

IB426 Environmental and Evolutionary Physiology of Animals

Fall 2020 ♦ MWF 12:00 noon ♦ Online by Zoom

	Instructor	TA
Office Phone Email Office hour	Chris Cheng	none
	17 Burrill Hall	
	333-2832	
	c-cheng@illinois.edu	
	Flexible; by appointment whenever needed. Please email me to set up online meeting.	

Course Web Site: <https://learn.illinois.edu/course/view.php?id=50051>
on ATLAS Moodle Log in with your Net-id and Active Directory password.

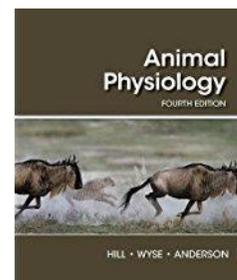
Textbook: **Animal Physiology** - Hill, Wyse & Anderson, 4th edition, 2016.

Add'l reading: Scientific papers; will be posted on IB426 website.

Lecture files: Preview files posted. Updated files to be posted after each class.

Grade breakdown:

- **Exams:** 4 hourly exams - 20% each, total 80%. **NO** cumulative final exam.
- **Homework:** 4-5 – 20% total of course grade. Short answer and essays.



	Exam date	Lectures covered	Topics covered
Exam I	9-21-20 Mon	Lectures 1-11 (11 lectures)	♦ Fundamentals of animal physiology ♦ Salt & water balance. Excretion ♦ Water locomotion
Exam II	10-19-20 Mon	Lectures 12-21 (10 lectures)	♦ Food, fuel and metabolism ♦ O ₂ and CO ₂ -- Transport and gas exchange
Exam III	11-09-20 Mon	Lectures 22-30 (9 lectures)	♦ Life at depths and heights: Diving and altitude physiology ♦ Heat and cold: Temperatures and thermal physiology
Exam IV	12-09-20 Wed	Lectures 31 - 38 (8 lectures)	♦ Life in freezing environments for ectotherms ♦ Light and visual ecology and evolutionary physiology

Extra credit: **Awareness Project – Plastic Pollution and Damage to Organisms**
 Project details to be announced in class.
 ≤ 4 pts will be added to your weighted score from 4 Exams+HWs (over 100 pts).

Final course grade: “Curved”, *i.e.* your final total weighted score (4Exams+HW+extra credit) will be normalized to the top student score in the class. *E.g.*, if the top student score is 90, that student will have 100% (90/90). A final total weighted score of 80 is 88.8% (80/90).
Tentative grade assignment of normalized % score is given in the following table:

% of top score	100%	90-99%	85-89%	80-84%	75-79%	70-74%	65-69%	60-64%
Grade	A+	A	B+	B	B-	C+	C	C-

LEARNING OBJECTIVES OF THE COURSE

The overall goal of the course is to gain a clear and in-depth understanding of the breath of animal physiological mechanisms relevant to their life history and the environments they live in.

These mechanisms were driven to evolve by certain physical factors and challenges in different environments. Thus in this course, you will also learn what these physical factors are and how they limit life, and how animal and cellular physiologies adapt to sustain life.

To understand these relationships, we begin with first principles, defining the physical and chemical laws that govern cellular and organismal function, followed by the physiological responses that animals have evolved to solve these challenges to be viable.

Thus one key objective, or assesment of your understanding, is that when you are given a set of environmental conditions, you would be able to predict what physiological processes and mechansims must be put in place for the animals to survive those conditions.

It is also the goal of the course that you come away with an appreciation of the remarkable ingenuity of animal life and adaptations in diverse environments of our planet, and learn to value all living organisms.

CLASS ATTENDANCE & PARTICIPATION

The covid19 crisis has necessitated the online format of this course this semester. It is not ideal. But with a small class size (currently at 20), I hope we can still achieve good interaction. Students are expected to attend all scheduled synchronous class meetings. If any of you anticipates internet difficulties, please do not hesitate to contact me for help.

IB426 is an upper level course, thus the expectations on your understanding of the course content are substantially greater and much more in-depth than introductory biology courses. Attending class meetins is therefore very important for understanding the concepts and the level of complexities in animal physiology mechanisms, which are much easier to comprehend when explained. Lecture slides will be posted on Moodle before classes for preview. Class meetings with use updated slides. Please watch for announcements in the news forum of Moodle or class emails for additional relevant updates.

COURSE OUTLINE & SCHEDULE

- **Please note that the time line for the syllabus is the closest approximation. Minor variations in the time table will likely occur.**
- **Updates to the schedule will be announced by email and in the course Moodle site.**
- **Preview lecture files will be posted before class. Updated files will be posted after class.**
- **Study guides to the four exams will also be posted.**
- **Exams will be multiple choice questions and given online. Details to be given in class.**

FUNDAMENTALS OF ANIMAL PHYSIOLOGY (Aug. 24 – Sept. 04, 2020)

Lectures: 1 – 6 ♦ HWA (Hill, Wyse & Anderson) Chapters: 1, 2, 5

Introduction to course

Central questions of animal physiology

Overview of diverse environments and physiological demands

Concepts of adaptations; Time course and range of responses to change

Molecules and cells underlying animal physiology and response

Enzyme biochemistry fundamental; Transport of solutes and water

ANIMAL FUNCTIONS IN VARYING ENVIRONMENTS (Sept. 9 – Dec. 04, 2020)

