Comparative Physiology of Animals

Course Information:	T/TH (12:00PM-1:15PM)
Instructor/TA Information:	Ashley Blawas Email: ashley.blawas@duke.edu Phone: 919-880-4208 Office: TBD Office Hours: TBD

Course Description

In this course we will use a comparative approach to learn about the functions that allow vertebrate animals with varying ecologies, life histories, and behavior adapt to and survive in a diversity of ecosystems. We will study how vertebrates work at all levels of an organism (cells, tissues, organs, organ systems, whole organisms) and the drivers that influence these functions. We will identify physiological characteristics that differ between species and taxa and compare physiological solutions that different animals have adapted to address the challenges associated with particular environments. Topics that we will cover include energetics, thermoregulation, circulation, respiration, and the nervous system. While these topics do not cover the entirety of the field of physiology, they cover many of the systems that support the functions an animal must carry out for basic survival. In this course we will often draw on Krogh's principle and will examine a given system or adaptation by studying a single animal in which the system or adaptation can be "most conveniently studied." If there is an animal or adaptation that is of specific interest to you I welcome you to discuss with me opportunities to incorporate that topic into our curriculum. Although this class will have a number of predetermined assignments, I am willing to be flexible to adjust assignments if students agree there are ways to make them more interesting and useful for their short-term success in this course and long-term success as well-rounded and scientifically-literate citizens.

While much of the material in this course will be delivered in a lecture format, I will also incorporate group discussion, self-teaching, interactive activities, and min-labs into my teaching. In the mini-labs you will perform experiments that allow you to practice data collection and analysis, interpreting results, and conveying your results in both written form and through figures and tables. I will periodically ask you to reflect on these activities to assess your learning throughout the semester and will adjust my teaching methods to help students meet the learning objectives.

Learning Objectives

Students will be able to:

- Compare major physiological systems across taxa (e.g. mammals, birds, reptiles, fishes) using drawn diagrams and describe examples of multiple differences in each system between taxa.
- Connect physiological principles to knowledge of other scientific disciplines (e.g., behavior, ecology, molecular biology, anatomy).
- Examine current research topics in animal physiology by reading journal articles and developing their own critiques of the approach and major conclusions.
- Relate physiological processes, from the biochemical to the system level, to the function of the entire organism in its environment.
- Develop experimental techniques and understand how to use physiological equipment to collect data, choose appropriate data analyses, and effectively present results to others both in written reports and through oral presentations.

Recommend Textbooks

These texts are great supplements to the lectures. If you are struggling to understand a concept in class it can be helpful to hear how someone else explains it. I encourage you to use other reliable resources in addition to the lecture slides while you review the material.

- Animal Physiology, 3rd or 4th edition (Hill, Wyse, and Anderson)
- Eckert Animal Physiology, 5th edition (Randall, Burggren and French)

Assessments

1. **In-class assignments -** these will include group discussion, paper critiques, diagraming, reading jigsaws, chapter study guides, and popular science articles. These assignments will be graded based on participation and completion. In addition to helping you become familiar with the course material, these activities are intended to help students prepare study materials for exams, familiarize students with the academic literature, and allow students to practice scientific writing for different audiences.

2. **Homework problem sets -** problem sets will be assigned five times throughout the semester. Homework is due within the first 15 minutes of your class on the due date. For homework assignments, you may discuss the problems with other students in the class. Copying all or part of a solution from somewhere else (classmate, website, textbook, previous students, etc) is not permitted and will be considered Academic Dishonesty and a violation of the Duke Community Standard. All homework problems within the set will be graded for completion, but only a fraction of the problems within the set will be graded for correctness (adapted from C. Wallace, Duke University).

   Late homeworks
   15% penalty = TA receives the homework 15 mins after class starts, but before the class ends
   25% penalty = TA receives homework after the class ends, but before 5pm on due date
   50% penalty = TA receives homework between 5pm on due date and next day by noon
   100% penalty = TA receives homework after noon on day after the homework was due

3. **Exams** - will occur three times throughout the semester including the final exam. Questions on the exam will include a combination of multiple choice, short answers, and diagramming. Each exam will last the duration of one class period.

4. **Final Research Project** - each person will choose a physiological phenomenon to investigate in detail. This could be something that has been discussed in class or something that you have found on your own. Each student will present their research on this topic in a written report that will take the form of a popular scientific article. In addition, students will do a 10-minute oral presentation to the class on their chosen topic.

