Biology 513-PHYSIOLOGICAL ECOLOGY OF ANIMALS
Winter 2009 Syllabus

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Course description:

Physiological Ecology is the study of how animals physiologically and biochemically adapt to and live in varying environments. Among other things, we are interested in exploring how animals avoid desiccation, gather food, and survive in fluctuating temperatures, salinities, and oxygen levels.

Many of the examples and organisms that will be used in this course come from marine intertidal and estuarine habitats. These habitats exhibit large fluctuations in many of the variables we are interested in and, as such, are ideal for the study of physiological ecology. Likewise, given the proximity of the habitat the organisms are readily available for lab purposes.

Course format:

The class will meet for lecture MWF 9:00-9:50 and for lab either T or Th 1:00-5:00. Lectures are meant to be interactive and I expect you to ask and answer questions, supply examples from other classes or personal experience, and comment on the material being presented. Lectures will cover the general principles of Physiological Ecology using examples from the literature. There will be **two exams** covering the lecture material. They are **each worth 20%** of your final grade. In the laboratory, the first five labs will familiarize you with some physiological techniques. The last four weeks of the lab will be devoted to a major independent research project in which you will use one or more of these techniques. You should learn experimental design, data collection and analysis, literature search, formal report writing, and oral presentation skills during your laboratory experience.

Evaluation:

Lecture exams:	
Midterm (Feb. 6)	20%
Final (Mar. 19, 10:30-12:30)	20%
Laboratory	
Group reports	10%
Group research project	30%
PowerPoint presentation of group project	10%
Annotated Bibliography	10%

The grading scale is as follows

95% or greater: A	82-85%: B	72-74%: C	63-65%: D
90-94%: A-	78-81%: B-	69-71%: C-	60-62%: D-
86-89%: B+	75-77%: C+	66-68%: D+	below 60%: F

Laboratory:

The first five laboratory exercises are designed to introduce to some common techniques and instruments used in animal physiology. You will work in small groups on these experiments. Some times, you will be able to design your specific experiment and choose your experimental animal. At other times, the experiment will be specified and the entire class will participate in gathering data. For each labs, **each student** will turn in a brief report describing the results of the experiment. You may consult your group members on results and interpretations, **but each student should write their own report**. The format of the report should follow that of a published research paper in a biological journal such as *Physiological Zoology* or *Journal of Comparative Physiology*. There is a short section describing the format in your laboratory manual. The grades for these reports will total **10% of your grade**.

The last four weeks of the course will be devoted to an independent research project. You are to work in small groups on this project, but **each of you will turn in your own written report**. I will guide you in

designing your experiment. A written proposal is due from each group on **Feb. 17 or Feb. 19** (depending on your lab day). The proposal should clearly state the objective of the project and outline the experimental procedures you will use. Be very specific about the procedures so I can help you avoid potential problems. Each group will present a short (15 min) oral report on the last laboratory day (**Mar. 10 and 12**). On **Mar. 13**, each of you will submit **two** copies of your paper to me. The extra copy will be on file for future students. This report should be much more detailed than your earlier reports and you should include a thorough review of the literature.

An **annotated bibliography** will be required for the papers you have used for you independent research project. An annotated bibliography is a list of the papers you have read on a particular topic which includes the full reference as well as a brief (1 paragraph) description of the paper. You annotated bibliography should include at least 25 references.

Laboratory Assignments:

Jan. 13 and 15: Whole animal temperature tolerance You will conduct a whole-animal temperature tolerance experiment using small fish or shore crabs. You will design a simple experiment that investigates the interaction of temperature with one other variable such as salinity, humidity, or pre-trial temperature conditioning.

Jan. 20 and 22: Tolerance of bivalve mollusc gill tissue The class will determine the temperature tolerance of gill tissue from several different local species of bivalve molluscs. Each group will be assigned a particular species and will determine the temperature tolerance for two to three temperatures. The entire class data will be available for your report.

Jan. 27 and Jan 29: Respirometry One half of the class will measure the resting oxygen consumption of purple shore crabs (*Hemigrapsus nudus*) over a wide range of body size using a Gilson differential respirometer. The other half of the class will use a polarographic oxygen electrode in a sealed respirometry system to measure the oxygen consumption of the hermit crab *Pagurus granosimanus* (or another organism if needed) during locomotion. Data from all of the groups in the class will be compiled to generate a regression of resting oxygen consumption *vs.* mass for *H. nudus* and an estimation of cost of transport or aerobic scope for *P. granosimanus*. No formal report is required for these labs.

Feb. 3 and 5: Respirometry We will continue with the respirometry labs from last week with each group performing the exercise they did not do last week.

Feb. 10 and 12: Osmotic concentration of body fluids You will compare the effect of salinity on the osmotic concentration of hemolymph of two species of crab: *Hemigrapsus nudus* or *H. oregonensis* (high intertidal species) and *Oregonia gracilis* (a subtidal species). Each group will process several samples from several crabs of each species at each salinity. Data from the entire class will be combine for you written report.

