School of Molecular & Cellular Biology

MCB 493 sxn MTB, Spring 2025

Modern Technologies in Biological Research, 3 Credit Hours

Instructor

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Instructional Team

TAs
TBD

MCB Instructional Program Office

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Class Meeting Schedule *(all times are Central)*

Monday, Wednesday, and Friday 3:00pm – 3:50pm
Location: TBD
Office Hours: Thursday 3pm – 4pm RAL 314F
TA Help Office Hours: TBD

Course Overview and Description

Modern biotechnology is a fast-evolving field that drives advancements in research, industry, medicine, and other areas. This course provides an in-depth exploration of contemporary approaches, emphasizing the principles and research applications of cutting-edge technologies, including genetic engineering, CRISPR, DNA sequencing, functional genomics, and structural biology. Students will gain hands-on experience with these techniques and bioinformatics tools. Through dry-lab practices and group projects, students will develop skills in research project design, data analysis, and interpretation.

Course Prerequisites and Requirements met

MCB 354 or MCB 450 or instructor consent

This is a 3-credit hour course. Students should dedicate approximately 5 or 6 hours per week to working on the course, but actual time commitments will vary depending on your input, needs, and personal study habits.

Student Learning Outcomes for the Course

At the end of the course, through assignments, discussions, activities and assessments, students will be able to:

- Understand the basic concepts, procedures, and importance of modern biotechnologies and their applications in research, medicine, industry, and other fields.
- Develop critical thinking and research skills to explore innovative solutions and contribute their own ideas to ongoing biotechnological challenges.
- Gain hands-on experience in using bioinformatics tools and analyzing high-throughput sequencing data through dry-lab practices.
- Design a research project that incorporates various biotechnological approaches to tackle a real-world research question.
- Develop skills of understanding and evaluating primary scientific literature.
- Enhance teamwork and science communication skills.

Course Calendar (Spring 2025)

	Day	Date	Lecture Topic
1	W	Jan 22	Course overview
2	F	Jan 24	History of biotechnology & introduction to modern biotechnology
Part I. DNA manipulation and gene therapy			
3	M	Jan 27	Cloning and DNA synthesis (Q1)
4	W	Jan 29	Genetic engineering in bacteria (Q2)
5	F	Feb 31	Genetic engineering in eukaryotic organisms (Q3)
6	M	Feb 03	Gene editing technologies and gene therapy (Q4)
7	W	Feb 05	CRISPR technology (Q5)
8	F	Feb 07	CRISPR applications (Q6)
9	M	Feb 10	**Lab 1-1:** Design to build a transcription reporter and a translation reporter of the gene of interest
10	W	Feb 12	**Lab 1-2:** Design a strategy to introduce mutation into *E. coli* genome using CRISPR-Cas system
11	F	Feb 14	**Discussion 1:** Gene editing & gene therapy (literature presentation) **Assignment 1:** Bacteria genome editing using different approaches
Part II. Sequencing-based technologies			
12	M	Feb 17	Introduction to DNA sequencing technologies (Q7)
13	W	Feb 19	Genome sequencing projects (Q8)

14	F	Feb 21	Genome assembly and Phylogenetics/phylogenomics (Q9) **Assignment 1 due date**
15	M	Feb 24	**Lab 2:** Obtain genome and gene information from online databases **Assignment 2:** Finding and comparing homologs of your gene of interest in different organisms
16	W	Feb 26	Sequencing and DNA replication (Q10)
17	F	Feb 28	Sequencing and genome structure (Q11)
18	M	Mar 03	Transcriptomics I: RNA-seq (Q12) **Assignment 2 due date**
19	W	Mar 05	Transcriptomics II: RNA synthesis (Q13)
20	F	Mar 07	**Discussion 2:** Current genome sequencing projects (literature presentation)
21	M	Mar 10	Transcriptomics III: RNA degradation (Q14)
22	W	Mar 12	Transcriptomics IV: RNA structure (Q15)
23	F	Mar 14	**Lab 3**: RNA secondary structure prediction **Assignment 3:** Can RNA structure affect gene expression? Optimize your reporter.
Spring Break Mar 15 - Mar 23			
24	M	Mar 24	Translatomics I: Ribosome profiling (Q16)
25	W	Mar 26	Translatomics II: Translational regulation (Q17) **Assignment 3 due date**
26	F	Mar 28	**Lab 4:** RNA-seq and Ribosome profiling data analysis **Assignment 4:** Interpreting results of RNA-seq and ribosome profiling using gene function analysis

