Bio 457 – Marine Invertebrate Zoology
Lecture: T Th 1:30 - 2:45 PM, BioSci 245
Lab: T Th 3:00 - 5:30 PM, LaKretz Hall room 344
Course web page:
instructional1.calstatela.edu/pkrug/Bio%20457/

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Office hours: W 2-4 PM

Winter 2010 Lecture Schedule

Date		Lecture Topic	Reading (Pechenik)
Jan	05	Protists and marine ecology	Ch. 3
	07	Porifera	Ch. 4
	12	Cnidaria	Ch. 6-7
	14	Ctenophores, Acoels & Platyhelminthes	Ch. 8-9
	19	Annelida	Ch. 13
	21	sipunculans, echiurans; Nemertea	Ch. 11
	26	-- *no class -- furlough day*	
	28	**MIDTERM** #1	
Feb	02	Mollusca 1 - body plan and basal groups	Ch. 12
	04	Mollusca 2 - gastropods	
	09	Mollusca 3 - bivalves and cephalopods	
	11	Field trip (-0.6, 2:26 PM)	
	16	Lophophorates	Ch. 19
	18	Nematoda & Arthropoda I	Ch. 14-17
	23	Arthropoda 2	
	25	**MIDTERM** #2	Ch.20
Mar	02	Echinodermata 1	
	04	Echinodermata 2	
	09	Urochordata (Ascidians), Cephalochordata	Ch. 21-22
	11	Metazoan Phylogenies and Animal Evolution	Ch. 2

FINAL EXAM: **Tuesday, March 16th**, 1:30 - 4:00 PM, BioSci Room 245

Course Description: This course will examine the astounding diversity of marine invertebrates, through lectures and laboratory exercises. Students will review the major branches on the tree of life, introducing the basics of animal development and body construction among different invertebrate clades. Initial lectures and labs will focus on protists and simple marine invertebrates that remain ecologically significant today. We will then survey the more advanced taxa group-by-group. For each phylum, we will study the evolutionary innovations in body plan and ecological adaptations that made the group successful. Finally, relationships among the surveyed phyla will be investigated in an overview of metazoan evolution. Conflicts between recent molecular phylogenies and classical systematics based on morphology will be examined using recent literature.

Labs will emphasize comparative physiology, using dissection and drawings of local organisms. Students will perform experiments on animal behavior, and learn taxonomic techniques used by marine biologists to identify species. Field trips to local intertidal sites will allow students to observe invertebrates in natural settings and assemblages, and to personally collect specimens for use in subsequent lab exercises. Microscopic examination of live material will illustrate the complexity of life in shallow tide pools or in between grains of sand. This hands-on approach is designed to encourage creative exploration of the natural world, while underscoring major points of the lecture section.

Course Objectives:

(1) Understand theories surrounding the origins of eukaryotic diversity, including (1) endosymbiosis and photosynthetic organelles; (2) the Cambrian explosion; (3) the role of developmental gene networks in metazoan evolution.

(2) Know protist groups of importance to marine ecology, with particular emphasis on macroalgae.

(3) For each major invertebrate phylum, know the major **evolutionary innovations** of the body plan that led to that phylum's initial or persistent success. Be conversant with synapomorphies that unite the members of each phylum or well-established clade.

(4) Understand how key **ecological adaptations** spurred the success of representative taxa, and of key species discussed in lecture. Understand how convergent adaptations and reduction in body size or complexity may confound morphological attempts to unravel evolutionary relationships between groups. Recognize taxonomic problems caused by **homoplasy**.

(5) For each phylum or class, know the **larval form** that corresponds to a given adult. Understand the major larval development modes, how they differ, and consequences of each for a taxon (i.e., range, speciation + extinction rates.)

(6) Learn techniques in dissection, examination of microscopic details, and use of taxonomic keys to identify unknown specimens. Produce drawings of representative specimens, and record personal observations of live animal behavior in a scientific manner.

(7) Understand recent (a) controversies in reconstructing animal evolution and defining the relationships between invertebrate taxa, and (b) conflicts between recent molecular and traditional morphological approaches, including where their respective trees agree and disagree.

Textbook: *Biology of the Invertebrates*, Pechenik, 6th edition, 2010. If you have a copy of Brusca & Brusca, that will also be perfectly fine. Daily handouts for the lab will be provided on the course website.

Field Trip: There is a **required field trip** to a local intertidal site (Abalone Cove, in Palos Verdes) which is mandatory and counts as a lab. Suitable footwear, gear, and travel arrangements will be discussed in class. The trip will replace both lecture and lab on that day.

Drop Policy: Please see the schedule of classes for information. No exceptions will be made to the established University deadline for no record drops, which is **Monday, Jan 11.**

Missed class: Attendance is mandatory for lectures and labs. If you skip a lecture without a valid excuse, you won't be permitted in that day's lab, as the lecture is designed to set up the lab activities. If a lab is missed for a valid reason or you do not have enough time to complete all stations, make arrangements with me to come back before the next lab and complete the exercises.

Exams: Lecture exams will be definitions, short answer and essay questions. There are two midterms and a final exam covering lecture material. Missed exams will require prior approval by the instructor or an official excuse (i.e., doctor's note) or no make-up exam will be given. You must take **all exams** to receive a grade in the course. If you miss an exam, you must notify the instructor within 48 hr or you will be given an incomplete. You have one week from the time that the lecture exams are returned to report errors in the grading or discuss appropriateness of alternative answers.

