

I ILLINOIS
Bioengineering

BIOE 498/598: Biotechnology Principles, Tools, and Applications

Meeting time: Monday/Wednesday, 9:00 – 10:20 AM

Location: 2233 Everitt

Credit hours: 4

Semester: Spring 2024 (01/16/24 – 05/01/24)

Instructor Information

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Office: 0250 Everitt Lab

Office hours: Wednesday 2-3 PM and by appointment (In person or Zoom meeting)

Course Description

This course aims to stimulate students' interdisciplinary thinking and discussion about bioengineering approaches in both basic and translational research. Students will exploit (1) structures of DNA, RNA, protein, and related molecules/complexes, (2) bioengineering tools and techniques for creation of functional biomaterials, and (3) uses of the biotechniques in disease prevention, diagnostics, therapeutics, etc., for specific applications. Students will learn from the instructor-led lectures, in-class activities, homework, group literature discussions, and team project preparation. To be successful in this class, students will need to:

- Review lecture materials and attend lectures.
- Participate in group literature discussion and team project presentation sessions.
- **For online students, review the recording of group literature discussion and answer relevant questions online.
- Read and discuss the state-of-the-art research papers to gain a deeper understanding of the respective biotechniques and/or their applications.
- Prepare team project report to apply the learned knowledge and skills to new situations and use case scenarios in theoretical settings.

Course Learning Objectives

- Gain the basic principles and concepts of biotechnology.
- Understand historical and the state-of-the-art technologies for DNA, RNA, and protein engineering and sequencing.
- Learn the applications of biotechnology by evaluating published findings.
- Clearly and concisely communicate the rationale, approach, and expected outcomes of published research and team project in oral and written formats.
- Utilize short primary literature and other reputable scientific resources to understand a research topic and develop team project goals.
- Apply concepts from lecture, literature, and other course activities and assignments to identify areas of need in biotechnology.
- Understand professional and ethical responsibility in biotechnology.
- Learn and exercise collaboration with teammates of different backgrounds.

Course Schedule

Week	Date	Topic	Assignment
1	Jan 15	No class (Martin Luther King, Jr. Day)	
	Jan 17	Course/syllabus overview and brief introduction of biotechnology	
2	Jan 22	The ABC's of life: DNA, genes, RNA, protein, and their sequences	
	Jan 24	Tools for DNA and RNA sequencing	HW-1
3	Jan 29	Group literature discussion and video tour of DNA Services Lab, UIUC Biotech Center	
	Jan 31	Nucleic acid bioengineering	HW-1 due on Jan. 31
4	Feb 05	DNA and RNA bionanotechnology	
	Feb 07	Disease diagnosis	
5	Feb 12	Group literature discussion	
	Feb 14	Recombinant DNA technology	HW-2
6	Feb 19	Genome editing techniques	
	Feb 21	Application of CRISPR technology	HW-2 due on Feb. 21
7	Feb 26	Group literature discussion	HW-3
	Feb 28	RNA biology and RNAi technology	
8	Mar 04	Group literature discussion	HW-3 due on Mar. 4
	Mar 06	5-page team project write-up Q&A and discussion	
9	Mar 11	No class (Spring break)	
	Mar 13		
10	Mar 18	mRNA vaccine	
	Mar 20	Production and characterization of proteins	
11	Mar 25	Group literature discussion	

	Mar 27	Team project ideas presentation and discussion (1)	
12	Apr 01	Team project ideas presentation and discussion (2)	
	Apr 03	Protein engineering and applications	HW-4
13	Apr 08	Group literature discussion	
	Apr 10	(Targeted) Drug delivery techniques	HW-4 due on Apr. 10
14	Apr 15	Group literature discussion	
	Apr 17	Cancer immunotherapy	HW-5
15	Apr 22	Group literature discussion	
	Apr 24	Plant, environmental, and animal biotechnology	HW-5 due on Apr. 24
16	Apr 29	Group literature discussion	
	May 01	Biotechnology ethics, safety, and regulation Group discussion	
	May 15	Final team project report due at 11:59 PM	Due on May 15

Course Materials

- Lecture slides.
- Primary research papers, review articles, and book chapters.
- No specific textbook is required (a few books are recommended below) and students are encouraged to read books related to biotechnology.
 - Molecular Biotechnology: Principles and Application of Recombinant DNA, ISBN 1-5558-1936-2.
 - Biotechnology, ISBN 978-3-11-034110-2.
 - Bionanotechnology, Proteins to Nanodevices, ISBN 10 1-4020-4219-1.
 - DNA and RNA Nanobiotechnologies in Medicine: Diagnosis and Treatment of Diseases, ISBN 978-3-642-36852-3.

