

BIOL498U/685A: Environmental Microbiology

Winter 2012 • Tuesday & Thursday 11:45-13:00 in CC301

Instructor

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Course Description: We live in a microbial world. There are billions of times more microbes on Earth than stars in the universe and microbial metabolisms are critical to the maintenance of life on our planet. The objective of this course is to provide an overview of microbial diversity and ecophysiology with special emphasis on how the activities and interactions of micro-organisms influence biological systems ranging from humans to the planet as a whole. Special emphasis will be placed on aquatic ecosystems and the microbiology of the ocean. The course structure will consist mainly of lectures. However, students will be required to summarize the findings of a research article by both oral presentation as well as by written assignments (detailed below). Students are expected to have a strong background understanding of molecular biology, biochemistry, genetics, and the general structure and function of cells and their components.

Course Topics

01. *Significance and History of Environmental Microbiology*
02. *Microbial Diversity and Systematics*
03. *The Environment and Microbial Habitats*
04. *Metabolic Diversity and Ecophysiology*
05. *Origins of Life and Formation of the Biosphere*
06. *Global Processes - The Carbon Cycle*
07. *Nutrient Cycles - Nitrogen, Sulfur, and Phosphorous*
08. *Microbe-Microbe Interactions and Ecological Principles*
09. *Symbiotic Associations with Plants and Animals*
10. *Applied Environmental Microbiology*

Suggested Textbook: Madigan *et al.* Brock Biology of Microorganisms, 12th edition. The textbook is not required but strongly suggested, as it is a great reference for many fundamental concepts in environmental microbiology and will be a very useful source of information. The course will follow certain sections of Brock (see sections below), but is also developed from the primary scientific literature. Lecture material (*i.e.* power point slides) will be made available at the Moodle site prior to the beginning of each lecture.

Office Hours: Office hours with Dr. Walsh are held in GE 330.17 on Wednesdays at 10:00-12:00. Alternatively, please schedule an appointment if you wish to discuss the course outside of these hours.

Student Evaluation

20%	Midterm exam	15%	Participation (including written assignments)
15%	Student presentation	50%	Final exam

Class	Date	Section	Associated Sections in Brock
01	Jan 03	Course introduction	
02	Jan 05	History of microbiology	1.6-1.10
03	Jan 10	Microbial diversity and	2.1-2.11, 4.1-4.8, 14.10-14.14
04	Jan 12	systematics	
05	Jan 17	The environment and	23.6-23.10
06	Jan 19	microbial habitats	
07	Jan 24	Nutrition and	5.1-5-18
08	Jan 26	metabolism	
09	Jan 31	Microbial growth and	6.1-6.18
10	Feb 02	cultivation	
11	Feb 07	Microbial locomotion	4.13-4.15, 9.6-9.7
12	Feb 09	and behavior	
13	Feb 14	Oxygen depletion	
14	Feb 16	MIDTERM EXAM	
	Feb 21	<i>Reading break</i>	
	Feb 23		
15	Feb 28	Origins of life	14.1-14.4
16	Mar 01	Evolution and genomics	14.5-14.9, 13.1-13.14
17	Mar 06	Nutrient cycling and	20.1-20.15, 21.1- 21-19, 24.1-24.5
18	Mar 08	metabolic diversity	
19	Mar 13		
20	Mar 15	Microbial loop	
21	Mar 20	Microbe-microbe	23.1-23.5
22	Mar 22	interactions	
23	Mar 27	Symbiosis with plants	24.10-24.15, 28.1-28.5
24	Mar 29	and animals	
25	Apr 01	Applied environmental	24.6-24.9
26	Apr 03	microbiology	

Plagiarism: The most common offense under the Academic Code of Conduct is plagiarism, which the Code defines as “**the presentation of the work of another person as one’s own or without proper acknowledgement.**” This could be material copied word for word from books, journals, internet sites, professor’s course notes, etc. It could be material that is paraphrased but closely resembles the original source. It could be the work of a fellow student, for example, an answer on a quiz, data for a lab report, a paper or assignment completed by another student. It might be a paper purchased through one of the many available sources. Plagiarism does not refer to words alone - it can also refer to copying images, graphs, tables, and ideas. “Presentation” is not limited to written work. It also includes oral presentations, computer assignments and artistic works. Finally, if you translate the work of another person into French or English and do not cite the source, this is also plagiarism. In Simple Words: ***Do not copy, paraphrase or translate anything from anywhere without saying where you obtained it!***

