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Office hours are by appointment. Several regularly scheduled discussion hour(s) will also be held each week at times selected to accommodate student schedules.

Class time: 9:40-10:30, MWF, CSC205

Objectives and Expected Learning Outcomes. This course will provide a broad introduction to the diversity of form and function in the prokaryotic world. Particular emphasis will be given to the metabolic capabilities of prokaryotes, including discussion of various kinds of anaerobic respiration, oxygenic and anoxygenic photosynthesis, nitrogen fixation, and multiple pathways of carbon fixation. Some topics in prokaryotic cell biology will also be explored, as a means of highlighting the surprising degree of organization occurring in some prokaryotic cells. General foundation information will be provided by the textbook *Brock Biology of Microorganisms*. Selected topics will be explored in greater depth using papers from the primary literature and some fairly short review articles. This exploration of the literature is intended to develop skills of independent inquiry and will allow some discussion of the investigative processes by which we arrived at our present knowledge in selected areas of microbial biology. Frequent in-class exercises guided by short prompts will provide opportunities to work independently in small groups. Prompts will have specific answers in some cases but will often involve fairly open-ended exploration of the implications of the material covered in class.

Although microbial biology includes single-celled eukaryotes as well as prokaryotes, the majority of the genetic diversity and distinctive biochemistry of microbes occurs in the prokaryotes. The emphasis will accordingly be on bacteria and archaea rather than eukaryotic microbes.

Readings. Textbook: *Brock Biology of Microorganisms* (15th ed). Papers to be posted each week on Canvas

Grading will be based on 4 midterm exams, 3 problem sets, participation in short in-class exercises, and a final exam. You will be given about 10 days to complete each problem set. They will be distributed at times chosen to minimize interference with the midterms (dates to be announced). You are allowed and encouraged to discuss the
problems in groups, but the final answers you provide must be your own, presented in your own words.

Basic component weights will be:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>4 Exams, each 80 points:</td>
<td>320</td>
</tr>
<tr>
<td>3 Problem sets, each 80 points:</td>
<td>240</td>
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<tr>
<td>In-class exercises</td>
<td>140</td>
</tr>
<tr>
<td>Final exam</td>
<td>300</td>
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Some students are strong finishers and can benefit from additional weighting of the final exam whereas others might do best knowing that no single component is very critical. To accommodate both styles we will compute the final point tally in two ways, giving additional weight to either to the final exam or to the midterms-plus-problem sets, and use the higher score for assigning a final grade. Formulas are:

Method 1: Total = 9/7(everything besides final) + (final)
Method 2: Total = (everything besides final) + 5/3 (final)

Both schemes give a maximum possible score of 1200 points, but the final can count for either 25% or about 42% (whichever gives the better outcome).

**Schedule of Lecture Topics.**

Note: I might deviate a bit from this timeline if certain topics go more slowly or quickly than anticipated. If the sequence of topics changes for any reason, I’ll let you know so you can adjust your reading schedule.

**Week 1.** Introduction to microbial diversity; elements of prokaryotic cell structure & function
Textbook reading: Brock Chapters 1, 2
Papers: Prokaryotes: The Unseen Majority (Whitman et al., 1998)
Global Distribution of Microbial Abundance and Biomass in Subseafloor Sediment (Kallmeyer et al., 2012)

**Week 2.** Prokaryotic cell struct cont.; Intro to metabolism
Textbook reading: Brock Chapter 2, Chapter 3 sections I and II
Papers: The carboxysome and other cellular compartments (Kerfeld et al., 2010)
Bacterial outer membrane evolution via sporulation? (Vollmer, 2012)

**Week 3 (no class on Monday Jan 20).**
Overview of microbial metabolism
Textbook reading: Brock remainder of Chapter 3 (but omit 3.14, 3.15, 3.16)
Papers: Cultivation of an obligate Fe(II)-oxidizing lithoautotrophic bacterium using electrodes (Summers et al., 2013)
Iron-reducing bacteria accumulate ferric oxyhydroxide nanoparticle aggregates that may support planktonic growth (Luef et al., 2013)
**Week 4.**  **First midterm exam Monday, Jan. 27**
Week 4 topics: Molecular Microbiology; Microbial growth and its control
Textbook reading: Brock Chapters 4, 5 (most material in Ch. 4 should be familiar)
Papers: Growing Unculturable Bacteria (Stewart, 2012)
Microbial competition: Escherichia coli mutants that take over stationary phase cultures (Zambrano et al., 1993)

