AVS 254: Introduction to Animal Microbiomes

Instructor
Dr. Sue Ishaq (she/her); sue.ishaq@maine.edu
I do not have pre-scheduled office hours, but I am happy to meet anytime to answer questions or help you navigate your project. You can book me in Google Calendar using this link [removed for online version].

Time and mode of instruction
[Removed for online version]
This class is in person and synchronous, but students may attend remotely and/or asynchronously as needed.

Location
[Removed for online version]

Syllabus Table of Contents, Click the Heading to go to that section
DESCRIPTION OF COURSE AND PREREQUISITES 2
COURSE MATERIALS AND DIGITAL SERVICES USED 2
COURSE GOALS 3
STUDENT LEARNING OUTCOMES 3
Population and Environmental Gen Ed Learning Outcomes 3
EXPECTATIONS OF STUDENTS AND UNIVERSITY POLICIES 3
Attendance 3
Late Assignments 3
Class participation 3
Campus Policies 4
Students Accessibility Services (SAS) Statement 4
ASSIGNMENTS AND ASSESSMENT: DETAILED INSTRUCTIONS AND RUBRICS ON BRIGHTSPACE. 4
SCHEDULE OF LECTURES AND ASSIGNMENTS 6
THERE IS ALWAYS SOMEONE ON CAMPUS TO HELP YOU 12
Free food and clothing 13
University Rainbow Resource Center 13
Pregnancy, lactation, and parenting 13
University Veterans Education and Transition Services (VETS) 13
University Counseling Services 13
Description of course and prerequisites
This course introduces students to host-associated microbiomes; the genomic collection of bacteria, archaea, fungi, protozoa, and viruses present in a host ecosystem. In each lecture, we will focus on an anatomical location, and discuss the host and environmental pressures which select for the resident microbial community. The material is primarily in animals (mammals, birds, fish, amphibians) but includes some human-specific comparisons. This course will introduce ecological theories (e.g. environmental selection, neutral theory) in the context of microbial communities, the history of host-associated microbiology, and how technology has contributed to or limited our understanding of organisms and their critical role in our health and development. The skill-set objectives include group discussions, reading scientific literature, and scientific writing in a variety of styles and both technical and non-technical formats.

Credit Hours: 3
Prerequisites: BIO 200 or BIO 208 or BMB 155 or BMB 280 or SMS 201; or permission
General Education requirements satisfied: Population and Environment

Course materials and digital services used
- Textbook: There is no required textbook for this class.
- Lecture slides: All lectures are provided at the beginning of the semester as pdfs with annotated speaker notes included as comments in the document. These will be updated as needed with corrections.
- Lecture recordings: All lectures are recorded, and audio-only and video files added to Brightspace after class.
- Readings: Reading material will be provided as electronic journal articles or readings.
- Discussions: There are several topics for reflection and open discussion, either in class or online as a forum post with the option of making it anonymous. These are optional and not graded.
- Assignments: All assignments can be submitted through Brightspace, and each assignment portal has more detailed instructions, grading rubrics, and the proposal assignment has an optional document template.

Brightspace Online Learning Software
  - Log into Brightspace. Read the tutorial. Download the Pulse app.
  - Brightspace is the online learning management system used at the University of Maine. In our course Brightspace site, you will be able to access course materials, assignment descriptions, this syllabus, and the course schedule. You will submit your work through Brightspace and will be able to access your grades and feedback as well. You can download a "Brightspace Pulse" app for most mobile devices from your regular app store. Be aware: Some functions in Brightspace work better when accessed through a laptop/desktop than through a mobile device. Support for the website and mobile apps includes video tours, IT Help Desk, and other resources. If you continue to have problems, please let me know.
  - If you wish to retain a personal copy of course materials, please do so before the end of the semester. You will not have access to a course’s Brightspace site after you complete the course. You can store copies of material you wish to retain on Google Drive, your hard drive, or other media of your choosing. Other materials posted by your faculty may be found at the library.

Zoom Online Conferencing Software
  - Read the UMaine tutorial.
  - Zoom is an online conference software that students can use to attend class remotely as needed.

I am happy to provide accommodations to the way course materials are formatted or provided to make them easier to access and understand. Please let me know if you have suggestions to improve the course materials.
Course Goals

- Introduce concepts, techniques, historical background, terminology, and technology of microbial ecology.
- Familiarize students with online resources, including sequence and other databases.
- Discuss factors which shape host-associated microbiomes and how the microbiome can affect the host.
- Review current literature on host-associated microbial ecology.