Grading

● Participation	5%
● In-class Assignments	10%
● Homework	15%
● Exam 1, Exam 2, Final Exam	22% (highest), 20% (middle), 13% (lowest)
● Project	15%

Final letter grades will be determined as follows:

Grade	(Grade)-	(Grade)	(Grade)+
A	90-92.99%	93-96.99%	97-100%
B	80-82.99%	83-86.99%	87-89.99%
C	70-72.99%	73-76.99%	77-79.99%
D	60-62.99%	63-66.99%	67-69.99%
F	N/A	<60	N/A

Course Schedule:

Date	Topic	Assignments/Activities
8/18	Course Introduction, Fundamentals of Physiology (History, Systems, Homeostasis)	Use Zygote Body to familiarize yourself with body systems; read the course syllabus In class: Lecture
8/20	Metabolic rate, Fuel, Energy consumption	Read an article: • How Humans Became Meat Eaters • Pushing the Limits of Human Endurance • Not easy eating green: Herbivores most at extinction risk • Why It's Hard to Break the Gnus In class: Lecture/Write short popular science article on assigned topic
8/25	Feeding, SDA, Allometric scaling	Readings Jigsaw: 1. B. Z. Stanger. 2008. **The biology of organ size determination.** Diabetes, Obesity and Metabolism, 10 (Suppl. 4), 16–22 2. West, G., Savage, V., Gillooly, J. et al. **Why does metabolic rate scale with body size?** Nature 421, 713 (2003) 3. Pilbeam D, Gould SJ. **Size and scaling in human evolution.** Science. 1974 Dec 6;186(4167):892-901. In class: Lecture/Jigsaw
8/27	Locomotion strategies, Exercise	**Due: Homework 1** Skim The Physics of Animal Locomotion In class: Lecture/Collaborate on chapter study guide
9/1	Muscles, Excitation/Contraction, Metabolic subtypes of muscles	Video Lecture Professor Dave Explains: Muscle Contraction In class: Lecture/ Group discussion of muscle contraction
9/3	PROJECTS/Discussion Day	Student presentations
9/8	Thermoregulation: heat strategies and overview	Podcast Ologies, Thermophysiology with Dr. Shane Campbell-Staton

		In class: Lecture
9/10	Ectotherms in extreme environments	**Due: Homework 2** Review Homeostatic Processes for Thermoregulation and Extreme Cold Hardiness in Ectotherms Knowledge Project articles In class: Lecture
9/15	Endotherms in cold environments; Endotherms in hot environments	Readings Jigsaw: 1. Downhower, J., Blumer, L. **Calculating just how small a whale can be**. Nature 335, 675 (1988). 2. Köhler, M., Marín-Moratalla, N., Jordana, X. et al. **Seasonal bone growth and physiology in endotherms shed light on dinosaur physiology.** Nature 487, 358–361 (2012). 3. Baker MA. **Brain cooling in endotherms in heat and exercise.** Annu Rev Physiol. 1982;44:85-96. In class: Lecture/Jigsaw
9/17	OPEN CLASS	Review for exam
9/22	**EXAM 1**	
9/24	Respiration: oxygen and CO_2 content in air and water; gas laws	Read Evolution of Air Breathing: Oxygen Homeostasis and the Transitions from Water to Land and Sky In class: Lecture/Paper critique
9/29	Transport of respiratory gases in the blood and respiratory pigments	Video Lecture Armando Hasudungan: Respiration Gas Exchange In class: Lecture/Group discussion of oxygen transport
10/1	Respiratory surfaces & gas exchange; respiratory regulation	**Due: Homework 3** Skim Systems of Gas Exchange In class: Lecture/Collaborate on chapter study guide
10/6	Breathing at high altitude and while diving; pH regulation	Read ● Into thin air: Medical problems at new heights ● Diving and oxygen In class: Lecture
10/8	PROJECTS/Discussion Day	Student presentations

10/13	Cardiovascular and circulatory function	Review UM Cardiac Physiology Tutorial In class: Lecture
10/15	Open/closed circulatory systems; vertebrate hearts	**Due: Homework 4** Bring into class one example of a animal with an open heart and one with a closed heart In-class: Lecture/Individual diagram activity
10/20	Heart rate, SV, CO, BP; hemodynamics	Readings Jigsaw: • Dive heart rate in harbour porpoises is influenced by exercise and expectations • Gravitational haemodynamics and oedema prevention in the giraffe • Cardiac function adaptations in hibernating grizzly bears (Ursus arctos horribilis) • Warm fish with cold hearts: thermal plasticity of excitation–contraction coupling in bluefin tuna In class: Lecture/Jigsaw
10/22	OPEN CLASS	Review for exam
10/27	**EXAM 2**	
10/29	Regulation of cardiovascular function	Video Lecture Neural Control of the Heart In Class: Lecture
11/3	Nervous system: the nerve cell, synapses, neurotransmitters	Podcast The Science of Everything, Episode 38: Neurons and Synapses In-class: Lecture/Group diagram activity
11/5	Nervous system: autonomic nervous system; regulation of body temperature, hunger, feeding	**Due: Homework 5** Read an article: • The Other Brain Also Deals With Many Woes • The Brain: Our Food Traffic Controller • The Science of Brain Freeze (!) • The People Who Can Control Their Goose Bumps In class: Lecture/Write short popular science article

		on assigned topic
11/10	PROJECTS/Discussion Day	Student presentations
11/12	Interesting final thoughts	Bring in articles or topics to discuss
11/17	OPEN CLASS	Review for exam
11/19	**FINAL EXAM**	