Microbial Ecology through the Analysis of Scientific Literature

Course Information
Department and Number:
BIOL490

Time and Location:
Tuesday and Thursday 9:30 – 10:45
Genome Sciences Building 1374

Instructor
Dr. Elizabeth Shank

Contact information:
4157 Genome Sciences Building
919-962-4459
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Office hours:
Regular office hours will be 11:00 – 12:00 Tuesday in 4101 GSB
You may email me to set up an additional time to meet outside of class if this time doesn’t work for you

Course description
Have you ever wondered about the microbes associated their animal hosts? How did these interactions evolve? How are they maintained? How do they impact the environment we live in? In this highly interactive class, we will emphasize the creativity of the scientific process and an understanding of how scientific information is communicated by using a small number of chronologically sequential scientific papers rather than a textbook. We will focus on the amazing leaf-cutter ant symbioses, which includes four different organisms: leaf-cutting ants, a fungus they farm for food, a parasitic fungus that can infect the ant’s fungal gardens, and a bacterium that is carried on the ant exoskeleton and produces antifungal compounds that inhibit the parasitic fungus. The breadth and complexity of this system will allow us to explore how microbes affect the ecology and environment of the world we live in.

Pre-requisite:
BIOL 201 or permission of the instructor.

Target audience:
Science majors and other undergraduates who are excited not only to learn about the microbes that exist and shape the world we live in, but also have an interest in the process of scientific research, communication, and discovery. No previous experience reading scientific papers is required, but curiosity about science and/or scientific research will be helpful.

Course Organization:
This course is not standard lecture-style class. Instead, we will be using an approach termed C.R.E.A.T.E.: Consider, Read, Elucidate the hypotheses, Analyze the data, Think of the next Experiment. The class will be structured so that early in the semester, we will spend class periods not only learning concepts in microbial ecology, but also talking about and modeling concrete skill you need to read and understand scientific primary literature (e.g. concept maps, annotations, re-phrasing, cartooning, etc.) As we move further into the semester, these tasks may frequently be expected to be completed as homework as we read new portions of each paper, while in-class time will focus more on discussing hypotheses, interpreting data, and proposing and evaluating future scientific directions. Overall, both individual and small-group participation are an integral part of this class. Underlying all of these discussions will be principles of microbial ecology, which will be covered on a need-to-know basis as we delve into each scientific paper and its content.
Overview of Class Schedule and Topics:

Week 1 (August 19/21): Organization and overview; Consensus on participation definitions; Intro Paper
Week 2 (August 26/28): Background: Concepts of microbial ecology; microbe and fungal review
Week 3 (Sept 2/4): Paper 1: Environmental distribution of microbes; Symbioses/host-microbe interactions
Week 4 (Sept 9/11): Paper 1: Observations and hypotheses; Phenotypes vs. genotypes
Week 5 (Sept 16/18): Paper 1: Growth and inhibition assays; Grant panel 1
Week 6 (Sept 23/25): Midterm 1; Paper 2: Phylogenetic relationships and trees; microbial diversity
Week 7 (Sept 30/Oct 2): Paper 2: Evolution and co-evolution; Grant panel 2
Week 8 (Oct 7/9): Paper 3: Genotyping; Mechanisms of host-parasite interactions
Week 9 (Oct 14): Paper 3: Testing hypothesis; Statistical tests of variance; Grant panel 3
Week 10 (Oct 21/23): Paper 4: Nitrogen and carbon/nutrient cycling
Week 11 (Oct 28/30): Paper 4: Measuring microbial activity; Biological functioning of ecosystems
Week 12 (Nov 4/6): Midterm 2; Generating questions for scientists
Week 13 (Nov 11/13): Paper 5: Phylogenetic and metagenomic analyses; Comparative genomics
Week 14 (Nov 18/20): Paper 5: Metabolic assays; Plant biomass degradation and decomposition by microbes
Week 15 (Nov 25): Grant panel 4
Week 16 (Dec 2): Review scientist’s answers and perspectives

Course Goals

1. To provide you with knowledge about the principles of microbial ecology. You will use the readings, lectures, and discussions in the classroom to gain content knowledge about microbial ecology. This includes learning about the potential roles that pathogenic and commensal microbes have in affecting the behavior and actions of their associated hosts and the mechanisms by which they do so, as well as the processes of microbial activity in the environment and the consequences of how those activities affect ecosystem functioning. This knowledge will be covered in the context of recent, hypothesis-driven scientific research, and so will be contextualized with specific, real-world examples.

2. To teach you how to apply high-level critical thinking skills to the analysis and interpretation of data. In your previous coursework, you have certainly had opportunities to demonstrate that you are proficient at remembering facts and memorizing details. This class will ask you to consistently apply and analyze information and draw conclusions from it. We will do this by sequentially studying individual parts of research studies to build a successive understanding of them as a complete scientific story. As a class, in small groups, and individually, we will discuss and consider how to dissect data and figures by: identifying the scientific question being addressed, ensuring we have the background knowledge necessary for the question, exploring the experimental design, interpreting and drawing conclusions from the data, and proposing and evaluating potential follow-up experiments.

