BIOE 434/498/598: Immunoengineering

ILLINOIS
Bioengineering

Meeting time: Tuesday/Thursday, 12:30 – 01:50 PM
Location: 1302 Everitt Laboratory
Credit hours: 3 undergraduate hours, 4 graduate hours
Semester: Spring 2025 (01/21/25 – 05/07/25)

Course website: https://canvas.illinois.edu/courses/54711

Instructor Information
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TA Information
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Course Description
Students will explore concepts surrounding the field of immunoengineering, with a focus on understanding engineering approaches in both basic and translational research, as applied to the immune system and its manipulation for disease intervention and management. Students will rigorously study design principles underlying immunologically based therapies and diagnostics. Critical analysis of scientific findings will be facilitated through instructor-led lectures, student-led literature discussions, in-class activities, and homework. Through activities and assignments, students should gain a deeper understanding of the underlying physical, chemical, and biological components that have facilitated immunoengineering advances, with an emphasis on developing novel, innovative solutions to address limitations in existing technology. Assignments, quizzes, and in-class activities will focus on critical analysis and thoughtful evaluation of data and conclusions, as well as effective written and oral communication skills.

Textbook and Reading Materials
- Assigned reading material will be posted online and may include but is not limited to the following: primary research papers, review articles, and book chapters.
- *Recommended (not required)*: Murphy K, Weaver C. Janeway's Immunobiology. Ninth ed. New York, NY, USA: Garland Science, Taylor & Francis Group, LLC; 2017.
    - This book is an excellent resource, covering fundamentals as well as in-depth topics. The content –both figures and text – are clearly presented and of value to individuals at all levels of expertise.

Course Learning Objectives
- Gain basic knowledge of the human immune system.
- Understand historical and updated standard of care for diseases in which immunoengineering has been implemented, including limitations and risks of new approaches.
- Understand contemporary issues, including professional and ethical responsibility, in immunoengineering.
- Apply concepts from lecture, literature, and other course activities and assignments to identify areas of need in immunoengineering fields.
- Critically evaluate published findings – impact, relevance, approach, etc.

- Utilize primary literature, review articles, and other reputable scientific resources to understand a research topic and develop research goals.
- Understand and implement the design of logical and meaningful experiments, including appropriate controls.
- Propose, critically evaluate, and modify experimental solutions.
- Clearly and concisely communicate the rationale, approach (including technical details), and expected outcomes of published and proposed research in both oral and written formats.
- Function in multidisciplinary teams.

Course Policies

- **Attendance:** Attendance is required for literature discussions and in-class activities except for pre-authorized absences or unavoidable emergencies. You are not required to attend lectures. However, you will get out of this class what you put into it – attending lectures ensures that you have access to information and discussion points brought up in class that are not available on posted lecture slides.
    - Quizzes may only be taken during class.
    - Makeup work will not be accepted for in-class activities that are missed due to unexcused absences.
- **Course-related communications:** Course announcements will be sent out via Canvas and/or email so please check your inbox regularly. For general course questions and information, first consult the syllabus and course material on Canvas. If your question/issue is still not answered/addressed, please ensure that any emails you send to me use a professional format and tone. I will make every effort to reply promptly.
- **Academic integrity:** *I take academic integrity, and ethical behavior in general, very seriously.* It is your responsibility to be familiar with the UIUC student code regarding cheating, plagiarism, fabrication, facilitating infractions, bribes/favors/ threats, and academic interference. In this course, all submitted work must be your own – you may discuss, you may not copy (words or ideas).
- **Laptops and mobile devices:** Mobile devices should be on silent and out of sight during class. Laptops may be used for course-related tasks, e.g., to take notes or investigate relevant topics. If you choose to use class time to do anything that may be disruptive or distracting to other students, please excuse yourself and take some time to reflect on your academic, educational, and professional goals and priorities.
- **Diversity statement:** The diversity of the participants in this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your or anyone's contribution is not being valued for any reason, please speak with myself or your TA privately or contact the department if you wish to remain anonymous.

Grading

Total points for the course = 1000

- **Quizzes and literature discussion participation – *attendance required***
    - 80 points (*8 literature quizzes x 10 points each)*
    - Weekly assessment of comprehension and critical thinking based on assigned literature discussion paper and associated lecture material.
    - Literature discussions will begin in small groups and transition to full-class discussion of assigned paper and associated lecture topics. All students are required to read assigned paper (maybe multiple times) prior to class and be prepared to answer (and ask) questions about rationale, methods, results, and

impact of the study. All students are expected to participate in both the small-group and full-class discussions.