• **Salt and Water Balance. Excretion (Sept. 9 - 14, 2020)**

Lectures: 7 – 9 ♦ HWA Chapters: 27, 28, 29

Introductions, and mechanisms

Osmotic and salt challenges of aquatic and terrestrial environments

Non-renal and renal osmotic regulation

Osmotic regulation par excellence in desert mammals

Nitrogenous excretion

• **Water Locomotion – fun topic (Sept. 16 – 18, 2020)**

Lectures: 10 – 11 ♦ assigned papers

Locomotion of water striders and Jesus (basilisk) lizard on water

Exam I: Sept. 21, 2020 (Monday), on lectures 1 - 11 (11 lectures: 8.24.2020 through 9.18.2020)

• **Food, Fuel and Metabolism (Sept. 23 - Sept. 30, 2020)**

Lectures: 12 – 15 ♦ HWA Chapters: 6, 8; additional reading

Food sources; range of digestive systems

Physiology of vertebrate digestion and adsorption

Special digestive strategies and systems: Infrequent eaters; fermenters

Aerobic and anaerobic metabolisms

• **O₂ and CO₂: Transport and Gas Exchange (Oct. 2 – Oct. 14, 2020).**

Lectures: 16 – 21 ♦ HWA Chapters: 22 – 25; additional material

Evolution of the Earth's atmosphere

Atmospheric and aquatic gaseous compositions and properties

Respiratory systems and physiology of air and water breathers

Cardiovascular systems and circulation

Respiratory proteins and gas exchange; Controls of breathing

O₂ secretion in teleost swim bladder; "Bloodless" (no kidding) Antarctic icefishes

Exam II: Oct. 19, 2020 (Monday), on lectures 12-21 (10 lectures: 9.23.2020 through 10.14.2020)

• **Life at Depths and Heights: Diving and Altitude Physiology (Oct. 16 - 26, 2020)**

Lectures: 22 – 25 ♦ HWA Chapters: 26; (partial)3, 8, 23, 24; additional lecture material

Return to the sea-Evolution of marine mammals

Decompression physiology of air-breathing divers

Adaptations of diving marine mammals and birds

Hypobaric hypoxia at heights

Acclimatory and evolutionary responses to hypobaric hypoxia

• **Heat and Cold: Temperatures and Thermal Physiology (Oct. 28 - Nov. 6, 2020)**

Lectures 26 – 30 ♦ HWA Chapters 10, 11; additional lecture material

Range of thermal environments

Thermal balance and thermal exchanges

Temperature effects and responses at biochemical, cellular and organismal levels

Short-term, long-term and evolutionary temperature compensations

Strategies & mechanisms: Ectothermy, endothermy, heterothermy, torpor

Exam III: Nov. 9, 2020 (Monday), on lectures 22-30 (9 lectures: 10.16.2020 through 11.06.2020)

• **Life in Freezing Environments for Ectotherms (Nov. 11 – 18, 2020)**

Lectures: 31 – 34 ♦ Chapter 10 (partial); additional lecture material

Paleogeography and glacial histories of Earth's cryosphere

Problems of cellular freezing

Freeze avoidance strategies

Antifreeze proteins: mechanism and evolutionary innovations

Freeze tolerance mechanisms: Frozen but alive



(Thanksgiving break: Nov. 23 – 27, 2020)

• **Light and Visual Ecology and Evolutionary Physiology (Nov. 20, 30; Dec. 2-4, 2020)**

Lectures: 35 – 39 ♦ HWA Chapters (partial) 1, 14; additional lecture material; additional reading

Seeing the environment – Lens crystallins; Phototransduction and visual processing in vertebrates

Adaptive spectral tuning in deep water: coelacanth, Lake Baikal sculpins

Bioluminescence - luciferins and photoproteins (if there is time)

Dec. 7, 2020 – Class presentations on Awareness Research Project

Exam IV: Dec. 9, 2020 (Wed). On lectures 31 - 38 (8 lectures: 11.11.2019 through 12.02.2019)

Note:

- Exam IV is the last exam of the course and takes place in the last class period on Dec. 9, 2020.

STATEMENT OF ACADEMIC INTEGRITY

As required by the UIUC Student Code of Conduct, the Academic Integrity Policy and Procedure from the Student Code 2018-2019 (<http://studentcode.illinois.edu/index.html>) will be enforced. This applies to all exams, homework and other assignments. Infractions of academic integrity regulations are taken seriously and can result in severe consequences, including expulsion from the University.

It is the student's responsibility to become familiar with, understand, and abide by the Academic Integrity section of the Student Code. It should be noted that ignorance of these regulations is not a defense in cases of infringement of the rules of academic integrity.

ACCOMMODATIONS

Your success in studying this course is important to me. If you have to miss class or exams, or need more time for completion of exams or homework assignments because of professional or personal obligations or emergency situations, you should notify me immediately.

Request for accommodations must be clear and brief. Decisions will be made on an individual basis. If you have a disability, please send me a Letter of Academic Accommodations within the first two weeks of the semester. Guidance to obtaining Letter of Academic Accommodations from DRES is at <http://disability.illinois.edu/academic-support/accommodations>.