Student Learning Outcomes

As a result of taking this class, students will be able to:

- Describe the dynamics which shape host-associated microbiomes.
- Access online databases of scientific articles and databases.
- Review scientific journal articles and distill their findings while understanding their limitations.
- Communicate science in a variety of formats.
- Discuss topics related to science, such as recognition for achievements and the role of scientists in communicating results to the general public.

Population and Environmental Gen Ed Learning Outcomes

- Describe how host-associated microbial ecosystems are affected by environmental (external to the body) conditions.
- Describe how climate change affects range and diet selection, and how this can impact gut microbial communities and animal survival.
- Describe vertical and horizontal transmission, as well as environmental exposure of microorganisms.
- Describe the effect of pollution and air quality on health and the microbiome.

Expectations of students and university policies

Attendance

Students are expected to attend lectures, but it is understood that life often precludes this and that students may be performing field work or are located off-campus. Students may attend class virtually, through Zoom, which will be offered for each class. Students who will miss a significant number of classes, or who require additional accommodations, may contact me to make alternate arrangements. Students who are lactating or caring for young children may bring them to class (see section on Pregnancy, lactation, and parenting).

Late Assignments

I will accept assignments after the due date. You will not receive a grade reduction for late assignments, but you waive the right to receive feedback which might impact the quality of successive assignments and your next grade. Assignments will not be accepted after the last day of the semester.

Class participation

Students are expected to participate in discussions in class, or on Brightspace. I strive to create inclusive discussions, but if students still find it challenging to participate please notify me and I will alter the discussion format as needed. Supporting inclusion and community is an active process that involves both invitation, and support to ensure that the learning community is and remains an equitable and inclusive place. Students are expected to conduct themselves in a professional, courteous manner and abide by University policies.
Campus Policies
“The University of Maine is an EEO/AA employer, and does not discriminate on the grounds of race, color, religion, sex, sexual orientation, transgender status, gender expression, national origin, citizenship status, age, disability, genetic information or veteran’s status in employment, education, and all other programs and activities.” Follow the links for more information.

Students Accessibility Services (SAS) Statement
If you are requesting an accommodation to the course or assignments, please contact SAS, 121 East Annex, (207) 581-2319, as early as possible in the term. Students who have already been approved for accommodations by SAS and have a current accommodation letter should contact me as soon as possible.

Assignments and Assessment: Detailed instructions and rubrics on Brightspace.
Instructions (in both written and audio format), grading rubrics, and assignment submission can be found on Brightspace, but may be submitted in class/on paper. Some homework can be used to create portions of the essay exams or the final project. All assignments must be written in your own words, although you are allowed to use some quotes.

Homework assignments
• Host-Microbe Interaction playlists: choose 2 songs to add to the Host-Microbe Interactions Playlist
• Learn to use NCBI using a walkthrough.
• Learn to use MG-RAST using a walkthrough.
• Quiz (not timed, 2 attempts possible) on Brightspace; “What is plagiarism”.
• What big teeth you have: Choose any animal, and write 1 paragraph about how their teeth/oral anatomy is tied to their diet, and what the major components of that would be (ex. Fat, protein, fiber). Include a photo of the teeth.
• What thick fur you have: choose any animal and describe its skin/fur/exoskeleton, local environment, and what factors might affect their external microbiome.
• Probiotic summary: Locate a product labeled as “probiotic”. Write down the product, the microbes used, and health claims included on the product. Do a literary search to find at least one scientific article associated with at least one microbe listed, and try to find out if that health claim is justified.
• Article Summaries (multiple assignments): Write a 1 paragraph non-technical summary of a scientific journal article on a recent class topic. You may use an article from class or of your own choosing, be sure to include the citation. You must summarize the background/hypothesis, at least one method, and the main results. For extra credit, post your corrected assignment and link to the original article to a social media site and send me a link or screen shot.

Group work (multiple assignments):
➤ Students must enroll in a group even if they are working alone to open the assignment submission portal on Brightspace. Enroll in a group under the categories named for each assignment. You may enroll in a different group each time.

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A Map and A Plan (4): Create a visual outline (diagram) to use as a study guide around the specified topic. Starting with a main idea or topic in the center, create branches out to secondary ideas, and so on, like a spider web, to create a map of important related topics. Upload final draft to Brightspace as a group assignment. Next, students will discuss a provided scenario or case-study and create a decision tree/workflow about how to go about solving it. By the end of the day, one group member will submit a copy/screenshot to Brightspace. Asynchronous students can connect remotely later, or complete this on their own, and upload their notes to Brightspace.

