20% final paper
20% midterm II (December 7th)

**Attendance**
As this is primarily a discussion based class, more than one unexcused absence lowers your participation grade. Excused absences must be made up through individual meetings.

**Academic honesty**
Please review the Duke Community standard at http://www.integrity.duke.edu/new.html. Additional information can be found at http://www.integrity.duke.edu/ugrad/index.html. If a student has any questions regarding the policy, please contact the instructor.

Week

1 **Introduction:** Course structure, expectations, “What is an adaptation?”

2 **Life without water:** water conservation, arid environments, metabolic water, cryptobiosis. Example animals: tardigrades camels, kangaroo rats.

3 **Life without oxygen**: increasing $O_2$ stores, responses to hypoxia, dive response. Example animals: beaked whales, sperm whales, seals, penguins, thermal vent communities.

4 **Life below zero**: Hb/Mb viscosity, enzymes, antifreezes, heat shock proteins, adaptations to the cold. Example animals: Antarctic notothenioid fishes.

5 **Extreme eating:** morphological adaptations to ingesting large amounts of prey, temperature dependence on digestive enzymes. Example animals: reptiles, snakes.

6 **Extreme non-eating and sleep (hibernation):** fasting physiology, phases of starvation, ketone bodies, nitrogenous waste, importance of fat and protein stores. Example animals: bears, lemurs.

**7** **Extreme metabolic rate:** muscle fiber types, $VO_2$ max, anaerobic metabolism, fuel sources. Example animals: cheetahs, hummingbirds, insects.

**8** **Extreme camouflage:** transparency, dynamic camouflage with chromatophores. Example animals: hyperiid amphipods, cephalopods.

9 **Extreme senses (smell, taste, hearing):** chemosensory importance in vision limited environments. Example animal: star-nosed mole.

10 **Extreme senses (vision):** UV vision, polarized light vision. Example animal: mantis shrimp.

11 **Extreme animal migrations:** sustained and prolonged periods of travel, directional senses (magnetoreception). Example animals: Arctic terns, monarch butterflies, antelope.

12 **Extreme reproduction**: sexual cannibalism, gender manipulation. Example animals: arachnids, clown fish, flat worms.

13 **Student’s choice** of adaptations not yet covered! For example, students may choose to learn more about animals that make their own light (bioluminescence) or animals that parasitize a host.