MICB 301 Microbial Ecophysiology
(New course in 2010)

Instructor: Dr. William Mohn, wmohn@interchange.ubc.ca

Class meetings: MWF, 10:00 AM, LSC3

MICB 301 (3) Microbial Ecophysiology. Dynamics and control of prokaryotic cellular processes in response to the biotic and abiotic environment including metabolic interactions and metabolic cooperation between microorganisms. [3-0-0] Prerequisite: BIOL 201, MICB 201.

Tentative Course Outline

1. Dynamics of prokaryotic cell expansion and division (3 weeks)

- The replisome
- Cell wall peptidoglycan synthesis and assembly
- Biogenesis of the Gram-negative outer membrane
- The Z-ring and the dynamic cytoskeleton
- Chromosome segregation
- Mechanisms of protein export and secretion
- Coordination of chromosome replication with septation

2. Sensing and responding to the environment: the principles (2 weeks)

- Two-component and phosphorelay signal transduction systems
- Traffic between the environment and the cytoplasm: prokaryotic membrane transporters
- Metabolic regulation: multiple levels, hierarchical control, transcriptional control,
- and enzyme control
- Link between transport and regulatory functions,
- Global regulation: multigene systems, stimulus-response pathway, coordination devices
- Taxis: signal amplification, signal integration, integral feedback, locomotion
- Cell to cell communication: Quorum sensing
- Experimental approaches used to study prokaryotic physiology in relation to the environment.

3. Phototrophic growth in response to the environment and physiological adaptations (2 weeks)

- Review of prokaryotic phototrophic diversity
- Regulation of photosystem synthesis in response to light and O_2
- Photoautotrophy vs photoheterotrophy: response to availability of organic carbon
- Specialization in phototrophs as a competitive strategy: genome stream-lining and ability to respond to the environment
- Case study: Niche partitioning among species (Example Prochlorococcus ecotypes)

4. **Chemotrophic growth in response to the environment and physiological adaptations (2 weeks)**

- Review of prokaryotic chemotrophic (respiratory) diversity; diversity of electron transport
- Respiratory control
- Regulation of electron acceptor use (Example: dentrification in response to O_2)
- Electron acceptors as limiting resources
- Diversification as a competitive strategy
- Microbial community structure along redox gradients (Example: stratified sediment environments)

5. **Metabolic interactions between microorganisms-I: Anaerobic food webs (2 weeks)**

- Mechanisms of anaerobic energy conservation
- Functional guilds
- Syntrophy (Example: human gut environment -fermentation and syntrophy with normal flora)
- Endergonic fermentation and interspecies H_2-transfer
- Methanogens and methanogenesis

6. **Metabolic interactions between microorganisms-II: Organic Decomposition (2 weeks)**

- Global C cycle: reservoirs, fluxes
- Wood decomposition: microbial ecology and enzymology of cellulose and lignin degradation
- The mycorrhizal symbiosis: physiology and role in regulating carbon fluxes between the biosphere and the atmosphere.
- Microbial community interactions and the production of ethanol from lignocellulose
- Bioremediation: Microbial community interactions and petroleum degradation

Learning Outcomes

By the end of the course, students will be able to

- Explain what is known about some of the dynamic protein molecular machines central to the ordered prokaryotic cell division process and how their functions are coordinated.
- Explain the various mechanisms and devices prokaryotes use to sense and respond to the environment.
- Explain the various mechanisms and devices prokaryotes use to regulate physiological changes, the hierarchical organization of these regulatory networks the levels at which regulation occurs.
- Use an understanding of basic sensory and regulatory mechanisms to explain how selected physiological groups of chemotrophic and phototrophic prokaryotes behave

and function in relation to the environment and changes in environmental conditions.

- Using selected physiological groups of prokaryotes as a focus, explain how environmental pressures can mold genomes to yield particular adaptations.
- Using carbon-cycling as a focus, explain how metabolic interaction and cooperation between different physiological groups of microorganisms can bring about elemental cycling.
- Describe genetic, biochemical and genomic approaches used to study bacterial physiology and physiological ecology as well as their limitations.
- Propose experiments to test hypotheses about physiological roles of genes and gene products and experiments to dissect the metabolic interactions between prokaryotes in the environment.
- Appreciate that the study of microbial ecophysiology is interdisciplinary endeavor requiring expertise from the molecular-cellular level to ecosystem level.

Tentative Evaluation Criteria

Poster proposal (individual assignment)	5%
Group poster preparation and in-class presentation	20%
iClicker question participation	10%
Midterm exam	25%
Final exam	40%
	100%