Microbial Ecology and Evolution, GEN713/813 "MicroPopBio" University of New Hampshire

2012 Syllabus

About

This is Microbial Ecology and Evolution, Genetics 713/813, at the University of New Hampshire.

Where/When?

Lectures will be held in SLS G16

Laboratories and Recitations will be held in Rudman G40

The instructor is:

Vaughn Cooper, Associate Professor of Microbiology and Genetics

Office phone: 603-862-3422, but email is better. Office hours are Mondays 2-4.

OBJECTIVES

1) To comprehend the breadth of the fields of microbial evolution, ecology, and community ecology, and their practical/social relevance

2) To continue to learn to write and think critically as a scientist

3) To become an adept consumer and critic of contemporary science literature, and to participate in its discourse, using modern social network methods

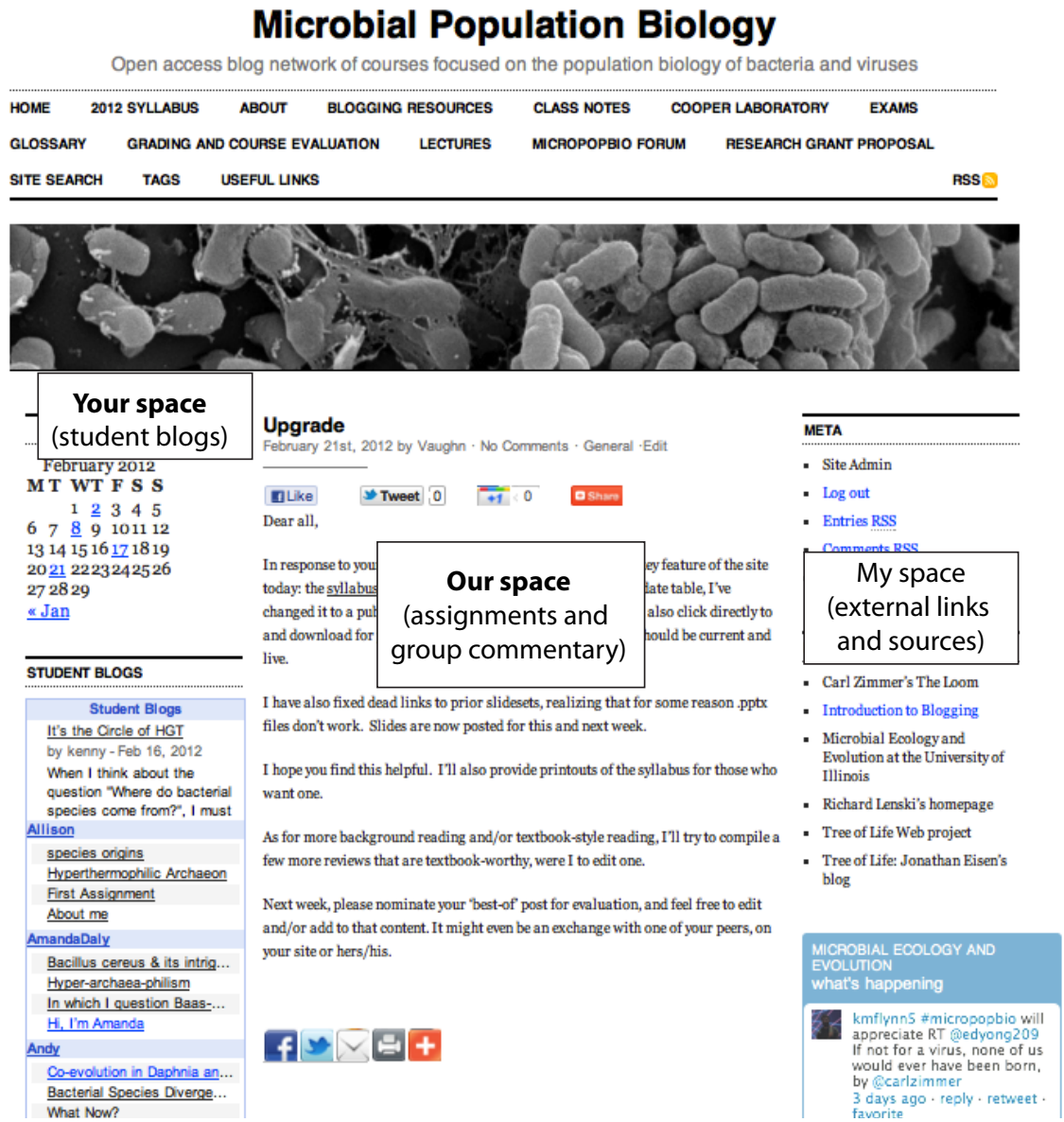
4) To understand that microbiology is fundamentally about large populations and/or communities of [small] organisms, and its implications on microbial evolution and ecology. Thus, to become a skilled "population thinker"