Feb. 17 and 19: Develop proposal for group research projects You will meet in lab to develop a group research project and write a research proposal. You will have the next two weeks to complete this project. I will be available to read your proposal, give you feedback, and approve your project.

Feb. 20 through Mar. 9: Group research projects.

Mar. 10 and 12: Oral (PowerPoint) presentation of group research projects.

Mar. 13: Written group research projects due.

Lecture Topics:

Introduction to physiological adaptation

Adaptation, acclimatization, and acclimation; Homeostasis; Conformers and regulators

Physical factors

Seawater (temperature, salinity, oxygen levels, pressure, light); Intertidal zone (tides and waves); Microenvironments

Temperature adaptations

Resistance Adaptations (tolerance to high temperatures, cold and freezing); Capacity adaptations (biochemical effects of temperature, rate-temperature curves, biochemical aspects--focus on enzymes); Body temperature control

Nutrient acquisition and energy metabolism

Energy and nutrients; Calorimetry; Standard metabolic rate (body mass relationships); Specific dynamic action; Energy budgets

Oxygen and respiratory gas exchange

Respiratory pigments; Hypoxia and anoxia; Anaerobic metabolism; Diving mammals

Locomotion

Biomechanics of running, swimming, flying, and crawling; Aerobic scope; Cost of transport

Osmotic and ionic regulation

Hyperosmotic regulation; Hyposmotic regulation; Volume regulation; Terrestrial adaptations

Reading Assignments:

The primary text for the course is *Environmental Physiology of Animals 2nd Ed. by P. Willmer, G. Stone, and I. Johnston, Blackwell Science, Oxford*. Other books and papers will be available to supplement this text .

Introduction to Physiological Adaptation

Ch1; Ch 2

Temperature adaptations

Resistance adaptation:

Thermal tolerance: Ch. 8 pp. 187-202; Ch. 12 pp. 466-470; Ch. 13 pp. 502-504; Ch. 16 pp. 628-631

Heat shock proteins: Ch. 8 pp. 182-183

Freeze tolerance and resistance: Ch. 8 pp. 183-187; Ch. 11 pp. 436-440; Ch. 12 pp. 470-471; Ch. 13 pp. 504-505; Ch. 16 pp. 650-655

Capacity adaptation:

Metabolic rate-temperature curves: Ch. 6 pp. 126-133; Ch.8 pp. 175-177, 200-202; Ch. 16 pp. 628-629

Biochemical adaptation: Ch. 8 pp. 175-183; Ch. 11 pp. 401-404

Body temperature control: Ch. 8 pp. 192-196, 202-212; Ch. 11 pp. 404-408; Ch. 15 pp. 565-581

Nutrient acquisition and energy metabolism

Standard metabolic rates: Ch. 3 pp. 40-42; Ch. 6 pp. 126-133

Energy budgets: Ch. 6 pp. 133-139

Oxygen and respiratory gas exchange

Ch. 6 and Ch. 7 and relative sections in the chapters dealing with specific environments.

Metabolic regulation: Ch. 1 pp. 11-14; Ch. 7 pp. 140-153; Ch. 11 pp. 408-411; Ch. 12 pp. 471-473; Ch. 13 pp. 505-511; Ch. 16 pp. 669-670

Respiratory pigments: Ch. 7 pp. 162-169

Anoxia adaptations: Ch. 6 pp. 115-119; Ch. 12 pp. 473-475

Diving mammals: Ch. 11 pp. 440-442

Locomotion

Biomechanics: Ch. 11 pp. 422; Ch. 12 pp. 477-479; Ch. 15 pp. 596-599

Cost of transport: Ch. 3 pp. 42-46

Osmotic and ionic regulation

Ch. 4 and Ch. 5 and relative sections in the chapters dealing with specific environments.

Body fluid comparisons: Ch. 5 pp. 76-80; Ch. 11 pp. 396-400; Ch. 12 pp. 455-458; Ch. 13 pp. 495-496; Ch. 14 pp. 529-532

Ionic regulation: Ch. 11 pp. 400; Ch. 12 pp. 455

Hyperosmotic regulation: Ch. 1 pp. 11-14; Ch. 5 pp. 80-85, 88-92, 108-109; Ch. 12 pp. 456-462; Ch. 13 pp. 496-502

Hyposmotic adaptations: Ch. 5 pp. 85-86; Ch. 11 pp. 432-436; Ch. 14 pp. 529-532

Volume regulation: Ch.12 pp. 462-466; Ch. 13 pp. 496-499

Terrestrial adaptations: Ch. 5 pp. 86-88, 92-108; Ch. 15 pp. 552-565, 583-585; Ch. 16 pp. 620-644