Marine Microbial Ecology MEES684

Course will be taught at the Institute of Marine and Environmental Technology, or the Horns Point Laboratory. Course will also be taught entirely over Zoom.

Course Instructors:

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Course Description:

This course presents a survey of marine microbial ecology, proceeding from seminal discoveries and the development of widely used molecular tools, to current advances. The course will cover a suite of microorganisms, with particular emphasis on Bacteria (including cyanobacteria), Archaea, micro-eukaryotes, and viruses. Students will become familiar with their population dynamics, genetic diversity, ecological interactions, microscale processes and biogeochemical cycling in marine environments. The class will involve lectures, some flipped; reading and discussion of primary scientific literature and published reviews, and a hands-on component where students will interactively explore microbial ecological data. Students will demonstrate mastery of course material by leading class discussions of primary literature, participation in class discussions, hands on analysis of microbial oceanographic data, and preparation of a written and oral report on data analysis. A background in molecular microbiology is not required. A computer programming background is not required, but a willingness to learn and apply some computer code is.

Class Schedule:

Classes are taught over Zoom at 11-12:30 Tuesday and Thursday.
Typically, instructors or guest lecturers will give a lecture on Tuesday, and student presentations of the literature, followed by student lead discussions will be on Thursday. In some weeks, lectures will be flipped, so that students are expected to watch the lecture on their own, in which case class time will be used either to work on data analysis projects, and/or for additional discussion. Detailed class schedule and paper selection will be available a week before the class.

Expected Learning Outcomes:

1. Students will become familiar with marine microorganisms, their biogeochemical activities and energetic constraints, and their ecological roles in marine environments through lectures and from reading and discussion of primary scientific literature and published reviews.
2. Students will demonstrate mastery of course material by working with a graduate student to co-lead a class discussion of primary literature, and participation in class discussions. Every opportunity will be provided for all students to actively participate in the discussion and students are strongly encouraged to comment on strengths and weaknesses of the papers discussed in this class.
3. Students will analyze original microbial datasets through the hands-on section. Students will first interact with prepared exercises to explore the TARA oceans, or similar microbial oceanographic data-set. The students will then write a brief research proposal about how they might modify the existing analysis to generate new insight. The students will then either modify the example analysis of the TARA oceans, data, apply existing analysis to an existing dataset, or both. Students will report on their findings with an oral report to the class, and a written report. These reports will provide background, justification for the research, a description of methodology, a description of findings and a summary. The students will also be asked to concurrently submit their well commented analysis code.

<u>Grading:</u>

Paper presentations 20%
Sending out reading questions to the class (10%)
Answer reading questions (10%)
Class participation 10%
Research project proposal (1-2 paragraphs, 2 page maximum + references) 10%
Project report (5 page maximum + code + references) 30%
Final oral presentation on term paper (10 min) 10%

Paper Presentation (20%)
Each week, a student will present a seminar on two papers on a related topic. Dates for paper presentations will be determined in the first week of class. The presentation will include a general introduction to the topic covered, a detailed explanation of the methods employed in the paper, detailed examination of the results described in the papers, discussion of the significance of the work, and a critique of the strengths and weaknesses of the papers. Undergraduate students will work with the graduate student who is leading the paper discussion. The pair of students will cover background material and additional details of methods by doing supplementary reading as necessary. They will also co-lead a class discussion. All students are expected to read all discussion papers and to participate in class discussion on the topic.

Send out reading questions (10%)
The student will work with the presenting graduate student to email 2-3 reading questions related to the presenting papers to the class a week before the presentation.

Answer reading questions (10%)
All students will be required to answer reading questions raised by presenting students and email answers to the instructors and presenter before the class.

Participation (10%)
Students will be encouraged to actively participate in class discussion which includes raising and answering questions, sharing opinions or commenting on the papers and/or lecture material.

Research project proposal (10%)
Students will conduct a mini data-analysis based research project. A large database, with many variables such as the Tara Ocean Dataset will be explored to address different ecological questions. Students will have access to the database, and some example code that analyzes that database, and hands on instruction in learning about what the code does and modifying the code does. By the mid-term of class, students will be expected to come up with a short research project proposal (<two pages, one page is acceptable) which includes the rationale, questions, hypothesis, and a brief plan. The expectations for the scope of the proposal will be smaller for this 484 level course than for the 684 level class. Students at the 484 level may choose to work with another student, either another undergraduate or graduate student, on their research project proposal, in which case it should be made clear to the professors which student performed what work on the final project.

