The Microbiology of Food
Bio 196-05 - Fall 2015
Tu 6:30PM - 9:00PM
Barnum Hall, Room 114
Tufts University

Instructor: Benjamin Wolfe (Assistant Professor, Department of Biology)
e-mail: benjamin.wolfe@tufts.edu
Office Hours: after each lecture or by appointment (please email).

Course Description:
From the production of raw materials used to make food all the way to the digestion of food in our bodies, microbes impact what and how we eat. This interdisciplinary course will use a systems-based approach to explore how microbes play critical roles in the production, processing, and consumption of foods. In our farm-to-gut journey, we'll examine basic principles of microbial diversity, ecology, evolution, physiology, and genetics and learn about the tools that microbiologists are using to study the microbiology of food systems. The course will pay equal attention to both beneficial microbes as well as the historical and contemporary impacts of pathogens. Guest lectures from farmers, chefs, and local food producers and in-class demonstrations and tastings will highlight the practical applications of managing food microbes.

Course Prerequisites, Intended Audience, and Expectations:
Students are expected to have taken a basic biology and chemistry course in high school in order to succeed in this course. This course is intended for students who are not science majors, but are interested in developing microbial literacy that they can apply to their own lives or to their field of study. Biology majors and other science students may take the course if interested, but this course does not have the rigor necessary to prepare for vet or med school. Students should take Bio 106 (Microbiology with Lab) for a more in-depth exploration of basic microbiology.

Course Learning Objectives:
- Learn how microbes play a role in the production, processing and consumption of food
- Understand the microbiological, economic, and cultural concepts/tools used to measure the diversity and impacts of microbes in food ecosystems
- Explore how microbes play roles in different cultures around the world and the history of microbes in food systems
- Critically evaluate scientific data underlying important problems and opportunities in food microbiology including the emergence of antibiotic resistance, genetically modified organisms, and global outbreaks of foodborne diseases.
- Examine the challenges that food producers/practitioners face when trying to manipulate and manage microbes in food ecosystems
- Learn approaches for communicating technical aspects of food microbiology to the general public

Course Materials:
The following textbook is required for the course (a copy will be on reserve at Tisch Library):
In addition to this textbook, numerous readings from other books or from the primary scientific literature will be posted on TRUNK. See course schedule below for when these readings are due.

Breakdown of Final Grade for Course:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Participation*</td>
<td>10%</td>
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<tr>
<td>Mid-term Exam</td>
<td>20%</td>
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<tr>
<td>Reading Responses</td>
<td>20%</td>
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<tr>
<td>MicrobialFoods.org post</td>
<td>15%</td>
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<tr>
<td>Chez Microbe Menu</td>
<td>15%</td>
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<tr>
<td>Research Paper</td>
<td>20%</td>
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*A participation grade will be determined based on whether students were present at all class meetings and if students actively engaged in the class by asking questions and participating in discussions. This grade ranges from 0 for students who never come to class and don’t ask questions to 10 for students who are always present in class and are actively engaged in the course.

Assignments:

Reading responses – Students will write short (2-3 page) responses to 5 readings assigned throughout the semester. Prof. Wolfe will post on TRUNK a series of questions to guide responses for each reading. Many of these readings will be scientific papers from the primary literature. The goal of these assignments is to help students better understand the way that scientists study microbes in food systems and how to interpret findings from original research. If you've never read a scientific study before, have no fear! You may not understand all of the technical details, and that is OK. We'll discuss any confusing techniques or jargon in class. A guide to writing reading responses will be posted on TRUNK.

Blog post for MicrobialFoods.org - I co-founded a website called MicrobialFoods.org that digests the science of fermented foods for the general public. When we discuss fermented foods in the second part of the course, each student will chose an aspect of the microbiology of fermented foods and write a 700-1500 word post for the general public. You may chose to write about the biology of a specific microbe (Microbe Guide), profile a producer of a fermented product that you interview (Producer Profile), or write more broadly about a general topic in fermented foods (Feature). More details on this assignment will be provided in lecture and on a handout posted on TRUNK.

Chez Microbe Menu presentation - Microbes play some role in supporting the production, processing, or consumption of all foods on your dinner plate. In this assignment, you will show your fellow students the links between microbes in food systems and your favorite meal in a very short presentation. Using just three PowerPoint slides, you will highlight the connections of microbes to an appetizer, a main course, and a dessert. More details on this assignment will be provided in lecture and on a handout posted to TRUNK.