Take Home Exams (3): Three short essay-style exams will demonstrate comprehension of the lectures and readings as students describe a specific aspect of microbiomes. Include at least 3 scientific references, including in-line citations and full citations in a reference list. This should be written for a more technical, scientific audience, and written in your own words. No more than ¼ of the text may be direct quotations. Instructions, examples, and submission on Brightspace.

Final Project: Students will create a public outreach project in the format of their choice. The aim is to discuss a particular aspect, ecosystem, problem, or unanswered question in host-associated microbiomes, and to present it in a way that would promote scientific literacy to the general public. Students may use material they generated in assignments or exams, but you may not submit these as the exact same version — you will need to rewrite and improve them in some way. Students will be graded on the quality of information, the creativity of the presentation, and the effectiveness of their communication. Students may opt to work alone or in groups of up to three. Format examples include but are not limited to:
- Written essay (2 pg)
- Pamphlet or poster, presentation (10+ slides), etc. IN ADDITION, students must submit a long-form description of their topic which describes the intended audience and the goal of the thing you made. The written summary should be approximately 1/2 page (not including citations).
- An Op-Ed/Letter to the Editor, with the goal of submitting to a local news agency or UMaine extension newsletter after revisions.
- A “concerned citizen” letter to a legislator, institution, or public policy makers, with the goal of informing them on an issue related to host-associated microbiology and how public policy can support health.
- A 1,500-word essay, with the goal of submitting this to Frontiers for Young Minds scientific journal under the Biodiversity designation as a Core Concept. Your final project submission should follow journal guidelines. Students will be main authors on this publication, and I will be last author, as I will facilitate editing and submission. For this version, students must be available to make edits and approve submission after the end of the semester.

Discussions: We will have informal discussions in class throughout the semester, but there will also be Discussion topics in Brightspace and you may enter your comments there anonymously, instead. These are not graded but they are a great way to get us thinking about abstract concepts and form collaborations.

Grading (out of 100 points): Assignments: 40 pts, Group work: 15 pts, Take Home Exams: 30 pts (10 pts each), Final Project: 15 pts. Points in the grade are additive, so to achieve a passing grade you need to accumulate enough points. A = 93–100; A− = 90–92; B+ = 87–89; B = 83–86; B− = 80–82; C+ = 77–79; C = 73–76; C− = 70–72; D+ = 67–69; D = 63–66; D− = 60–62; F = 0–59
## Schedule of lectures and assignments

