

**MICROBIAL DIVERSITY**  
**PLP 329A/MIC 329A/ECOL 329A**

**Tuesdays and Thursdays, 12:30-1:45pm**  
**405 Chavez**  
**Spring • 2009**



Course description: Microbial Diversity is a three-unit lecture course offered to students in with an interest in the remarkable genetic, species-level, physiological, phylogenetic, functional, and ecological diversity of prokaryotic and eukaryotic microorganisms.

Underlying principle: Microorganisms -- including viruses, bacteria, archaea, and microbial eukaryotes -- represent the vast majority of Earth's biodiversity, but are the least-studied organisms in almost every ecosystem. Critical as pathogens, parasites, mutualists, decomposers, nutrient cyclers, bioremediators, and model systems, microbes represent many unique and remarkable branches on the tree of life. This course is designed for undergraduate students interested in understanding the basic principles and interactions of microbial organisms, their biodiversity, and their often cryptic but critical roles in ecology at scales ranging from individual cells to the planet as a whole. The study of microbial diversity is perhaps more exciting now than ever before -- new tools, new methods, and newly interdisciplinary approaches are setting the stage for rapid growth in this field, and for broad applications of the material covered in this course to medicine, industry, agriculture, and the study of evolutionary biology.

Major topics: I. *Microbial diversity: genes, species, -omics, and functions:* the structure of, and inference of, the microbial tree(s) of life; major groups of microbes: current knowledge; functional biodiversity of microbes, and its inference; horizontal gene transfer and microbial evolution; genomics, proteomics, and metabolomics in microbial biology; overview of microbial genetics, and what model systems tell us. II. *Microbial ecology:* the structure of, and diversity of, microbial communities; microbes and ecosystem function; microbes and community ecology of macroscopic organisms; microbe-microbe interactions: signaling, competition, and niche partitioning; microbial symbioses with plants, animals, and other organisms. III. *Microbes in human uses:* bioremediation, bioprospecting, current uses and abuses, and the future. IV. *The future of microbial diversity.*

Prerequisites: BIO181; one year of Chemistry

Instructor: Dr. A. Elizabeth Arnold, Division of Plant Pathology and Microbiology  
Department of Plant Sciences

Office: 202 Herring Hall (small building between Forbes and Marley)

Phone: 621-7212

Email: [arnold@ag.arizona.edu](mailto:arnold@ag.arizona.edu) (this is **by far** the best way to reach me)

Web: <http://www.endophytes.org/teaching/microbialdiversity.htm>

Graduate TA: Ms. Michele Hoffman, Ph.D. candidate, Plant Pathology and Microbiology

Dr. Arnold's office hours: Tuesday, 3-4pm; also by appointment. Contact me by email, and I'll be glad to arrange a meeting.

Reading material: After much review, I'm not convinced that any of the available textbooks highlights microbial diversity in the depth and breadth we desire. Therefore, course readings will be drawn from multiple sources, including recent papers from the primary literature and an array of texts. Readings will be posted to the course website and, in some cases, will be available in hard copy in class and on reserve in the Mycological Herbarium (Herring Hall, on green shelves outside room 202).

Grading: Grades will be based on a total of 250 points, with a standard grading scale (A: 90-100%; B: 80-89%, C: 70-79%, D: 60-69%, F: <60%). Boundaries for letter grades may be phase-shifted slightly according to point distributions. Grades will be based on a total of three exams and additional assignments and measures, with the maximum points available from each as follows:

Exam 1	50 points
Exam 2	50 points
Exam 3	50 points
Tree of Life assignment	10 points
Reading summaries	50 points (5 X 10 points each)
Project and presentation	30 points
Class participation	5 points
Meet your professor	5 points

**The Tree of Life assignment** will consist of a short-answer questionnaire that you will complete while touring the Tree of Life Web Project (online); details to follow (10 points). Over the term, you will be expected to turn in a total of five **written summaries of selected reading assignments** for the course; each summary will consist of one page of written work (single-spaced) summarizing the major points, and listing two to three original questions based on the reading (5 X 10 points = 50 points). When appropriate, interesting questions raised by students will be discussed at the start of later class meetings. Students will work individually or in groups of up to three to prepare a **semester project** on a topic such as a group of organisms or an aspect of microbial ecology that excites you; this project will include a short written paper (five pages, single spaced, not including the list of references) and a poster or oral presentation that will be presented to the class. **Consistent attendance** and active participation in class will earn you up to five additional points over the course of the semester. Finally, you can earn five points by **meeting your professor** in my office at the start of the term.

