26:375:540:01:36143 Bioremediation

Earth and Environmental Sciences
Rutgers Newark
Fall 2009

Course Time:	Thursday 6:00-9:00PM
Location:	Smith Hall 127
Instructor:	Adam Kustka
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Office:	Smith 140
Office Hours:	Tuesdays and Fridays 10AM-5PM (please contact in advance)

Course Description: Bioremediation describes the environmental applications of microbes (mostly bacteria and fungi) to remediate contaminated soils and waters. Remediation can be accomplished by breaking down or altering toxic compounds to compounds that are less or non-toxic, or by immobilizing toxic contaminants to retard their movement into non-contaminated areas. To best understand the potential for bioremediation of a site, one must have a thorough understanding of the microorganisms present in the subsurface (or proposed organisms for introduction), the chemistry of the interaction between the microbes and contaminant of interest, the rates of bioremediation, and the *in situ* factors that influence these rates.

This course will explore how microbes transform contaminants in soils and groundwater with a requisite overview on microbial physiology and how microbes interact with environmental conditions present at bioremediation sites. There will be emphases on molecular methods developed to detect impacted sites, to monitor the effectiveness of bioremediation and/or the presence of contaminant degrading organisms, and the development of genetically modified organisms to deal with contaminants. In this regard, there will be significant discussion of the legal and social factors that influence the potential use of GMOs for bioremediation.

Learning Objectives:

- Achieve an understanding of the microbiological and energetic underpinnings of microbially mediated contaminant remediation in soils and groundwater.
- Achieve an understanding of microbial physiology and how microbes interact with environmental conditions present at bioremediation sites.
- Understand how molecular methods are developed and utilized to detect impacted sites and to monitor the effectiveness of bioremediation and/or the presence of contaminant degrading organisms
- Understand how genetically modified organisms can be used to deal with contaminants, and the social and legal factors that influence their potential use.

Required Text:

Groundwater Microbiology and Geochemistry, 2nd Edition. 2001. F. H. Chapelle. Wiley. ISBN-13: 9780471348528.

Additional reading will be provided. It is expected that readings are done prior to class.

A note about the textbook: I have not found any single text that addresses all the course materials. Chapelle comes close, but some of the basic biology is off base (and in some cases, misleading). When I have found problems with an assigned reading, I will either bring this up during class or assign alternate readings in these cases.

Other texts which I have drawn from include:

- Introduction to Geomicrobiology. 1st Edition. 2006. Konhauser. 9780632054541.
- Bioremediation. 1st Edition. 2005. Atlas & J. Philp [Eds]. 9781555812393
- Brock Biology of Microorganisms. 10th Ed. 2002. Madigan et al. 9780130662712.*
- An Introduction to Genetic Engineering. 2nd Ed. 2002. Nicholl. 9780521004718*

*Newer editions are available, but this is the one on my shelf.

Assignments:

Three short homework assignments will be given throughout the semester to gage how effectively the course materials are taught and learned. Each is worth 5% of the grade. At least one week will be allowed to complete the assignments. Late assignments will be subject to grade reductions.

Class format:

The course will consist of lecture-based teaching and learning only to provide background information on key concepts necessary for future discussions. Otherwise, our time will be spent having critical, and hopefully insightful, discussions on the assigned readings and (especially) the student presentations.

Presentation / discussion leader:

On 22 October*, I will meet with each of you to discuss candidate articles that you will present later in the semester. These articles should be seminal ones in the field and ideally will be ones you have chosen out of personal interest in the topic. I find it is best to start perusing literature long before the time when "the" article is decided. Often, you may find an article that was initially interesting to be a "dud"- you may have to sift through several to find the gem. One way find a good article is through web of science (available from any Rutgers terminal)… once you have a list of pertinent articles you can sift through these by sorting by "times cited" (the duds won't be cited often). However, you can miss important new papers in this way, as cutting edge 2009 publications will not yet be cited. Usually, published conference abstracts are not appropriate.

Each student will present the article and open the floor for discussion. The discussion could include questions from the students to the presenter to clarify some aspect of the methods, a critical evaluation of the methods or conclusions, or a discussion of the implications of the work.

* You are invited to discuss the topic with me earlier than this. Those that discuss earlier can give presentation on 19 Nov 09.

Grading Policy:

Final grades for the course are calculated based on the following breakdown:

Mid term	32.5
Final exam	32.5
Homework assignments	15
Presentation / discussion leader	12
Class participation	8

Attendance will not be taken during class, but students are responsible for all materials covered in class.

Date	Week	Topics covered	Readings before class
3-Sep-09	1	Introduction to Bioremediation; Bioremediation and the societal and legal background	Chapter One, Handouts
10-Sep-09	2	Structure and function of prokaryotes and eukaryotes; taxonomy; microscopy.	Chapter Two, Handouts.
17-Sep-09	3	Metabolism, growth and energy and nutrient limitation, food chains.	Chapter 3-4; Handouts
24-Sep-09	4	Guest TBA- Kustka at National Science Foundation panel	TBA
1-Oct-09	5	Modeling and monitoring bioremediation	Handouts and Chapter 8
8-Oct-09	6	Cycling and redox processes in groundwater systems	Chapter 10, 11 and Handouts
15-Oct-09	7	Genetic tools for monitoring; Intro to bacterial genetics;	Chapter 5 =OR= Handout.
22-Oct-09	8	Mid-term exam (75 minutes); meet to discuss presentation paper - topic.	Handouts.
29-Oct-09	9	Genetic modification as bioremediation tools; GMO and plasmid injections in situ	Handouts.
5-Nov-09	10	Remediation of radioactivity and metals	DOE handbook; other handouts
12-Nov-09	11	Remediation of organic contaminants; Preemptive bioremediation and ex situ processing	Handouts.
19-Nov-09	12	Preemptive bioremediation continued; presentation/discussion	Handouts.
26-Nov-09	13	THANKSGIVING BREAK	
3-Dec-09	14	Presentation, and lecture or laboratory TBD	Student handouts
11-Dec-09	15	Presentation; Review for final exam and loose ends.	Student handouts