COLLEGE OF ENGINEERING
Chemical & Environmental Engineering

CHEE 377 – Microbiology for Engineers

Days / Time / Location

Description of Course

This course focuses on the principles of microbiology, including physiology, metabolism, genetics, and ecology. The course explores fundamental microbial processes as well as their environmental significance and application in environmental engineering.

Course Prerequisites:

Advanced Standing in Engineering

Instructor and Teaching Team Contact Information

Instructor:	Dr. Byron Hempel
Email:	byronhempel@email.arizona.edu
Office:	HB 105D
Phone:	520-621-6055
Student Hours:	[TBD]

Teaching Team

Name	Email	Tutor Hours
[name]	[email]	[1 to 2 hour availability]

Course Format and Teaching Methods

This course is an in-person course where students are expected to attend lectures two times per week. During lecture, students are expected to interact with formative assessment polling questions, work on group mini assignments/tasks in class, and engage in discussions on pair, small group, and large group discussion. Outside of the classroom, students are expected to collaborate on homework assignments and reading assignments in preparation for and reinforcement of lecture material. The class will include various forms of active engagement to facilitate learning.

Course Objectives

The course will cover the following topics, of which students are expected to gain a basic working understanding. The course will have five main sections with the subtopics below:

1. Cells and What They Do
2. Inside the Cell
    a. Biomolecules
    b. Metabolism
    c. Bioxidation and bioreduction
    d. Biodegradation
    e. Biosynthesis
    f. Cells and cellular aggregates
    g. Reproduction, proliferation and growth
3. Cell Types
    a. Microbial ecology
    b. Groups of anaerobic fermenting prokaryotes
    c. Anoxic prokaryotes
    d. Microaerophilic and facultative aerobic microbes
    e. Aerobic prokaryotes
4. A Modeling Approach to Microbiology
    a. Models of Microbial Growth
    b. Continuous Culture
    c. Bioreactor Design
5. Specialty Topics
    a. Students will select and learn in depth from 3 of the following topics:
        i. Microorganisms and public health
        ii. Biosafety in civil and environmental engineering
        iii. Biotechnical processes
        iv. Microbiological methods used in engineering
        v. Aquatic ecosystems
        vi. Biotreatment of polluted water
        vii. Anaerobic and anoxic biotreatment of waste
        viii. Aerobic biotreatment of wastewater
        ix. Value-added microbial byproducts
        x. Biotreatment of industrial hazardous wastes
        xi. Solid waste biotreatment
        xii. Bioremediation of polluted soil
        xiii. Biomaterial and bioprocess of construction biotechnology
        xiv. Microbiology of air and air biotreatment
        xv. Microbiology of closed ecosystems
        xvi. Biodeterioration, biocorrosion, and biofouling

Expected Learning Outcomes

Upon completion of the course, students will be able to:

Content

- Describe the various types of microbes found in the environment.
- Describe the interactions of cells in the environment.
- Describe how cell function on a molecular and organelle level to survive.
- Analyze data to determine kinetics of cellular reactions.
- Define the various types of cells in oxygen rich or deprived environments.
- Explain three different specialty topics of application for microbes in environmental engineering.

"Soft Skills"

- Work well in a team and communicate effectively to all members. This involves identifying and rectifying group conflicts.
- Identify personal difficulties during problem solving and to take corrective action.
- Apply a growth mindset to learning about microbes and build self-efficacy of learning abilities.
- Conceptually link levels of information and ideas in a problem-solving framework.

Required Texts or Readings

The following texts will be used through the website Perusall.com:

Volodymyr Ivanov. (2020). *Environmental microbiology for engineers*. Crc Press. ISBN 9780367321659

Required or Special Materials

Students will need a laptop, the most current version of MatLab, and the Microsoft Suite 365 downloaded (to have Excel access). Note, if you are using a Mac, it may help to use the virtual desktop vcat.arizona.edu.

