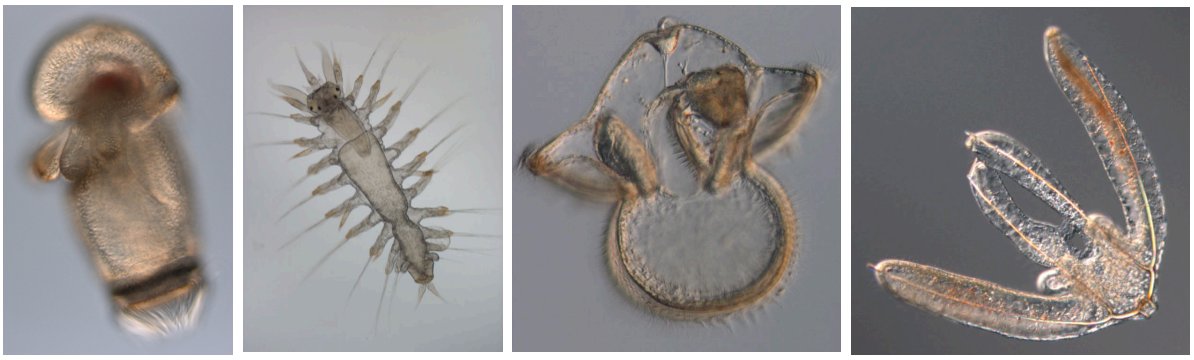

Comparative Embryology and Larval Biology
OIMB Spring 2011 Syllabus

In this class students survey embryonic and larval development in a broad selection of marine invertebrate phyla, including but not limited to Cnidaria (jellyfish), Ctenophora (comb jellies), Platyhelminthes (flatworms), Annelida (segmented worms), Mollusca (snails, clams, and their allies), Nemertea (ribbon worms), Phoronida (horseshoe worms), Echinodermata (starfish, sea urchins, and their allies), Bryozoa (tiny colonial "moss-like" animals) and Ascidians (sea squirts). Students will explore the diversity of marine embryos and larvae by culturing dozens of representative species in the laboratory. Field trips will be dedicated to learning about the local marine habitats and collecting live material for use in class. This course is a great opportunity to improve your microscopy, observation and scientific illustration skills, while learning about the diversity of animal development.

Learning goals:

1. Be able to: (a) culture embryos and larvae of a wide variety of marine invertebrates in the lab; (b) use a microscope for observation and documentation; (c) identify, and understand the morphology of embryos and larvae introduced in the course
2. Learn to make meaningful labeled drawings of embryos and larvae, and create a comprehensive notebook of drawings illustrating the development of species covered by this course.
3. Write and "publish" 2 to 3 web entries describing and illustrating developmental stages or processes you learned about in this course. Collectively we will have created a website which will serve as a "window" into the nature and content of the course, and a source of information and inspiration to others.
4. Be familiar with the developmental concepts and vocabulary covered by the course (as assessed by quizzes and the final exam).

Instructor: Dr. Svetlana Maslakova svetlana@uoregon.edu

Teaching Assistant: Laurel Hiebert lhiebert@uoregon.edu

Meets: 8:30-5:00 Wednesdays, McConnaughey Teaching Lab, OIMB
We will have 1 hour break for lunch at noon.

Office Hours: drop by any time

Required reading: See Blackboard for handouts, lecture notes and assigned reading. Students are responsible for downloading and reading weekly assignments.

Week 1. Echinoderms (echinoids)

Week 2. Echinoderms (asteroids, ophiuroids, holothuroids).
Week 3. Plankton. Photomicrography. Notebook advice.
Week 4. Bryozoans.
Week 5. Spiralians (mollusks and annelids).
Week 6. Spiralians (nemerteans and flat worms).
Week 7. Ascidians
Week 8. Phoronids
Week 9. "Jellies" (ctenophores and cnidarians)
Week 10. Crustaceans
Week 11. Final exam

Notes on the schedule: The schedule below is tentative because embryological lab work depends in part on reproductive timing of animals which we do not control. Changes in schedule for unexpected opportunities or disappointments are likely. Because we only meet once a week, but the development goes on in between - students will only be successful if they devote time to observing and caring for cultures outside of regular class hours.

Recommended texts: 1) M. F. Strathmann (1987) Reproduction and Development of Marine Invertebrates of the Northern Pacific Coast. Univ. Washington Press. 2) S. F. Gilbert and A. M. Raunio, eds (1997) Embryology: Constructing the Organism. Sinauer. 3) Young, Sewell and Rice (Eds). 2006. Atlas of Marine Invertebrate Larvae. Academic Press. A few copies will be available in class.