27	M	Mar 31	**Discussion 3:** Approaches to characterize gene regulation at different levels (literature presentation)
Part III. Functional Genomics Screening			
28	W	Apr 02	Introduction into high-throughput phenotypic screens (Q18)
29	F	Apr 04	Approaches in functional genomics screens (Q19) **Assignment 4 due date**
30	M	Apr 07	Applications of functional genomics screens in research & industry (Q20)
Part IV. New approaches in structural biology			
31	W	Apr 09	Introduction to integrative structural biology (Q21)
32	F	Apr 11	**Discussion 4:** New approaches used in functional genomics screens (literature presentation, Part III)
33	M	Apr 14	AlphaFold: an AI-based methodology **Lab 5:** Protein structure prediction using AlphaFold **Assignment 5:** Predict the structure of your protein of interest
34	W	Apr 16	Structural biology approaches at different size and time scales (Q22)
35	F	Apr 18	**Discussion 5:** Future of integrative structural biology (literature presentation)
Part V. Other topics of modern biotechnology			
36	M	Apr 21	Imaging technology in research and biomedical fields (Q23) **Assignment 5 due date**
37	W	Apr 23	Proteomics (Q24)
38	F	Apr 25	Metabolomics and metabolic engineering (Q25)
39	M	Apr 28	Antibiotics and phage therapy (Q26)

40	W	Apr 30	Microbiome and diseases (Q27)
41	F	May 02	Antibodies, T cells, and immunotherapy (Q28)
42	M	May 05	**Final project presentation I**
43	W	May 07	**Final project presentation II**
May 14: Final project proposal due date			

Q: in-class quizzes

Discussions: Graded group presentations of primary literature; 1-2 groups per discussion session

Final project presentation I and II: Graded group presentations of final projects

Text/Materials Information

No specific textbook is required for this course.
Student assignments include reading primary literature and review articles related to the topics of lectures.

Class handouts, original research articles and reviews will be posted on the course website (https://canvas.illinois.edu/)

Grading Information and Breakdown

Student grades will be based on total of **1000 points** from the following categories.

30% Class participation and quizzes (25 total, 12 point each)	**300**
25% Graded homework assignments (5 total, 50 points each)	**250**
20% Graded presentations (2 total, 100 points each)	**200**
25% Final project proposal (250 points)	**250**

Total **1000** points

Grade Scale:

Letter Grade	Point Ranges
A+	950-1000
A	900-949
A-	850-899
B+	800-849
B	750-799
B-	700-749
C+	650-699
C	600-649
C-	550-599
D+	500-549
D	450-499
D-	400-449
F	0-399

Course Grading

Quizzes

Quizzes will offer opportunities in class or occasionally after class where you will be asked to answer 5 questions based on the material that is/was covered that day. Due to the nature of these questions being asked/answered in real-time, the possibility for extensions on these assignments is not possible. The scale below will be used to determine the total number of

points earned for each quiz. At the end of the semester, points earned from the **25 quizzes with the highest scores** will count toward the final grade.

% Correct	Points student earns
100% (5/5)	12
80% (4/5)	10
60% (3/5)	8
40% (2/5)	6
20% (1/5)	4
Below 20% (0/5)	2

Homework Assignments

Five post-lecture assignments will be in the form of problem-solving questions. The questions will be based on the material covered in the lectures. Assignments will be due **a week** after they are posted on the course management system, Canvas.

Please check your Canvas course for the assignments' open and close dates and times to avoid missing deadlines. Late submissions will incur a **5-point** deduction per day.

Presentations and Final Project

Students will participate in two graded presentations and a final project.

Presentations will be completed in groups.

Presentation 1: Each group will present one research paper. This presentation will demonstrate the group's understanding and analysis of the given literature.

Presentation 2: Each group will present their final project based on the chosen topic, which includes the main question to be addressed, experimental plans, and potential outcomes. This presentation will include a Q&A session where the group member will answer questions from other students and the instructor.

Final Project:

Topic Selection: Each group will choose one topic from the five provided candidates for their final project. Students will integrate the different techniques learned during the semester to answer a specific biological question.

Team Collaboration: Students will collaborate within their group to brainstorm the research question, develop experimental plans, and discuss potential outcomes.

Group presentation: The final project will be presented to the class, including a discussion session where the group will answer questions from peers and the instructor.

Research Proposal: After incorporating feedback from the presentation, **each** student will **independently** complete a research proposal. This proposal should describe the project, outline experimental plans, and anticipate results. Additional independent thoughts and data discussion from students are highly encouraged.

Grading Rubrics: The rubrics for grading the presentations and the final project proposal will be posted three weeks before the due date. These rubrics will detail the criteria and expectations for each component of the presentations and final project.

Course Policies

Students are expected to have knowledge of the Course Policies. These policies were developed in agreement with the *2024-2025 Illinois Student Code*.

