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BIOM 450.01: Microbial Physiology

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MICROBIOLOGY 450-Fall 2014

Microbial Physiology-Lecture Schedule

Instructor: Jim Driver. ISB 017 (EM Lab, basement) Office Hrs. 1:30-2:20 T or by appointment (jim.driver@mso.umt.edu).

Prerequisites: Micro. 300 (now Biom 360) and 6 hours of Chemistry/Biochemistry, OR Consent of Instructor

Text(s): *Texts used in the course:* Recommended but not required. A copy of both texts is on reserve in the library.

White et al. (2012) *The Physiology and Biochemistry of Prokaryotes* 4th Ed.
Brock Biology of Microorganisms, 11th Ed., Brock (2005), 12th Ed. (2008)

UMOnline – Moodle: Lectures posted prior to class (variable postings)

Overview, Outcomes, and Assessment:

Overview: We will define Microbial Physiology as ‘microbial growth and survival in response to external change’ and will emphasize the structural attributes of the microbial cell (membranes, ribosome’s, etc.) in relation to function. Function, for the sake of this course, is **uptake** (resource processing and transport mechanisms), **growth** (formation of bioprecursors, energy conservation, movement, cell division, etc.), **maintenance** and **survival** (cellular adjustments to adverse environmental change).

Outcomes: You will notice that the general content outlined below often covers material that you have been introduced to in a number of other classes. One goal for this course is to lightly review many fundamental principles of the cell and then extend your understanding of each emphasizing the cellular response to external stimuli (physiology). For example how does central metabolism (e.g. glycolysis, Krebs cycle, and electron transport) change in response to changes in the availability of external electron acceptors? With this in mind the course will have broad two sections:

- a. **Introduction -Cell physiology across phylogenetic domains** – a 6 lecture section on comparative physiology across the three domains (Eubacteria, Archaea, Eukaryotes (microeukaryotes)). After this section you should understand similarities and differences in cell structure and function across phylogenetic domains. You will begin to grasp the great metabolic diversity in the microbial world. In addition you will review some of the basics that you have learned in other biology courses.
- b. **Uptake, growth, and survival in response to external change-** The section constitutes about 75% of the course.
 - i. *Uptake* – After this section you should understand how cells transform resources (e.g. carbon, nitrogen, phosphorus) in the surrounding medium

and **transport** processed resources into the cell. In one of your lab exercises, you will actually extract and assay for an important resource processing protein. Also in this section, we will review structures such as the outer membrane and cell wall, the periplasm (G-), and the cytoplasmic membrane.

- ii. *Growth* – You will learn that there are many ‘growth states’ including balanced growth and unbalanced growth. These depend on resources and external conditions suitable for:
 - a. Energy generation- After this section you should understand the fundamentals of metabolism including fermentation, respiration, and photosynthesis – you will learn how the cell alters energy conservation when the environment around the cell changes.
 - b. Carbon Metabolism –You will learn that there are 12 important Precursors and see how their synthesis is regulated.
 - i. Specifically you should understand how the production of the 12 precursors changes in oxygen tension – we will also review of glycolysis, the krebs cycle, pentose phosphate pathway, and entner duodoroff pathways.
 - ii. Finally, you will learn how respiration is regulated and understand two component transduction systems such as Arc and Nar.
 - c. Cell Division and biomass changes- You will learn how the cell divides through the concept of the divisome and compare E. coli with that of Enterococcus.
- c. **Maintenance and Survival**- The microbial cell lives in a feast and famine world. In this section you will learn how cells maintain themselves during the “famines” but also how they respond to cellular changes such as a changing pH or osmotic condition. The three parts of this section are:
 - i. Homeostasis –maintaining an internal environment
 - ii. Encystation and the story of a bacterium and an amoeba
 - iii. Sporulation

Assessments – For any assignment, students are required to do original work specifically for this class.

Exams will be given at the scheduled time. Make-up exams will only be given in emergency situations and only if the instructor is appropriately notified. The final exam is comprehensive, but half of the points will be from the last section of the course over which you have not been tested. The **exam format** is short answer/ short essay, fill-in, and some matching.