**Week 5.** Growth and control, cont.; Metabolic regulation
Textbook reading: Brock chapters 6,7
Papers: Bacterial swimmers that infiltrate and take over the biofilm matrix (Houry et al., 2012)
Regulation by small RNAs in bacteria: expanding frontiers (Storz et al., 2011)

**Week 6.** Regulation cont; Intro to microbial genomics.
Textbook reading: Brock Chapter 9, begin Chapter 13
Papers: Metagenomic discovery of biomass-degrading genes and genomes from cow rumen (Hess et al., 2011)
Ten years of next-generation sequencing technology (van Dijk et al., 2014)

**Week 7.** (no class on Mon Feb 17)
Genomics and evolution, cont.
Textbook reading: Brock Chapter 13
Papers: The phylogenomic species concept for Bacteria and Archaea (Staley, 2009)

**Week 8.**  **Second midterm exam Monday, Feb. 24**
Week 8 topics: Evolution and systematics (cont) and some origin of life
Textbook reading: Brock Chapter 14
Paper: The origin of membrane bioenergetics (Lane and Martin, 2012)

**Week 9.** Diversity of metabolism (beginning with styles of phototrophy)
Textbook reading: Brock Chapter 14
Paper: Early evolution of photosynthesis (Blankenship, 2010)

**Spring break March 9-13**

**Week 10.** Metabolism, cont.: respirations using sulfur and nitrogen compounds; alternative pathways of carbon fixation
Textbook: Brock Chapter 14
Papers: Evidence for autotrophic CO₂ fixation via the reductive tricarboxylic acid cycle by members of the ε subdivision of proteobacteria (Hugler et al., 2005)
An optional paper will also be posted for those interested: Ecological aspects of distribution of different autotrophic CO₂ fixation pathways (Berg, 2011).
**Week 11. Third midterm exam Monday, March 23**
Metabolic diversity, cont.; fermentations, unusual respirations, acetogenesis, methanogenesis.
Textbook reading: Brock Chapter 14
Papers: An ancient pathway combining carbon dioxide fixation with the generation and utilization of a sodium-ion gradient for ATP synthesis (Poehlein et al., 2012)
Hydrogen, metals, bifurcating electrons, and proton gradients: the early evolution of biological energy conservation (Martin, 2012)

**Week 12. Bacterial diversity**
Textbook reading: Brock Chapters 15,16
Paper: Identification of proteins likely to be involved in morphogenesis, cell division, and cell division in *Planctomycetes* by comparative genomics (Jogler et al., 2012)

**Week 13. Diversity, cont.**
Textbook reading: Brock Chapters 15,16
Paper: Gene transfer from *Bacteria* and *Archaea* facilitated evolution of an extremophilic eukaryote (Schönknecht et al., 2013)

**Week 14. Fourth midterm exam Monday, April 13**
Introduction to nutrient cycles; bioremediation
Textbook reading: Brock Chapters 21, 22
Papers: Synthesis of methylphosphonic acid by marine microbes: A source for methane in the aerobic ocean (Metcalf et al., 2012)
Deep-sea oil plume enriches indigenous oil-degrading bacteria (Hazen et al., 2010)

**Week 15. Nutrient cycles and bioremediation, cont.**
Textbook reading: Brock Chapter 22
**Last class period Monday, April 20**

**Final Exam: Friday April 24, 8:00 – 10:00**

**Disability Services**
The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, please contact the Center for Disability Services, Room 162 Olpin Union Building (200 S Central Campus Drive), 581-5020 (V/TDD), FAX 581-5487. CDS will work with you and the instructor to make arrangements for accommodations. Written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.