FISH 324: Aquatic Animal Physiology and Reproduction

Winter 2014

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Course Description and Approach

The overall focus of the course is on the functional adaptations and adjustments animals use to cope with the various environmental and physiological challenges to life in aquatic environments. The main animal groups that will be considered are crustaceans, molluscs, fishes, and marine mammals, although examples from other aquatic animal groups will be given where they illuminate a particular challenge or adaptation to the aquatic environment. After considering the challenges of life in aquatic environments, the beginning theme (and a central paradigm in physiology) will be the partitioning of energy. Understanding how the flow of energy in animals is regulated is fundamental to understanding virtually every aspect of physiology, reproduction and life history strategies. Energy obtained through feeding and digestion is allocated to basic maintenance functions (metabolism, movement, repair,), dealing with homeostatic challenges (gas exchange, osmoregulation, thermoregulation, etc), channelled into growth, and ultimately is invested in reproduction. The course will first address the particular challenges faced by animals living in an aqueous medium, and the basics of bioenergetics. It will then deal with the physiology of metabolism, respiration, and homeostasis. The roles of the endocrine system in regulating and coordinating these processes will be discussed, with emphasis on the role of these systems in mediating environmental information. A portion of the course will be devoted to the ultimate measure of success of these processes, reproduction. After an overview of reproductive processes and their environmental and endocrine regulation, topics such as environmental sex determination, adult sex change and methods of reproductive manipulation will be reviewed.

The course will emphasize the physiological mechanisms are conserved across taxa and those that are unique to a particular aquatic animal group, with some case studies on how particular groups of animals cope physiologically with extreme environments and with contrasting environments at different parts of their life cycle (e.g., anadromy in salmon, catadromy in eels). Case studies will also be used to focus on the constraints solutions to particular physiological problems may impose on other aspects of the life of the animal.

Learning objectives

• understand the important environmental variables in the aquatic environment that impact on the physiology of aquatic animals
• understand the fundamentals of bioenergetics as a basis for understanding how animals gain and invest energy in various physiological processes
• understand the physiological adaptations of aquatic animals to their environment
• understand the basics of gamete development, the diverse reproductive strategies displayed by aquatic animals, and the underlying regulatory mechanisms
• appreciate how physiological knowledge can be used in an applied sense, ranging from predicting environmental impacts, to controlling reproduction.
• acquire theoretical (3-credit) and practical (2-credit) experience in experimental techniques for understanding the physiology of aquatic animals
• develop the ability to access, analyze and critically evaluate key literature in aquatic animal physiology

Textbooks

The course does not adhere to any particular comparative/environmental physiology textbook, and some subjects in the course are not well represented in any major comparative/environmental physiology textbook. Most

comparative/environmental physiology texts give good coverage of the basics. Of those available, the following two books should be available used at a reasonable cost:

Environmental Physiology of Animals (P. Willmer, G. Stone, I. Johnston). Blackwell Publishing, 2nd edition (The 1st addition would also be useful, but only page numbers from the 2nd edition are referred to in the lecture schedule – this later edition is on reserve)

Eckert Animal Physiology. Randall, Burggren, and French. W. H. Freeman, 4th edition (The 5th edition is available but only page numbers from the 4th edition are referred to in the lecture schedule - this earlier edition is on reserve)

Other textbooks:

Introductory biology textbooks are a useful general resource, especially for basic cell physiology/biochemistry/metabolism

Textbooks on reserve:
1. Environmental Physiology of Animals. Willmer, Stone, and Johnston. (2nd ed.) 2005

2. Eckert Animal Physiology. Randall, Burggren, and French. (4th ed.) 1997

3. The Physiology of Fishes. Evans and Clairborne. (3rd ed). 2006

4. The Invertebrates: a synthesis. Barnes, Calow, Olive, Golding, and Spicer. (3rd ed.) 2001

5. Biology. Campbell. (7th ed.) 2005

Assessment and deadlines
3-credit (lecture only):
- Written critique of a primary, peer-reviewed journal research paper in animal physiology (25%) (Feb 24)
- two in-class exams (25% each) (Jan 29, Feb 19): based on material from the start of the course (exam 1) or on material covered since the last in-class exam (exam 2).
- final exam (25%) (March 20, 9.30-10.20 pm): the final exam will ONLY be on material covered since the last in-class exam.