<table>
<thead>
<tr>
<th>Day</th>
<th>Week</th>
<th>Lecture</th>
<th>Title, Objective, Assignments</th>
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<tbody>
<tr>
<td>M 8/30</td>
<td>1 0</td>
<td>Introduction to the course, explanation of the syllabus and course expectations, materials.</td>
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<tr>
<td><strong>Introduction to Microbial Ecology Theory and Technology</strong></td>
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<td>M 8/30</td>
<td>1 1</td>
<td>“What is a host-associated microbiome?”</td>
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<td>An introduction to what a host-associated microbiome actually is.</td>
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<td>Reading: Gilbert_2014_life in a world without microbes</td>
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<td>Reading: Ishaq_2019_microbes and social equity</td>
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<td>Assignment (2 pts): choose 2 songs to add to the Host-Microbe Interactions Playlist Discussion Topic on Brightspace. Due by end of Friday.</td>
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<td>W 9/1</td>
<td>2</td>
<td>“Who’s there? Major players in the microbial world.”</td>
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<td>An overview on different microorganisms.</td>
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<td>Discussion: Are microbes a natural resource?</td>
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<td>Reading (choose 1):</td>
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<td>o Caumette_2015_Historical elements of microbial ecology</td>
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<td>o Gibbs_2012_history_vets_one_health</td>
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<td>o Opal_2010_brief_history_micro_immunology</td>
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<td>F 9/3</td>
<td>3</td>
<td>“A brief history on the discovery of microorganisms.”</td>
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<td>The discovery of microorganisms, historical perspective, development of theories.</td>
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<td>Due (online): add 2 songs to our PlayList Discussion threads.</td>
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<td>Discussion: Elitism, recognition, and credit for intellectual property</td>
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<td>Reading (choose 1):</td>
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<td>o Barberan_2014_microbial_to_macroeccology</td>
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<td>o DAbramo_2020_historical_epistemology_microbes</td>
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<td>o Prosser_2007_ ecological theory in microbial theory</td>
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<td>Assignment (2pts): Learn to use NCBI, due next class.</td>
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<td>M 9/6</td>
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<td>Labor day, no class</td>
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<td>W 9/8</td>
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<td>“DNA technology and how it changed our view of the world.”</td>
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<td>A historical perspective and explanation of DNA technology.</td>
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<td>Due: Learn to use NCBI</td>
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<td>Reading: Clarridge_2004_16S and clinical microbiology, up to “Basics of sequencing”</td>
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<td>F 9/10</td>
<td>5</td>
<td>“Sequencing technology and how it revolutionized microbial ecology.”</td>
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<td>Current sequencing technology, comparisons, and different applications.</td>
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<td>Reading: Choose one of the sequencing technology submodules, watch the videos (~10 min total), and read the paper for that technology</td>
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<td>Assignment (3pts): Article Summary on microbial tech or theory, due by next class</td>
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<td>M 9/13</td>
<td>3 6</td>
<td>“An introduction to phylogeny and how our understanding of biodiversity is changing.”</td>
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<td>Explanation of phylogenetics, genetic diversity, and what constitutes a species.</td>
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<td>In class group work, draw your group’s hair color ordination plot.</td>
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<td>Due: article summary</td>
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<td>Reading: Clarridge_2004_16S and clinical microbiology, rest of paper</td>
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<td>Assignment (5pts): Quiz (not timed) on Brightspace; “What is plagiarism”. Due in 1 week.</td>
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<td>W 9/15</td>
<td>7</td>
<td>“Other methods of profiling microbial communities.”&lt;br&gt;Other microbial profiling techniques, stains, fluoroscopy, SEM/TEM, RAMAN. &lt;br&gt;➤ <strong>Reading:</strong> Valm_2012_CLASI-FISH &lt;br&gt;➤ <strong>Reading:</strong> Recorded lecture, “Translating sequencing data to journal articles.”</td>
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<td>F 9/17</td>
<td>8</td>
<td><strong>In-class or Zoom room group assignments</strong>&lt;br&gt;➤ <strong>A Map and A Plan 1: microbes and technology.</strong> In groups, draw a concept map on microbial tech or theory. Next, come up with a research question/scenario about trying to find or visualize microbes in any location or host. Describe what technology you might use and why. You may set this in modern times or historical times. Detailed instructions on the assignment portal. &lt;br&gt;➤ <strong>Take Home Exam 1 (10pts): due next Fri at noon</strong></td>
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**Digestive Tract Ecosystems**

