Comparative Physiology of Animals ("Environmental Adaptations")
BISC 437L Catalina Semester 2005

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Teaching Assistant: Mr. David Ginsburg, Biological Sciences, USC.

Course Textbook:
K. Schmidt-Nielsen, 1997. *Animal Physiology: Adaptation and Environment*.
University of Cambridge Press, 5th Edition.

Additional course readings will be handed out for the daily Journal Club.

Course Outline

This course will consist of three distinct, but related, parts -- formal lectures; meetings of the "Journal Club;" and laboratory experiments.

1. Formal Lectures. Monday, Tuesday, Wednesday, and Thursday. There will be one lecture meeting on each of these lecture days. Sometimes this first morning meeting will have the standard lecture format, but it will also have a more informal format (e.g., class discussion, presentation of class data sets) depending on the progress of the laboratory experiments during the course.

2. Journal Club. This part of the course will meet Tuesday, Thursday, and Friday. During each meeting we will discuss papers from the scientific literature that will be related to the experiments to be undertaken during the course. One student will be assigned each paper and that person will present a summary of the paper to the class and lead the group discussion.

3. Laboratory experiments/field trips. Monday, Tuesday, and Thursday. All experiments must be written up. Your TA will inform you of the dates that you are expected to hand in your laboratory reports (ca. once a week).

Weekly schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Lecture	11am	9am	9am	9am	
Journal Club		11am		11am	9am
Laboratory	1pm	1pm		1pm	

Grading

50% of your grade will be based on your laboratory write-ups of your experiments. Some of the experiments that you will be undertaking will be new, in that we don't know at the outset what kind of data we will obtain ("new" to science, for the most part). Grading will be based on your careful collection and presentation of your novel data sets, and your laboratory reports that you will write in the standard scientific format (Introduction, Methods etc., see papers from journal club for examples).

40% of your grade will be based on a written, comprehensive, final examination. The format of this examination will be short-answer and long-essay. It will include material from the book, lectures, and all papers presented in journal club. The test is designed so that you can offer syntheses and approaches to problems in environmental physiology. This will be a 3-hour-long *open book examination* and you can refer to the literature to support your statements during the examination.

10% of your grade will be based on your presentations in journal club and your participation in class discussions.

SCHEDULE OF LABORATORY EXPERIMENTS

Section I. Physiology of Development – Growth, Nutrition, and Metabolism.

Mon 21st Importance of quantification and statistics in physiological research.

Tue 22nd Growth and Development I. Eggs, 0-day-old: Tracking development and measurement of protein content.

Thurs 24th Growth and Development II. Embryos, 2-day-old: Tracking development and measurement of protein content.

Mon 28th Growth and Development III. Fed and starved larvae, 6-day-old: Tracking development and measurement of protein content.

Tues 29th Growth and Development III. Fed and starved larvae, 6-day-old: Tracking development and measurement of protein content.

Thurs 31st Growth and Development IV. Fed and starved larvae, cell volume during development.

Mon 4th Metabolism: Measurement of metabolic rates (& field collections of animals).

Section II. Physiological Responses to Environmental Stress.

Food deprivation

Tues 5th Metabolism and excretion: Measurement of ammonia excretion and metabolism. Determination of biochemical utilization for metabolism through O:N ratios on field collected animals. Pt. I

Thurs 7th Metabolism and excretion: Ammonia excretion and metabolism during starvation. Determination of biochemical utilization for metabolism through O:N ratios on field collected animals. Pt. II

Temperature

Mon 11th Effect of temperature on physiological processes. Measurement of Na^+,K^+-ATPase in sea urchin embryos at different temperatures.

Section III. Ocean productivity and respiration

Tues 12th *In situ* measurement of oxygen consumption in ocean waters. Determination of net primary productivity, Pt. I.

Wed 13th *In situ* measurement of oxygen consumption in ocean waters. Determination of net primary productivity, Pt. II.

Daily Journal Club – Reading list

Students will lead group discussions on papers they are assigned.

Tues 22nd (Importance of quantitative analysis) **Students 1 & 2**
Schwartz, L.M., 1989. Calibration of pipets - A statistical view. Analytical Chemistry, 61: 1080-1083.

Hulbert, S.H., White, M.D., 1993. Experiments with freshwater invertebrate zooplanktivores – Quality of statistical analyses. Bulletin of Marine Science, 53: 128-153.

Thurs 24th (Measurement of protein) **Students 3 & 4**
Bradford, M.M., 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem., 72: 248-254.

Tal, M., Silberstein, A., Nusser, E., 1980. Why does Coomassie Brilliant Blue R interact differently with different proteins? J. Biol. Chem., 260: 9976-9980.

