

## Syllabus: MCDB 4350/5350, Semester I, 2009

### “MICROBIAL DIVERSITY AND THE BIOSPHERE”

#### Instructors:

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For faster responses, please start e-mail sent to us with the subject line “MCDB4350”; your correspondence should be written in a professional way. You need the practice.

#### When and Where:

MWF from 10:00-10:50 a.m. in Porter B121.

#### Class Web Site

<http://mcdb.colorado.edu/courses/4350>

Lecture notes can be downloaded as PDFs from the class Web site as they become available. If you have questions/suggestions on how to make the material more conveniently available, please bring them up.

#### Credits:

Three credits cross-listed undergrad (MCDB4350)/grad (MCBD 5350).

#### Prerequisites:

Chemistry 1131 or 1171 or consent of instructor. Introductory microbiology (EPOB 3400) and/or organic chemistry (Chem 3311) recommended.

#### Text and lecture notes:

M. T. Madigan, J. M. Martinko, J. Parker, “Brock Biology of Microorganisms,” 12th ed., Prentice Hall, 200. One copy will be on reserve in the library.

Older editions of this text are around, but don’t go any earlier than the 10<sup>th</sup> edition. (I sometimes will give page numbers for readings in the earlier editions that are comparable to the 12<sup>th</sup> ed.) Additional readings will be assigned. Reading assignments are for clarification of lectures and/or additional information that may be of interest. Students are explicitly **not** responsible in examinations for reading material that is not discussed in the lectures **unless** otherwise specified. Students **are** responsible in examinations for anything covered in lectures unless specifically indicated.

#### Examinations and Grading:

There will be two midterms and a final examination. All examinations will be “closed-book” format. The final grade will be based on 440 points: 100 points for each midterm examination, 200 points for the

final and 40 points for the term paper. An ABCDF scale based roughly on intervals of 10-15 percent will be used. I.e., it is possible for everyone to get an A.

### **Molecular Phylogeny Workshop**

A required molecular phylogeny workshop will consist of the use of a "sequence editor" (program for manipulating sequences) and a series of different types of programs for inferring phylogenies. You will be given sets of nucleic acid and protein sequences, and asked to carry out certain operations with the sequences and different methods in order to demonstrate the principles of molecular phylogeny and highlight some pitfalls. **Completion of the exercise will be worth 20 points on Midterm I.**

### **Grant and Paper Writing Workshop:**

All students must write a term paper, five text pages less references for undergraduates and ten pages less references for graduate students. One inch margins, 12 point Times font, single-spaced text with one space between paragraphs. The theme can be anything that captures your imagination in the course. I encourage you to do something new, correlating information available in the data bases or analyzing the data in new ways. Vast amounts of genomic and environmental sequence collections are emerging and await "the right question."

**Everyone** must turn in an **abstract** of what they plan to write about by **Friday, October 30**. **Papers will be due on the last day of class in hard copy at class AND via electronic submission at [www.turnitin.com](http://www.turnitin.com)** (further instructions for electronic submission to follow).

Examples of projects would be undertakings to address questions such as the following. Grad students are encouraged do 1) or 2).

- 1) Prepare a grant proposal following the guidelines: 2-3 pp. Introduction; 1-2 pp. Preliminary Data if relevant; 6-8 pp. Proposal. Try to outline specific experiments or proposed observations. Propose an interesting project related to microbial diversity and the biosphere. Specify why the proposed project is important.
- 2) Carry out and describe in a paper (5 or 10 pages plus references and any electronic submission for documentation) the results of an original research project based on microbial genome sequences now available (or will be released over the next few months). One such project might be for example: Identify and correlate functional and/or structural aspects of different gene families ("paralogs," not necessarily with same cellular function) in different genomes (see Tatusov *et al.* Science 278:631-637 [1997]; Nucl. Acids Res. 28:33-36[2000]). Another example might be: Analyze and discuss the phylogenetic congruency of organismal lineages (as reflected in, e.g., rRNA) and some set of genes reflecting physiological traits. Still another might be: What are the gene-signatures that constitute (or separate) the bacterial divisions? A more physiology-related project might be to (try to) track the phylogenies of the hydrogenases and their families, or other families; they probably won't be straightforwardly organismal (rRNA). Still another: What are the relative abundances and phylogenies of crenarchaeal rRNA and ammonia monooxygenase genes in environmental ("metagenomic") libraries? There are many possibilities, here, some of which might even be publishable. You also should provide appropriate brief review of the subject area. Topics must be approved by NP or LB to minimize wheel-spinning.
- 3) Tell us something interesting about the microbial world.