5) To learn how microbial populations can be models for testing evolutionary and ecological theory

6) To become proficient in the modern genome technology that drives much of this field

7) To collaborate and interact critically with your peers over this subject matter; to inspire others by your creativity.

HOW THIS CLASS WORKS:

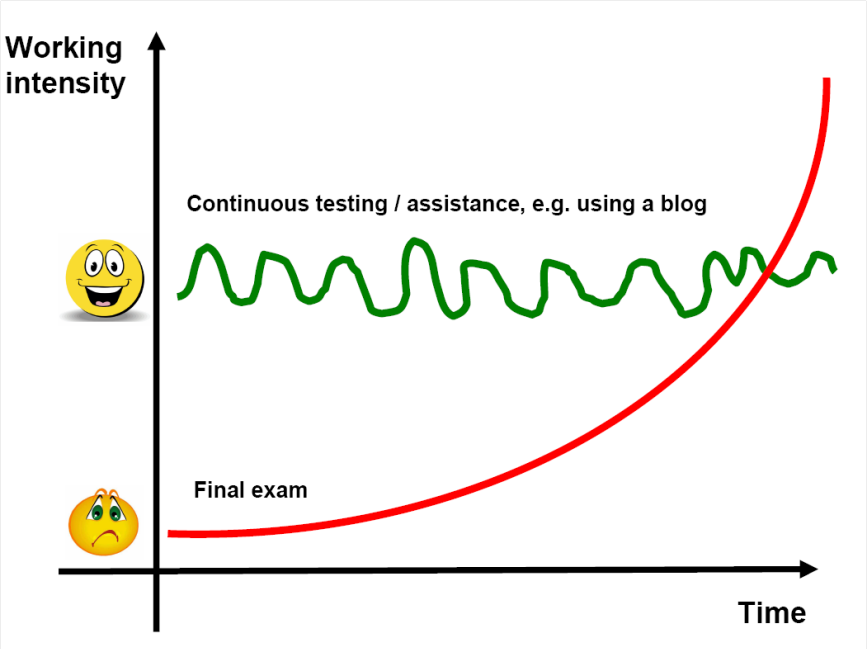


1. Each student is assigned their own blog (left), which is theirs to personalize and serve as a public journal of their work related to this course. The major goal is to facilitate exchange among students as well as with the faculty, to break down barriers inherent to the interdisciplinary nature of this material and the varied background of the students. Each student is encouraged to respond to class assignments in their own way, both teaching and learning from peers.

2. The course is OPEN-ACCESS, with all materials freely distributed. It also uses social media to distribute information and alert everyone of news in this field

3. The course also encourages students to become active participants in scientific dialogue, both as reviewers and as producers of new material.

WHY WE USE BLOGS:



In using blogs, students are constantly engaged with the material and encouraged to revisit their past writing. This facilitates steady progression rather than erratic "boom and bust" work habits. It also encourages collaboration (below)

Encouraging collaboration

From a single student essay…

Borg
Theory of Bacterial Systematics

From Aristotle, Linneaus, Darwin, Mayr to Hennig to…….Cohan? Ideas on the fundamental "units" of the biological organization of individuals.

