MICROBIAL ECOLOGY
Biology 405 & 545G
Spring 2008

Instructors: Craig Moyer & Marion Brodhagen
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Office Hours: Brodhagen: 9-10 WF; Moyer: 1-2 MW or by appointment
Class Meetings: Tues/Thur 10:00 to 11:50 in BI 415

Course Resources:
Texts:

J. Vaun McArthur. 2006. Microbial Ecology, An Evolutionary Approach. Academic Press. ISBN # 10: 0-12-369491-4

Betsey Dexter Dyer. 2003. A field guide to bacteria. Cornell University Press. ISBN # 0-8014-8854-0

Updated information & additional **reading assignments** to be posted on the class web site:
http://fire.biol.wwu.edu/cmoyer/cmoyer.courses.html

Course Description:
Microbial ecology is the relationship of microorganisms with one another and with their surroundings. It concerns all three of the major Domains of life including Eucarya, Archaea, and Bacteria. Microbes, by their omnipresence, impact the entire biosphere. They are present in virtually all of our planet's environments except the most extreme, from high mountain glaciers to the deepest ocean depths, and from frozen permafrost to superheated hydrothermal vents. Microbes are the backbone of all ecosystems, even where light cannot penetrate and thus photosynthesis cannot be the basic means to collect energy. In such habitats, chemosynthetic microbes provide energy and carbon to the rest of the ecosystem. Microbes are also decomposers and remineralizers, with the ability to recycle nutrients from other organisms' waste products. They play a critical role in biogeochemical cycles. The nitrogen cycle, the sulfur cycle, the phosphorus cycle and the carbon cycle all depend on microbes in one way or another. For example, nitrogen which makes up 78% of the planet's atmosphere is "indigestible" for most organisms, and the flow of nitrogen into the biosphere depends on a microbial process called fixation.

Microbes, especially bacteria, often engage in symbiotic relationships (either positive or negative) with other organisms, and these relationships affect the ecosystem. An example is chloroplasts, which allow eucarya to conduct photosynthesis. Chloroplasts are considered to be endosymbiotic cyanobacteria; these bacteria were among the first to perform photosynthesis, and therefore made and still make major impacts on global climate change. Microbes interact with eukaryotes in a number of ways, ranging from symbiotic or commensal to pathogenic. Plants and animals are home to thousands of bacterial species – some beneficial and some harmful.   For example, agricultural practices exert selective pressure on microbial communities that favor microbial communities benefiting a particular crop. Conversely, well-adapted pathogens can destroy plant and animal communities in days or weeks. The adaptations that facilitate interactions of microbes with their eukaryotic hosts range from elaborate signaling processes and structures that provide checks and balances at the community level, to elaborate molecular regulatory processes and machines used to interact with the host on a cell-to-cell level. With modern DNA sequencing techniques, scientists are now examining "metagenomes", or collections of genes that comprise an entire microbial community rather than a single genome. Current projects include agricultural metagenomes as well as projects to reveal the "human microbiome".

Understanding the biology and ecology of unseen majority is essential to understanding the health of our own bodies, other animals, plants, ecosystems… and so on. Knowledge about microbial ecology is directly applied in such fields as agriculture (e.g., food and dairy, plant pathology), industrial and chemical engineering (e.g., industrial biocatalysis), health (e.g., biofilms and pathogenesis), and bioremediation (e.g., pollution elimination). On a broader scale, scientists study microbial ecology in order to understand the role of microbes in the functioning of the biosphere.

Course Objectives:
We will examine both classic and recent seminal papers on microbial ecology. We will compare and contrast the classic morphologically based systematics with modern molecular phylogeny, explore the potential for spatial and temporal variability over strong physical gradients, and examine the multiple biochemical options regarding the metabolic menu. We will discuss the interactions of microbes with eukaryotic hosts, and explore the genetic and molecular mechanisms underlying these interactions at the cellular level, as well as the community structure, signaling processes, and selective pressures governing these associations at the community level.

Course Format:
All students will read and review assignments from text and papers from the scientific literature **prior** to attending the class meeting. The default format will be for instructors and/or graduate students to cover general topics during the first hour of our meetings so that all students will have a firm foundation regarding fundamental topics. After that, we use a discussion format driven by student participation during the second hour of our meetings with an emphasis on specific papers related to these topics.

Discussion facilitation: Each undergraduate student will lead one of our discussions. Discussion leaders will generate one set of discussion questions for their classmates to consider and respond to in writing – this will prompt everyone to be thinking about the material ahead of time. Discussion leaders must also compose a second set of questions to have "on hand" to guide the conversation of the class. Both sets of questions must be given to the instructors two weeks in advance, for comment and editing. All students must turn in discussion questions from assigned readings at the beginning of class.

Graduate students will provide one presentation on a "capstone" topic to the class *and* facilitate a corresponding paper discussion. In addition, graduate students will be expected to participate as peer reviewers for undergraduate term papers to qualify for graduate credit.

Writing intensive students: A writing intensive section will also be made available for undergraduate students who want to focus more attention to the development of their scientific writing skills. Those students who opt to take this course as writing intensive will make special arrangements with the instructor to produce an expanded term paper (through an iterative process of outline, draft, and then final product) in order to fulfill the requirements for WI credit.

Term paper/literature review: All students will be asked to put together a literature review on a topic of interest within the broad umbrella of microbial ecology. Papers should succinctly summarize the current status of research within the chosen topic; examples will be available. Papers should be no longer than 5 pages, single-spaced, 12 point font, in length (not including the References section). Each paper should include at least 5 references to primary research articles (in *addition* to review articles and/or book chapters) pertinent to the topic chosen by the student. Students will be asked to make a slide presentation of their topic, to be shared with the rest of the class during the final week of the course.