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<tr>
<th>Date</th>
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<tr>
<td>M 9/20</td>
<td>4</td>
<td><strong>“The oral microbiome.”</strong>&lt;br&gt;Bacteria in the mouth are affected by salival production, and have systemic health effects.&lt;br&gt;➤ <strong>Due:</strong> quiz on Brightspace.&lt;br&gt;➤ <strong>Reading (choose 1):</strong>&lt;br&gt;  o Proctor_2017_nose_mouth_throat_humans&lt;br&gt;  o Ruparell_2020_canine_oral_microbiome&lt;br&gt;  o Barden_2020_oral_microbiome_calves&lt;br&gt;  o Borsanelli_2018_cow_periodontis</td>
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<td>W 9/22</td>
<td>10</td>
<td><strong>“Monogastrics, ceca, and intestines.”</strong>&lt;br&gt;Anatomy and the gut microbiome of monogastrics, a comparison of animal species.&lt;br&gt;➤ <strong>Reading (choose 1):</strong>&lt;br&gt;  o Moeller_2014_human_gut_microbiome&lt;br&gt;  o PachecoSandoval_2019_harbor_seal_gut&lt;br&gt;  o Kauter_2019_horse_gut_microbiome&lt;br&gt;  o Wasimuddin_2016_cheetah_gut</td>
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<td>F 9/24</td>
<td>11</td>
<td><strong>“Coprophagy and microbes.”</strong>&lt;br&gt;Coprophagy and why rabbits recycle, bats feces and humans don’t mix, dung beetles are helpful, and the benefits and drawbacks of the “cage effect” in mice and zebrafish.&lt;br&gt;➤ <strong>Due:</strong> Take Home Exam 1, due by noon&lt;br&gt;➤ <strong>Reading:</strong> Levesque_2020_hot_takes&lt;br&gt;➤ <strong>Assignment (3 points):</strong> Choose any animal, and write 1 paragraph about how their teeth/oral anatomy is tied to their diet, and what the major components of that would be (ex. Fat, protein, fiber). Include a photo of the teeth. Due two classes from today.</td>
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<td>M 9/27</td>
<td>12</td>
<td><strong>“Gut microbiota of birds.”</strong>&lt;br&gt;The unique digestive tract of birds, their gut microbiota, bats vs. birds vs. mammals.&lt;br&gt;➤ <strong>Discussion:</strong> How do we do we talk about conservation efforts when zoonotic disease and human land use is a higher priority in the conversation?&lt;br&gt;➤ <strong>Reading (choose 1):</strong>&lt;br&gt;  o Price_2015_digestion and aerial lifestyle&lt;br&gt;  o Martinez-Garcia_2016_nest_microbiome_eggs&lt;br&gt;  o Oliveira_2020_raptor_microbiome</td>
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<td>Date</td>
<td>Monday</td>
<td>Topic</td>
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| W 9/29 | 13 | “Ruminants- bacteria.” | The rumen bacterial community, and its importance to the herbivore.  
- **Due**: teeth and diet summary  
- **Reading (choose 1)**:  
  - A journal article of your choice on an animal species, diet, and gut microbiome  
  - Henderson_2015_core rumen microbiome  
  - Williams_2019_wildlife_microbiomes  
- **Assignment (3pts)**: Using a journal article of your choice on an animal species, diet, and gut microbiome, summarize the results as related to diet and gut microbes in a paragraph, due two classes from today. |
| F 10/1 | 14 | “Ruminants- fungi, protozoa, archaea, and viruses.” | Bacteria aren't the only members of the gut community.  
- **Reading (option 1)**: Ishaq_2015_prot methanogen moose  
- **Reading (option 2)**: Huws_2018_rumen_microbiome_agriculture |
| M 10/4 | 15 | “Effect of diet on the gut microbiome.” | Specific nutrients in a diet create nuances in the gut microbiome.  
- **Due**: animal species, diet, gut microbiome summary  
- **Reading (option 1)**: Singh_2017_influence of diet  
- **Reading (option 2)**: Vangay_2018_immigration_gut_microbiome  
- **Assignment (3pts)**: Learn to use MG-RAST, due next class. |
| W 10/6 | 16 | “Rumen acidosis.” | The effect of rumen acidosis in wild and domesticated animals, and microbial therapeutics  
- **Due**: Learning to use MG-RAST  
- **Discussion**: livestock paleo diet  
- **Reading (option 1)**: Ishaq_2017_rumen_microbes_SARA  
- **Reading (option 2)**: Felton_2017_wild_ungulates_acidosis |
| F 10/8 | 17 | “The many benefits of fiber.” | How fiber affects the gut microbiota, including carnivores, the curious case of the panda.  
- **Reading (choose 1)**:  
  - Zhao_2018_fiber and diabetes  
  - Slavin_2013_fiber_health  
  - Sonnenburg_2014_microbial_accessible_carbohydrates |
| M 10/11 | 7 | Indigenous People’s Day, no class | |
| W 10/13 | 18 | “I don’t need that kind of toxicity in my life.” | How gut microbes detoxify plant-secondary compounds.  
- **Due**: concept map on gut microbes  
- **Reading**: Kohl_2016_woodrats and toxins |