Adding the Course after the Semester Start

We understand that the University has an add deadline 10 days into the semester, but the University allows individual courses and/or programs determine their policies for late adds. Students who choose to add a course late do so at their own discretion with knowledge that material has been missed and points may be lost as a result.

Class Absences and Late Submission

Regular class attendance is expected of all students at the University. (https://studentcode.illinois.edu/article1/part5/1-501/)

- If you find yourself ill, you must submit confirmation of a visit with a medical practitioner within 24 hours of your absence.
- The Office of the Dean of Students will only provide informative letters to instructors for protracted illness of 3 or more days, certain emergencies and to be present during the serious illness of immediate family members (parents, legal guardian, spouse/partner, siblings, children, or grandparents). These letters do not excuse you from class but merely provide information for the instructor to consider regarding excusing the absence and permitting make-up work. Students must request absence letters from the Office of the Dean of Students after the student has returned to class but not more than 10 business days after the last date of absence.
- Absences that may be excused without a letter include circumstances beyond the student's control such as medical treatment, surgery related to prolonged illness or injury, pregnancy, legal matters, citizenship or naturalization processes, or acts of nature which cause destruction to a primary residence or disrupt air travel. All will require documentation.
- Absences that may also be excused without a letter from the Dean of Students Office include a conference or job, graduate or professional school interviews, though a best effort should be made to schedule these events to minimize class attendance disruption. All will require documentation.
- Absences that will not be excused include family events such as reunions or weddings, or presence during serious illness of extended family members (aunt, uncle, niece, nephew, or cousin).
- Unplanned absences may result in the loss of opportunity to reschedule the missed class period and, therefore, the portion of the grade associated with this class period.
- Absences will be handled according to individual course policy.

All assignments and the final project proposal must be submitted through the Canvas system by the specified due date and time. Late submissions will incur a grade deduction in the respective category.

Academic Integrity

The Student Code will be applied in all instances of academic misconduct committed by students. This applies to all presentations, assignments, and materials distributed or used in this course. You can review these polies in the Student Code, specifically (https://studentcode.illinois.edu/article1/part4/1-401/) Ignorance is not an excuse for any academic dishonesty. It is the students' responsibility to read this policy to avoid any misunderstanding. 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.

Disability Resources and Educational Services (DRES) Accommodations

We are committed to providing a learning environment where our students can succeed. If you require special accommodations, please contact the course personnel and the DRES as soon as possible. To contact DRES, you may visit 1207 S. Oak Street, Champaign, call 217-333-4603, or email disability@illinois.edu. Please note that accommodations are not retroactive to the beginning of the semester, but begin the day you contact your professor, instructor, or coordinator with a current letter of accommodation from DRES. DRES accommodation documentation needs to be submitted to course instructor(s) by the end of the second week of class.

Religious Observances and Practices

It is the policy of the University of Illinois Urbana-Champaign to reasonably accommodate its students' religious beliefs, observances, and practices that conflict with a student's class attendance or participation in a scheduled examination or work requirement, consistent with state and federal law. Students must request a reasonable accommodation for their religious belief, observance, and practice **in advance of the conflict** to allow time for both consideration of the request and alternate procedures to be prepared.

A reasonable accommodation for a religious belief, observance, and practice is defined as a change that allows the student to participate in their religious belief, observance, and practice and which does not fundamentally alter the educational requirement or place an undue hardship on an instructor, department, or office.

Students must direct a request for a reasonable accommodation for a religious belief, observance, and practice to the instructor(s) of the affected course(s), who shall review the request and determine whether a reasonable accommodation can be made. This form serves as a resource to assist students as they are making such requests to their instructors. Once submitted, students will receive a copy of this request form. Students must then forward the form to each instructor to request the accommodations.

Request to Instructor Religious Accommodation form:
https://cm.maxient.com/reportingform.php?UnivofIllinois&layout_id=42)

Inclusivity Statement

The effectiveness of this course is dependent upon the creation of an encouraging and safe classroom environment. Exclusionary, offensive, or harmful speech (such as racism, sexism, homophobia, transphobia, etc.) will not be tolerated and in some cases may subject to university harassment procedures. We are all responsible for creating a positive and safe environment that allows all students equal respect and comfort. Students are expected to help establish and maintain and environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language.

Contacting MCB Course Personnel

MCB course personnel are more than happy to assist students. Emails to instructors, TAs, or course coordinators will only be answered if they come from an @illinois.edu account. When you email a staff member, please include all pertinent information so that we can assist you in the most efficient and effective manner possible. This information includes:

- The course rubric in the subject line
- Your full first and last name
- Your NetID (the first part of your illinois.edu email account)
- Your UIN (9-digit number that you use to register for classes)
- The course that you are concerned about (the course personnel often work with multiple courses)
- Your section letter/number
- The previous email "thread" or previous communicated information pertinent to the situation