Course Change Request

New Course Proposal

Date Submitted: 03/05/20 5:28 pm

Viewing: **CHEM 560 : Environmental Biotechnology**

Last edit: 03/05/20 5:28 pm

Changes proposed by: bvanaken

Are you completing this form on someone else's behalf?

No

Effective Term: Fall 2020

Subject Code: CHEM - Chemistry

Course Number: 560

Bundled Courses:

Is this course replacing another course? No

In Workflow

1. **CHEM Chair**
2. **SC Curriculum Committee**
3. SC Associate Dean
4. Assoc Provost-Graduate
5. Registrar-Courses
6. Banner

Approval Path

1. 05/21/18 11:49 am Rebekah Zacharias (rzachari): Approved for Registrar-Courses:Repeatable-RT
2. 09/19/19 6:46 am Gerald Weatherspoon (grobert1): Rollback to Initiator
3. 12/16/20 11:18 am Gerald Weatherspoon (grobert1): Approved for CHEM Chair

Equivalent Courses:

Catalog Title: Environmental Biotechnology

Banner Title: Environmental Biotechnology

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May only be taken once for credit (NR)
GRADUATE ONLY

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):
CHEM 446 Bioinorganic Chemistry
BIOL 213 Cell Structure & Function
Or equivalent courses

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):
CHEM 211, 213 General Chemistry I (lecture and lab)
CHEM 212, 214 General Chemistry II (lecture and lab)

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description:

Biotechnology plays a central role in many environmental fields, such as wastewater treatment, bioremediation, pathogen control, and biofuel production. The objective of the course is to provide environmental scientists with advanced chemical and biochemical concepts necessary for understanding environmental processes and control systems. The course integrates chemical, biological, and biochemical principles for building a quantitative framework applicable to various environmental biotechnologies. The course begins with a revision of the fundamentals of microbiology, biochemistry, and molecular biology. Quantitative concepts of biochemical and microbial kinetics, metabolic pathways, and bioenergetics are then covered, with special emphasis on environmental processes. These principles are applied to different environmental biotechnologies, including water and wastewater treatment, bioremediation, environmental genomics, biofuel production, and biosensors.

Justification:

The course will introduce students in science and engineering to theoretical and applied concepts in environmental biotechnologies with specific focus on chemical and biochemical processes. The course will respond to the increasing need to form professionals with specific scientific background for designing and operating environmental control systems. As far as I can assess, no equivalent or significantly overlapping course is currently offered at GMU.

Does this course cover material which crosses into another department? No

Learning Outcomes:

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

Attach Syllabus

CHEM 560 F20 - Syllabus.pdf

Additional Attachments

Staffing:

Benoit Van Aken

Other instructors in Chemistry & Biochemistry should be able to teach the course (TBD)

Relationship to Existing Programs:

BS in Chemistry

BS in Chemistry with Biochemistry Concentration

BS in Chemistry with Environmental Chemistry Concentration

BS in Environmental Science

BS in Biology

BS in Civil and Infrastructure Engineering

MS in Chemistry

MS in Environmental Science & Policy

MS in Biology

MS in Civil and Infrastructure Engineering

PhD in Chemistry and Biochemistry

PhD in Environmental Science & Policy

PhD in Biosciences

PhD in Civil and Infrastructure Engineering

Relationship to Existing Courses:

None

Additional Comments:

It is recommended that students enrolling in this course have basic knowledge in biochemistry and microbiology. A review of fundamentals of microbiology and biochemistry will be provided at the beginning of the course. Student without backrgound in biochemistry and/or microbiology may enroll in the class, but they may have to put extrawork to learn basic knowledge in these areas.

Reviewer Comments

Gerald Weatherspoon (grobert1) (09/19/19 6:46 am): Rollback: Under the additional comments, it states that students should have a knowledge of biochemistry and microbiology. Should include both as prerequisites or corequsites for the class.

Key: 15924

ENVIRONMENTAL BIOTECHNOLOGY
CHEM 560

DR. BENOIT VAN AKEN
SPRING 2019

LECTURE DAY – TIME – ROOM	TBD
OFFICE	Planetary Hall 355
PHONE	703-993-1091
EMAIL	bvanaken@gmu.edu
OFFICE HOURS	TBD

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

COURSE DESCRIPTION

Biotechnology plays a central role in many environmental fields, such as wastewater treatment, bioremediation, 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 integrates biological concepts and engineering principles for building a quantitative framework applicable to various environmental biotechnologies. The course begins with a revision of the fundamentals of microbiology, biochemistry, and molecular biology. Quantitative concepts of microbial kinetics, metabolic processes, and bioenergetics are then covered, with special emphasis on environmental processes. These principles are applied to different environmental biotechnologies, 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%

The final grade in this course will be based on a percentage of points earned relative to total possible points. Listed above is the tentative point distribution for examinations, quizzes/homework assignments, and student presentation. However, an absolute grading scale cannot be determined until all scores have been compiled and evaluated. In order to optimize your overall performance, use the following scale as a rule of thumb: 100-90% (A); 89-80% (B); 79-70% (C); <69% (D or F).

George Mason University does not dictate a grading scale. Instructors may determine cut off points for A, B, C, etc. The use of plus and minus grades for A, B, C is also at the instructor's discretion.

SCHEDULE

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