The proposal (10 points) will be graded on the following breakdown.
Rationale, Experimental Questions and Hypothesis \5
Quantity of research plan /5

Project report (30%)
Students will continue to work on the research project following the research proposal they submitted. Instructors will engage with students and provide guidance to students. Some class time, corresponding to

flipped lectures, will be spent working on this analysis. Each student will prepare a project report based on his/her own research project. The report should include an abstract, introduction, methods, figures/tables, results and discussion, and references. The report should be written with double space and font size 12. The report is due two weeks before the class ends. At the 484 level, the expected degree of detail is less than is expected at the 684 level.

The report (30 points) will be graded based on the following breakdown.

Abstract /4
Does the abstract concisely summarize the key parts of the report?
Introduction /4
Does the introduction convey the significance of the research problem and have appropriate references?
Results /4
Are the results clearly described?
Figure /4
Does the figure clearly convey the analysis? Is it well formatted?
Discussion /4
Is the discussion well integrated with the results and supply a compelling narrative that ties back into the introduction?
Overall clarity, writing quality and grammar /5
Code /5
Does the student provide well commented, reproducible code with data that generates at least a preliminary version of the figure used in the manuscript, as a supplement?

Final oral presentation on research project report (10%)
Students are required to give an oral presentation based on their research project. The oral presentation includes a 10 minute PowerPoint presentation (plus 5 minutes for questions). Students should present background, questions, approach, data, and summary. This presentation may be given as a joint presentation with any students with whom the student chooses to work.

The presentation will be based on the following criteria

Slides /4
Do the slides have an appropriate amount of text on them? Are the figures clear to the audience?

Content /3
Does the presentation convey the main aspects of the report (background, questions, approach, data, and summary) in a way that is clear.

Quality /3
Does the presenter speak slowly and clearly, while remaining under the time limit?

Ungraded Assessment
There will be a brief, ungraded assessment of student understanding of several key topics at the beginning and end of the course, which we will use to judge the efficacy of some of our approaches.

Course Evaluation
At the end of the course, students are strongly encouraged to complete the on-line process facilitated by the MEES Graduate Program to provide anonymous feedback to the instructors on our course. This

feedback is extremely valuable for planning and preparing future classes. Time will be allocated at the end of the course for a general discussion led by students for improving the course in future years.

Topics and Course Schedule for Spring 2022 (at a glance)

Week	Topic	Date	Activities	Instructor
1	Course Meeting/paper selection Introduction of Microbial Ecology	Tu Jan 25 Th Jan 27	Course meeting Lecture	Feng Chen & Jacob Cram Feng Chen & Jacob Cram
2	Microbial Data Analysis	Tu Feb 1 Th Feb 3	Lecture Paper discussion	Jacob Cram
3	Isolation of marine microbes – culture the "unculturable"	Tu Feb 8 Th Feb 10	Lecture Paper discussion	Feng Chen
4	Photosynthetic and phototrophic bacteria – light utilization	Tu Feb 15 Th Feb 27	Lecture Paper discussion	Feng Chen
5	Marine viruses and their ecological role	Tu Feb 22 Th Feb 24	Lecture Paper discussion	Feng Chen
6	Protists, dinoflagellates and phytoplankton	Tu Mar 1 Th Mar 3	Lecture Paper discussion	Feng Chen
10	Oxygen Minimum Zones	Tu Mar 8 Th Mar 10	Lecture Paper discussion	Guest lecture TBD
11	Microbial biogeography	Tu Mar 15 Th Mar 17	Flipped Lecture/ Analysis Workshop Paper discussion	Jacob Cram
12	Spring break March 20-27			
13	Particulate Organic Matter and the Biological Pump	Tu Mar 28 Th Mar 31	Flipped Lecture Analysis Workshop Paper discussion	Jacob Cram
14	Microscale Processes	Tu Apr 5 Th Apr 7	Flipped Lecture Analysis Workshop Paper discussion	Jacob Cram
15	Deep Sea/Hydrothermal Systems	Tu Apr 12 Th Apr 14	Lecture Paper discussion	Guest Lecture TBD
16	Marine carbon cycling	Tu Apr 19 Th Apr 21	Lecture Paper discussion	Michael Gonsior
17	Marine Nutrient cycling	Tu Apr 26 Th Apr 28	Lecture Paper discussion	Sairah Malkin
18	Oral presentations	Tu May 3 Th May 5	Oral presentations Oral presentations	Feng Chen/Jacob Cram Feng Chen/Jacob Cram
19	Last class	Tu May 10	Course evaluation	