| F 10/15 | 19 | *In-class or Zoom room group assignments* | A Map and A Plan 2: microbes and gut. In groups, draw a concept map on microbes along the GI. Next, come up with a way to sample microbes from hard-to-reach locations in the gut without harming the animal. Describe what technology you might use and why. You may use existing technology or brainstorm new technology. Detailed instructions on the assignment portal. Upload final draft to Brightspace as a group assignment.
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<th>Date</th>
<th>Week</th>
<th>Reading</th>
<th>Topic</th>
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<tbody>
<tr>
<td>M 10/18</td>
<td>8</td>
<td><strong>“Vaginal microbiome.”</strong>&lt;br&gt;The vagina, drivers of the microbiome, comparisons across primates, and studies on smoking.&lt;br&gt;<strong>Reading (choose 1):</strong>&lt;br&gt;  o Messman_2021_bovine_vaginal_microbiome&lt;br&gt;  o Nelson_2018_smoking_vaginal_microbiome&lt;br&gt;  o Zhang_2020_panda_vaginal_microbiome&lt;br&gt;  o Matějková_2020_field_mice_vaginal_microbiome&lt;br&gt;  o Miller_2016_comparison_vaginal_microbiome</td>
<td>Nature vs. Nurture and Development of the Immune System</td>
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<td>W 10/20</td>
<td>21</td>
<td><strong>“Pregnancy and microbial transfer at birth.”</strong>&lt;br&gt;Pregnancy changes to microbiome, in utero transfer, and developing neonatal microbiome.&lt;br&gt;<strong>Discussion:</strong> Should we have neonatal probiotics?&lt;br&gt;<strong>Reading (choose 1):</strong>&lt;br&gt;  o Zhang_2021_developing_gut_neonamte_ruminants&lt;br&gt;  o Bunker_2021_egg_maternal_bacteria_lizards&lt;br&gt;  o Bjork_2019_vertical_transmission_sponges</td>
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<td>F 10/22</td>
<td>22</td>
<td><strong>“Vertical transmission of microbes by milk.”</strong>&lt;br&gt;Breastmilk and the development of the neonate GI microbiome, discussion of vertical transmission of microbes.&lt;br&gt;<strong>Video (optional):</strong> Yeoman et al. 2018 effect of colostrum on calf rumen&lt;br&gt;<strong>Reading:</strong> Yeoman_2018_effect of colostrum on calf rumen&lt;br&gt;<strong>Due:</strong> Take Home Exam 2, due by noon</td>
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<td>M 10/25</td>
<td>23</td>
<td><strong>“Microbes and the nature vs. nurture debate.”</strong>&lt;br&gt;Generational effects of microbes, and nature (host) vs. nurture (environment) in microbiomes.&lt;br&gt;<strong>Reading (choose 1):</strong>&lt;br&gt;  o Rothschild_2018_nurture_over_nature&lt;br&gt;  o Wang_2018_rearing_conditions_in_ducks&lt;br&gt;  o Yan_2016_env_filtering_fish_microbiome&lt;br&gt;  o Prabhu_2020_wild_domestic_bovine_microbiome&lt;br&gt;  o Byrd_2020_gut_microbes_health_disparities</td>
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<tr>
<td>W 10/27</td>
<td>24</td>
<td><strong>“Probiotics, prebiotics, and synbiotics.”</strong>&lt;br&gt;Do probiotics work? Federal regulations, assessment of efficacy, and theory.&lt;br&gt;<strong>Reading (Option 1):</strong> Gupta_2016_FMT in perspective&lt;br&gt;<strong>Reading (Option 2):</strong> Fijan 2014 microorganisms with claimed probiotic properties</td>
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<tr>
<td>F 10/29</td>
<td>25</td>
<td><strong>“Probiotics in animal industries.”</strong>&lt;br&gt;Improving health, feed efficiency, etc. Do dogs need probiotics?&lt;br&gt;<strong>Reading:</strong> Garcia-Marcorro_2019_saccharomyces_rumen&lt;br&gt;<strong>Assignment (5pts):</strong> Locate a product labeled as “probiotic”. Write down the product, the microbes used, and health claims included on the product. Do a literary search to find at least one scientific article associated with at least one microbe listed, and try to find out if that health claim is justified. Submit your notes in Brightspace, due next class.</td>
<td></td>
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<tr>
<td>M 11/1</td>
<td>26</td>
<td><strong>“Host-microbe interactions in the gut – part 1.”</strong></td>
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<table>
<thead>
<tr>
<th>Date</th>
<th>Due</th>
<th>Reading (option 1)</th>
<th>Reading (option 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/5</td>
<td>27</td>
<td>Intestinal parasites and immune monitoring.</td>
<td>Knoop_2020_breastfeeding_allergies</td>
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<tr>
<td>11/8</td>
<td>28</td>
<td>Seasonal effects on the gut microbiome.</td>
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<tr>
<td>11/10</td>
<td>29</td>
<td>In-class or Zoom room group assignments</td>
<td>A Map and A Plan 3: microbes and nature/nurture.</td>
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<tr>
<td>11/12</td>
<td>30</td>
<td>Factors driving the skin microbiome.</td>
<td>Kong_2017_skin_microbiome</td>
</tr>
<tr>
<td>11/15</td>
<td>31</td>
<td>Lobster shell bacteria and climate change</td>
<td>DeCandia_2019_mange_microbes</td>
</tr>
</tbody>
</table>

