

BIOL 4XX/6XX
Environmental Microbiology

Instructor: Dr. Mary Beth Leigh

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Office hours: XXXXXXXX or by appointment

Class time and place

Tuesday and Thursday 9:45-11:15

Course overview

This course provides a comprehensive overview of the role of microorganisms in environmentally-relevant processes including bioremediation of pollutants, biogeochemical cycling and wastewater treatment, and covers modern molecular methods for studying microbes in the environment. Upper level undergraduate and graduate students in Biology, Environmental Chemistry, Environmental Engineering or other related disciplines will gain expertise in microbial processes with an emphasis on their application to environmental quality issues.

Prerequisites

Students should have taken BIOL 115/116 (Fundamentals of Biology), BIOL 342 (Microbiology) and CHEM 105/106 (General Chemistry) or equivalent, or permission of instructor. Exceptions may be made on an individual basis with permission of instructor.

Reading materials

- Many readings will be in the form of **scientific journal articles**, which are electronically available through UAF library and/or provided on Blackboard.
- There is no required text. A text you might like to own is *Brock Biology of Microorganisms* by Madigan and Martinko (11th or 12th Ed.). This and several other books are on reserve at the BioSciences library from which some reading assignments will be made, including:
 - *Environmental Microbiology*, by Maier, Pepper and Gerba
 - *Microbe*, by Schaechter, Ingraham and Neidhardt
 - *Microbiology*, by Bauman
 - *Biocatalysis and Biodegradation*, by Wackett and Hershberger
 - *Brock Biology of Microorganisms*, 11th edition, by Madigan and Martinko
 - *Microbial Ecology*, by Atlas and Bartha

Course goals

- Provide a comprehensive overview of the role of microorganisms in environmentally relevant processes including bioremediation of pollutants, biogeochemical cycling and wastewater treatment
- Cover up-to-date modern molecular methods for studying microbial diversity, microbial function and the impacts of microbes in the environment

Student Learning Objectives

- Understand application of microbial processes to environmental remediation
- Appreciate contribution of microorganisms to geochemical cycling
- Become familiar with methods for studying microbes in the environment
- Develop skills in reading and criticism of primary scientific literature
- Develop literature research, writing and oral presentation skills

Course format: Lectures with supporting readings from textbooks and primary scientific literature will form the knowledge base of the course. Journal articles relevant to the current topic will be assigned for critical group discussion.

Assignments: The goals of these exercises are to help develop research, writing and oral presentation/teaching skills important to success in their postgraduate scientific careers.

- *Reading questions:* When journal articles are assigned for reading and discussion, reading questions (short answer) will also be assigned which should be completed before the beginning of the discussion class period.
- *Invisible Jungle:* Practice skills in communicating science to the public by developing a short (2-min) radio story about a topic in environmental microbiology. See <http://www.invisiblejungle.com/> for more information and for sample programs. Students' stories will be submitted to Invisible Jungle for consideration for future broadcasts.
- **[B] Term paper and presentation:** All students will independently research an environmental microbiology topic of their choice, subject to instructor approval. Students will prepare a term paper in the form of a review article of 20 pages in length. Students will then deliver ~25 min oral presentations to the class near the end of the semester. Detailed instructions for papers and presentations will be provided in class. **[D]** An outline and first draft of the paper will be due prior to the final deadline. **[C]** Detailed instructor feedback will be provided at all stages in written form and through 1-2 individual conferences with students. See schedule below for relevant deadlines.

**Support for term paper:* Assistance with library research can be provided by Biosciences librarian Anne Christie (anne.christie@uaf.edu). For guidance with writing consult the Writing Center (8th floor, Gruening Bldg).

Exams: One in-class midterm and final exam will be given to all students, with questions in a variety of formats from multiple choice, fill-in-the-blank, short answer and short essay. Grading of the in-class exam will be identical for all students, however graduate students have an additional take-home written component for the midterm test.

Additional expectations for graduate students:

Graduate midterm essays: Following the midterm exam, graduate students will be assigned a take-home written test in the form of several essay questions requiring independent reading of text and primary literature and preparation of essay responses. Graduate essays require that students make use of the primary scientific literature to prepare research proposals on given

topics. This ensures that graduate students are engaged with and applying environmental microbiology at an advanced, post-graduate level.

Graduate term papers and presentations: The term paper assignment (described above) must be completed by all students, but graduate students are subject to additional expectations beyond the undergraduate assignment. Graduate student papers must select a highly focused topic on which the student can go further in-depth. Grad term papers must integrate and cite 50% more peer reviewed references in the paper over the undergraduate term papers. Grad student oral presentations will also include an additional component, in which the student assigns a paper on their topic for class reading ahead of time, then after the grad term paper presentation, the grad student leads the class in a discussion of that paper.

Journal article discussions: Journal articles will be assigned in advance of discussions and made available on Blackboard. Reading questions will also be assigned at the same time. Written responses to these questions should be completed before the beginning of the discussion class period. On discussion days, I will assign 1-2 class members to lead the discussion.

Note on written assignments: Plagiarism will result in a failing grade. Be sure to acquaint yourself with the definition of plagiarism to avoid accidental errors at <http://www.uaf.edu/library/instruction/handouts/Plagiarism.html>

Course evaluations: I welcome your positive and negative comments at any time. Opportunities to provide anonymous evaluations will be provided at the middle and end of semester.