Quizzes: There will be about 4 Thursday quizzes which mostly cover material you have had on the Thursday and Tuesday of the previous week. All but one of these will count; your lowest score out of the total will be dropped automatically. Some of

the quizzes may be unusual and **unannounced**. There are no make up quizzes. If you miss a quiz this 0 will be dropped, if you miss a second quiz, it's not good.

In-class oral presentation. Each student will be required to give a short (10 minute) presentation on a topic provided by the instructor or a topic of interest to you (with instructor approval) or on any microbial research you are performing at UM. This will be graded on accuracy of information and professionalism of the presentation.

Grading: Your final grade in the course will be based on total points from the following:

Exams, 3 x 100	300
Final Exam	200
In class oral presentation	20
Thursday Quizzes 4x20	<u>80</u>
Total	600

The letter grade breakdown will be approximately as follows: Only **letter grades** are given (no P or NP).

<u>% Total Points</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Students	90+	80- 89	70- 79	60- 69

Incompletes: will only be given for the reasons stated in the student handbook.

Drops: The instructor will **ONLY** approve drops* after the published drop date for very specific reasons. * (University policies on drops, adds, changes of grade option, or change to audit status will be strictly enforced in this course. These policies are described in the current catalog. Students should specifically note that after the 30th day of the semester, such changes are NOT automatically approved. They may be requested by petition, but the petition **MUST** be accompanied by documentation of extenuating circumstances. Requests to drop a course or change the grade basis to benefit a student's grade point average will not be approved.)

Graduate students: Exams and quizzes are expected to reflect graduate level work (more detail, more concise, more critical thinking, less ambiguity) and they will be graded accordingly. In addition, you are required to give one presentation to the class on a topic related to your research but physiology oriented (instructor must approve). If you do not have a research topic yet, the instructor will provide you one.

Tentative Course Schedule (The dates and topics given in the course syllabus are tentative and may change at the discretion of the instructor.)

<i>Dates</i>	<i>General Topics</i>	
Aug 26	Introduction to Microbial Physiology – A definition and structure for the course	Syllabus
The comparative physiology of microorganisms across phylogenetic domains		
28	Physiology across domains- Nutritional Motifs	
Sep 2	Nutritional Motifs (cont.) -The lower eukaryotes; The archae –Life in the extreme – special physiology for special environments	
4	The Archaea –Life in the extreme – special physiology for special environments The early Eubacteria – aquifex, purple and green sulfur and non-sulfur bacteria and anoxygenic photosynthesis	
9	The Eubacteria: Phylogeny and general physiology of the CFB and the Planctomycetes.	
11	Eubacteria	
16	The Cyanobacteria also Quiz#1	
18	The Gram-positive Bacteria	
23	Review for Exam I	
25	Exam I	
Uptake		
Sept 30	The Proteobacteria	
Oct 2	Uptake – The Cell wall, the Membrane and membrane proteins	
Growth and Energetic Principles		
7	Principles of oxidation/reduction revisited, the proton motive force. Oxidative phosphorylation, photophosphorylation, and substrate level phosphorylation also Quiz#2	
9	Formation of precursors and reducing power – Embden Myerhoff and Fermentations	
14	Citric acid cycle and Metabolic Regulation Regulation in response to changes in availability of electron acceptors –	
16	Pentose Phosphate	
21	Review for Exam II also Quiz #3	
23	Exam II	

28	Regulation of Central Metabolism; The Arc and Nar systems in <i>E. coli</i>
30	Autotrophy and the Calvin-Benson
Nov 4 Election Day no class, go vote.	
6	Growth- general kinetics in response to environmental change, sigma factors also Quiz #4
11 Veterans Day - No class	
13	Cell Division - The Divisome
18 Review Exam III	
20	Exam III
Maintenance and Survival	
25	Homeostasis, Quorum sensing, Encystation,
Dec 2	Sporulation
4 Review for Final	
12	Final Exam