This workshop will meet once independently of the lecture portion in order to discuss the grant-proposal process, current trends in research funding and paper-writing in general.

**Lecture Schedule – this is approximate only and lists topics, not the Lecture title in the notes**

<b>Date</b>	<b>Day</b>	<b>General Topic</b>
August 24	Mon	Introduction to Microbial Diversity
August 26	Wed	Defining microbial diversity: a changing paradigm
August 28	Fri	Large-scale evolution: the Big Tree
August 31	Wed	Molecular characterizations of organisms
September 2	Fri	Overview of phylogenetic diversity
September 4	Mon	Principles of molecular phylogeny
September 7	Mon	LABOR DAY – NO CLASS
September 9	Wed	Phylogenetic methods: Molecular phylogeny workshop
September 11	Fri	Phylogeny cont.; Review results of workshop
September 14	Mon	Overview of genomic diversity: technology and organisms
September 16	Wed	Genomic diversity – cont.
September 18	Fri	Dr. Kirk Harris – Tracking the explosion in microbial diversity
September 21	Mon	What is <i>E. coli</i> - a concept of microbial species
September 23	Wed	Diversity and DNA-transfer: mechanisms
September 25	Fri	<b>Pre-Exam discussion</b>
September 28	Mon	<b>Examination 1</b>
September 30	Wed	DNA transfer in physiology - islands and modules
October 2	Fri	DNA transfer in evolution – lateral transfer
October 5	Mon	DNA transfer and the structure of genomes
October 7	Wed	Microbial life in the biosphere – Where? How much?
October 9	Fri	Distribution of life in the biosphere - counting microbes
October 12	Mon	Diversity in the environment – How do we know?
October 14	Wed	Detecting microbes and their activities
October 16	Fri	The geothermal way of life

October 19	Mon	Geothermal life – cont.
October 21	Wed	Mechanisms of thermal stability
October 23	Fri	Archaea - Not only extreme
October 26	Mon	Archaeal vs. bacterial fine-structure (Dr. Chuck Robertson)
October 28	Wed	Phylogeny to physiology
October 30	Fri	Carbon flow in the biosphere ( <b>Abstracts due</b> )
November 2	Mon	The photosynthetic way of life
November 4	Wed	The photosynthetic way of life, cont.
November 6	Fri	Anaerobic horizons – fermentations and hydrogen
November 9	Mon	Anaerobic horizons – Syntrophy
November 11	Wed	Methanogenesis – the bottom line
November 13	Fri	<b>Pre-Exam discussion</b>
November 16	Mon	<b>EXAMINATION 2</b>
November 18	Wed	Common themes of diverse pathogens (Dr. Dan Frank)
November 20	Fri	What makes a pathogen a pathogen? (Dr. Dan Frank)
Nov. 23-27		No class – Fall/Thanksgiving Holiday
November 30	Mon	Novel approaches to idiopathic diseases (Dr. Dan Frank)
December 2	Wed	Eucaryal diversity – more than meets the eye
December 4	Fri	Eucarya – cont.
December 7	Mon	The Microbial World and the evolution of Earth
December 9	Wed	Origin of life and Astrobiology
December 11	Fri	Discussion: Last day of class. <b>Term papers due.</b>
December 15	Tue	<b>FINAL EXAM – 4:30 PM-7:00 PM</b>