Assignments and Examinations: Schedule/Due Dates

There will be 6 homework assignments due for the course, due at the end of every other week graded on a summation of 5 P/F items. There will be 28 Perusall readings which will be graded on a P/F basis. There will be two midterms and a final, of which we will collaborate on a letter grade earned for the exam. You have the option to substitute a project for the final exam. There are extra assignments under "character growth;" see D2L for more information. Late work will not be accepted. You are encouraged to resubmit homework assignments that were peer reviewed.

Final Examination

The final exam will be on the last day of the course. You can opt to replace the final exam with a project. See D2L for more information.

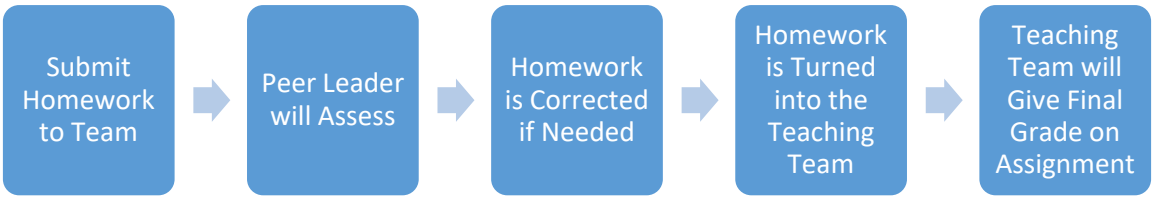
Final Exam Regulations and Final Exam Schedule: https://registrar.arizona.edu/faculty-staff-resources/room-class-scheduling/schedule-classes/final-exams

Grading Scale and Policies

University policy regarding grades and grading systems is available at http://catalog.arizona.edu/policy/grades-and-grading-system

Ungrading

I am expanding on a method of grading this fall termed "ungrading" which was piloted this past summer. You determine your grade for this course by fulfilling a contract that spells out in advance the requirements you will complete for your desired grade. Peer evaluation comes in when students charged with leading a unit assess (as Satisfactory or Unsatisfactory) how well their classmates fulfill the assignments. Peer leaders for the given unit will work with the other students in this class, giving feedback to each student and working to achieve an S grade. If a student fails to submit an assignment or does not submit a satisfactory revision after receiving careful feedback, the peer leader will record a U grade for that assignment. (The same method will work on assignments graded by the teaching team.) Every student will be in a position of peer grader (working with two students at a time) at least once during this semester. After peer review, students will submit the homework for grading by the teaching team. Learning together, and giving and receiving feedback, is a subject we will discuss in depth. *It is the single most valuable life skill you can take away from this course.*



General Process Flow of Assignment Submissions

Contract Grading

The advantage of contract grading is that you, the student, decide how much work you wish to do this semester. If you complete your work on time and satisfactorily, you will

receive the grade for which you contracted. This means planning ahead, thinking about all of your obligations and responsibilities this semester, and also determining what grade you want or need in this course. If you complete the work you contracted for, you get the grade. Done. I respect the student who only needs a C, who has other obligations that preclude doing all the requirements to earn an A in the course, and who contracts for the C and carries out the contract perfectly. (*This is another one of those major life skills: taking responsibility for your own project management and workflow.*)

Grade Calculating

After our first lecture, each student will sign a contract for a grade. There are only two grades for any assignment: Satisfactory and Unsatisfactory or a summation of P/F items. Satisfactory is full credit. Unsatisfactory (poor quality, late, or not submitted) is no credit. At the end of the course, we tally. In terms of peer feedback, your team leader will determine if the homework assignments posted each week are satisfactory. If not, they will give extensive and thoughtful feedback for improvement with the aim of collaborating toward satisfactory work. The goal is for everyone to produce satisfactory work (no matter what quantity one has contracted for). The teaching team will work with students to achieve that goal. Basically, the contract specifies the quantity of satisfactory work a student promises to complete during the term.

