



# AVS 254: Introduction to Animal Microbiomes

## Instructor

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I do not have pre-scheduled office hours, but I am happy to meet anytime to answer questions.

## Time and mode of instruction

Fall, M/W/F

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## 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 about 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, reports, or blogs.
- 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 accommodation 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 accommodation, 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 up to 24 hours after the posted due date. After 24 hours, a more difficult version of the assignment rubric will be applied, and you have until the last day of class to submit.** 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 classes without medical or personal excuse, SAS accommodations, or instructor permission.** The final is accepted during finals week.

### 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.

[Academic Honesty Statement\\*](#)

[Students Accessibility Services Statement\\*](#)

[Course Schedule Disclaimer\\*](#)

[Observance of Religious Holidays/Events\\*](#)

[Sexual Discrimination Reporting \(Long\)\\*](#)

[Sexual Discrimination Reporting \(Short\)\\*](#)

[UMaine Land Acknowledgement](#)

## 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 accommodation 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; “Learn the syllabus”, “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 big ears 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 reference, not just a link. You must summarize the background/hypothesis, at least one method, and the main results. You are not allowed to simply rewrite the abstract. For extra credit, post your corrected assignment and link to the original article to social media 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.

- **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 the 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. 1 page or 1500 words.
- 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 help. 1 page or 1500 words.
- 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 the 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 and on Brightspace throughout the semester. 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 and Quizzes: 39 pts, Group work: 16 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

| Day  | Week | Lecture | Title, Objective, Assignments   |
|--|------|---------|---|
| M<br>8/28  | 1    | 0       | Introduction to the course, explanation of the syllabus and course expectations, materials.   |
| <u>Introduction to Microbial Ecology Theory and Technology</u> |      |         |   |
| M<br>8/28  | 1    | 1       | <p><i>“What is a host-associated microbiome?”</i><br/>An introduction to what a host-associated microbiome actually is.</p> <ul style="list-style-type: none"> <li>➤ <b>Quiz on Brightspace (4 pts):</b> Answer questions about info on the syllabus. Not timed, have until next Wednesday at midnight to take it, can take it twice.</li> <li>➤ <b>Reading:</b> Gilbert_2014_life in a world without microbes</li> <li>➤ <b>Reading:</b> Ishaq_2019_microbes and social equity</li> </ul>  |
| W<br>8/30  |      | 2       | <p><i>“A brief history on the discovery of microorganisms.”</i><br/>The discovery of microorganisms, historical perspective, development of theories.</p> <ul style="list-style-type: none"> <li>➤ <b>Assignment (2 pts):</b> choose 2 songs to add to the Host-Microbe Interactions Playlist Discussion Topic on Brightspace. Due by Friday 9 am.</li> <li>➤ <b>Reading 1:</b> Recorded lecture/pdf, <i>“Who’s there? Major players in the microbial world.”</i></li> <li>➤ <b>Reading 2 (choose 1 off the list):</b> <ul style="list-style-type: none"> <li>○ DAbromo_2020_historical_epistemiology_microbes</li> <li>○ Caumette_2015_Historical elements of microbial ecology</li> <li>○ Opal_2010_brief_history_micro_immunology</li> </ul> </li> </ul> |
| F<br>9/1   |      | 3       | <p><i>“Through the looking glass.”</i><br/>Microbial visualization techniques, stains, fluoroscopy, SEM/TEM, RAMAN.</p> <ul style="list-style-type: none"> <li>➤ <b>Due (online):</b> add 2 songs to our Playlist Discussion threads, due by 9 am.</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Valm_2012_CLASI-FISH</li> <li>○ Emerson_2017_live_or_dead_cells</li> </ul> </li> <li>➤ No assignment, but take the Syllabus quiz by Wednesday</li> </ul>  |
| M 9/4  | 2    |         | <i>Labor Day, no class</i>  |
| W<br>9/6   |      | 4       | <p><i>“DNA technology and how it changed our view of the world.”</i><br/>A historical perspective and explanation of DNA technology.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> Syllabus quiz</li> <li>➤ <b>Assignment (2pts):</b> Learn to use NCBI, due Friday 9 am.</li> <li>➤ <b>Reading:</b> Janda_2007_16S</li> <li>➤ <b>Reading:</b> <a href="#">“A journey through the history of DNA sequencing”</a>, ~1500 words</li> </ul>   |
| F<br>9/8   |      | 5       | <p><i>“Sequencing technology and how it revolutionized microbial ecology.”</i><br/>Current sequencing technology, comparisons, and different applications.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> Learn to use NCBI due by 9 am</li> <li>➤ <b>Reading:</b> Choose one of the sequencing technology submodules on Brightspace, watch the videos (~10 min total), and read the paper for that technology</li> </ul>   |
| M<br>9/11  | 3    | 6       | <p><i>In class or Zoom room group assignment: Make a phylogenetic tree</i><br/>We will align DNA sequences in class and make small phylogenetic trees, ordinations.</p> <ul style="list-style-type: none"> <li>➤ <b>Assignment (4 points):</b> submit the results of your in-class activity to receive the points</li> <li>➤ <b>Reading:</b> pre-recorded lecture/pdf, AVS254_Intro_phylogeny</li> </ul>  |

