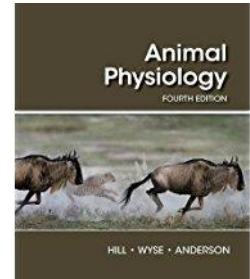


IB426 Environmental and Evolutionary Physiology of Animals

Fall 2022 ♦ MWF 11:00 am – 11:50 am ♦ NHB2083 (in-person)

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

Course credit: 3 credit hours (undergraduate or graduate)
Prerequisites: [MCB 150](#); [IB 202](#); [CHEM 232](#); or consent of instructor.
Moodle course Site: <https://learn.illinois.edu/course/view.php?id=69070>
 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:** 5 HW – 20% total of course grade (HW1-4:15%; HW5-5%). Short answer and essays.

	Exam date	Lectures covered	Topics covered
Exam I	9-19-2022 Mon	Lectures 1-11 (11 lectures)	♦ Fundamentals of animal physiology ♦ Water locomotion ♦ Salt & water balance. Excretion
Exam II	10-17-2022 Mon	Lectures 12-21 (10 lectures)	♦ Food, fuel and metabolism ♦ O ₂ and CO ₂ -- Transport and gas exchange
Exam III	11-07-2022 Mon	Lectures 22-30 (9 lectures)	♦ Life at depths and heights: Diving and altitude physiology ♦ Heat and cold: Temperatures and thermal physiology
Exam IV	12-07-2022 Wed	Lectures 31 - 38 (8 lectures)	♦ Life in freezing environments for ectotherms ♦ Light and visual ecology and adaptive spectral tuning

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).
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, and assessment of your understanding, is that when you are given a set of environmental conditions, you would be able to predict what physiological processes and mechanisms must be present 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, and their habitats that must be preserved for their survival.

CLASS ATTENDANCE & PARTICIPATION

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 meetings 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 are posted on Moodle before classes for preview. Bear in mind, they can't replace in class explanations. Class meetings will use updated slides, which will replace the preview file after class.

Please watch for announcements in the news forum of Moodle or class emails for additional relevant updates.

COVID SAFETY

The great majority of us are fully vaccinated. UIUC does not currently require in-classroom face covering. You are welcome to make your own decision based on your comfort level regarding indoor masking.

COURSE OUTLINE & SCHEDULE

- Please note that the timeline for the syllabus is the closest approximation. Some variations in the timetable 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 for 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. 22 – Sept. 02, 2022)

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. 07 – Dec. 05, 2022)

• Water Locomotion – fun topic (Sept. 07 -09, 2022)

Lectures: 7 – 8 ♦ assigned papers

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

• Salt and Water Balance. Excretion (Sept. 12 -16, 2022)

Lectures: 9 – 11 ♦ HWA Chapters: 27, 28, 29(partial)

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

Exam I: Sept. 19 2022 (Monday), on lectures 1 - 11 (11 lectures: 8.22.2022 through 9.16.2022)

• Food, Fuel and Metabolism (Sept. 21 - Sept. 28, 2022)

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 (Sept. 30 – Oct. 12, 2022)

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" Antarctic icefishes

Exam II: Oct. 17, 2022 (Monday), on lectures 12-21 (10 lectures: 9.21.2022 through 10.12.2022)

• **Life at Depths and Heights: Diving and Altitude Physiology (Oct. 14 - 24, 2022)**

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. 26 - Nov. 4, 2022)**

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: Nov7, 2022 (Monday), on lectures 22-30 (9 lectures: 10.14.2020 through 11.04.2022)

• **Life in Freezing Environments for Ectotherms (Nov. 09 – 16, 2022)**

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. 21 – 25, 2022)

• **Light and Visual Ecology and adaptive spectral tuning (Nov. 18, 28, 30 ; Dec. 2-5, 2022)**

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)

Exam IV: Dec.07, 2022 (Wed). On lectures 31 - 38 (8 lectures: 11.09.2022 through 12.05, 2022)

NOTE: Exam IV is the last exam of the course and takes place on the day of the last class period.

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 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, please 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>.

Weekly Calendar_IB426_FA2022

Note – some variations in the lecture schedule will likely occur.

Month	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Aug 2022	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21 Week1	22 Intro to IB426 L1: Fundamentals of animal physiology -HW1	23	24 L2: Fundamentals - environments, physiol demands, concept of adaptation	25	26 L3: Fundamentals - molecules, cells underlying physiology	27 HW1 due
	28 Week2	29 L4: Fundamentals - Enzyme biochem fundamental	30	31 L5: Fundamentals - Transport of solutes and water	1	2 L6: Fundamentals - Transport of solutes and water	3
Sep 2022	4 Week3	5 Labor day holiday	6	7 L7-8(2) L7: Water locomotion - strider	8	9 L8: Water locomotion - basilisk	10
	11 Week4	12 7 L9-11(3) L7: Water and salt balance, excretion	13	14 L10: Water and salt balance, excretion	15	16 L11: Water and salt balance, excretion	17
	18 Week5	19 EXAM I Lectures 1-11	20	21 L12-15(4) L12: Food, fuel, metabolism	22	23 L13: Food, fuel, metabolism	24
	25 Week6	26 L14: Food, fuel, metabolism	27	28 L15: Food, fuel, metabolism	29	30 L16-21(6) L16: O ₂ & CO ₂ transport; gas exchange	1
Oct 2022	2 Week7	3 L17: O ₂ & CO ₂ transport; gas exchange	4	5 L18: O ₂ & CO ₂ transport; gas exchange	6	7 L19: O ₂ & CO ₂ transport; gas exchange	8
	9 Week8	10 L20: O ₂ & CO ₂ transport; gas exchange	11	12 L21: O ₂ & CO ₂ transport; gas exchange	13	14 L22-25(4) L22: Diving and altitude physiology	15
	16 Week9	17 EXAM II lectures 12-21 (10 lectures)	18	19 L23: Diving and altitude physiology	20	21 L24: Diving and altitude physiology	22
	23 Week10	24 L25: Diving and altitude physiology	25	26 L26: Temperature & thermal physiology	27	28 L27: Temperature & thermal physiology	29

Month	Sun	Mon	Tue	Wed	Thu	Fri	Sat
	30 Week11	31 L28:Temperature & thermal physiology	1	2 L29:Temperature & thermal physiology	3	4 L30:Temperature & thermal physiology	5
Nov 2022	6 Week12	7 EXAM III lectures 22-30 (9 lectures)	8	9 L31-34(4) L31: Life in freezing environments	10	11 L32: Life in freezing environments	12
	13 Week13	14 L33: Life in freezing environments	15	16 L34: Life in freezing environments	17	18 L35-39(4) L35: visual systems / phototransduction	19
	20 Week14	21 Thanksgiving	22 Thanksgiving	23 Thanksgiving	24 Thanksgiving	25 Thanksgiving	26
	27 Week15	28 L36: Phototransduction (Awareness project due)	29	30 L37: visual ecology /adaptive spectral tuning	1	2 L38: visual ecology /adaptive spectral tuning; bioluminescence	3
	4 Week16	5 L39: bioluminescence	6	7 EXAM IV lectures 31-39	8 Reading Day	9 Finals	10
Dec 2022	11 Week17	12 Finals	13 Finals	14 Finals	15 Finals	16 Finals	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31

This Calendar is printable and fully editable. Courtesy of [WinCalendar](#)