Molecular Marine Biology
BI 457/557 Fall 2013

Syllabus

The purpose of this course is to provide hands-on experience with basic universally applicable molecular techniques in a context of research projects focused on marine organisms. Students generate novel sequence data and learn to analyze it using public databases (such as NCBI Genbank) and a variety of sequence and phylogenetic analysis software (e.g. Codon Code Aligner, ClustalX, PAUP). Most of the class time is spent on laboratory exercises, tutorials, lectures, and paper discussions. Students practice DNA extraction, gel electrophoresis, PCR, and DNA sequence analysis. We read and discuss current scientific literature on the use of molecular methods in marine biology research. Each student is expected to maintain a detailed laboratory notebook. Students write a final research project paper, and present results to the class.

Learning goals:

1. Become familiar with how molecular techniques are applied in marine biology by reading and discussing relevant scientific literature and participating in research projects.
2. Gain laboratory experience and become comfortable with basic molecular techniques.
3. Learn to analyze sequence data using a variety of software tools.
4. Practice keeping a laboratory notebook.
5. Participate in writing a scientific report paper based on class research project.

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Teaching Assistant: Terra Hiebert (terrah@uoregon.edu)

Class meets in the McConnaughey teaching lab at the OIMB
8:30 - 17:00 Mondays (1 hour break for lunch at noon)
10:00 - 11:00 Fridays

Office Hours: drop by any time

Required reading: No textbook is required. See Blackboard for weekly assignments.

Week 1 (Sept 30, Oct 4) Introduction to course and individual research projects (identification of planktonic larvae using DNA sequence data). *Lecture*: Molecular methods in marine biology. *Lab*: Select organisms for ID. (micro)Pipetting practice. DNA extraction from individual planktonic organisms using InstaGene matrix. **Assignment 1 (due 10/7)** - chose papers for discussion (see Blackboard). *Friday*: paper discussion.

Week 2 (Oct 7, 11) *Lecture*: Polymerase Chain Reaction (PCR). *Lab*: PCR, gel electrophoresis: amplify two standard "barcoding" gene markers from DNA extracted during Week 1. Meet individually with instructor for notebook review and advice. *Friday*: Interpreting PCR results from agarose gels, troubleshooting strategies.

Week 3 (Oct 14, 18). **Quiz 1:** Interpreting results of PCR. *Lecture:* DNA sequencing. *Lab:* PCR product purification and quantification. Sample prep for sequencing. TA - arrange for the samples to be sequenced. **Assignment 2 (due 10/21)** - explain the results and propose troubleshooting strategies for each of your PCR samples. *Friday*: paper discussion.

Week 4 (Oct 21, 25) *Lecture:* Species identification and delimitation using molecular techniques. *Lab:* DNA extraction using column-based methods (Qiagen DNEasy kit). Tutorial: DNA sequence analysis (using Codon Code Aligner software, NCBI Blast web-tools). Formulate group research projects, define research groups. **Assignment 3 (due 10/28)** - Individual project write-up (1 page): sequence analysis (chromatogram quality, trimming primer sequences, Blast) and 5 min presentation of results. *Friday*: paper discussion.

Week 5 (Oct 28, Nov 1) Students present results of individual research projects (5 min each). *Lab:* Begin work on group research projects (sample collection, DNA extraction, PCR). *Friday:* paper discussion.

Week 6 (Nov 4, Nov 8). **Quiz 2 -** sequence analysis. *Lecture:* Sequence alignment, measuring change. *Lab:* Sequence alignment, using ClustalX; tree-viewing software. Continue work on research projects (PCR troubleshooting; PCR product purification, quantification, prep for sequencing). **Assignment 4 (due 11/11)** - sequence alignment. *Friday:* paper discussion.

Week 7 (Nov 11, 15) *Lecture:* Phylogenetic analysis using parsimony, consensus trees, clade support. *Lab:* Using PAUP software. Continue working on projects (Sequence analysis; PCR product purification, quantification, prep for sequencing). **Assignment 5 (due 11/18)** - distance trees (Neighbour-Joining) and parsimony phylogenetic analysis using PAUP. *Friday:* paper discussion.

Week 8 (Nov 18, 22) Quiz 3 - phylogenetic analysis. *Lecture:* Analysis of protein coding sequences. *Lab:* Continue work on projects (sequence analysis). *Tutorial:* TCS - building haplotype networks using statistical parsimony. *Friday:* paper discussion.

Week 9 (Nov 25) Quiz 4 - protein coding sequences. *Lecture:* TBA. *Lab:* Continue work on projects. Discuss project results. Draft final paper. *Friday:* THANKSGIVING BREAK.

Week 10 (Dec 2, 6) *Lab:* Archive project samples and data. Lab clean up. *Friday:* **Group research project presentations** (10-15 min each)**.**

********* Project papers and notebooks are due Dec 9 *********

Participation in class

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 (e.g. illness), notify the instructor as soon as possible. Tardiness and absences without a good reason will negatively effect the grade.

Research projects

The main purpose of this course is to provide a significant laboratory experience and exposure to standard molecular laboratory techniques. It is much more interesting to learn techniques while using them for something meaningful - e.g. in a context of a research project. We will dive right into **Individual research projects** on day 1: DNA-identification of planktonic larvae of marine invertebrates. Instructor and TA will provide the samples. Each student will choose four unidentified larval samples to extract DNA from, and work individually to identify them using DNA sequence data in subsequent weeks. Each student will report results in a short (2-5 min) presentation during Week 5. **Group research project**: During Week 5 students will split into groups (2-4 per group)

and being to carry out research projects of their choosing (prior consultation and approval by instructor is required to ensure feasibility) utilizing laboratory methods covered in weeks 1-4. Because it is often difficult for students to come up with a feasible research project on their own, instructor will make suggestions.

Laboratory notebook

Students are expected to maintain a high-quality laboratory notebook. The notebook should contain notes on where, when, how and by whom the samples were collected and stored, how DNA was extracted, parameters of PCR reactions, including primer names and sequences, results of gel electrophoresis: annotated pictures of gels (so it is clear which band on the picture corresponds to which sample) and so on. Be as detailed as is necessary for you to be able to 1) repeat each procedure independently, and 2) reconstruct exactly how the data was obtained and, VERY IMPORTANTLY, which tube in the freezer corresponds to which sample. It is important to note deviations from the standard protocols and operator errors (mislabeled tubes, uncertainties about labels or compositions of reaction mixtures and so on). It is not necessary to copy standard protocols into the notebook. Simply attach the protocol, and refer to it. *During Week 2 we will have brief one-on-one meetings with the instructor to review the notebooks.*

Paper discussions

Reading and discussing current scientific literature is one of the more intellectually stimulating aspects of this course. All students are expected to actively participate by asking and answering questions, and commenting. Discussion leaders will give a brief (~ 5-10 min) summary of the paper to open the discussion. Points to consider when reading / presenting a paper: What was the topic/main question/purpose of the study? What are the methods? What are the main findings? Is there any controversy in the interpretation?

Assessment and Grading:

Assignments (5) 25%	97-100 A+
Quizzes (4) 20%	93-96.9 A
Lab notebook 10%	90-92.9 A-
Participation in group research project 15%	87-89.9 B+
Participation in paper discussions 10%	83-86.9 B
Final group presentations 10%	80-82.9 B-
Final group papers 10%	77-79.9 C+
	73-76.9 C
	70-72.9 C-
	67-69.9 D+
	63-66.9 D
	60-62.9 D-
	<59.9 = F