|  |   |    |   |
|--|---|----|---|
|  |   |    | ➤ <b>Assignment (4pts):</b> Quiz (not timed) on Brightspace; “What is plagiarism”. Due in 1 week.   |
| W<br>9/13                                |   | 7  | <p><b><i>In-class or Zoom room group assignments</i></b></p> <p>➤ <b>A Map and A Plan 1: microbes and technology (3 pts).</b> 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. Upload the final draft to Brightspace as a group assignment.</p> <p>➤ <b>Assignment (4pts):</b> Article Summary on microbial tech or theory, due by Friday 9 am</p> <p>➤ <b>Reading:</b> Recorded lecture, “<i>Translating sequencing data to journal articles.</i>”</p> |
| F<br>9/15                                |   | 8  | <p><b><i>Full-class cooperative assignment: Microbes in time</i></b></p> <p>Using the link to a google sheet, we are going to collaboratively make a timeline and add events in microbiology, genetics, and microbiomes. We’ll use what we learned in class, plus other events we’ve learned about. Each person should add 5 events.</p> <p>➤ <b>Due:</b> article summary due Friday at 9 am</p> <p>➤ <b>Take Home Exam 1 (10pts):</b> Write something new or combine/revise previous assignments into &gt;1 page essay on technology and microbes. <b>Due next Friday 9 am</b></p>   |
| <b><u>Digestive Tract Ecosystems</u></b> |   |    |   |
| M<br>9/18                                | 4 | 9  | <p><b><i>“The oral microbiome.”</i></b></p> <p>Bacteria in the mouth are affected by salival production, and have systemic health effects.</p> <p>➤ <b>Due:</b> plagiarism quiz on Brightspace, due by midnight</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Proctor_2017_nose_mouth_throat_humans</li> <li>○ Ruparell_2020_canine_oral_microbiome</li> <li>○ Barden_2020_oral_microbiome_calves</li> <li>○ Borsanelli_2018_cow_periodontis</li> </ul>  |
| W<br>9/20                                |   | 10 | <p><b><i>“Monogastrics, ceca, and intestines.”</i></b></p> <p>Anatomy and the gut microbiome of monogastrics, a comparison of animal species.</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Moeller_2014_human_gut_microbiome</li> <li>○ PachecoSandoval_2019_harbor_seal_gut</li> <li>○ Kauter_2019_horse_gut_microbiome</li> <li>○ Wasimuddin_2016_cheetah_gut</li> </ul>  |
| F<br>9/22                                |   | 11 | <p><b><i>“Coprophagy and microbes.”</i></b></p> <p>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.</p> <p>➤ <b>Due:</b> Take Home Exam 1, due by 9 am.</p> <p>➤ <b>Assignment (3 points):</b> 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 next Wed at midnight.</p> <p>➤ <b>Reading:</b> Levesque_2020_hot_takes</p>   |
| M<br>9/25                                | 5 | 12 | <p><b><i>“Gut microbiota of birds.”</i></b></p> <p>The unique digestive tract of birds, their gut microbiota, bats vs. birds vs. mammals. Non-graded discussion in class, as future veterinary health professionals, how will you balance animal welfare with public health concerns?</p> <p>➤ <b>Reading (choose 1):</b></p>   |