**Skin and Lung Ecosystems and the Effect of the Environment**

**In-class or Zoom room group assignments**

- A Map and A Plan 3: microbes and nature/nurture. In groups, draw a concept map on microbes in the context of health or nature vs. nurture. Next, pick any topic/problem in animal microbiomes and describe the issue. It is recommended that you choose an aspect or a topic in your map to focus on more specifically and create a plan around that. Detailed instructions on the assignment portal. Upload final draft to Brightspace as a group assignment.

**Bonus content:** AVS254_skin_problems_2021_bonus_content

**Take Home Exam 3 (10pts):** due Wednesday next week, at noon

**Due: probiotic summary**

GI tract microbiome and interactions with the epithelium and immune system, medication efficacy, how interactions here lead to systemic effects.

- **Due:** probiotic summary

**Reading (option 1):** Wilkinson_2018_microbiota drug interactions

**Reading (option 2):** Knoop_2020_breastfeeding_allergies

Intestinal parasites, and origin of the Hygiene Hypothesis.

- **Reading (choose 1):**
  - Mamun_2020_parasites_bacteria_sheep
  - Dunstand-Guzmán_2019_parasites_microbes_medicine
  - Leung_parasite_microbes_ecology
  - Scudellari_2017_cleaning up hygiene hypothesis
  - Shi_2017_microbiota and immune system
  - (insects) Ishaq_nematode_ant_bacterial_transfer or annotated presentation version: Ishaq_etal_Ent2020_nematodes_ants_bacteria

**Discussion:** should we feed wild animals in the winter?

- **Reading (choose 1):**
  - Carey_2012_ground squirrel hibernation
  - Wiebler_2018_urea_hydrolysis_hibernating_frog
  - Sommer_2016_brown_bear_microbiota
  - Video: “Badger Talk: Hibernators and Their Microbes”, Edna Chiang

**Skin microbiota of humans, terrestrial mammals, and aquatic mammals.**

- **Reading (choose 1):**
  - Kong_2017_skin_microbiome
  - Ross_2019_skin_microbiome_vertebrates
  - DeCandia_2019_mange_microbes

**Bonus content:** AVS254_skin_problems_2021_bonus_content

Epizootic shell disease is a tricky business.

- **Reading (choose 1):**
### W 11/17

**32** “Skin microbiota of amphibians and health.”

Amphibians’ skin connects them to the environment – for better or worse.

- **Due:** Take Home Exam 3, due by noon
- **Reading (choose 1):**
  - Osvatic_2021_chemosynthetic_symbionents_sponges
  - Groner_2018_lobster_disease_climate
  - Miller_2020_whale_gut_microbiome
- **Assignment (2 pts):** Choose any animal and describe its skin/fur/exoskeleton, local environment, and what factors might affect their external microbiome. Due two classes from now.

### F 11/19

**33** “Lung microbiome and the difficulty of sampling.”

Discussions on the lung microbiome connections to viral infections.

- **Readings:** Dickson_2015_lung_microbiome

### M 11/22

**34** “Horizontal transmission.”

Sharing microbes, cohabitation, and how transfer can be mediated by the built environment.

- **Due:** external anatomy and microbiome
- **Reading (choose 1):**
  - Song_2013_cohabiting_with_microbe
  - Rader_2021_masks_infection_control
  - Aguirre_2019_one_health_toxoplasmosis
  - Kilic_2021_AirQualityMeasurementsSheepBarns
- Optional bonus content: AVS254_microbes_built_environment_bonuscontent_2021

### W 11/24

Thanksgiving, no class

### F 11/26

Thanksgiving, no class

### M 11/29

**35** “Environmental microbes and health.”

Environmental microbial diversity, cloud microbiomes, and transmission of epidemics in dust.

- **Reading (pick 1):**
  - Griffin_2007_desert_dust_and_human_health
  - Mills_2019_urban_biodiversity_and_health
  - Jatzlauk_2017_env_microbes_and_asthma
  - Trinh_2018_microbes_humans_animals_environment
  - Reber_2016_Mvaccae_stress_reduction

### W 12/1

**36** “Captivity and the loss of biodiversity.”

The loss of microbial diversity as relates to captivity, urbanization, and loss of biodiversity.

- **Discussion:** Do we have a right to microbes?
- **Reading (choose 1):**
Clayton_2016_captivity_primate_microbiome
vanLeeuwen_2019_captivity_relocation
Leong_2018_biodiversity_and_socioeconomics
Reese_2021_domestication_industrialization
Prabhu_2020_wild_domestic_bovine_microbiome

Assignment (3pts): Article summary, environment host microbes, due next class
Online course evaluations – these are really helpful for improving the class and getting my contract renewed. I will not see the results until after grades have been posted.