Let's forget the word "species or "populations" for a second and just consider that all individual organisms have a definable relationship to one and other. We all share common ancestry; you, me, the tuna fish you ate for lunch, the bacteria that was in the mayonaisse and one of those Sulfolobus cells from Kamchatka (thanks Darwin). But we can group each other according to similarity (thanks Linneaus), which turns out to be an indirect, but generally good measure of relatedness (Darwin again). When individuals over time are trading, sharing, swapping DNA, we see that those individuals are inescapably part of a collective meta-individual, a kind of amorphous borg (http://en.wikipedia.org/wiki/Borg_(Star_Trek)). We can call these meta-individuals species, populations, sub-populations, meta-populations, whatever depending on the magnitude and frequency of exchange and relatedness. But, cohesion within these meta-individuals depends purely and simply on DNA exchange, without

…to a collaborative conversation

laura Says:
February 17th, 2008 at 3:28 pm edit

Abe,
I enjoyed reading what you've written about the 'borg.' I have a hard time swallowing this whole thing about ecotypes. It would seem that looking at the genetics will best help determine relatedness of individuals; but, even if they started with the same genetic material, what do we call them when they've acquired so much of another group's genetic material through HGT that they are now more different from their ancestor? I guess that is unlikely, but they could acquire enough new DNA to now be functionally different, which I guess goes back to the ecotype classification. In that sense, they would be two different ecotypes. Aaaarg!

dan Says:
February 18th, 2008 at 7:58 pm edit

Something that helped me understand this bacterial systematics we've been discussing occurred during my Prokaryotic Genetics class. While we were studying for the first exam, I asked for clarification between a strain and a variant. Before she answered, my view of a strain was defined as a subset of the species - just one more rung on the taxanomic ladder.

It turns out that it is never assumed that similar bacterial isolates could be derived from the exact same bacteria. The letters and numbers following a bacterial species, i.e. E. coli 0157:H7, designate a similar but not necessarily identical isolate of the bacterium. Cheryl Whistler, our instructor, used V. fischeri to illustrate the example. A new strain ID is assigned to each new V. fischeri isolated from its host: a small squid that uses the bacteria to

BASIC EVALUATIVE STRUCTURE (GRADING)

1. Blogging and discussion of readings (40%), reports of lab on your blog
2. Two exams (30%)
3. Research paper (30%)
4. General Participation (max 10% extra credit)

This course is writing intensive.

Let me first say that I want this class to be an enjoyable adventure for us all. A class like this, filled with new modes of science, demands a new mode of learning. Above all, it demands conversation, interaction, creativity, and reflection. We must all commit to engage, critique, praise, and build upon the material we see, read, and create.

This webpage and its embedded blogs are central to the course. Each of you will have your own blog that represents a major part of your interaction with me and with one another. More importantly, you will all be able to read each other's blog entries, and you should plan on doing so. Following each assigned reading, you will reflect and respond on your blog. Some weeks, rather than focusing on new material, you will write in response to your classmates' ideas to continue the conversation. Most importantly, the blog is **yours**. Be creative, be provocative, be critical, be humorous.
Three times this semester (**TBA**), you will decide which of your blog entries represent your best work and you will highlight them to be evaluated. You can even write a separate entry explaining why they're your best work. These evaluations, combined with your weekly contributions to our discussions in class and in recitations or labs, and your write-up of your laboratory (on your blog) will be worth **40%** of your grade.

Twice this semester, on **Thursday, March 8, 2012**, and on **Tuesday, April 24, 2012**, we will have a cumulative, in-class exam to evaluate your comprehension of the material. It will be open-book and -blog. It will be worth **30%** of your grade.
Finally, you will, either as solo agents or as cooperative pairs, spend the semester developing a compelling grant proposal on any subject relevant to microbial population biology that is enlightened by population thinking. You will have multiple occasions to develop your ideas and receive formal criticism on a draft. It will be due on the last day of class, in class, and will be worth **30%** of your grade.