In addition, you will have the option to receive up to 10 '**optional**' points that will be added to your final total before letter grades are assigned. Opportunities for optional points will come up throughout the semester and will include, but not be limited to, participating in a tour of the mycological herbarium, attending a microbial biology seminar and providing a short written summary, and providing a written summary of news articles pertaining to microbial diversity. Each of these will be worth up to two points, at the discretion of the instructor.

Finally, you will have the option of taking a final exam at the end of the term (worth 50 points) that can replace your lowest test score. This exam **cannot** be used to replace any part of the non-exam portion of your grade. Your score on the optional final can **only** be used to replace **one** of your regular exams. **You only have this option if you have taken all three regular exams in the course.**

All assignments are due on the date specified and should be turned in **at the start of class**. Late work will lose 10% of its maximum point value with each 24 period following the original due date/time (e.g., a 10 point assignment turned in on Friday at 1pm – but due Thursday at 1pm – will have a maximum point value of 9 points, and so on). Incomplete work may be returned without being graded, and will be treated like late work: the assignment will immediately lose 10% of its value and will diminish by 10% of the maximum value with each 24 period following its return to you. You owe it to yourself to do your best on all assignments!

Academic integrity: As in all aspects of life, your integrity is your greatest asset. I encourage you to share your intellectual merits and views, and to openly discuss course topics with one another. However, I will implement a zero-tolerance policy with regard to cheating: evidence of cheating on course exams will result in zero points for all students involved. With the exception of the group project, all out-of-class assignments must be written independently; evidence of non-independent work will result in zero points for all students involved. Take care to cite sources for your ideas in your written work; avoid plagiarism: you have a unique perspective and fresh ideas. Exercise your intelligence and maintain your honor. Evidence of plagiarism will be brought to your attention and may result in zero

points for a given assignment. For information regarding the UA Academic Code, under which this course operates, see <http://web.arizona.edu/~studpubs/policies/cacaint.htm>.

Attendance policy: Success in this course depends on your presence in class. Attendance is in your best interest: students who rely only on course notes without also attending class typically average a full letter grade lower than those who attend lectures, and full notes for this course will **not** be posted to the web. Do not miss the exams! Makeup exams will only be given in very unusual situations, and only if permission is obtained from me **before** the regular exam is given. Makeup exams may differ in format and content relative to the regular exams. Please note that all holidays or special events observed by organized religions will be honored for students who show affiliation with that particular religion. Absences pre-approved by the UA Dean of Students (or the Dean's designee) also will be honored.

Classroom behavior: A classroom is a unique environment that will be disrupted by the use of cell phones or pagers. Please **turn off your cell phone** or pager before the start of class: I will not use these in class and I expect that you will not use yours. Please respect University policy regarding food and drink in classrooms. Please note as well that the Arizona Board of Regents' Student Code of Conduct (ABOR Policy 5-308) prohibits threats of physical harm to any member of the University community, including one's self. For more information, see <http://policy.web.arizona.edu/~policy/threaten.shtml>.

Special needs and accommodations: Students needing special accommodations or special services should contact the Disabilities Resource Center, 1224 E. Lowell Street, Tucson, AZ 85721, 520.621.3268 (fax: 520.621.9423); email, [uadrc@email.arizona.edu](mailto:uadrc@email.arizona.edu); web, <http://drc.arizona.edu/>. You must register and request that the DRC send me official notification of your accommodations needs as soon as possible, and must happen before the first exam scheduled for this course. Please meet with me by appointment or during office hours to discuss accommodations and how the requirements of this course may influence your ability to succeed in class given your special needs accommodations. With the assistance of these programs, I will do all possible to enhance the educational quality and academic environment of this course.

Withdrawals from the course: Withdrawal must follow the procedures outlined in the UA General Catalog. The last day to drop the course and thereby delete it from your enrollment record is Feb. 10, 2009; the last day to drop the course with a W (if passing) is Mar. 10, 2009. The latter requires a change of schedule form and my signature; you can download the form at this address: <http://www.registrar.arizona.edu/registration/changereg/onpaper.htm>.

Confidentiality of student records: <http://www.registrar.arizona.edu/ferpa.default.htm>

Subject to change: Information contained in this course syllabus, other than the grade and absence policy, is subject to change without advanced notice, as deemed appropriate by the instructor.