ASSESSMENT

1. Notebook (30%) All students are expected to maintain a high-quality laboratory notebook. The notebook should contain labeled drawings of eggs, embryos, and larvae raised by you, and organized by species. The notebook should also include notes on where and how animals were collected, and which techniques were used to procure embryos. The notebook should not contain lecture notes, handouts, or reading lists. The drawings must be sufficiently detailed and well-labeled to demonstrate understanding of the subject, and must include indications of scale (measurements). *See separate handout on notebooks, and examples of good embryology notebooks in the lab. At the end of week 2 of class instructor will review notebooks, and provide individual notebook advice to each student during week 3.*

2. Embryology blog posts (20%). Instead of a traditional class paper, we will keep a course blog in which we will record our field and laboratory observations. See examples from last year: http://invert-embryo.blogspot.com/ This will provide a useful on-line record of what we did in class, and serve as a resource for other students, researchers, and members of the public. In the process students will get to practice scientific writing. Each **undergraduate** student will create two posts on the embryological topic of their choice (with instructor's approval). Each **graduate** student will create an additional post that will describe one of the class field trips (a total of three posts). *See separate handout on blog assignment.*

3. Weekly quizzes (20%). Every week we will have a short quiz based on the material learned the previous week.

4. Final Exam (20%). Cumulative.

5. Participation in class (10%). Students are expected to keep track of class schedule and participate in all class activities, including the final lab clean up. If you are unable to attend some activity for a respectable reason, notify the instructor as soon as possible and discuss how you will make up for it. Tardiness and absences without a good reason will negatively effect the grade.

Day	Tide	Time	Activities
Week 1 Wed March 30	+0.94 16:45	8:30	Course orientation: introductions, handouts, Blackboard, grading, notebook. **Lab.** Inject sea urchins *Strongylocentrotus purpuratus* and sand dollars *Dendraster excentricus*. Use and care of microscopes. Making slide preps. Using ocular micrometer. Documenting *normal* development.
		10:00	**Lecture.** Fertilization and early development in echinoids.
		11:00	**Lab.** Fertilization on the slide. Students start individual cultures of both species. TA: start a class culture of *D. excentricus* right before lunch and leave at RT.
		13:00	Buy supplies from the office
		13:30	**Lab.** Observe and draw early cleavage stages (cultures started in the morning), micromere formation, blastula, mesenchyme, gastrula, prism (cultures started ahead of time). **DEMO:** crowd control, changing water, feeding larvae.
		16:00	**Lecture.** Regulation and specification in echinoids.
			Change water and feed cultures every other day!
Week 2 Wed April 6	0.00 8:39	8:30	**Quiz.** Early development of echinoids.
		8:45	**Lecture.** Larval development of echinoderms I. Pluteus development and metamorphosis. Oocyte maturation, fertilization in starfish.
		10:00	**Lab.** Inject starfish *Pisaster ochraceous and Evasterias troschelii* with 1-methyl adenine to induce spawning. Excise ovaries and testis. Observe GVBD, fertilization. Start cultures.
		13:00	**Lecture.** Larval development of echinoderms II. Asteroids. Evolution of larval development in echinoderms.
		14:00	**Lab**. Dissect and observe internally brooded embryos of brittle star *Amphipholis squamata.* Externally brooded larvae of six-armed starfish *Leptasterias hexactis*. Cleavage in asteroids.
		16:00	**BLOG ASSIGNMENT.** **DEMO:** Taking pictures through the microscope.
			SUBMIT NOTEBOOKS FOR EVALUATION

Day	Tide	Time	Activities
Week 3 Wed April 13	+0.53 14:57	8:30	**Quiz.** Larval development in echinoderms.
		8:45	**Lecture.** Larval plankton.
		9:30	**Boat trip** to collect plankton.
		11:00	**Lab.** Dilute plankton, start sorting. Save any nemertean and echinoderm larvae, cyphonautes larva, anthozoan planulas, doliolids, salps, nechtochaetes, trochophores, and actinotroch larvae.
		13:00	**Lecture.** Larval biology: feeding, growth, regeneration, cloning.
		14:00	**Lab.** Continue sorting plankton. Take pictures, draw. **Notebook advice:** students meet individually with the instructor to get feedback on their notebooks. Pay attention to echinoid and asteroid cultures. TA: start cultures of *Micrura alaskensis,* if available
Week 4 Wed April 20	-1.74 8:30	8:30	**Quiz.** Larval plankton
		8:45	**Field trip to South Cove.** Collect chitons, gastropod *Calliostoma ligatum*, bryozoans (*Crisia sp., Flustrellidra corniculata,* if available), any nudibranchs, gastropod egg masses (*Nucella, LIttorina, Lacuna)* TA - collect *Schizoporella japonica* and *Bugula sp.* from the little boat basin, set up with lights to observe release of coronate larvae.
		13:00	**Lecture.** Development of bryozoans.
		14:00	**Lab.** Brooded coronate larvae (*Schizoporella*, *Bugula*), planktotrophic *cyphonautes* larvae (if available), *Crisia* - polyembryony, pseudocyphonautes in *Flustrellidra* (if available). TA: collect polyclad flatworms from the little boat basin, set in ziplock bags to lay eggs **FIRST BLOG ENTRY DUE**