Research paper – Each student will write a 10-page (double-spaced) research paper on some aspect of food microbiology. Students can chose to write about the microbiology of food from any academic perspective (e.g. scientific, historical, cultural, economic, etc.), but microbiology should be the focus. Each student will hand in an outline of possible paper topics in the middle of the semester (see schedule below).
<table>
<thead>
<tr>
<th>Class #</th>
<th>Class Topic</th>
<th>Microbial Literacy Concepts</th>
<th>Readings Due</th>
<th>Assignments Due</th>
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<tbody>
<tr>
<td>1 (9/8)</td>
<td><strong>Introduction to the microbiology of food</strong></td>
<td>- History of microbiology&lt;br&gt;- Microbial cell structure/function</td>
<td><em>Microbes and Society</em>, Chapter 1</td>
<td>Pre-course knowledge assessment (in class)</td>
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<td>2 (9/15)</td>
<td><strong>Fungi in food systems</strong></td>
<td>- Microbial diversity</td>
<td><em>Microbes and Society</em>, Chapter 8</td>
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<td>3 (9/22)</td>
<td><strong>Bacteria, archaea and viruses in food systems</strong></td>
<td>- Microbial diversity</td>
<td><em>Microbes and Society</em>, Chapter 5/6</td>
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<td>4 (9/29)</td>
<td><strong>Microbes in food production: plant agriculture</strong></td>
<td>- Microbiome&lt;br&gt;- The rhizosphere&lt;br&gt;- Soil microbiology&lt;br&gt;- Metagenomics</td>
<td><em>Microbes and Society</em>, Chapter 15</td>
<td>Response to “How Microbes Can Help Feed the World”</td>
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<td>5 (10/6)</td>
<td><strong>Microbes in food production: plant agriculture part 2 and microbes of the forest (mushrooms!)</strong></td>
<td>- Plant-microbe interactions&lt;br&gt;- The phyllosphere&lt;br&gt;- Plant pathogens&lt;br&gt;- Microbial genetics</td>
<td>Coffee Readings: 1) “What’s inside the seed we brew?” 2) “The decaffeinator” 3) “Ecological complexity and pest control in organic coffee production” Citrus Greening Readings: 1) “A race to save the orange by altering its DNA” 2) “Citrus greening management” Mushroom Readings: 1) “Snow White and Baby Bella” 2) “Commercial harvests of edible mushrooms from the forests of the Pacific Northwest United States”</td>
<td>Response to Coffee and Citrus Greening Readings</td>
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<td>6 (10/13)</td>
<td><strong>Microbes in food production: animal agriculture</strong></td>
<td>- Microbiome&lt;br&gt;- Animal-microbe interactions&lt;br&gt;- Microbial evolution and antibiotic resistance</td>
<td>“Food animals and antimicrobials: Impacts on human health.”</td>
<td>Response to “Food animals and antimicrobials...”</td>
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<td>7 (10/20)</td>
<td><strong>MID-TERM</strong> Lab exercise (Barnum 001)</td>
<td>- Methods to quantify and visualize microbes</td>
<td>“Basic techniques in food microbiology”</td>
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<td>8 (10/27)</td>
<td><strong>Microbes in food processing: fermentation, part 1: alcoholic and acetic fermentation</strong></td>
<td>- Microbial metabolism&lt;br&gt;- Microbial biogeography</td>
<td>“Fermentations in world food processing”</td>
<td>Research Paper Due&lt;br&gt;Response to reading “Microbial biogeography of wine grapes...”</td>
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<td>Date</td>
<td>Topic</td>
<td>Content</td>
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| 9 (11/3) | **Microbes in food processing:** fermentation, part 2: lactic fermentation of dairy and meats | - Microbial interactions  
- Links between microbial composition and function | “Diversity of Geotrichum candidum strains isolated from traditional cheesemaking fabrications in France.”  
“Cheese rind communities provide tractable systems for in situ and in vitro studies of microbial diversity”  
“Microbiopolitics” | Response to reading  
“Diversity of Geotrichum candidum...”  
and “Cheese rind communities...” |
| 10 (11/10) | NO CLASS 11/10 | | |
| 10 (11/17) | **Microbes in food processing:** fermentation, part 3: lactic fermentation of vegetables; microbial domestication | - Microbial evolution and genome structure | “The genomics of microbial domestication in the fermented food environment”  
“Genomics of Aspergillus oryzae”  
“The evolutionary imprint of domestication on Aspergillus oryzae” | |
| 11 (11/24) | **Microbes in food processing:** pathogens and preservatives | - Controls on microbial growth  
- Host-microbe interactions  
- Pathogenesis | **Microbes and Society,** Chapter 19  
“Improving food safety through a one health approach” | Blog post for MicrobialFoods.org |
| 12 (12/1) | **Microbes in food consumption:** the ecology of spoilage | - Controls on microbial growth  
- Microbial interactions  
- Microbial metabolism | **Microbes and Society,** Chapter 13  
“Why fruits rot, seeds mold, and meat spoils.”  
“Bacterial communities associated with the surfaces of fresh fruits and vegetables.”  
“Origin of bacterial communities associated with meat and seafood spoilage” | Chez Microbe Presentation |
| 13 (12/8) | **Microbes in food consumption:** the gut microbiome | - Host-microbe interactions  
- Microbial metabolism | “Taking a metagenomic view of human nutrition.”  
“Fate, activity, and impact of ingested bacteria within the human gut microbiota” | Research Paper  
Post-course Knowledge Assessment (in class) |