Microbiome Research Lab (Bio 55) - Fall 2019

Course Meeting Times:
*Required Lab Section:* Tuesdays, 6:00-9:00pm, SEC Room 027a

*Open Lab Hours:* Fridays - 1:00-3:30pm, SEC Room 027a and by appointment. The goal of these office hours is to give students extra time to maintain experiments and to get assistance from the instructors.

Instructor: Dr. Benjamin Wolfe, benjamin.wolfe@tufts.edu
Teaching Assistant: Elizabeth Landis, elizabeth.landis@tufts.edu

Course description: This laboratory course will teach undergraduate students concepts and techniques in microbiome science through independent research projects. Using model microbiomes (fermented foods, plant leaf surfaces, and planarian worms), students will design and conduct experiments to characterize microbiome diversity, identify processes that control microbiome composition, and quantify functional roles of microbiomes. Students will learn principles of experimental design, microbial genomics and metagenomics, microbiome data management and analysis, *in vitro* microbiome reconstruction, experimental evolution, microbial trait analysis, and/or microbial genetic screens. No prior lab experience is required.

Prerequisite: Bio 13

Course objectives: The exact learning outcomes of this course will depend on the specific project that each student develops. The list below is a general list of learning outcomes that are possible in this course.

- Read, comprehend, and communicate concepts and techniques used in microbiome research
- Understand how to ask robust scientific questions in the field of microbiome science and develop testable hypotheses
- Write a research proposal that clearly defines research objectives, context for the scientific objectives, and expected outcomes
- Analyze genomic/metagenomic/transcriptomic datasets to quantify the diversity and function of microbes/microbiomes
- Use microbial culture collections to experimentally quantify microbiome processes including microbe-microbe interactions, host-microbe interactions, and mechanisms of microbiome assembly
- Visualize and communicate results from microbiome experiments by writing a lab report and presenting research findings to peers
- Learn how to provide constructive feedback on the scientific writing and experimental design of peers
Assignments and Grading:

**Participation (20%)**:
- A participation grade will be based on student engagement with the course material.
- Engagement includes: 1) being present at each class meeting, 2) coming to lab office hours to check on experiments, 3) cleaning up at the end of lab sessions and making sure materials and supplies are put away, 4) working well with other students in peer review activities and during class meetings.
- A rubric for participation grades will be provided on Canvas

**Lab notebook (20%)**:
- Lab notebooks are essential tools for recording the process of science. They are critical for keeping a research project organized and for being able to do reproducible science.
- Each student will be required to keep an online lab notebook (as a Google Document) that contains experimental plans, protocols, data, observations, etc.
- Professor Wolfe will review lab notebooks regularly and provide comments (directly in the Google Doc) on how to improve the organization and content of the notebook
- A guide for how lab notebooks should be maintained and how they will be graded will be posted on Canvas

**Paper (30%)**:
- Each student will write a final research paper that details the findings from their research project. Throughout the semester, drafts of different components of the paper will be due. These components include: Introduction, Methods, Results, and Discussion. These drafts will not be graded, but will provide opportunities to get feedback from your peers and from instructors on how to improve each section of your paper.
- The final research paper is due on the second day of Reading Period (December 11th).
- The paper should be as long as you need to fully explain your project. There is no minimum number of pages or page limit.
- Guides on how to write each section will be posted on Canvas. A rubric for how the final paper will be graded will be provided in late October.

**Presentation (30%)**:
- Each student will present a 12-minute talk to the class on their research in the final class meeting.
- The presentation will review the experimental goals for the semester, research questions, methods, results, and implications of the research.
- A rubric on how these presentations will be graded will be provided in October.

**Expectations**: For this course to accomplish the learning objectives outlined above, the following is expected from each student:
- Come to each class meeting prepared to engage in your research projects and support your peers in the course. If an unexpected situation will prevent you from attending class or prevent you from maintaining your experiments, please contact Professor Wolfe ASAP to plan time to make up missed work.
- Attend office hours to maintain experiments and obtain guidance from instructors. The course is only scheduled for 3 hours each week, but we expect students to spend additional time working on their experiments during “Open Lab Hours” and outside of the classroom.
- Maintain a detailed electronic lab notebook that records all experimental planning, procedures, results, and analysis.