Oral presentations (498U students only)

A collection of ten “special topics” in environmental microbiology have been selected for student presentations. These topics cover some of the more recent and ground breaking research that has occurred in the related fields of environmental microbiology, microbial ecology and evolution. In week three, students will begin presenting the research articles **at the beginning of class**. The presentations will build upon the lecture material covered the week prior to the scheduled presentations, providing ample time to understand and prepare for the specific presentations. A list of special topics and the associated research articles are posted at the Moodle site and included below. Students are asked to review the topics, select one of interest, and then sign up for the topic on the sheet posted outside Dr. Walsh’s office in GE330.17. **Please sign up no later than 10-Jan-2012**. Students will also be required to work in pairs. Sign up early to ensure you get the topic that most interests you!

The presenters: Students will work in pairs to present the findings of a recent research article. We will have two presentations once a week at the beginning of class starting 19-Jan-2012. Student presentations will be 15 minutes in length, followed by a 5 minute question/discussion period.

Preparing the presentation: Students are strongly encouraged to visit Dr. Walsh’s office for help and input as they prepare their presentations. The content of the oral presentation should be as follows:

- 01. Introduction of the topic:* Concisely present the background information that frames the current research article and the question/problem being examined. Most of this information will be referenced in the introduction of your paper. **Read some of these key references to increase your familiarity with the topic** and use NCBI pubmed to explore the topic more thoroughly. Be sure to describe the goal/objective of the research.
- 02. The methodology:* Provide an adequate description of the methods such that the results can be properly understood and interpreted. Given the time constraint, you do not need to present a detailed description, only a general overview.
- 03. The results:* This is the most important part of the research and your presentation. Clearly and logically present a summary of the major findings of the research article. **If nothing else, get the results right!** Pay special attention to the order in which the results are presented in the article as they are most likely presented in a logical manner, the latter building on the former.
- 04. The discussion and conclusions:* This is typically the most interesting part of the research article (and your presentation), because it is where the results are interpreted and their impact on our state of knowledge is presented. Be sure to point out the major strength and weakness of the study. Also, many of the selected research articles were published a few years ago, therefore certain questions raised in the discussion of your paper may have already been addressed in the literature. Don’t be afraid to investigate the impact of your research article by looking for additional articles where it has been referenced. Science is a continuum!

The audience and written summaries (498U/685A students): All students are expected to have read the research articles prior to class. In addition, each student will be assigned a total of 3 papers over the course of the semester for which they will be required to summarize and critique in written format. Papers for written summaries will be assigned once students have signed up for their oral presentations. The written summaries are expected to be between 400-600 words in length. The content of the written summaries should be the same as for the oral presentations (see above). The summaries are due prior to the oral presentation of the research article. Late assignments will be docked by 50%.

Written minireviews (685A students only)

Graduate students will not be required to present a research article orally, but instead will be asked to compose a written minireview of a special topic that is of particular interest to them. This will allow students to explore a topic more deeply. The review should be focused and concise, can be somewhat speculative, and should suggest potential new lines of experimentation. There will be no strict format for the review, however it is suggested that students follow the general format for Minireviews published in the journal *Environmental Microbiology*. These short reviews consist of a Summary, Introduction and Concluding Remarks, which bracket the main text. See the following website for examples: [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1462-2920/homepage/minireviews.htm](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1462-2920/homepage/minireviews.htm)

Preparing the review: In preparing the review article, graduate students are **STRONGLY** encouraged to meet with Dr. Walsh for help and input. You should think of this as a publication quality review. In general, the review article should be prepared in the following stages (feel free to use Dr. Walsh as a critical reviewer of your work at any time in the process):