We will guide your literature review to the extent that I will request a topic from you April 10; an outline by May 1, and the final paper by May 22. Graduate students will critique a subset of the reviews in the same manner as someone from the academic community who was peer-reviewing it. In the academic community, papers and proposals are reviewed anonymously by your peers and returned to you along with the decision of the journal editor or grant panel. Reviewers' comments are meant to help you write the best work that you possibly can, and papers and proposals are frequently resubmitted after considering the suggestions. In this course, you will have the option to re-submit your paper after the first round of "peer review" by May 22, for the best grade possible. Your presentations should be ready to present on May 27 in the form of a 20-minute slide presentation (aim for about 15 minutes worth of slides, and 5 minutes for questions and discussion afterward). Your grade will reflect the quality of both the review/proposal, and your ability to present technical material in a manner that your audience can understand and appreciate. Graduate students will be further evaluated on the quality of their peer reviews.

Field trips: We will arrange field trips during the course; participation in at least two is mandatory.

Course Evaluation and Grading (Tentative):

Undergraduates

Midterm Exam	100 points
Final Exam	200 points
Discussion & Participation	100 points
Term Paper & Presentation	100 points
Total points possible:	500 points

Graduates

Midterm Exam	100 points
Final Exam	200 points
Term Paper & Presentation	100 points
Topical presentation & Discussion	100 points
Peer Review of Term Papers	100 points
Total points possible:	600 points

Important dates

April 10	Inform instructors (in writing) of choice of term paper, discussion, and capstone lecture topics
April 24	In Class Midterm
May 1	Term paper outline due to instructors
May 8	First draft of term paper to peer reviewers
May 15	Peer reviews due to authors and instructors
May 22	Final drafts of term papers due to instructors
May 29	Presentations
June 3 & 5	Capstone lectures (graduate students)
June 12	Final exam

Academic dishonesty and plagiarism. One word: DON'T. If you are unsure of how to properly cite work, especially in your review/proposal, please see me and/or consult the following website: http://www.library.wwu.edu/ref/plagiarism.html

If you are unsure of the consequences of academic dishonesty at WWU, see the website: http://www.acadweb.wwu.edu/senate/acc/ACCplagiarismAppD.htm

Tentative lecture schedule: See below.

<u>Date</u>	<u>Lecture Topic</u>	<u>Assigned Reading</u>	<u>Lecturer</u>
4/1	What is a microbe? Review of microbial cell biology.	McArthur Ch. 1; Dyer "Introduction" a "Guide to Habitats". Web Site: "The uncharted microbial world"	Brodhagen
4/3	Origins of life: Miller-Urey experiment, hot-start hypothesis, cold-start hypothesis, RNA world, rise of oxygen	McArthur Ch. 2; Dyer Ch. 1. Web Site 1 & 2 from "Life as we do not know it"	Moyer
4/8	Origins of life: Miller-Urey experiment, hot-start hypothesis, cold-start hypothesis, RNA world, rise of oxygen	McArthur Ch. 2; Dyer Ch. 1. Web Site 1 & 2 from "Life as we do not know it"	Moyer
4/10	Methods in microbial ecology: sampling challenges in various habitats, detection and enumeration, culturing (or not), identification, characterization	Reading assignments posted on course web site	Moyer
4/15	Microbial diversity: generation of diversity (DNA transfer, evolution) and categorization of diversity (molecular phylogeny). Endosymbiosis	McArthur Ch. 3, Ch. 11; additional rea posted on course web site	Moyer

4/17	Overview of growth and adaptation to environments: microbial nutrition, adaptations to stress (molecular and biochemical adaptations; endospores).	McArthur Ch. 4, 5, 6 & 10	Brodhagen
4/22	Microbial habitats: Freshwater and estuarine	McArthur Ch. 12	Apple
4/24	Microbial habitat: Soil	McArthur Ch. 12, Dyer Ch. 11	Brodhagen
4/29	Microbial habitats: Marine and lithosphere	TBA	Moyer
5/1	Microbial adaptations for “extreme” habitats: salinity, radiation, pressure, temperature, pH	TBA	Moyer
5/6	Plant-microbe interactions	McArthur Ch. Ch. 14 & 15; Dyer Ch. 1	Brodhagen
5/8	Microbial communities: cell-cell signaling, antibiotics	McArthur Ch. Ch. 9 & 10	Brodhagen
5/13	Microbial communities: communities: biofilms	TBA	Brodhagen
5/15	Indigenous microbiota of humans – commensals, pathogens, human microbiome	Dyer Ch. 12 & 15; others TBA	Brodhagen
5/20	Biogeochemical cycling: N & C cycles	McArthur Ch. Ch. 13; Dyer Ch. 2	Brodhagen/Moyer
5/22	Biogeochemical cycling: P, S, Fe cycles	McArthur Ch. Ch. 13; Dyer Ch. 9	Moyer
5/27	Presentation of term paper topics	None	Undergraduates
5/29	Presentation of term paper topics	None	Undergraduates
6/3	Capstone topics: Bioremediation? Microbial energy production?	TBA	Graduate students
6/5	Field Trip: Bellingham Water Treatment Plant and Sewage Treatment Plant – 10a.m. – 2 p.m. BRING LUNCH.		Peg Wendling and other Local Experts

Final Exam: Thursday, June 12 from 8-10 a.m.