Day	Tide	Time	Activities
Week 5 Wed April 27	+1.4 15:07	8:30	**Quiz.** Development of bryozoans.
		8:45	**Lab.** Start cultures of *Calliostoma ligatum*
		10:00	**Field trip to the docks** to collect scallops and other clams (*Mytilus californianus*, *Entodesma sp.)*, polychaete *Serpula columbiana*, nudibranchs and their egg masses. Start cultures of *Serpula*
		13:00	**Lecture**. Spiral cleavage. Equal vs. unequal spiral cleavage. Development of annelids and mollusks.
		14:00	**Lab.** Observe equal spiral cleavage in *Calliostoma* and identify cells according to spiralian nomenclature. Polar lobe in bivalves and *Sabellaria cementarium* (if available). Gastropod egg masses, encapsulated veligers of nudibranchs.
Week 6 Wed May 4	-0.73 7:42	7:30	**Field trip to a mudflat** to collect *Cerebratulus* (nemertean), *Phoronopsis harmeri* (phoronid) and *Owenia collaris* (polychaete)
		11:00	**Lecture.** Flatworm development
		13:00	**Quiz.** Spiralian development I.
			Lab. Start cultures of *Cerebratulus* and *Owenia*. Look at flatworm eggs.
		14:00	**Lecture.** Nemertean development.
		15:00	**Lab.** Observe early cleavage in nemertean cultures started earlier. Pilidium larvae from plankton and from cultures started ahead of time.
			STAFF collect ascidians (*Distaplia, Botrylloides, Styela, Molgula*) from the Charleston docks.
Week 7 Wed May 11		8:30	**Quiz.** Spiralian development II.
		8:45	**Lecture.** Development of ascidians

Day	Tide	Time	Activities
		10:00	**Lab.** Dissect and start cultures of solitary ascidians (*Styela clava and Styela montereyensis*), remove broods of *Corella inflata*, examine cleavage stages and tadpole larvae.
		13:00	**Lab.** Observe cleavage in ascidians. Watch for released tadpoles from *Distaplia* and *Botrylloides.* Dissect broods of *Molgula pugetiensis* and observe different stages of development and metamorphosis.
			SECOND BLOG ENTRY DUE
			STAFF start cultures of *Phoronopsis*
Week 8 Wed May 18		8:30	**Quiz.** Ascidian development.
		8:45	**Lecture**. Development of phoronids
		9:30	**Lab.** Dissect females of *Phoronopsis harmeri*, and start cultures. Advanced developmental stages from cultures started ahead of time. Actinotrochs from plankton.
		13:00	**Lab.** Catch up on larval cultures, especially the long-lived planktotrophs (echinoderms, nemerteans, polychaets, molluskan veligers etc.)
			STAFF collect jellies (cnidarians and ctenophores) from the Charleston docks
Week 9 Wed May 25		8:30	**Lab.** Look for eggs and embryos of hydrozoan medusae and ctenophores. Unipolar cleavage.
		10:00	**Lecture.** Development of cnidarians.
		11:00	**Quiz.** Development of phoronids
		13:00	**Lecture.** Development of ctenophores.
		14:00	**Lab.** Continue with cnidarian and ctenophore development. Blastula, planula larva of hydrozoans. Ctenophore cleavage.

Day	Tide	Time	Activities
			STAFF collect *Pollicipes polymerus,* crab megalopae, amphipods, crabs with broods
Week 10 Wed June 1		8:30	**Quiz.** Development of cnidarians and ctenophores.
		8:45	**Lecture.** Development of crustaceans.
		9:30	Plankton tow off the dock.
		10:30	Sort plankton - look for crustacean larvae: nauplius, ciprid, zoea.
		13:00	Dissect and examine egg plates of goosneck barnacles *Pollicipes polymerus,* examine brooded embryos of amphipods, crabs, as available.
		15:00	**LAB CLEANUP**
			NOTEBOOKS DUE
Week 11 Wed June 7		9:00	**FINAL EXAM**