Laboratory Topics for Biol 457

Date		Lab Topic	Reading (Nybakken)
Jan	05	Macroalgae + associated fauna	
	07	Porifera	pp. 14-21
	12	Cnidarians	pp. 27-68
	14	finish Cnidarians; Platyhelminthes	pp. 72-95
	19	Annelida	pp. 118-132
	21	weird worms: sipunculans, echiurans, Nemerteans	
	26	-- *no class -- furlough day*	
	28	**MIDTERM** #1; *Notebooks due*	
Feb	02	Mollusca 1 (chitons, limpets, vetigastropods)	pp. 140-189
	04	Mollusca 2 (caenogastropods, opisthobranchs)	
	09	Mollusca 3 (bivalves, cephalopods)	
	11	Field trip (-0.6, 2:26 PM)	
	16	Lophophorates	pp. 96-117; 256-267
	18	Arthropoda 1 (barnacles, amphipods)	pp. 202-255
	23	Arthropoda 2 (decapods + isopods)	
	25	**MIDTERM** #2; *Notebooks due*	
Mar	02	Echinodermata 1 (sea stars, brittlestars)	pp. 268-278
	04	Echinodermata 2 (sea urchins, sea cucumbers)	pp. 280-289
	09	Ascidians	pp. 293-301
	11	Group presentations; *Notebooks due*	

Laboratory Section: You will keep a **laboratory notebook,** to be turned in and graded at several points in the course. The notebook shall be a 3-ring binder with un-lined paper suitable for drawing and labeling diagrams; this needs to be separate from your lecture notes. This class will require you to draw what you see, by naked eye or under a microscope, and to record observations of animal behavior. You will be graded not on artistic skill, but on the effort put into your drawings and into the accompanying notations + observations, particularly:

1. **Drawings, descriptions, and observations of animals you see in the lab**
2. **Accurate anatomical labeling on sketches of animals and their body parts**
3. **Full classification for each organism**
4. **Results of lab experiments**

Your drawings don't have to include every detail of the whole animal; it is generally better to focus in on structures of particular interest for that group (e.g. nematocyst-bearing tentacles of an anemone, crustaceans appendages.) Questions asked at the stations are designed to stimulate your thinking, especially to make comparisons between different organisms. Try to record the features of the organism that will best help you remember what you observed about it. Make your sketches half a page at least, so there's space to add parts, labels and notes. If a subject has numerous repeated parts (e.g., segments on a polychaete worm), just make an enlargement of one representative section.

Each lab will have a handout in 2 parts. Part 1 will be taken from the out-of-print Nybakken 1996 manual to marine invertebrates of this coast; it contains valuable background information and excellent labeled drawings for your reference. Part 2 will be specific instructions for that week's stations, which will sometimes refer you to the appropriate section of the Nybakken handout for procedures. (Part 2 will vary each week

depending on what animals are available.) You should download Part 1 handouts in advance from my website, where they will be posted as PDF files, and read them before coming to lab.

Each species shall get its own page of your notebook, **and shall be fully identified taxonomically** to the best of your ability at the top of the page—Phylum, Class, Order, etc. Note that classifications in some older books may be out of date now; taxonomy is ever-changing. I recommend the Taxonomy Browser run by the National Center for Bio-Informatics (http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi) and the Tree of Life website (http://tolweb.org/tree/phylogeny.html) as resources.

Specimens will primarily be live local species. Draw what you see, do **not** just mimic the drawings in the lab handouts. **Label** your drawings to account for the features you observe; an unlabelled drawing is not useful to you or to science. Make plentiful notes around your drawings to remind yourself what you have seen. Be sure to include a **size scale** so I can tell how big the actual organism was. This lab is about getting intimately familiar with the animals; the notebook is your way of showing me how closely you got to know their bodies, their behaviors, their phylogenetic relationships to one another, etc.

For each lab, there will be a series of numbered stations. Each station will have one or more objectives based around a particular organism, detailed on the daily handout. Some stations require you to work alone; others may be done in groups. Some stations may ask you to make observations and think about an organism; others will require you to carry out detailed procedures. Each lab may include any or all of the following:

- **dissection** of whole organisms (drawing)
- **microscopic examination** of tissue sections (drawing)
- **taxonomic identification** using keys + personal observations
- **experiments**, often of animal behavior
- activities designed to highlight **major features** of a group (i.e., nematocyst discharge for cnidarians)
- **spawning**, larval rearing, larval settlement behavior

In some experiments, there is a predicted but uncertain outcome; you will be graded not on your results, but on how well you document your findings and formulate hypotheses to account for your observations. Often, for lack of enough organisms, you will need to work together in small groups to perform an experiment (i.e., everyone does not need to feed their own personal octopus; a group of 6 students can watch one octopus eat.) You are encouraged to work together and talk to each other during labs, which are designed to stimulate your creativity and interest in the organisms. However, you are responsible for your own notebook and for recording your own observations. A group may perform an experiment together, but each member does her/his own write-up. If you think of something interesting that you would like to try, run it past me and we'll find a way to test your idea; independent inquiry is encouraged.

For the final lab, you will be assigned to groups for **short presentations**. Each group will present an overview of one assigned phylum, and current hypotheses of how that phylum is evolutionarily related to the other major animal groups. This exercise will be based on the recent literature in phylogenomics and will emphasize the ability to read and interpret phylogenetic trees. This exercise will be included in your overall lab grade. Detailed instructions will be given mid-quarter.

Grading: Grades are curved, with the mean of a normal distribution (typically ~70%) set as the border between B-/B; scores one standard deviation above the mean are in the A-range, those one standard deviation below the mean are in the C range. Total points will be awarded as follows:

Midterm Exams -	75 pts each
Final Exam --	150 pts
Lab Notebook –	300 pts
	600 pts total for course

Reasonable accommodation will be provided to any student who is registered with the Office of Students with Disabilities and requests needed accommodation.