|           |      |  |
|-----------|------|--|
|           |      | <ul style="list-style-type: none"> <li>○ Price_2015_digestion and aerial lifestyle</li> <li>○ Martinez-Garcia_2016_nest_microbiome_eggs</li> <li>○ Oliveira_2020_raptor_microbiome</li> <li>○ Watch dissertation defense, "<a href="#">The Effect of Nest Architecture on Nest Microclimate and Microbiome Assembly in Tropical Birds</a>"</li> </ul>  |
| W<br>9/27 | 13   | <p><i>"Ruminants- bacteria."</i></p> <p>The rumen bacterial community, and its importance to the herbivore.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> teeth and diet summary</li> <li>➤ <b>Assignment (3pts):</b> Learn to use MG-RAST, due Friday 9 am.</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ A journal article of your choice on an animal species, diet, and gut microbiome</li> <li>○ Henderson_2015_core rumen microbiome</li> <li>○ Williams_2019_wildlife_microbiomes</li> <li>○ Jonge_2022_gut_microbiome_mammals</li> </ul> </li> </ul>   |
| F<br>9/29 | 14   | <p><i>"Ruminants- fungi, protozoa, archaea, and viruses."</i></p> <p>Bacteria aren't the only members of the gut community.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> Learning to use MG-RAST due 9 am.</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Ishaq_2015_prot methanogen moose</li> <li>○ Huws_2018_rumen_microbiome_agriculture</li> <li>○ Thomas_2022_gut_archaea_mammals</li> </ul> </li> </ul>   |
| M<br>10/2 | 6 15 | <p><i>"Effect of diet on the gut microbiome."</i></p> <p>Specific nutrients in a diet create nuances in the gut microbiome.</p> <ul style="list-style-type: none"> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Harris_2019_gutmicrobiome_diet_parasites</li> <li>○ Singh_2017_influence of diet</li> <li>○ Vangay_2018_immigration_gut_microbiome</li> </ul> </li> <li>➤ <b>Assignment preparation:</b> find an example of the digestive tract anatomy of the animal species you are interested in, and would want to write your next article summary on. You'll need anatomy, diet, and microbes info for our next Map/Plan group assignment</li> </ul> |
| W<br>10/4 | 16   | <p><i>"The many benefits of fiber."</i></p> <p>How fiber affects the gut microbiota, including carnivores, the curious case of the panda.</p> <ul style="list-style-type: none"> <li>➤ <b>Assignment (3pts):</b> Follow the instructions on Brightspace to check out the CAZYME database. Submit to Brightspace, due by Friday at 9 am.</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Zhao_2018_fiber and diabetes</li> <li>○ Slavin_2013_fiber_health</li> <li>○ Sonnenburg_2014_microbial_accessible_carbohydrates</li> </ul> </li> </ul>   |
| F<br>10/6 | 17   | <p><i>"Rumen acidosis."</i></p> <p>The effect of rumen acidosis in wild and domesticated animals, and microbial therapeutics.</p> <ul style="list-style-type: none"> <li>➤ <b>Assignment (3pts):</b> 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 next Wednesday at 9 am.</li> <li>➤ <b>Reading (option 1):</b> Ishaq_2017_rumen_microbes_SARA</li> <li>➤ <b>Reading (option 2):</b> Felton_2017_wild_ungulates_acidosis</li> </ul>  |