- **In-class activities – *attendance required***
  - 120 points (*3 activities x 40 points each)*
  - In-class activities designed to support and guide group project development will take place on days noted in schedule below. Associated assignments due in class or at 11:59 pm on indicated days.
- **Homework**
  - 240 points (*434, 498: 4 assignments x 60 points each, 598: 6 assignments x 40 points each)*
    - 434, 498, and 598 students: 4 milestone assignments for Group Project (see schedule below).
    - 598 students only: 2 additional literature-based assignments.
  - All assignments due at 11:59 pm on indicated days.
- **Group project final report**
  - 260 points
  - Self-assembled groups of 4-5 students each will select a topic and formulate a proposal related to immunoengineering. Detailed guidelines will be provided and discussed in class. Milestone assignments will help guide your progress and substantial time will be devoted to working on projects in class. Students will present their proposal in a poster session during finals week, along with a final written version.
- **Final exam**
  - 300 points
  - Comprehensive exam covering lecture and literature topics, critical analysis, and experimental design.

Course Schedule (*subject to change*)

Week	Date	Topic	Assignment Due
1	Jan 21	**Intro Lecture A** Course overview, intro to human immune system and immunology basics	
	Jan 23	**Intro Lecture B** Immune system continued; history of immune therapy	
2	Jan 28	**Lecture 1** Vaccines	
	Jan 30	**Literature Discussion 1** – see Canvas for assigned paper	
3	Feb 04	**Lecture 2** Cancer and Immunology	
	Feb 06	**Literature Discussion 2** – see Canvas for assigned paper	
4	Feb 11	**Lecture 3** Antibody engineering	
	Feb 13	**Literature Discussion 3** – see Canvas for assigned paper	
5	Feb 18	**Lecture 4** Checkpoint inhibitors	HWA: 598 only
	Feb 20	**Literature Discussion 4** – see Canvas for assigned paper	
6	Feb 25	**Lecture 5** Autologous cell therapy and engineered cells	
	Feb 27	**Literature Discussion 5** – see Canvas for assigned paper	
7	Mar 04	**Lecture 6** Gene therapies and oncolytic viruses	HWB: 598 only
	Mar 06	**Literature Discussion 6** – see Canvas for assigned paper	
	Mar	**Lecture 7**	

8	11	Microbiota and neuroimmunology	
	Mar 13	**Literature Discussion 7** – see Canvas for assigned paper	
9	Mar 18	No class (Spring break)	
	Mar 20		
10	Mar 25	***Activity 1: Networking and group formation for projects*** *Attendance* ***REQUIRED***	
	Mar 27	**Dedicated in-class group work time with instructor feedback**	**Activity 1:** Submit group member names *(individual)*
11	Apr 01	**Lecture 8** Regenerative medicine, autoimmunity, biomaterials, transplantation	
	Apr 03	**Literature Discussion 8** – see Canvas for assigned paper	
12	Apr 08	**Project Guidelines Overview** Optional group work time	
	Apr 10	**Dedicated in-class group work time with instructor feedback**	**HW 1:** Select project topic (*group submission)*
13	Apr 15	**Dedicated in-class group work time with instructor feedback**	
	Apr 17	***Activity 2: Lightning talks with peer feedback*** *Attendance* ***REQUIRED***	**Activity 2:** Peer feedback summary *(individual)*
14	Apr 22	**Dedicated in-class group work time with instructor feedback**	**HW 2:** Project updates *(individual)*
	Apr 24	**Dedicated in-class group work time with instructor feedback**	**HW 3:** Intro draft and full proposal outline *(group submission)*
15	Apr 29	**Dedicated in-class group work time with instructor feedback**	**HW 4:** Draft of overview schematic *(group submission)*
	May 01	***Activity 3: Group project discussions with instructor feedback*** *Attendance* ***REQUIRED***	**Activity 3:** Summary of intended revisions *(group submission)*
16	May 06	**Dedicated in-class group work time with instructor feedback**	
Finals week	May 12	**FINAL EXAM** **Day: Monday, May 12** **Time: TBD** **Location: TBD**	
	May 15		**Final reports** *(group submissions)*