Students with disabilities

UAF is committed to equal opportunity for all students. Students with even minor disabilities, students who are the first in their families to attempt a four-year college degree, or students whose incomes are low, have opportunities for tutorial and other forms of support from the office of Disability Services or the office of Student Support Services. If you need classroom accommodations or other support, please meet with me during office hours as soon as possible to let me know; and please make an appointment with the Office of Disability Services and Student Support Services, to enlist the appropriate support. I will collaborate to provide the appropriate accommodations and supports or services to assist you in meeting the goals of the course.

Grading Scale

(% of total course points)

A+	97 - 100
A	94 - 96.99
A-	90 - 93.99
B+	87 - 89.99
B	84 - 86.99
B-	80 - 83.99
C+	77 - 79.99
C	74 - 76.99
C-	70 - 73.99

D	50 - 69.99
F	< 50

Late policy:

Assignments turned in after the deadline will have 5% of the total possible points deducted per day it is late. Exceptions may be made in the case of excused absences due to documented family/medical or other reasons or when arrangements have been made with instructor in advance. In general, when an absence is anticipated due to travel or other conflicts, work should be turned in ahead of time.

Activity	Number of assignments	Points per assignment	Total	A Written-intensive work
UNDERGRADUATES				
Midterm	1	100	100	100
Final	1	100	100	100
Term paper				
Term paper outline	1	10	10	10
Term paper draft	1	50	50	50
Term paper final draft	1	100	100	100
Oral presentation	1	30	30	
Invisible Jungle radio story	1	20	20	
Reading questions	4	10	40	40
Discussion participation	1	50	50	
		Total (Undergraduates)	500	400
GRADUATE STUDENTS				
Midterm	1	100	100	100
Midterm take-home essays	1	100	100	100
Final	1	100	100	100
Term paper				
Term paper outline	1	10	10	10
Term paper draft	1	50	50	50
Term paper final draft	1	100	100	100
Oral presentation	1	30	30	
Invisible Jungle radio story	1	20	20	
Reading questions	4	10	40	40
Discussion participation	1	50	50	
		Total (Graduates)	600	500

[A] Note (highlighted above) that written-intensive work comprises the majority of the grade for this class.

Environmental Microbiology- Tentative schedule. Subject to change. Additional reading assignments will be made during the semester from journal articles, material posted on blackboard or on reserve in the BioSciences library.

Day	Date	Lecture topic	Reading assignment	Assignments due
FUNDAMENTALS OF MICROBIOLOGY				
R	9/1/11	Syllabus, Introductions, Overview of Microbial Diversity	Brock (12th Ed) Chapter 1 Section I, Chapter 2 Section III	
T	9/6/11	Microbial Cell Structure and Function Review		
R	9/8/11	Microbial Species Concept, Identifying Microbes	Rosello-Mora 2001 FEMS Microbiology Reviews 25:39-67	
T	9/13/11	Fueling the microbial cell	Bauman p 125-150, Chapter 6 in <i>Microbe</i>	
BIOGEOCHEMICAL CYCLING				
R	9/15/11	Term paper guidelines, diagnostic writing assignment		
T	9/20/11	Carbon cycling	Brock Chapter 24 Section I	Deadline for term paper topic approval
R	9/22/11	Discussion	Journal articles TBA	Reading questions
T	9/27/11	N cycling	Brock 24 Section II, Journal articles TBA	
R	9/29/11	In-class small group assignment		Reading questions
T	10/4/11	Sulfur cycling, Geochemical cycles gone wild	Maier 14.4, Maier Chapter 15	
R	10/6/11	Winogradsky column exercise		
T	10/11/11	MIDTERM EXAM		
BIOREMEDIATION				
R	10/13/11	Organic contaminants, policy, evolution of biodegradative pathways	Chapter 16 Maier, Wackett Chapter 7	Grad student exam essay responses due
T	10/18/11	Aromatic pollutants, crude oil	Chapter 16 Maier, Wackett Chapter 7	Term paper outlines due
R	10/20/11	Methods for studying organic contaminant degraders		
T	10/25/11	Discussion	Journal articles TBA - Deepwater horizon papers	Reading questions
R	10/27/11	Aerobic PCB degradation	Journal articles TBA	
T	11/1/11	Anaerobic degradation of organic and halogenated contaminants		
R	11/3/11	Discussion	Journal articles TBA	Reading questions
T	11/8/11	Guest lecturers from Alaska Department of Environmental Conservation (tentative date)		Term papers drafts due
R	11/10/11	Metal transformations, Bioremediation of uranium	Maier Chapter 17, Wall and Krumholz. 2006. Annu. Rev. Microbiol.60:149-166	

WASTEWATER TREATMENT				
T	11/15/11	Wastewater treatment, Invisible Jungle draft presentations	Brock Chapter 36	Invisible Jungle drafts (in class)
R	11/17/11	Field trip to wastewater treatment plant (tentative date)		
SPECIAL TOPICS: STUDENT PRESENTATIONS				
T	11/22/11	Student term paper oral presentations		
R	11/24/11	NO CLASS - THANKSGIVING HOLIDAY		
T	11/29/11	Student term paper oral presentations		
R	12/1/11	Student term paper oral presentations		Final term papers due
T	12/6/11	Student term paper oral presentations		
R	12/8/11	Student presentations, final Invisible Jungle stories		
R	12/15/11	FINAL EXAM 8:00-10:00 am		