Microbial Ecology (EEB446)

Instructor: Prof. Vincent Denef (734-764-6481 / vdenef@umich.edu)

Lecture location and time: Tuesday and Thursday, 10-11:30am; 3733 CCRB

Workshops: Tue 09/24, Thu 09/26, Thu 10/03: 10:00am - 11:30am [Mac computer classroom, such as Angell Hall Classroom C]

Office Hours: Monday, 10am - noon (1141 Kraus Natural Science Building) or by appointment.

Prerequisites: Introductory Microbiology (BIO 207 or the equivalent) and one 300 level biology course; Microbial diversity (EEB470) and general ecology (EEB281/381) are recommended.

Course objective/goals: A greater focus on the microbial component of the biosphere is warranted, since 'microbes run the world'. If we are to build comprehensive and predictive models for ecosystems important to environmental and human health, we need a better understanding of how microbial communities assemble and operate. An emphasis is placed on Bacteria, Archaea, and their viruses. This course will cover the ecology of microbes by highlighting their interactions with each other and the environment, and will present the latest insights into their role in ecosystems ranging from thawing permafrost to the human gastrointestinal tract. Ecological and evolutionary concepts and tools used in microbial research, including novel "omics" techniques, will be introduced. The course also aims at uncovering how concepts developed in plant and animal ecology do and do not translate to the microbial world.

Intended audience: This class is intended for juniors and seniors in Program in Biology concentrations, in particular Microbiology (class is in Group I: Microbial Genetics, Physiology, Cellular Biology, Diversity, and Ecology), Ecology and Evolutionary Biology, General Biology. Graduate students (Masters and PhD) in the EEB program, as well as in Environmental Engineering, The School of Public Health, the Medical School, School of Natural Resources and the Environment, and Earth and Environmental Sciences are welcome as well. This course is intended for students interested in learning more about the principles of how microbial life is shaped by and shapes the environment, about the latest genomics-based techniques that allow us to gather insights into the ecology of the unseen majority of the biosphere, and about the latest research insights in the area of microbial ecology and evolution.

Required reading: There is currently no comprehensive textbook available to support a microbial ecology class. Required readings include all papers posted on the course's website and handouts. Additional readings will be distributed throughout the course.

Independent project: Part of the grade will be based on an independent project, carried out individually or in groups, depending on enrollment. Students will develop a concept from plant / animal ecology in the microbial field, written as a short research proposal, and presented during the last week of classes. The week after Fall break we will have a class session based on the first summary page (Specific aims) of their proposals. One-on-one discussions will be held where the students explain their research question to other student and critique their fellow students specific aims.

Grading: 15% Midterm
30% Final (comprehensive)
Exams will be short answer and essay style questions that develop and synthesize information from lectures and reading.
10% Discussions: part on participation and part on written assignments (a short opinion piece based on the debate, questions/answers submitted for the paper discussion classes).
5% Guest lectures: based on questions to lecturer
10% Problem sets for the computer labs.
30% Independent project (1/3 on written, 1/3 on oral presentation, 1/6 on questions, 1/6 on mid-term discussion).

Academic Integrity: UM guidelines apply to all aspects of EEB401. For information, see the UM web site – http://www.lib.umich.edu/academic-integrity

While effort has been made to make this syllabus an accurate reflection of what this course will cover, changes to its content are possible throughout the semester.

	Tue	**Thu**
Week 1	Sep 3: Introduction + start Discussion: The role of ecological theory in microbial ecology **[Assignments: Short essay due Sep 10 – not graded // Prepare for discussion by addressing questions posed in class (upload to ctools prior to Sep 5 class)]**	Sep 5: Paper Discussion: The role of ecological theory in microbial ecology **[Read: Prosser 2007; Jessup, 2004** to help address q's Class 1] + Microbial diversity inside the tree of life: bacteria, archaea, and eukaryotes **[Read: Pace, 2006]**
Week 2	Sep 10: Evolutionary processes I (including species concept introduction) **[Read: Vos, 2008; Barrick, 2012]**	Sep 12: Microbial diversity outside the tree of life: viruses and mobile genetic elements / Evolutionary processes II (lateral gene transfer) **[Read: Raoult, 2008; Doolittle, 2000; Polz, 2013 - suggested]**
Week 3	Sep 17: Debate: microbial species concepts **[Assignment: opinion due Sep 24] [Read: pro or contra species concept readings by group]**	Sep 19: Methods in microbial ecology I: marker genes (includes diversity concepts) **[Read: Baum, 2005; Schloss, 2007; Prosser, 2012 (suggested)]**
Week 4	Sep 24: Workshop – computational analyses in microbial ecology: molecular markers I {computer lab} **[Read: Schloss, 2009; tutorial instructions]**	Sep 26: Workshop – computational analyses in microbial ecology: molecular markers II {computer lab} **[Assignment: problem set due Oct 3]**
Week 5	Oct 1: Methods in microbial ecology II: omics **[Read: Tyson, 2008; Muller 2013]**	Oct 3: Workshop – computational analyses in microbial ecology: metagenomics {computer lab} **[Assignment: problem set due Oct 10]**

Week 6	Oct 8: From populations to ecosystems **[Read: Loreau, 2010, Chapter I; Treseder, 2012 - suggested]**	Oct 10: Methods in microbial ecology III: linking microbes to process **[Read: Orphan, 2009; Musat, 2008 - suggested]**
Week 7	Oct 15: Fall study break	Oct 17: Review
Week 8	Oct 22: Mid-term exam	Oct 24: Discussion based on specific aims independent project **[Pre-class assignment: specific aims section ready, version for grading due Oct 31][Read: Prosser 2010; Lennon, 2011]**
Week 9	Oct 29: Microbial communities I: bottom-up controls (includes competition, niche theory) **[Read: Tilman, 1982, p. 349-356; Chesson, 2000, p. 343-348]**	Oct 31: Guest lecture: Current research in aquatic microbial ecology **[Dr. Anita Narwani, Read: Narwan, in press?]**
Week 10	Nov 5: Microbial communities II: top-down controls **[Read: Pernthaler, 2005; Rodriguez-Valera, 2009]**	Nov 7: Paper discussion: Current research in microbial ecology of engineered systems **[Read: Wittebolle, 2009]**
Week 11	Nov 12: Microbial communities III: resistance, resilience, and succession **[Read: Shade, 2012]**	Nov 14: Current research in terrestrial microbial ecology **[Prof. Tom Schmidt [read: Levine, 2011?]**
Week 12	Nov 19: Microbial Evolutionary Ecology **[Read: Schoener, 2011; Lau and Lennon, 2012**	Nov 21: Paper discussion: microbial biogeography **[Read: Hughes, 2006; Hanson, 2012]**
Week 13	Nov 26: Sociomicrobiology and symbiosis **[Read: Moran, curr Biol; West, 2007] [Due date written proposals]**	Nov 28: Thanksgiving
Week 14	Dec 3: Guest Lecture: Current research in host-associated microbial ecology **[Prof. Paul Dunlap; Read:]**	Dec 5: Student project presentations I
Week 15	Dec 10: Student project presentations II	Dec 12: Review
Week 16	Exam week	Exam week