Fri 25th (Echinoderm culturing and development) **Students 5 & 6**
Hinegardner, R.T., 1967. Echinoderms. In: Methods in Developmental biology. Wilt and Wessell, eds. p139-155

Davidson, E.H., Hough-Evans, B.R., Britten, R.J., 1982. Molecular biology of the sea urchin embryo. Science, 217: 17-26.

Tues 29th (Solute systems, amino acids, and starvation) **Students 1 & 2**
Yancey, P.H., Clark, M.E., Hand, S.C., Bowlus, R.D., Somero, G.N., 1982. Living with stress: Evolution of osmolyte systems. Science, 217: 1214-1222.

Moran, A.L., Manahan, D.T., 2004. Physiological recovery from prolonged 'starvation' in larvae of the Pacific oyster *Crassostrea gigas*.

Thurs 31st (Measurement of metabolic rate) **Students 3 & 4**
van Waversveld, J., Addink, A.D.F., van den Thillart, G., 1989. The anaerobic energetic metabolism of goldfish determined by simultaneous direct and indirect calorimetry during anoxia and hypoxia. J. Comp. Physiol. B, 159: 263-268.

Marsh, A.G., Manahan, D.T., 1999. A method for accurate measurements of the respiration rates of marine invertebrate embryos and larvae. Mar. Ecol. Prog. Ser., 184: 1-10.

Fri 1st (Measurement of ammonia excretion and indices of biochemical utilization) **Students 5 & 6**

Solórzano, L., 1969. Determination of ammonia in natural waters by the phenolhypochlorite method. Limno. Oceanogr., 14: 799-801.

Mayzaud, P., Conover, R.J., 1988. O:N atomic ratio as a tool to describe zooplankton metabolism. Mar. Ecol. Prog. Ser., 45: 289-302.

Tues 5th (Protein synthesis and physiological cost of growth) **Students 1 & 2**

Vavra, J., Manahan, D.T., 1999. Protein metabolism in lecithotrophic larvae (Gastropoda: *Haliotis refescens*). Biol. Bull., 196: 177-186.

Pedersen, B.H., 1997. The cost of growth in young fish larvae, a review of new hypotheses. Aquaculture, 155: 259-269.

Thurs 7th (Cost of growth and model organisms) **Students 3 & 4**

Bayne, B.L., 1999. Physiological components of growth differences between individual oysters (*Crassostrea gigas*) and a comparison with *Saccostrea commercialis*. Physiol. Biol. Zool., 72: 705-713.

Shpigel, M., Barber, B.J., Mann R., 1992. Effects of elevated temperature on growth, gametogenesis, physiology, and biochemical composition in diploid and triploid Pacific oysters, *Crassostrea gigas* Thunberg. J. Exp. Mar. Biol. Ecol., 162: 15-25.

Fri 8th (Measurement of Na^+/K^+-ATPase activity and differential Q_{10}) **Students 5 & 6**

Hochachka, P.W., 1988. Channels and pumps – determinants of metabolic cold adaptation strategies. Comp. Biochem. Physiol. B, 90: 515-519.

Leong, P.K.K., Manahan, D.T., 1997. Metabolic importance of Na^+/K^+-ATPase activity during sea urchin development. J. exp. Biol., 200: 2881-2892.

Tue 12th (Environment and physiological stress) **Students 1 & 2**

Somero, G.N., 2002. Thermal physiology and vertical zonation of intertidal animals: Optima, limits, and costs of living. Integ Comp. Biol., 42: 780-789.

Smith *et al.,* 1992. Ozone depletion – Ultraviolet radiation and phytoplankton biology in Antarctic waters. Science, 255: 952-959.

Wed 13th (Environment and physiological stress) **Students 3 & 4**
Wickner, S., Maurizi, M.R., Gottesman, S., 1999. Posttranslational quality control: Folding, refolding, and degrading proteins. Science, 286: 1888-1893.

Hofman, G.E., Buckley, B.A., Airaksinen, S., Keen, J.E., Somero, G.N., 2000. Heat-shock protein expression is absent in the Antarctic fish *Trematomus bernacchii* (Family Nototheniidae). J. exp. Biol., 203: 2331-2339.

Thurs 14th (Global primary production and climate change) **Students 5 & 6**
Falkowsit, P.G., Barber, R.T., and Smetacek, V. Biogeochemical contols and feedbacks on ocean primary production. Science, 281: 201- 206.

Fasham *et al*. A new vision of ocean biogeochemistry after a decade of the Joint Global Ocean Flux Study (JGOFS). Ambio, Sp. Iss: 4-31

Extra paper:
Weaver, A.J. and Hillaire-Marcel, C. 2004. Global warming and the next ice age. Science, 304: 400-402.