IB426 Environmental and Evolutionary Physiology of Animals
Fall semesters ♦ MWF 11:00am ♦ 2083 Natural History Building

<table>
<thead>
<tr>
<th>Instructor</th>
<th>TA</th>
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<tbody>
<tr>
<td>Chris Cheng</td>
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<tr>
<td>17 Burrill Hall (BH basement, west end)</td>
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<tr>
<td>333-2832</td>
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<tr>
<td><a href="mailto:c-cheng@illinois.edu">c-cheng@illinois.edu</a></td>
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<td>Flexible; by appointment whenever needed. Call or email me.</td>
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Course Web Site: [https://learn.illinois.edu/auth/shibboleth/gateway.php](https://learn.illinois.edu/auth/shibboleth/gateway.php)
on ATLAS Moodle Log in with your Net-id and Active Directory password.


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.

<table>
<thead>
<tr>
<th>Approx. Exam date</th>
<th>Lectures covered</th>
<th>Topics covered</th>
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<tbody>
<tr>
<td>Eg. Fall 2017</td>
<td>Lectures 1-11 (11 lectures)</td>
<td>• Fundamentals of animal physiology • Salt &amp; water balance. Excretion • Water locomotion</td>
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<tr>
<td>Exam I 9-25-17 Mon</td>
<td>Lectures 12-21 (10 lectures)</td>
<td>• Food, fuel and metabolism • O₂ and CO₂ -- Transport and gas exchange</td>
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<tr>
<td>Exam II 10-23-17 Mon</td>
<td>Lectures 22-30 (9 lectures)</td>
<td>• Life at depths and heights: Diving and altitude physiology • Heat and cold: Temperatures and thermal physiology</td>
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<tr>
<td>Exam III 11-13-17 Mon</td>
<td>Lectures 31 - 39 (9 lectures)</td>
<td>•Life in freezing environments for ectotherms • Light and visual ecology and evolutionary physiology</td>
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<td>Exam IV 12-13-17 Wed</td>
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**Extra credit:** Animal Awareness Project - ≤ 4 pts added to total score from exams+HW (over 100 pts). Project details to be announced in class.

**Final course grade:** “Curved”. I.e. your final total score (exams+ HW+extra credit) will be normalized to the top final score in the class. For example, if the top student score is 80, that student will have 100% (80/80). A final score of 70 is 87.5% (70/80). Tentative grade assignment of normalized score is given in the following table:

<table>
<thead>
<tr>
<th>% of top score</th>
<th>100%</th>
<th>90-99%</th>
<th>85-89%</th>
<th>80-84%</th>
<th>75-79%</th>
<th>70-74%</th>
<th>65-69%</th>
<th>60-64%</th>
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<tbody>
<tr>
<td>Grade</td>
<td>A+</td>
<td>A</td>
<td>B+</td>
<td>B</td>
<td>B-</td>
<td>C+</td>
<td>C</td>
<td>C-</td>
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COURSE OBJECTIVE

The overall goal of the course is to gain a clear and in-depth understanding of the breadth 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 various environments. Thus the course is also on understanding what these physical factors are and how they limit life, and how animal and cellular physiologies adapt to sustain life. A useful approach to understand these relationships is to begin with first principle, defining the physical and chemical laws that govern cellular and organismal function, followed by the physiological responses that animals must put into place or evolved to solve these challenges to be viable. It is also the goal of the course that you come away with an appreciation and value the remarkable ingenuity of animal life and adaptations in diverse environments of our planet.

CLASS ATTENDANCE & PARTICIPATION

Students are expected to attend all scheduled classes and to participate in class discussions. Students are encouraged to bring laptops and appropriate mobile device useful for in class participation in the iFLEX classroom. IB426 is an upper level course, thus the expectations on the understanding are substantially greater and much more in-depth than introductory courses. Attending class lectures 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. Slides are subject to change after lectures are delivered. Watch announcements on new forum of Moodle or class emails closely for updates.

COURSE OUTLINE & SCHEDULE (Fall2017 schedule given below as example)

- 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 as well as 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.

FUNDAMENTALS OF ANIMAL PHYSIOLOGY (Aug. 28– Sept. 11, 2017)
Lectures: 1 – 6 ♦ HWA HWA 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. 13 – Dec. 11, 2017)
- Salt and Water Balance. Excretion (Sept. 7 - 12, 2017)
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

  * Lectures: 10 – 11 ♦ assigned papers
  Locomotion of water striders and Jesus (basilisk) lizard on water


* Food, Fuel and Metabolism (Sept. 27 - Oct. 4, 2017)
  * 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

  * 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


* Life at Depths and Heights: Diving and Altitude Physiology (Oct. 20 - 30, 2017)
  * 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
  Hypobrar hypoxia at heights
  Acclimatory and evolutionary responses to hypobaric hypoxia

  * 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


* Life in Freezing Environments for Ectotherms (Nov. 15 – 17; Nov. 27 - 29, 2017)
  * 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. 20 – 24, 2017)

• Light and Visual Ecology and Evolutionary Physiology (Dec. 1 - Dec. 11, 2017)
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)

Note:
• Last lecture is on Wednesday Dec. 11, 2017.
• Exam IV is the last exam of the course and takes place in the last class period on Dec. 13.

STATEMENT OF ACADEMIC INTEGRITY

As required by the UIUC Student Code of Conduct, the Academic Integrity Policy and Procedure from the Student Code 2017-2018 (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. 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.