ENVIRONMENTAL BIOTECHNOLOGY **DR. BENOIT VAN AKEN**
CHEM 579 **FALL 2018**

LECTURE DAY – TIME – ROOM	Mon - 4:30 – 7:10 pm – Robinson Hall B205
OFFICE	Planetary Hall 355
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OFFICE HOURS	Tue/Thu 9:00 – 10:30 am, or by appointment

"Environmental biotechnology utilizes microorganisms to improve environmental quality" (Rittman & McCarty, 2001)

COURSE DESCRIPTION

Biotechnology plays a central role in many environmental fields, including wastewater treatment, biodegradation, pathogen control, and biofuel production. The objective of the course is to provide environmental scientists and engineers with advanced concepts and quantitative tools necessary for understanding environmental processes and designing environmental control systems.

The course Environmental Biotechnology integrates biological and microbiological principles, which are often observational and qualitative, into engineering principles, which are essentially quantitative. The course starts by a revision of the fundamentals of microbiology and biochemistry, including the microbial cell, microbial ecology, microbial diversity, microbial growth, and microbial molecular biology. Then, quantitative concepts related to the microbial metabolism will be covered, including microbial kinetics, metabolic processes, and bioenergetics, with special emphasis on their importance for environmental processes. These principles are then applied to the development of a scientific framework for understanding different environmental processes, including water and wastewater treatment, bioremediation, environmental genomics, biofuel production, and biosensors.

COURSE LEARNING OBJECTIVES

Students are supposed to have basic knowledge of biology and microbiology, including the structures of the cell and their biological functions, and the fundamentals of biochemistry, metabolic pathways, and genetics. A revision of these fundamentals will be provided at the beginning of the course.

At the end of the course, students will be able to:

1. Understand the environmental importance of major groups of microorganisms
2. Perform bioenergetics calculations
3. Equilibrate energy and overall reactions of microbial growth
4. Use growth rate expressions and mass balances to develop environmental biotechnology concepts
5. Apply the concepts of microbial metabolism, microbial kinetics, and bioenergetics to understand major environmental application of microorganisms, including water and wastewater treatment, biodegradation of organic pollutants, production of biofuel, and environmental genomics

PRIMARY REFERENCE TEXTS

Rittmann, B.E. & McCarty, P.L. 2001. Environmental Biotechnology: Principles and Applications. McGraw-Hill.
Glick B.R. & J.J. Pasternak J.J. 2003. Molecular Biotechnology. ASM Press.
Evans G.M. & Furlong J.C. 2003. Environmental Biotechnology: Theory & Application. Johns Wiley & Sons
Wang L.K., Ivanov V., Tay J.-H. & Hung Y.-T. 2010. Handbook of Environmental Engineering, Environmental Biotechnology. Humana Press.

ADDITIONAL REFERENCE TEXTS

Atlas, R.M. & Bartha, R. 1998. Microbial Ecology: Fundamentals and Applications. 4th edition. Addison Wesley Longman.
Madigan, M.T., Martino, J.M. & Parker, J. 2002. Brock Biology of Microorganisms. 10th edition. Prentice-Hall.
Mackenzie, L.D. & Masten, S.J. 2004. Principles of Environmental Engineering and Science. McGraw-Hill.

SELECTED PUBLICATIONS

Selected articles will be given to the students to serve as a basis of class discussions. Students are expected to read the articles ***before*** the designated classes. Selected articles are part of the matter of quizzes and exams.

CLASS POLICIES

Academic Honesty

Any student who misrepresents the work of others as his/her own will receive an 'F' for the semester and will be referred to the appropriate Chairperson and/or Dean for disciplinary action.

Lectures

Students are expected to have basic knowledge of mathematics and sciences. Attendance to lectures is mandatory and will be formally monitored. Attendance and class participation will be considered in the evaluation of the student's desire to learn. If you are unable to attend a lecture for a valid reason, please contact the instructor in person, or by e-mail, before the lecture. Late arrivals will not be accepted.

Homework

Homework assignments will be given on a regular basis (on average every other week) during the semester. Assignments will typically be given in class and collected at the beginning of the class one week later. Late homework will not be accepted. In case of emergency, students are required to talk to the instructor.

Quizzes

Quizzes will be given randomly at the end of selected lectures. Students not present and not excused will receive a zero.

Exams

A midterm exam will be given during the semester and a comprehensive (additive) final exam will be given at the end of the semester. Except for emergencies or compliance with university policy, make-up exams will not be organized.

Electronic Devices

The use of electronic devices, such as cell phones, iPads, and computers, are not permitted in the classroom or laboratory during sessions.

FIELD TRIP

A field trip will be organized during the semester to a wastewater treatment plant. The field trip will occur on Saturday morning. The instructor will try to accommodate as best as practicable the student schedules (due to time constraints, it is not possible to organize the field trip during the regular lecture time). Participation to field trip is encouraged.

STUDENT PRESENTATIONS

Working in groups, the students will prepare a review on an original environmental biotechnology topic and a slide presentation that will be presented to the class at the end of the semester. The students are requested to find the instructor to discuss their topic before to start working on the document. ***Topics and groups must be approved by the instructor.***

GRADES

Grades will be calculated according to the weighting factors listed in the following table:

Quizzes	20%
Homework assignments	20%
Student presentation	20%
Midterm Exam	20%
Final Exam	20%

TENTATIVE SCHEDULE

Week	Lecture	Date	Topics
1	1	08/27	Course introduction Introduction to microbiology: bacterial cell, taxonomy, microbial ecology
		09/03	***Labor Day***
2	2	09/10	Introduction to biochemistry: biomolecules, enzymes, molecular biology Bioenergetics: energy capture, metabolism
3	3	09/17	Energy & biosynthesis reactions: stoichiometry, empirical formula of the cell, substrate partitioning, energy reactions, overall reactions
4	4	09/24	Microbial kinetics & basic mass balances: chemostat, inert biomass, soluble microbial products
5	5	10/01	Biofilm theory: Idealized biofilm Steady-state biofilm
6	6	10/09 *Tuesday*	Wastewater treatment I: Types of reactors, settling & recycling, activated sludge
7		**10/15**	***Midterm exam: Parts 1 & 2***
8	7	10/22	Wastewater treatment II: Nitrification, denitrification, lagooning
9	8	10/29	Water treatment: Aerobic biofilm, denitrification, biodegradation of specific organics
10	9	11/05	Bioremediation: contaminant detoxification, metabolism and co-metabolism, recalcitrance, pathways & metamaps
11	10	11/12	Bioenergy I: biogas, bioethanol, biodiesel
12	11	11/19	Bioenergy II: second generation bioethanol, microbial fuel cells
13	12	11/26	Environmental genomics: microbial source tracking, metagenomics, metatranscriptomics
14		**12/03**	***Student presentations***
		12/18	***Final exam (4:30 pm – 7:15 pm)***