

Molecular Marine Biology
BI 457/557 Fall 2018

Syllabus

This course introduces students, whose primary interests are in marine biology, especially at organismal and ecosystem level, to molecular methods. The course offers hands-on experience with basic universally applicable molecular techniques in the context of small-scale research projects focused on marine organisms. Students practice DNA extraction, gel electrophoresis, PCR, and DNA sequence analysis, generate novel sequence data, and learn to analyze it using public databases and a variety of sequence and phylogenetic analysis software. Most of the class time is spent on laboratory exercises, tutorials, lectures, and paper discussions. Each week students read and discuss scientific papers that illustrate use of molecular methods in the field of marine biology. 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. Be able to analyze DNA sequence data using a variety of software tools.
4. Be able to keep an informative laboratory notebook.
5. Gain or improve skills writing a scientific report paper.

Instructor: Dr. Svetlana Maslakova svetlana@uoregon.edu

Teaching Assistant: Christina Ellison (cellison@uoregon.edu)

Class meets in the McConnaughey teaching lab at the OIMB
8:30 - 17:00 Wednesdays

Office Hours: by appointment

Required reading: Download weekly assignments from Canvas.

Week 1 (Sept 26) Introduction to course and individual research projects (identification of planktonic larvae using DNA sequence data). **Lecture:** Molecular methods in marine biology. **Lab:** Choose samples for DNA-barcoding. (micro)Pipetting practice. DNA extraction from individual planktonic organisms using InstaGene matrix. **Assignment 1 - choose and sign up for papers for discussion (see Canvas).**

Week 2 (Oct 3) **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. Interpreting PCR results from agarose gels, troubleshooting strategies. **Paper discussion - species identification using DNA-barcoding.**

Week 3 (Oct 10). Quiz 1: Interpreting results of PCR. Lecture: DNA sequencing. Lab: PCR product purification and quantification. Sample prep for sequencing. **Assignment 2 (due Oct 17)** - explain the results and propose troubleshooting strategies for each of your PCR samples. **Paper discussion - magnitude of marine biodiversity.**

Week 4 (Oct 17) Lab: DNA extraction using column-based methods (Qiagen DNEasy kit). Tutorial: DNA sequence analysis (using Codon Code Aligner software, NCBI Blast web-tools). Choose group research projects, define research groups. **Assignment 3 (due Feb 8)** - Individual project write-up (1 page); sequence analysis (chromatogram quality, trimming primer sequences, Blast) and 5 min presentation of results. **Paper discussion - identification of gut contents.**

Week 5 (Oct 24) Students present results of individual research projects (5 min each). Lab: Begin work on group research projects (sample collection, DNA extraction, PCR). **Paper discussion - species delimitation.**

Week 6 (Oct 31). 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 Feb 22)** - sequence alignment. **Paper discussion - marine microbiology.**

Week 7 (Nov 7) 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 Mar 1)** - distance trees (Neighbour-Joining) and parsimony phylogenetic analysis using PAUP. **Paper discussion - marine conservation.**

Week 8 (Nov 14) 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. **Paper discussion - population connectivity.**

Week 9 (Nov 21) Quiz 4 - protein coding sequences. Lecture: Species delimitation. Lab: Continue work on projects. Discuss project results. Draft final paper. **Paper discussion - metabarcoding.**

Week 10 (Nov 28) Lab: Archive project samples and data. Lab clean up. Work on final paper, each research group meets with instructor to get feedback on project outcome, plan for presentation, class paper. **Group research project presentations** (15 min each group, including time for questions).

******* Project papers and notebooks are due Dec 5 *******

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, notify the instructor as soon as possible to discuss how you can make up missed class. Tardiness and absences without a respectable reason or prior approval from instructor 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 in a context of research projects. We will dive right into **Individual research projects** on day 1: DNA-identification of planktonic organisms (e.g. larvae of marine invertebrates). Each student will collect 2 unidentified samples to extract DNA from, and work individually to attempt to identify them using DNA sequence data in subsequent weeks. Each student will report results in

a short (5 min) presentation during Week 5. **Group research project:** During Week 5 students will split into groups (2-4 students per group) and carry out research projects of their choosing (prior consultation and approval by instructor is required to ensure feasibility) utilizing laboratory methods learned 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, 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 each student will meet briefly one-on-one 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. We will break up into small groups for discussion (3 papers per week, see separate handout). Points to consider when reading and presenting a paper: What is 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