Grades

Grades Overview		
Item	P/F Items	Description
Perusall	28	Individual. Weekly readings for classes
Homework	30	6 homework assignments worth 5 P/F items each. Can submit individually or with team.
Midterm 1	9	Individual. Covers first two topics
Midterm 2	9	Individual. Covers second two topics
Final/Project	10	Can choose either Final or Project. Project involves three choices: two challenging homework assignments from MIT or a submission to the iGEM competition
Specialty Topics	9	3 P/F for each day. Group or Individual.
Peer Review of Specialty Topics	3	1 P/F for each day of Jigsaw
Character Growth	5	Individual. One submission is one P/F.
Total	103	

Number of P/F Items Achieved	Letter Grade
90	A
80	B
70	C
60	D
<60	E

Incomplete (I) or Withdrawal (W):

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Scheduled Topics/Activities

Week	Day	Lecture	Date	Topic
1	1	1		Introduction to Course
	2	2		Microorganisms
2	3	3		Cells
	4	4		Cells
3	5	5		Biomolecules
	6	6		Stoichiometry
4	7	7		Metabolism
	8	8		Bioxidation and bioreduction
5	9	9		biodegradation
	10	10		biosynthesis
6	11	11		Cells and cellular aggregates
	12	12		reproduction, proliferation, and growth
7	13	n/a		Midterm 1
	14	13		Microbial ecology
8	15	14		Group of anaerobic fermenting prokaryotes
	16	15		Anoxic Prokaryotes
9	17	16		Microaerophilic and facultative aerobes
	18	17		Aerobic Prokaryotes
10	19	18		Models of Microbial Growth
	20	19		Models of Microbial Growth
11	21	20		Continuous Culture
	22	21		Continuous Culture
12	23	22		Bioreactor Design
	24	23		Bioreactor Design
13	25	24		Bioreactor Design
	26	25		Open Modeling Practice
14	27	n/a		Midterm 2
	n/a	n/a		Thanksgiving
15	28	26		Specialty Topics + Jigsaw
	29	27		Specialty Topics + Jigsaw
16	30	28		Specialty Topics + Jigsaw
17	n/a	n/a		Final or Project Due

Teaching Philosophy

I have a strong student-centered focus for my teaching philosophy. I truly believe in student success and adapting my instruction to ensure an ideal learning environment for students. Several different instructional mindsets to help me accomplish my goal are:

1. Everyone has the right and ability to be successful in my courses. I provide many chances for low-stakes points for my courses. As a future engineer, I want to provide a level of rigor (appropriate for each course!) that will promote my students to be the best engineers they can be.
2. I vary my teaching methods to ensure that my courses are accessible to all students. I frequently was students to give any feedback onto what works or does not work for them so I can modify my instruction.
3. I believe in transparency and open communication, meaning I wish to be as clear as possible in class and give students insight into my teaching decisions. I want my classroom to be one where students can feel free to express their own ideas and thoughts to contribute to the wider discussions.
4. Foremost, I believe in student-centered active learning using evidence-based teaching practices (EBTP). Literature through EBTP support nearly every aspect and decision in this course. I am always open to students' feedback on each practice so I can continually develop them. Just as I want students to have a growth mindset, I too want to continuously improve my courses to be the best they can be.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Campus Health
http://www.health.arizona.edu/
Campus Health provides quality medical and mental health care services through virtual and in-person care.
Phone: 520-621-9202

Counseling and Psych Services (CAPS)

https://health.arizona.edu/counseling-psych-services
CAPS provides mental health care, including short-term counseling services.
Phone: 520-621-3334

The Dean of Students Office's Student Assistance Program
http://deanofstudents.arizona.edu/student-assistance/students/student-assistance
Student Assistance helps students manage crises, life traumas, and other barriers that impede success. The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow up services.
Email: DOS-deanofstudents@email.arizona.edu
Phone: 520-621-7057

Survivor Advocacy Program
https://survivoradvocacy.arizona.edu/
The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.
Email: survivoradvocacy@email.arizona.edu
Phone: 520-621-5767

Confidentiality of Student Records

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

University-wide Policies link

Links to the following UA policies are provided here,
https://academicaffairs.arizona.edu/syllabus-policies

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement