BE505/605 Molecular Bioengineering
Fall 2020 Course Information

Lectures Tu/Th 9-10:30

In this course we will introduce the fundamentals of molecular cellular biology underpinning applications in bioengineering. The course will emphasize core concepts, quantitative analyses, high-throughput advanced 'omics techniques, and multi-scale systems approaches. Textbook readings will be used to develop a foundation of basic facts and concepts. Lectures will build on this foundation to dive into key concepts, explore the experimental logic and techniques used to study molecular biology, and develop quantitative models.

Topics include:

- Protein and DNA structure
- Recombinant DNA, cloning and genomics
- Prokaryotic and eukaryotic gene regulation and single cell gene expression
- The structure and dynamics of gene regulatory networks
- Metabolism and cellular energetics
- Cell Structure, cytoskeleton and cellular motors
- Synthetic gene circuits and metabolic engineering

Lectures are also complemented by a graduate wet lab course. The first half of this lab will introduce students to essential techniques in molecular biology. The second half of the lab will allow students to perform a novel experiment and prepare a final report detailing the results of this experiment and the integration of these results with the facts and concepts covered in the lectures and readings. In place of a final exam, students will give a scientific presentation of their findings to the class. Undergraduates (BE505) who cannot take lab will do a non-lab based final project.

Course Staff

Lecturers: James Galagan, LSEB 1002, jgalag@bu.edu, 617-875-9874

Wilson Wong, CILSE 405B, wilwong@bu.edu, 617-358-6958

Lab Instructor: Xin Brown, ERB 723, xinq@bu.edu, 617-358-4193

Website

The course website is being hosted via BU Blackboard 8 at http://learn.bu.edu . You should be able to access the site if you are registered for the course. If you have any problem with this, please email us.

Grading

Your grade in this course will be based on the following:

- Problem Sets (20%)

- Midterm Exams (40%)
- Lab and Final Project (35%)
- Scribing (5%)

Textbooks

The **primary textbook** for the course will be

- (**MCB**) Molecular Biology of the Cell, by Alberts et al., Garland Science (we suggest the latest edition)

Reading will be assigned for each lecture or group of lectures from this book. It is essential that students complete the reading assignments before the lectures. The lectures will typically assume that students are familiar with the essential facts, terminology, and concepts covered in the textbook. There is a wealth of information that is necessary to truly understand molecular biology, and there is no substitute for completely reading and digesting a comprehensive textbook like MCB. Students who have not previously taken molecular biology should expect to read nearly all of MCB.   The lectures will build on this knowledge.

In addition, we also recommend the following **reference books**. Some material from these books will be presented in lecture, and interested students should consider including these texts in their own libraries:

- (**PBC**) Physical Biology of the Cell, by Phillips et al., Garland Science (we suggest the latest, 5th edition)
- (**Alon**) An Introduction to Systems Biology: Design Principles of Biological Circuits, by Uri Alon, Chapman and Hall
- (**Klipp**) Systems Biology, A Textbook, by Klipp et al., Wiley Blackwell

Primary Literature

Textbooks are only a foundation for delving into the primary literature in molecular biology. As a graduate level course, students will have the opportunity to read, interpret, and critically reason about methods and results presented in the published papers. A set of papers will be assigned to each lecture or set of lectures. In some cases, the lectures will include a discussion and analysis of some of these papers.

Problem Sets

There will be three problem sets during the first half of the course. Problem sets are designed to reinforce the integration of key concepts and facts, promote critical reasoning about experimental methods and data, and establish a foundation for quantitative analysis and modeling. Some basic programming in Matlab or similar programming language may be required.

Midterm Exams

There will be two midterm exams, as noted on the class schedule. There will be no final exam. Instead, students will present the results of their final project.

Final Project

Graduate students enrolled in BE605 are also required to enroll in the wet lab course. During the first half of the wet lab, students will learn basic molecular biology techniques and lab skills. During the second half of the course, students will apply and integrate these techniques in a final project.

The final project will apply chromatin-immunoprecipitation followed by sequencing (ChIP-Seq) to globally map and characterize the binding sites for *E. coli* transcription factors (TFs). Students will select a set of TFs that will include positive controls. Students will have the opportunity to perform all validation and expression of clones and immunopreciptitation. Sequencing will be performed by a core facility. Students will then analyze the sequencing data, draft a final report of their findings, and present these findings in a final presentation. Chip-Seq has been widely performed on other bacteria (as will be described in the lectures), but not for *E. coli.* Thus students will have the opportunity to generate and analyze primary data, integrate these data with existing literature, and present these novel results to their peers.

Scribing

Each student will be required to scribe for one lecture. Several students may be assigned to work together on each lecture, depending on course enrollment. As a scribe, you should strive produce a self-contained narrative of the lecture. However, the slides for each lecture will be available on the course web site, so you should pay particular attention to issues that the slides don't convey well on their own.

Collaboration Policy

You are welcome to collaborate on problem sets and the final project. However:

- You must work independently on each problem before you discuss it with others.
- You must write the answers on your own.
- You must acknowledge outside sources and collaborators.