5-credit (lecture and lab): as above plus
- lab attendance/participation
- lab reports
- oral (Powerpoint) presentation (7 min + 3 min question time) on your critique topic
  (% for each assignment, deadlines, etc., will be discussed during the first lab)

Academic Integrity
Plagiarism, cheating, and other misconduct are serious violations of the student conduct code. We expect that you will know and follow the University's policies on cheating and plagiarism. Any suspected cases of academic misconduct will be handled according to University regulations. More information, including definitions and examples of Academic Misconduct, can be found in the Faculty Resource for Grading and the Student Conduct Code (WAC 478-120), see: http://depts.washington.edu/grading/pdf/AcademicResponsibility.pdf

Disability Accommodations
To request academic accommodations due to a disability, please contact Disability Resources for Students, 448 Schmitz, (206) 543-8924. If you have a letter from that office indicating that you have a disability that requires academic accommodations, please present the letter to the instructor so we can discuss the accommodations needed for this class.

DATE	LECTURE TOPIC PROVISIONAL – FOR GENERAL GUIDANCE ONLY	BACKGROUND READING
Jan 6	1. Introduction to course I; characteristics of aquatic environments; general physiological challenges aquatic organisms face	**Ch4: 51-74, Ch11: 393-400, 415-429, Ch12: 444-455, Ch13: 487-495, Ch14: 526-528**
8	2. Introduction to course II; characteristics of aquatic environments; general physiological challenges aquatic organisms face	*Ch1: 3-9*
10	3. Trophic modes, life at hydrothermal vents, acquiring food	**Ch11: 429-430, Ch12: 480-481, Ch13: 515-518,** *Ch15: 627-634*
13	4. Ingestion, food processing, digestion	**Ch6: 134-139**
15	5. Nutrition; Bioenergetics and metabolism I	**Ch3: 40-42, 46-47, Ch6: 112-124, 126-133**
17	6. Bioenergetics II	**Ch8: 175-183, 188-191, 196-201, Ch11: 400-408, 439-440**
20	***Martin Luther King Jr. Day: no lecture***	
22	7. Bioenergetics III; Thermobiology I	**Ch12: 466-470, Ch13: 502-505**
24	8. Thermobiology II: life at low temperatures	**Ch8: 183-186, Ch11: 436-438, Ch12: 470-471**
27	9. Thermobiology III: life at high temperatures	**Ch8: 187-188**
29	**Lecture Exam #1**	
31	Case study – regional endothermy	
Feb 3	10. Osmoregulation I	**Ch5: 76-86, 88-99, Ch10: 361-363, Ch11: 408-411**
5	11. Osmoregulation II	**Ch12: 455-466, Ch13: 495-502,** *Ch14: 608-613*
7	12. Osmoregulation III: case study – benefits, costs and constraints of urea osmoconforming	**Ch5: 100-102, Ch11: 432-436,** *Ch14: 620-623*
11	13. Osmoregulation IV: Euryhalinity and diadromy; salmon parr-smolt transformation	
13	14. Gas exchange and circulation I	**Ch7: 144-153, 162-170, Ch11: 440-442**
15	15. Gas exchange and circulation II	**Ch12: 471-474, Ch13: 505-511,** *Ch13: 520-529, 552-554, 565-566*
17	***Presidents Day: no lecture***	
19	**Lecture Exam #2**	
21	16. Gas exchange and circulation III	**Ch7: 141-143, 154-162**
24	17. Surviving hypoxia/anoxia I	*Ch13: 562*
26	18. Surviving hypoxia/anoxia II: case studies-carp, diving mammals	
28	19. Defence systems: *guest lecture, Dr Steven Roberts*	
Mar 3	20. Reproduction I: modes, timing, diversity	**Ch11: 411-415, Ch12: 475-476**
5	21. Reproduction II: diversity; sex determination, differentiation, gamete production	**Ch13: 511-514, Ch10: 359-360, 372-375,** *Ch16: 717-719*
7	22. Fish reproduction I	
10	23. Fish reproduction II	
12	24. Fertilization; chemical signaling among and between species – semiochemicals and pheromones	
14	25. Reproductive dysfunction associated with contaminants	
20	**FINAL EXAM 9.30-10.20 am FSH 107**	

Suggested reading from **Wilmer et al., 2nd Edition (BOLD)**, *Randall et al., 4th Edition (ITALICS)*