|   |    |    |  |
|---|----|----|--|
|   |    |    | ➤ <b>Assignment preparation:</b> gather the digestive tract anatomy of the species you wrote your article summary on, diet info, and microbes relevant to that animal for Map/Plan 2   |
| M<br>10/9                               | 7  |    | <i>Indigenous People's Day, no class</i>   |
| W<br>10/11                              | 18 |    | <p><b><i>In-class or Zoom room group assignments</i></b></p> <p>➤ <b>A Map and A Plan 2: microbes and gut (4 pts).</b> 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 the final draft to Brightspace as a group assignment.</p> <p>➤ <b>Due:</b> article summary on animal diet and microbes, due 9 am</p> |
| F<br>10/13                              | 19 |    | <p><i>"I don't need that kind of toxicity in my life."</i></p> <p>How gut microbes detoxify plant-secondary compounds.</p> <p>➤ <b>Take Home Exam 2 (10pts):</b> due next Fri at 9 am.</p> <p>➤ <b>Reading:</b> Kohl_2016_woodrats and toxins</p>  |
| <b>Developing a microbial community</b> |    |    |  |
| M<br>10/16                              | 8  | 20 | <p><i>"Vaginal microbiome."</i></p> <p>The vagina, drivers of the microbiome, comparisons across primates, and studies on smoking.</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Messman_2021_bovine_vaginal_microbiome</li> <li>○ Nelson_2018_smoking_vaginal_microbiome</li> <li>○ Zhang_2020_panda_vaginal_microbiome</li> <li>○ Matějková_2020_field_mice_vaginal_microbiome</li> <li>○ Miller_2016_comparison_vaginal_microbiome</li> </ul>  |
| W<br>10/18                              |    | 21 | <p><i>"Pregnancy and microbial transfer at birth."</i></p> <p>Pregnancy changes to microbiome, <i>in utero</i> transfer, and developing neonatal microbiome.</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Zhang_2021_developing_gut_neonate_ruminants</li> <li>○ Bunker_2021_egg_maternal_bacteria_lizards</li> <li>○ Bjork_2019_vertical_transmission_sponges</li> <li>○ (Video) Jaserevic_microbiome_pregnancy_stress</li> </ul>   |
| F<br>10/20                              |    | 22 | <p><i>"Vertical transmission of microbes by milk."</i></p> <p>Breastmilk and the development of the neonate GI microbiome, discussion of vertical transmission of microbes.</p> <p>➤ <b>Video (optional):</b> <a href="#">Yeoman et al. 2018 effect of colostrum on calf rumen</a></p> <p>➤ <b>Reading:</b> Yeoman_2018_effect of colostrum on calf rumen</p>  |
| M<br>10/23                              | 9  | 23 | <p><i>"Microbes and the nature vs. nurture debate."</i></p> <p>Generational effects of microbes, and nature (host) vs. nurture (environment) in microbiomes. Short in-class or on zoom activity where we list all the "nurture" factors for an animal species of our choice (this will help us later in the Map/Plan 3 assignment).</p> <p>➤ <b>Due:</b> Take Home Exam 2, due by noon</p>   |

|            |                    |  |
|------------|--------------------|--|
|            |                    | <ul style="list-style-type: none"> <li>➤ <b>Assignment (5pts):</b> Locate a product labeled as “probiotic”. Write down the product, the microbes used, and health claims included on the product. Choose one microbe, and search for 1 journal article that confirms that microbe’s health benefits, and 1 journal article that refutes it. What circumstances were different between the studies that might account for difference in outcomes? Submit your notes in Brightspace, due Friday 9 am.</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Rothschild_2018_nurture_over_nature</li> <li>○ Wang_2018_rearing conditions in ducks</li> <li>○ Yan_2016_env_filtering_fish_microbiome</li> <li>○ Prabhu_2020_wild_domestic_bovine_microbiome</li> <li>○ Byrd_2020_gut_microbes_health_disparities</li> <li>○ Liu_2021_gut_microbiome_dogs_versus_wolves</li> </ul> </li> </ul> |
| W<br>10/25 | 24                 | <p><i>“Probiotics, prebiotics, and synbiotics.”</i><br/>Do probiotics work? Federal regulations, assessment of efficacy, and theory.</p> <ul style="list-style-type: none"> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Venugopalan_2010_regulations_safety_probiotics</li> <li>○ Gupta_2016_FMT in perspective</li> <li>○ Fijan 2014 microorganisms with claimed probiotic properties</li> </ul> </li> </ul>  |
| F<br>10/27 | 25                 | <p><i>“Probiotics in animal industries.”</i><br/>Improving health, feed efficiency, etc. Do dogs need probiotics?</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> probiotic summary due by 9 am.</li> <li>➤ <b>Reading:</b> Garcia-Marcorro_2019_saccharomyces_rumen</li> </ul>   |
| M<br>10/30 | 1<br>0<br>26<br>.1 | <p><i>“Host-microbe interactions in the gut – part 1.”</i><br/>GI tract microbiome and interactions with the epithelium and immune system, medication efficacy, how interactions here lead to systemic effects.</p> <ul style="list-style-type: none"> <li>➤ <b>Assignment (2pts):</b> Read the Peng et al. 2021 article, and choose any paragraph to rewrite or illustrate to make it easier to understand. For example, you could include definitions, write it using an analogy, or draw a cartoon to illustrate your point. Due by Friday 9 am.</li> <li>➤ <b>Reading:</b> Peng_2021_gut_microbes_mucosa_pigs</li> </ul>   |
| W<br>11/1  | 26<br>.2           | <p><i>“Host-microbe interactions in the gut – part 2.”</i><br/>GI tract microbiome and interactions with the epithelium and immune system, medication efficacy, how interactions here lead to systemic effects.</p> <ul style="list-style-type: none"> <li>➤ <b>Reading (option 1):</b> Wilkinson_2018_microbiota drug interactions</li> <li>➤ <b>Reading (option 2):</b> Knoop_2020_breastfeeding_allergies</li> </ul>  |
| F<br>11/3  | 27                 | <p><i>“Intestinal parasites and immune monitoring.”</i><br/>Intestinal parasites, and origin of the Hygiene Hypothesis.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> paragraph rewrite assignment due by 9 am</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Mamun_2020_parasites_bacteria_sheep</li> <li>○ Dunstand-Guzmán_2019_parasites_microbes_medicine</li> <li>○ Leung_parasite_microbes_ecology</li> <li>○ Scudellari_2017_cleaning up hygiene hypothesis</li> <li>○ Distel_2018_unpalatable_forage_ruminant_parasites</li> </ul> </li> </ul>  |