Useful links and resources on the Web:

Tree of Life Web Project: [www.tolweb.org](http://www.tolweb.org)

World Data Center on Microorganisms: <http://wdcm.nig.ac.jp>

American Society for Microbiology: <http://www.asm.org>

National Center for Biotechnology Information: <http://ncbi.nih.gov>

Astrobiology Institute at Woods Hole:

[http://microscope.mbl.edu/baypaul/microscope/general/page\\_01.htm](http://microscope.mbl.edu/baypaul/microscope/general/page_01.htm)

All about Archaea: <http://www.archaea.unsw.edu.au/>

TIGR: <http://www.tigr.org/tigr-scripts/CMR2/CMRHomePage.spl>

About extremophiles: <http://extremophiles.org/>

Introduction to fungi: <http://www.ucmp.berkeley.edu/fungi/fungi.html>

Understanding eukaryote relationships: <http://www.ucmp.berkeley.edu/alllife/eukaryotasy.html>

Microbe zoo! <http://commtechlab.msu.edu/sites/dlc-me/zoo/index.html>

Other thoughts: It's an honor and a pleasure to have you in my class. I look forward to working with you this term – let's make this a great course and enjoy our chance to learn together.

## LECTURE AND ASSIGNMENT SCHEDULE: MICROBIAL DIVERSITY

DATE	DAY	TOPIC	READING
Jan. 15	Th	Welcome; overview; introduction to microbial diversity	
Jan. 20	Tu	Historical perspective; Origins of life	BR 2, TL 4
Jan. 22	Th	Introduction to phylogenetic biology and the tree of life	TL 1, TL 2
Jan. 27	Tu	Viruses; <b>Tree of Life assignment due</b>	TL 8, BR 9
Jan. 29	Th	Archaea (1); Extremophiles	BR 13
Feb. 3	Tu	Special topic: molecular bioprospecting and biodiversity	-----
Feb. 5	Th	<b>EXAM 1</b>	-----
Feb. 10	Tu	Archaea (2)	Special reading
Feb. 12	Th	Bacteria (1): history and core concepts	BR 1, BR 12 I-II
Feb. 17	Tu	Bacteria (2): bacterial biodiversity; proteobacteria	BR 12 III
Feb. 19	Th	Bacteria (3): bacterial diversity; Gram-positive bacteria	BR 12 IV
Feb. 24	Tu	Bacteria (4): ecological, functional diversity; cyanobacteria	Special reading
Feb. 26	Th	The other phyla – bacteria from the chlamydias through <i>Aquifex</i>	BR 12 V-XV
Mar. 3	Tu	Guest lecture: Microbial symbioses	
Mar. 5	Th	<b>EXAM 2</b>	
Mar. 10	Tu	Bacterial wrap-up	BR 18
Mar. 12	Th	Special topic: methods in microbial ecology	BR 11 - excerpts
Mar. 24	Tu	Species concepts, horizontal gene transfer	Doolittle 1
Mar. 26	Th	Methods in microbial ecology...and eukaryotes!	BR 14
Mar. 31	Tu	Protists (1)	Special reading
Apr. 2	Th	Protists (2): excavates, amoebae	Special reading
Apr. 7	Tu	Protists (3): euglenoids, kinetoplastids; trypanosomes and more!	-----
Apr. 9	Th	<b>EXAM 3</b>	-----
Apr. 14	Tu	Rhodophytes, stramenopiles, alveolates	-----
Apr. 16	Th	Guest lecture: Microbial eukaryotes	BR 15 – optional
Apr. 21	Tu	Green algae and microbial opisthokonts...especially fungi	TL 12
Apr. 23	Th	Student presentations	TL 9 - excerpts
Apr. 28	Tu	Student presentations; <b>Semester papers due</b>	-----
Apr. 30	Th	Student presentations	BR 21
May 5	Tu	Microbial diversity in the 22 <sup>nd</sup> century	TL30
May 12	Tu	<b>EXAM 4 – 11am-1pm, Chavez 405 – Final reading summaries due</b>	

Please complete the readings before class. Abbreviations give source of reading and chapter numbers.

Sources of readings:

BR = Brock Biology of Microorganisms, 10<sup>th</sup> Edition, Madigan, Martinko and Parker, eds.

TL = Assembling the Tree of Life, 1<sup>st</sup> Edition, Cracraft and Donoghue, eds.

Special reading = pieces from the primary literature; will be made available throughout the semester.