**Co-authorship:** Because you are collecting original data that may be included in a peer-reviewed research article, you may be included as a coauthor on a paper. There is absolutely no need to generate publication quality data in this course.

**Student needs:** Students who may need specific assistance with taking this course should inform the instructor at the beginning of the semester.

**Listening Project:** *Class meetings of this course may be recorded and student work from this course may be collected for use in sessions of the Listening Project, a professional development program in which science instructors examine artifacts of student thinking and practice noticing the disciplinary substance therein.*

*The artifacts collected in this course will only be used at Tufts for now, but we may also want to use them in professional development beyond Tufts. If/when we seek to use the artifacts beyond Tufts, we will contact you again.*

*If you cannot appear on video or if you have questions, contact Lara.Appleby@tufts.edu*

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**SCHEDULE:**

<table>
<thead>
<tr>
<th>Week #</th>
<th>Activity</th>
<th>Learning Outcomes and Skills</th>
<th>Reading Due</th>
<th>Assignment Due</th>
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</thead>
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| 1 (9/3) | - Introduction (30min)  
- Lab orientation and safety (30min)  
- Microbiome research in the Wolfe lab (1 hour)  
- Introduce potential projects (1 hour) | - Microbiome diversity and function  
- How to ask robust and interesting questions about microbiome diversity and function |  
- Come to Friday open lab session (or another time by appointment) to chat with Professor Wolfe about interests and goals |
| 2 (9/10) | - Group discussion of Kastman et al. microbiome paper (1 hour)  
- How to keep a detailed lab notebook (1 hour)  
- Project selection and begin project experimental design (1 hour) | - How to read and understand microbiome research papers  
- Role of next-generation sequencing in microbiome research  
- Lab notebook organization | - Kastman et al. 2016  
- "How to Write the Introduction of a Scientific Paper" |  
- Read over ‘Potential Projects’ document and select project before 9/10 class meeting  
- Install Geneious software on personal computer |
| 3 (9/17) | - Peer review "Wolfe lab manuscript draft” (1 hour)  
- How to find scientific literature (30 mins)  
- Experimental design planning and request materials (1.5 hours) | - Effective peer review in science  
- How to find and cite scientific literature  
- Hypothesis development |  
- Read “Wolfe lab manuscript draft” for peer review |  
- Peer review comments on “Wolfe lab manuscript draft” |
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<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>9/24</td>
<td>Peer review of Introduction (1 hour) - Begin experiments (2 hour) - Experimental design - &quot;How to Write the Methods of a Scientific Paper&quot; - Introduction draft due in class</td>
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<tr>
<td>5</td>
<td>10/1</td>
<td>Continue experiments (3 hours) - Data collection and management - Draft of Materials and Methods</td>
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<tr>
<td>6</td>
<td>10/8</td>
<td>Continue experiments (3 hours) - Data collection and management</td>
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<td>7</td>
<td>10/15</td>
<td>No class (Monday schedule on Tuesday) - Come to Open Lab Hours to check in on experiments</td>
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<td>8</td>
<td>10/22</td>
<td>Continue experiments (3 hours) - Maintenance of experiments</td>
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<td>9</td>
<td>10/29</td>
<td>Continue experiments (3 hours) - How to learn from mistakes and failures in science</td>
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<td>10</td>
<td>11/5</td>
<td>What makes a good figure? exercise (1 hr) - Continue experiments (2 hours) - Fundamentals of data analysis and visualization - &quot;How to Write the Results of a Scientific Paper&quot;</td>
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<tr>
<td>11</td>
<td>11/12</td>
<td>Peer review of Results (1 hour) - Continue experiments (2 hours) - &quot;How to Write the Discussion of a Scientific Paper&quot; - &quot;How to Write an Abstract of a Scientific Paper&quot; - Draft of Results Section</td>
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<tr>
<td>12</td>
<td>11/19</td>
<td>Peer review of Abstract and Discussion (1 hour) - Wrap up experiments (2 hours) - Draft of Abstract and Discussion</td>
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<tr>
<td>13</td>
<td>11/26</td>
<td>Fundamentals of a good scientific research presentation - Oral communication of scientific research - Sign up for research presentation time</td>
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<td>14</td>
<td>12/3</td>
<td>Final research presentations - Research presentation must be uploaded to Canvas by noon on 12/3 - Final Research Paper Due Dec. 11th</td>
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