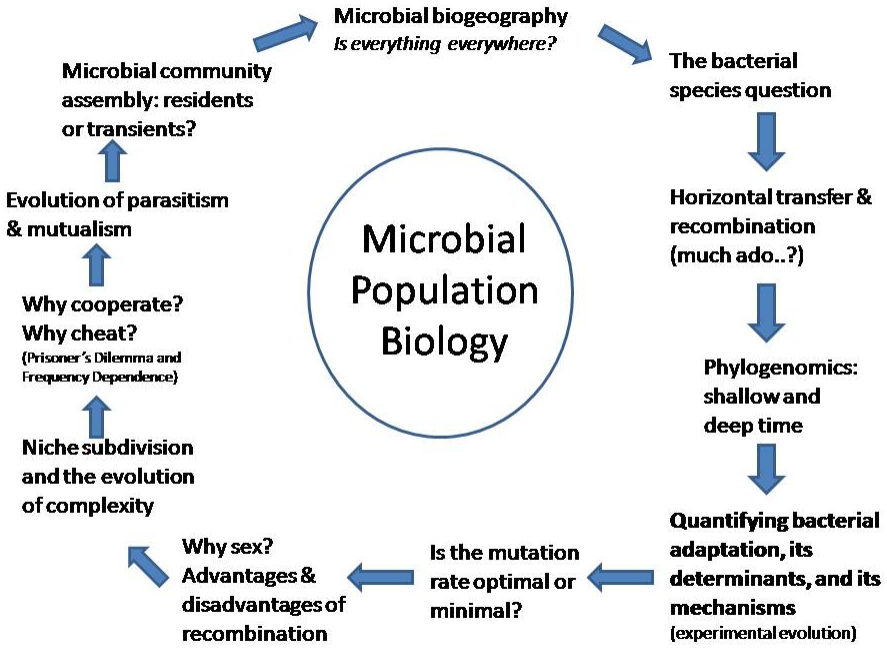
Some standard disclaimers and announcements:

SPECIAL REQUIREMENTS: If you are a student with a documented disability who will require accommodations in this course, please register with the Access Office in the Memorial Union Building, Room 118 (862-2607) for assistance in developing a plan to address your academic needs.

CLASS ATTENDANCE: For an upper-level course, this notice shouldn't be required, but here goes: ATTEND CLASS. You won't do well in this course without regular attendance and vocal participation.

GENERAL SUBJECTS

The overall flow of the class is as follows:



MICROPOPBIO CENTRAL QUESTIONS:

1. True or False: "Everything is everywhere; the environment selects."
2. What is a microbial species and why might they exist?
3. How important is horizontal gene transfer (HGT) in microbial evolution?
4. How do we construct the best models of evolutionary relationships among organisms?
5. What are the effects of chance, history, and adaptation on microbial evolution?

6. How do bacteria elude the “competitive exclusion principle” and shape their own niches?
7. In a given environment, how does immigration affect microbial diversity and diversification?
8. What are the consequences of adaptation to a constant environment?
9. Is the mutation rate minimal or optimal?
10. Why sex?
11. Why cooperate? Why cheat?
12. Why are some pathogens so virulent, and others so mild?
13. What are the optimal life-history strategies for pathogens under various transmission regimes?
14. What happens when the life history of a symbiont (parasites or commensals) becomes increasingly dependent on a host organism?
15. What fraction of human microbial commensals is stuck with us, and what fraction is just hitching a ride?
16. What differentiates probiotics from pathogens?
17. How stable is the structure of microbial communities, in general?
18. What rules govern the assemblage of microbial communities, and are they the same as for macroscopic eukaryotes?’
19. How many prokaryotic species are there really out there?