Grading

Total points for the course = 1,000

- In class group literature discussion
**Online students: quiz questions for the discussed literature
 - 500 points (10 discussions x 50 points each).
 - Attendance required.
- Homework
 - 200 points (5 assignments x 40 points each).

- Due at 11:59 PM on the days specified on the class schedule.
- Tentative assignment topics:
 - ◇ HW-1: Select appropriate sequencing method(s) for specific applications with rationales.
 - ◇ HW-2: Select vector and restriction enzyme for specific genome cloning with an experimental protocol.
 - ◇ HW-3: Compare the pros and cons of different gene editing techniques; Select CRISPR guide RNAs (gRNAs) for specific genome segments.
 - ◇ HW-4: Use protein engineering knowledge to determine which two proteins will interact with each other; Use protein engineering to develop antibodies that can interact simultaneously with two different cell types.
 - ◇ HW-5: Select drug delivery methods for specific payloads and their targets.
- **Team project report**
 - 300 points.
 - Self-assembled groups of students each will write a 5-page team project report for a subject chosen by the students and approved by the instructor. Each group is required to present their preliminary idea about the team project. Students are welcome to discuss their ideas with the instructor during the semester.
 - Group size will be determined based on the total enrollment.
 - Format and evaluation: Each team project report is expected to include experimental design to address the question(s) on the chosen topics. The length of the report will be limited to 5 pages (Arial font, 12 points, single space, 1 inch margin, no-more-than five figures) excluding references. The team project report should include: (1) Title, (2) Specific aims and significance, (3) Background, (4) Experimental design, and (5) References. The scope of the team project report is encouraged to be interdisciplinary and cover topics in biotechnology. Students will explain their team project ideas to the class before writing the report. At the end of the semester, each team project report will be reviewed and graded by the instructor. Detailed review criteria will be discussed in class and posted online.

Disability Statement and Resources

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting “Sign-Up for an Academic Screening” at the bottom of the page.

If you are interested in obtaining information to improve writing, study skills, time management or organization, the following campus resources are available to all students:

- Writer’s Workshop, <https://www.cws.illinois.edu/workshop>
- <https://www.disability.illinois.edu/strategies>

- <https://www.counselingcenter.illinois.edu/self-help-brochures/>

Also, most college offices and academic deans provide academic skills support and assistance for academically related and personal problems. Links to the appropriate college contact can be found by going to this website and selecting your college or school: <https://illinois.edu/colleges/colleges.html>

If you are experiencing symptoms of anxiety or depression or are feeling overwhelmed, stressed, or in crisis, you can seek help through the following campus resources:

- Counseling Center, 206 Fred H. Turner Student Services Building, 7:50 a.m.-5:00 p.m., Monday through Friday Phone: 333-3704.
- McKinley Mental Health, 313 McKinley Health Center, 8:00 a.m.-5:00 p.m., Monday through Friday Phone: 333-2705.
- McKinley Health Education offers individual consultations for students interested in learning relaxation and other stress/time management skills, call 333-2714.

Diversity, Equity, and Inclusion Statement

It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups.

Important note: Given the sensitive and challenging nature of the material discussed in class, it is imperative that there be an atmosphere of trust and safety in the classroom. I will attempt to foster an environment in which each class member is able to hear and respect each other. It is critical that each class member show respect for all worldviews expressed in class. It is expected that some of the material in this course may evoke strong emotions, please be respectful of others' emotions and be mindful of your own. Please let me know if something said or done in the classroom, by either myself or other students, is particularly troubling or causes discomfort or offense. While our intention may not be to cause discomfort or offense, the impact of what happens throughout the course is not to be ignored and is something that I consider to be very important and deserving of attention. If and when this occurs, there are several ways to alleviate some of the discomfort or hurt you may experience:

- Discuss the situation privately with me. I am always open to listening to students' experiences, and want to work with students to find acceptable ways to process and address the issue.
- Discuss the situation with the class. Chances are there is at least one other student in the class who had a similar response to the material. Discussion enhances the ability for all class participants to have a fuller understanding of context and impact of course material and class discussions.
- Notify me of the issue through another source such as your academic advisor, a trusted faculty member, or a peer. If for any reason you do not feel comfortable

discussing the issue directly with me, I encourage you to seek out another, more comfortable avenue to address the issue.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: <https://studentcode.illinois.edu/>

The Grainger College of Engineering uses the FAIR system to document and track academic integrity violations across courses. Multiple violations, even across multiple units, may be cause for dismissal. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Educate yourself on all policies here:

<https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/>

Please do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.