01. *Selection of the topic:* Students can either review a topic closely aligned with their thesis project OR take this opportunity to explore an additional topic of interest outside of their current area of training. It is suggested that students select a topic and inform Dr. Walsh within the first three weeks of the course.
02. *Outline and organization of key references:* A good place to start when reviewing a topic is to construct a 1-2 page outline (point form) of the main sections of the review. Also organizing the key references in the order in which you'd like to introduce them can help frame the review.
03. *First written draft:* From a solid outline, it can be reasonably simple to create the first draft of the review. Have other students or researchers in your lab read your first draft for comments. At this point what is important is the content of the review and that the ideas are presented in a logical manner. It doesn't have to sound pretty yet!
04. *Final written draft:* After incorporating the comments of others, you are now ready to finalize the draft. Be sure your grammar, spelling, and references are correct.

Special topics for oral presentations

01. Microbial diversity of the human body – 19-Jan-2012

- 1a. Ley et al. (2005) *Obesity alters gut microbial ecology*. PNAS.
- 1b. Costello et al. (2009) *Bacterial community variation in human body habitats across space and time*. Science.

02. Genome diversity and ecological adaptation – 26-Jan-2012

- 2a. Welch et al. (2002) *Extensive mosaic structure revealed by the complete genome sequence of uropathogenic Escherichia coli*. PNAS.
- 2b. Hunt et al. (2008) *Resource Partitioning and Sympatric Differentiation Among Closely Related Bacterioplankton*. Science.

03. Metagenomics and lateral gene transfer – 02-Feb-2012

- 3a. Martinez et al. (2007) *Proteorhodopsin photosystem gene expression enables photophosphorylation in a heterologous host*. PNAS.
- 3b. Hehemann et al. (2010) *Transfer of carbohydrate-active enzymes from marine bacteria to Japanese gut microbiota*. Nature.

04. Cultivation strategies and the taming of wild microbes – 09-Feb-2012

- 4a. Bryant et al. (2007) *Candidatus Chloracidobacterium thermophilum: An Aerobic Phototrophic Acidobacterium*. Science.
- 4b. Lehtovirta-Morley et al (2011). *Cultivation of an obligate acidophilic ammonia oxidizer from a nitrifying acid soil*. PNAS.

MIDTERM EXAM followed by READING BREAK

05. Where's my lunch? Chemotactic behavior in bacteria – 28-Feb-2012

- 5a. Stocker et al. (2008) *Rapid chemotactic response enables marine bacteria to exploit ephemeral microscale nutrient patches*. PNAS
- 5b. Oleksiuk et al. (2011) *Thermal Robustness of Signaling in Bacterial Chemotaxis*. Cell

06. Experimental studies in microbial diversification – 06-Mar-2012

- 6a. Lee et al. (2010). *Bacterial charity work leads to population-wide resistance*. Nature
- 6b. Beaumont et al. (2009) *Experimental evolution of bet hedging*. Nature.

07. Carbon cycling in the deep ocean – 13-Mar-2012

- 7a. Hansman et al (2009). *The radiocarbon signature of microorganisms in the mesopelagic ocean*. PNAS.
- 7b. Swan et al. (2011) *Potential for Chemolithoautotrophy Among Ubiquitous Bacteria Lineages in the Dark Ocean*. Science.

08. Novel metabolic pathways and their biogeochemical implications – 20-Mar-2012

- 8a. Ettwig et al. (2010) *Nitrite-driven anaerobic methane oxidation by oxygenic bacteria*. Nature.
- 8b. Canfield et al. (2010) *A Cryptic Sulfur Cycle in Oxygen-Minimum-Zone Waters off the Chilean Coast*. Science.

09. Photosynthesis genes in marine viruses – 27-Mar-2012

9a. Lindell et al. (2005) *Photosynthesis genes in marine viruses yield proteins during host infection*. Nature.

9b. Thompson et al. (2011) *Phage auxiliary metabolic genes and the redirection of cyanobacterial host carbon metabolism*. PNAS.

10. Predicting patterns of microbial diversity – 01-Apr-2012

10a. Follows et al. (2007) *Emergent Biogeography of Microbial Communities in a Model Ocean*. Science.

10b. Faith et al. (2011) *Predicting a Human Gut Microbiota's Response to Diet in Gnotobiotic Mice*. Science.