3. To empower you to think of yourself as scientist. You will practice skills in this class that parallel the way of thinking and approaches taken by real scientists. You will be coached at how to construct your own understanding of a series of experiments rather than accepting their results as given fact. You will build hypotheses to answer specific scientific questions, design experiments using the appropriate technique/assay to answer the question, and predict the results of your experiment. You will need to be able to identify and explain the purpose of positive and negative controls in well-designed experiments; interpret experimental data and infer conclusions from the results. We will also engage with the actual scientists who did the research in order to demystify and humanize science and those who perform it.

Course Materials

Reading:
There is no textbook for this course. We will be using primary literature (scientific journal) papers for our classroom discussions and homework assignments. These papers will not be provided in their entirety at the start
of the course, but instead on an as-needed basis by the instructor at least one week in advance of the class for which they are needed.

Reference Materials:
You will be compiling your own “reference textbook” for the course in the form of a personal notebook. As we analyze and discuss each reading (annotate figures, cartoon of experiments, draw concept maps, do homework), you will assemble this material into a three-ring binder notebook. This binder is expected to be brought to every class. You are encouraged to include in your notebook any supplementary notes that you independently collect as you identify your knowledge gaps (personal notes from your reading; information from references, textbooks or online resources). This will be the “book” that you can reference during the open-book exams.

Course Website: https://sakai.unc.edu/portal/site/biol490
This site will be where some of the reading materials will be provided. I will also have postings from my lectures such as outlines, power point slides, supplemental material that we mention in lecture. I will also post class announcements on this site. It is your responsibility to check it regularly and receive email announcements.

Course Policies

If you participate in class and do your reading, homework, and assignments, there should be no need to cram for an exam. This is not a class based on memorization of facts: you must think critically and solve logic-based problems — and there is no cramming for that! Instead, by consistently participating in the expected class activities both inside and outside of the classroom, you will be given many opportunities to practice problem-solving, as well as be provided with guidance and feedback on your progress towards this way of thinking.

1. Exams:
Two mid-semester exams and one final exam will be given. The final examination is cumulative. All students are expected to take all exams when they are scheduled unless they have a Dean’s office excuse. Unexcused absences for an exam will be given a grade of zero. If you feel an error has been made in determining an exam score, you may submit the exam for a re-grade within 3 school days after the exam has been returned to the class. You must submit in writing your reasons for requesting a re-grade. Legitimate reasons for a re-grade request include, for example, incorrect summation of scores, but do not include student judgments about the amount of partial credit deserved for incorrect answers. Written responses to student requests will be returned in class or in office hours.

2. Attendance:
All registered students are expected to:
-- Be on time to all class periods
-- Attend all classes (more than two unexcused classes will accrue grade penalties per class missed)
-- Meet deadlines for homework and other assignments

3. Participation
Participation during the class period is required. Every student should participate verbally in every class. This would include either asking a question, commenting on other student’s comments, responding when asked questions directly, and participating in small group work. Students are expected to: be courteous and respectful to the other participants and their ideas; contribute in a substantial way to class discussions and small group work; be actively involved in grant panel evaluations; and Honor the Honor Code. Note that scientific communication is a specific skill set that scientists need, and that we are developing in this class — therefore your active participation is essential for you to learn (practice) this skill.

4. Homework and Quizzes
Homework will be assigned in advance as much as possible; however, the flexible and dynamic nature of this class may make it impossible to do so far in advance. At the end of every class period, however, a clear and defined set of expectations for what you need to do or complete before the next class will be made, and posted onto Sakai by 5 pm that evening. Some of this homework will be graded, other parts will be spot-checked, and some will simply
be included in your notebook for your future reference. (All homework is expected to be included in your notebook, and will be evaluated as part of your notebook grade.) Quizzes may or may not be announced. No make-up credit will be given for in-class assignments or quizzes that are missed due to unexcused absences. To account for life and its unexpectedness, the average of one day’s worth of homework and quiz points will be excused for all students.

5. Grading:
   - 30% Notebooks, homework, quizzes
   - 25% Participation
   - 45% Exams

The notebook, homework, and quizzes grade will include: completeness of your self-assembled notebook; scores from pre-scheduled as well as unannounced pop-quizzes; completion of pre-assigned homework; spot-check evaluations of material expected to be prepared in advance of class. Participation will be evaluated is as defined above and discussed together in class. All exams (Midterm 1, Midterm 2, and Final) will be equally weighted (15% each). The final exam will be cumulative. All exams will be open notebook. The questions will mirror the activities and analyses we will be actively learning in class, and will emphasize critical analysis of data and interpretation as well as application of the microbial ecology principles we have learned.

6. Special Circumstances

Please talk with me if you directly if you are a student-athlete who will need to travel frequently and miss class. If you have a disability and need accommodations, please let me know, and ensure you register early with Accessibility Resources and Service (ARS) to be eligible for appropriate accommodations (http://accessibility.unc.edu/students).

Please Note:
The professor reserves to right to make changes to the syllabus, including project due dates and test dates (excluding the officially scheduled final examination), when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.

HONOR CODE: All work done in this class must be carried out within the letter and spirit of the UNC Honor Code. You must sign a pledge on all graded work certifying that no unauthorized assistance has been given or received. You are expected to maintain the confidentiality of examinations by divulging no information about any examination to a student who has not yet taken that exam. You are also responsible for consulting with your professors if you are unclear about the meaning of plagiarism or about whether any particular act on your part constitutes plagiarism. Please talk with the professor if you have any questions about how the Honor Code pertains to this course.