“The problem with pollution.”
How pollution, especially that from air pollution, is affecting your microbiota and health.
Discussion: air quality, city planning, and income inequality
Reading (pick 1):
- Allaire_2018_drinking_water_violations
- Kumpel_2016_intermittent_water_supply
- Pandey_2014_Contamination_Water_Resources
- Stillo_2017_contaminated_water_health_disparities
- Tessum_2019_air_pollution_and_racial_inequity

Due: Article summary on environment
Online course evaluations – these are really helpful for improving the class and getting my contract renewed. I will not see the results until after grades have been posted.

In-class or Zoom room group assignments
A Map and A Plan 4: microbes and environment. In groups, draw a concept map on microbes in the context of environmental exposures. Next, pick any topic/problem in animal microbiomes and describe how we could redesign human ecosystems to support microbial exposures. Detailed instructions on the assignment portal. Upload final draft to Brightspace as a group assignment.

Online course evaluations – these are really helpful for improving the class and getting my contract renewed. I will not see the results until after grades have been posted.

“In-class or Zoom room group assignments
A Map and A Plan 4: microbes and environment. In groups, draw a concept map on microbes in the context of environmental exposures. Next, pick any topic/problem in animal microbiomes and describe how we could redesign human ecosystems to support microbial exposures. Detailed instructions on the assignment portal. Upload final draft to Brightspace as a group assignment.

Online course evaluations – these are really helpful for improving the class and getting my contract renewed. I will not see the results until after grades have been posted.

“Now what?”
Where the field of host-associated microbiomes is headed, and relevant careers, what grad school is like. Featuring various speakers doing research around the globe.

Final Project Due, hand in materials or give presentation by this date (see Final Project Description)

There is always someone on campus to help you
My door is always open and I am always willing to help students, however, as a university employee I am also required to keep the community safe by disclosing information on crimes. This means I am a “mandatory reporter”. If you disclose something to me, including in assignments, I am obligated to provide this information to the campus Title IX office. The Title IX Office will contact you discretely, and offer you support services, guidance, and help you choose if you want to take action.

For confidential resources on campus:
- Counseling Center: (207) 581-1392
- Cutler Health Center: (207) 581-4000.
- Rape Response Services: 1-800- 871-7741
- Partners for Peace: 1-800-863-9909.

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For support services on campus which may have to report the incident to others who can help:

- (emergency and non emergency) **Title IX Student Services**, (207) 581-1406,
- (emergency and non emergency) University of Maine Police: (207) 581-4040 or 911.
- (non emergency) Office of Community Standards: (207) 581-1409.

**Free food and clothing**
- **Black Bear Exchange’s Food Pantry**, Orono campus
- Old Town Crossroads Ministry
- **Library laptop and media loan**

**University Rainbow Resource Center**
**The Rainbow Resource Center** located in Memorial Union, Room 224, empowers and increases the visibility of Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ) people by promoting equality and inclusiveness. We strive to maintain an open, safe, and supportive environment for students, staﬀ, faculty and alumni and provide educational opportunities, information, and advocacy services.

**Pregnancy, lactation, and parenting**
I am happy to make accommodations for students based on pregnancy, lactation, and parental needs, as well as work with the Office of Equal Opportunities (E.O.). The state of Maine and UMaine policies allows students to breastfeed in any space, including in class. If a lactation space is required, please contact E.O. for arrangements. The **Pregnant on Campus Initiative** provides pregnancy and parenting resources in Orono.

**University Veterans Education and Transition Services (VETS)**
**University of Maine’s VETS Center** serves student veterans as they apply to, attend and advance beyond UMaine. The Veterans Center connects student veterans with the resources they need to successfully transition from combat to classroom to career. This includes help navigating the admissions process, applying for financial aid and U.S. Department of Veterans Affairs education beneﬁts, academic assistance and preparing to re-enter the workforce. The VETS Center is located in Room 143 of the Memorial Union.

**University Counseling Services**
If you are experiencing a mental health emergency: Dial 911. You can also call campus Police Services at (207) 581-4040. For urgent help, please check this page for your options: https://umaine.edu/counseling/need-urgent-help/.

Over the course of our time at the University, we may face a variety of concerns – depressed mood, anxiety, stress, family concerns, body image, substance use, sexuality and many others – that may interfere with their ability to focus on their studies. **Counseling Services** provides mental health and social support for all currently enrolled students. Staff follow strict legal and ethical guidelines concerning the conﬁdentiality of counseling. Counseling services is located in Cutler Health Center, Room 125 and can be reached by phone at (207) 581-1392.

**Acknowledgement**
I would like to thank UMaine CITL, the STEM Pedagogy Working Group, and Minglei Zhang for providing text, resources, and feedback for improving this syllabus.

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