Course schedule

The specific course schedule is subject to frequent update, and hence is posted as a public Google Docs spreadsheet, here:

Google Doc syllabus

A snapshot of the current spreadsheet is posted on the next page:

Course schedule							
Class #	**Date**	**Lecture #**	**General topic**	**Specific topic**	**Reading**	**Recitation**	**Blog**
1	1/24/2012		no lecture				
2	1/26/2012	1,2	Intro, course mechanics,Microbial diversity	Is everything everywhere?	cho and tiedje 2000		Johnson, Chisholm et al
3	1/31/2012	3	Cooper lab research	biofilms, by Chuck Traverse et al.	Poltak and Cooper 2010		
4	2/2/2012	4	Defining bacterial species	Species-area relationships, island biogeography	Whitaker archaea biogeography	whitaker recombination sulfolobus mbe2006	whitaker SOM
5	2/7/2012	4	Defining bacterial species	Classification criteria	cohan perry current biology 2007		
6	2/9/2012		Defining bacterial species	Molecular and physiological methods	eBURST manual	MLST lab	
7	2/14/2012	5	Defining bacterial species	Horizontal genetic transfer, phylogenomics	ochman et al pnas, hgt and species concepts	Supplemental	
8	2/16/2012	6	Speciation and genomics	Bacterial speciation and genomics, a personal history	Link to "love the one you're with" pending	Discuss each other's examples of bacterial speciation	
9	2/21/2012	7	Adaptation	Experimental evolution	chapter of mine for reference		
10	2/23/2012	8	Adaptation	Rewinding life's tape	travisano et al 1995 science	How chance and history affect evolution (deconstruct the reading)	What macroevolutionary phenomenon would you like to test with microbes?
11	2/28/2012	9	Adaptation	Limits to adaptation: mutation supply	taddei mutator science mouse		
12	3/1/2012		Speciation	Adaptive radiation, immigration and diversity	rainey and travisano nature	Build your own adaptive radiation, design	What do these models mean for how microbial communities are constructed?
13	3/6/2012		Speciation	The paradox of the plankton	Death and cannibalism: Rozen et al		
	3/8/2012		Exam 1			none	
	3/13/2012		Spring Break				
	3/15/2012		Spring Break				
14	3/20/2012		Evolution of community complexity				
14	3/22/2012		Why sex?	Testing Fisher-Muller	Tim Cooper, PLoS	Build your own adaptive radiation (take III). Grant proposal workshop.	
17	3/27/2012		Cooperation and cheating	Prisoner's Dilemma and Game theory	Turner and Chao PD in an RNA virus		
18	3/29/2012		Cooperation and cheating	Quorum sensing, group behavior. Myxococcus xanthus behavioral evolution	The background: http://www.pnas.org/content/95/21/12376	Continue labs on own.	
19	4/3/2012		Cooperation and cheating	Mechanisms of myxo evolution	Resequencing to find adaptive mutations that alter behavior: velicer-pnas-px.pdf		
20	4/5/2012		Evolution of virulence	Why are some parasites mild and others severe?		Choose 1 of the following:1. velicer-et-al-nature-2000.pdf 2. velicer-and-yu-2003-nature.pdf 3. velicer-plos-2005.pdf 4. velicer-nature-2006.pdf	
21	4/10/2012		Evolution of virulence	Specific examples	Please find an article from the literature that addresses this question in some way, uses "population thinking" and specifically addresses how/why virulence evolves.		
22	4/12/2012		Host associated communities	Human microbiota	The Human Microbiome ProjectSupplemental: the role of microbes in obesity	Science Friday program or any article from a PubMed search on "Gordon JI"(you choose)	
23	4/17/2012		Host associated communities	Animal microbiota and transplants	From mouse to zebrafish and vice versa	Supp methods for this paper	
24	4/19/2012		Rules of community assembly			Sargasso Sea:Global Ocean Survey:http://collections.plos.org/plosbiology/gos-2007.php	
25	4/24/2012		Exam 2				
26	4/26/2012		Practical micropopbio	Bioprospecting			
27	5/1/2012		Grant proposals				
28	5/3/2012		Grant proposals				