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|  |        |    | <ul style="list-style-type: none"> <li>○ (insects) Ishaq_nematode_ant_bacterial_transfer or annotated presentation version: Ishaq_et al_ Ent2020_nematodes_ants_bacteria</li> </ul>  |
| M<br>11/6                                | 1<br>1 | 28 | <p><i>“Seasonal effects on the gut microbiome.”</i><br/>What happens when food is scarce, and what happens during hibernation?</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Carey_2012_ground squirrel hibernation</li> <li>○ Wiebler_2018_urea_hydrolysis_hibernating_frog</li> <li>○ Sommer_2016_brown_bear_microbiota</li> <li>○ Wei_2021_seasonal_diets_yak_sheep</li> <li>○ Video: <a href="#">“Badger Talk: Hibernators and Their Microbes”</a>, Edna Chiang</li> </ul>  |
| W<br>11/8                                | 1<br>1 | 29 | <p><b><i>In-class or Zoom room group assignments</i></b></p> <p>➤ <b>A Map and A Plan 3: microbes and nature/nurture (4 pts).</b> 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 the final draft to Brightspace as a group assignment.</p> <p><b>Take Home Exam 3 (10pts):</b> due Wednesday next week, at 9 am</p>   |
| <b>Host microbes and the Environment</b> |        |    |  |
| F<br>11/10                               |        |    | <i>Veteran’s Day, no class</i>   |
| M<br>11/13                               | 1<br>2 | 30 | <p><i>“Factors driving the skin microbiome.”</i><br/>Skin microbiota of humans, terrestrial mammals, and aquatic mammals.</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Kong_2017_skin microbiome</li> <li>○ Ross_2019_skin_microbiome_vertbrates</li> <li>○ DeCandia_2019_mange_microbes</li> </ul> <p>Bonus content: AVS254_skin_problems_2021_bonus_content</p>  |
| W<br>11/15                               |        | 31 | <p><i>“Lobster shell bacteria and climate change”</i><br/>Epizootic shell disease is a tricky business.</p> <p>➤ <b>Due:</b> Take Home Exam 3, due by 9 am</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ Osvatic_2021_chemosynthetic_symbionents_sponges</li> <li>○ Miller_2020_whale_gut_microbiome</li> <li>○ Ishaq_2023_lobster_shell_disease</li> <li>○ Ishaq_2022_lobster_transmission</li> </ul>  |
| F<br>11/17                               |        | 32 | <p><i>“Skin microbiota of amphibians and health.”</i><br/>Amphibians’ skin connects them to the environment – for better or worse.</p> <p>➤ <b>Assignment (2pts):</b> Choose any animal and describe its skin/fur/exoskeleton, local environment, and what factors might affect their external microbiome. Due Monday 9 am.</p> <p>➤ <b>Reading (choose 1):</b></p> <ul style="list-style-type: none"> <li>○ BritodeAssis_2017_skin microbiota frogs</li> <li>○ Hernández-Gómez_2020_AmphibianSkinMicrobiota</li> <li>○ Brucker_2008_amphibian_bacteria_antifungals</li> <li>○ Pounds_2006_climatechange_extinction</li> <li>○ Greenspan_2017_climate_infection_vulnerability</li> </ul> |

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| M<br>11/20 | 1<br>3 | 33 | <p>“Horizontal transmission.”<br/>Sharing microbes, cohabitation, and how transfer can be mediated by the built environment.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> external anatomy and microbiome, due 9 am.</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Valles-Colomer_2021_sharing_microbes_humans</li> <li>○ Bai_2022_AMR_farms</li> <li>○ Mhuireach_2022_grazing_soil_microbiomes</li> <li>○ Aguirre_2019_one_health_toxoplasmosis</li> <li>○ Kilic_2021_AirQualityMeasurementsSheepBarns</li> </ul> </li> </ul>   |
| W<br>11/22 |        |    | Thanksgiving, no class  |
| F<br>11/24 |        |    | Thanksgiving, no class  |
| M<br>11/27 | 1<br>4 | 34 | <p>“Lung microbiome and air quality.”<br/>Environmental microbial diversity, cloud microbiomes, and transmission of epidemics in dust.</p> <ul style="list-style-type: none"> <li>➤ <b>Assignment (3pts):</b> Article summary, environment host microbes, due Friday 9 am</li> <li>➤ <b>Reading (pick 1):</b> <ul style="list-style-type: none"> <li>○ Yagi_2021_lung_microbiome_healthy_disease</li> <li>○ Griffin_2007_desert dust and human health</li> <li>○ Rader_2021_masks_infection_control</li> <li>○ Trinh_2018_microbes_humans_animals_environment</li> <li>○ Reber_2016_Mvaccae_stress_reduction</li> </ul> </li> </ul>   |
| W<br>11/29 |        | 35 | <p>Where do scallops get their microbes?<br/>Differences in microbial acquisition in wild scallop larvae versus hatchery scallop larvae.</p> <ul style="list-style-type: none"> <li>➤ <b>Reading (pick 1):</b> <ul style="list-style-type: none"> <li>○ Ishaq_2023_scallop_bacterial_communities</li> <li>○ Rojas_2019_Vibrio_scallops_Chile</li> <li>○ Liu_2020_gut_microbes_scallops_carotenoids</li> <li>○ Yu_2019_healthy_diseased_Yesso_scallops</li> </ul> </li> </ul>  |
| F<br>12/1  |        | 36 | <p>“Captivity and the loss of biodiversity.”<br/>The loss of microbial diversity as relates to captivity, urbanization, and loss of biodiversity.</p> <ul style="list-style-type: none"> <li>➤ <b>Due:</b> article summary, due 9 am</li> <li>➤ <b>Reading (choose 1):</b> <ul style="list-style-type: none"> <li>○ Mills_2019_urban biodiversity and health</li> <li>○ Clayton_2016_captivity primate microbiome</li> <li>○ vanLeeuwen_2019_captivity_relocation</li> <li>○ Leong_2018_biodiversity and socioeconomics</li> <li>○ Reese_2021_domestication_industrialization</li> <li>○ Prabhu_2020_wild_domestic_bovine_microbiome</li> </ul> </li> <li>➤ <b>Online course evaluations</b> – 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.</li> </ul> |
| M<br>12/4  | 1<br>5 | 37 | <p>“The problem with pollution.”<br/>How pollution, especially that from air pollution, is affecting your microbiota and health.</p> <ul style="list-style-type: none"> <li>➤ <b>Reading (pick 1):</b> <ul style="list-style-type: none"> <li>○ Allaire_2018_drinking water violations</li> <li>○ Kumpel_2016_intermittent water supply</li> </ul> </li> </ul>  |

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|             |    | <ul style="list-style-type: none"> <li>○ Pandey_2014_Contamination Water Resources</li> <li>○ Stillo_2017_contaminated water health disparities</li> <li>○ Tessum_2019_air pollution and racial inequity</li> </ul> <p>➤ <b>Online course evaluations</b> – 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.</p>   |
| W<br>12/6   | 38 | <p><b><i>In-class or Zoom room group assignments</i></b></p> <p>➤ <b>A Map and A Plan 4: microbes and environment (4 pts).</b> 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 the final draft to Brightspace as a group assignment.</p>   |
| F<br>12/8   | 39 | <p>“Now what?”</p> <p>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.</p> <p>➤ Optional follow-up readings and videos: You have the opportunity to add ‘scientist’ to the other identities you have, and you don’t have to give up who you are to also be a scientist. These recorded guest lectures on Brightspace talk about integrated scientific and cultural/sexual/gender/socioeconomic identities.</p> <p>➤ <b>This is the last day that regular assignments (everything but the final) will be accepted for a grade. Submit to Brightspace by midnight.</b></p> |
| Th<br>12/14 |    | <p><b>Due:</b> Final Project by 9 am, (10 points) hand in materials or give presentation by this date (see Final Project Description)</p>   |

## 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.

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.

Support services off campus:

- [Mabel Wadsworth Center](#), Bangor: reproductive health care, abortion, addiction help, etc.
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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 provide accommodation 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 allow 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, check here 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, 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.