Syllabus for Bio 105 – Molecular Biology
Fall 2020

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What will we discuss in this course?

Molecular biology focuses on nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, transcription, splicing, protein synthesis, and gene regulation in different organisms. We will study the techniques and experiments used to discern these mechanisms, often referring to the original scientific literature. In addition, we will take an in-depth look at some rapidly evolving fields, including chromatin structure and function, genome editing techniques, and regulation of gene expression by non-coding RNAs.

What background knowledge will I need to succeed?

Bio 41 (Genetics) or the equivalent is highly recommended. We assume that you have a working knowledge of basic molecular genetics and general chemistry. If your background in these subjects is limited, you may want to find a copy of a good genetics or intro chemistry textbook for reference.

What is the format of this course and when will we be meeting together?

Most of the material for the course will be delivered asynchronously, through short videos and readings. This allows for maximum flexibility and helps students who are studying remotely or in quarantine. Canvas pages describing each week's independent work and an introductory video for the week will be posted every Friday evening.

During the normally scheduled class times (Tuesdays and Thursdays, 10:30-11:45 AM), we will meet on Zoom for problem-solving sessions. Much of your time in these sessions will be spent in breakout rooms with teams of your colleagues. You will only need to attend **ONE** session per week. Half of the class will meet on Tuesdays, while the other half will meet on Thursdays. Links to the Zoom sessions will be posted on Canvas. Please make sure that your actual name is visible on your Zoom profile on the screen. If you choose to keep your video off, please add a picture of yourself to your profile.

We will also hold an optional recitation session on Mondays, 3-4 PM. The purpose of the recitation is to give you an opportunity to ask questions about the problem sets, quizzes, and course material in general. Links to these optional sessions will be posted on Canvas and the sessions will be recorded.

When can you talk to us outside of class?

Professor McVey:	Wednesdays Thursdays	11 AM-12 noon 2:30-3:30 PM	Zoom meeting ID: 305 145 4632
Tokio Sano:	Mondays Wednesdays	12:30-1:30 PM 1-2 PM	Zoom meeting ID: 935 743 7363

It's helpful, but not necessary, if you email us if you plan on attending one of our office hours. To arrange a different time, please send either of us an e-mail.

What materials are required for the course?

The required textbook is Molecular Biology: Principles and Practice, 2nd edition, by Cox *et al.* An e-version of the text will be available through Tisch library. Additional handouts and papers will be posted on the Bio105 Canvas site.

In addition to Canvas, we will be using several online tools to enhance your learning experience. You will use the **Gradescope** platform to submit your problem sets and unit assessments. You will use the **Perusall** platform to read and annotate the journal club papers with your colleagues. During our online problem-solving sessions, we will use the **Poll Everywhere** student response system and **Google Docs**. These tools are free and details about how to connect to and use them will be provided prior to the first week of class.

What are our goals for this course? By the end of this semester, we want you to:

1. Understand how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information.
2. Appreciate that molecular biology is a dynamic and ever-changing experimental science.
3. Become comfortable with reading and critiquing primary research papers.

What are the course objectives? By the end of the semester, you should be able to:

1. Explain and give examples of how ionic, hydrophobic, and hydrogen bonding interactions determine the structure of nucleic acids and proteins and modulate the specificity of binding between them.
2. Distinguish between different molecular biology techniques that are used to isolate, separate, and probe for specific nucleic acids, proteins, and their interactions. Identify limitations of these techniques.
3. Given a biological question, identify which experimental techniques are best used to answer that question.
4. Compare and contrast the mechanisms of bacterial and eukaryotic DNA replication, DNA repair, transcription, and translation.
5. Explain how DNA topology and chromatin structure affect the processes of DNA replication, repair, and transcription.
6. Give examples of DNA and histone modifications and predict how they will affect replication, repair, and gene expression.
7. Describe mechanisms by which DNA can be damaged and describe the molecular mechanisms by which protein complexes repair or bypass different forms of DNA damage.
8. Explain how endogenous biological processes like homologous recombination, site-specific recombination, transposition, and genome editing systems are being used to modify eukaryotic genomes.
9. Describe how pre-mRNA splicing occurs and explain how alternative splicing (including backsplicing) can generate mRNA and protein diversity.
10. Explain the molecular mechanisms behind different modes of gene regulation in bacteria and eukaryotes at both pre- and post-transcriptional levels.
11. Compare and contrast various ways in which gene expression is regulated by different types of RNAs.
12. Interpret and critique data from primary research articles.
13. Write an analytical perspective about a primary research article.

What will you need to do to succeed?

Since this is an online course and some of you are participating from different time zones, much of the course material will be delivered asynchronously, via short videos that you can watch at times of your choosing. There will also be reading assignments from the textbook that will accompany the videos. Every Friday evening, we will release the content material for the upcoming week on Canvas.

To master the material, you will need to do 2 assignments each week (except for Journal Club weeks):

1. Complete a Canvas quiz **prior to** your weekly online problem-solving session
2. Answer questions on a weekly problem set and submit it via Gradescope by 11PM on Friday

How will your progress be evaluated?

The final course grade will be determined based on the following point breakdown:

Unit assessments, highest scores	**30%** (15% each)
Unit assessments, lowest score	**10%**
Problem sets (best scores from 10/11)	**20%** (2% each)
Perusall assignments (3)	**15%** (5% each)
Canvas quizzes (best scores from 10/11)	**10%** (1% each)
Journal club 3 group assignment	**10%**
Problem solving session participation	**5%**

Participation in problem-solving sessions: Each week, we'll ask you to attend a synchronous problem-solving session (either Tuesday or Thursday) on Zoom. Please let us know if you're unable to attend these and we will make alternate arrangements. To promote class discussion and to give you practice with the types of questions that appear on unit assessments, we will use Poll Everywhere during these Zoom sessions. Poll Everywhere is a free, student-response service that allows to you respond to instructor questions anonymously. Instructions for how to use Poll Everywhere will be provided on Canvas. Only participation (not correctness of answers) on the Poll Everywhere questions will be considered when determining your participation grade.

For more information about Poll Everywhere, visit this website.

Canvas Quizzes: Each week, we will ask you to read a section from the textbook and watch several short videos. Following this, you should complete the Canvas quiz that accompanies the material. The questions on these quizzes will test your **comprehension** of the course material. Their purpose is to ensure that you are keeping up with the class. You should complete them **before** you come to your assigned online problem-solving session (either Tuesday or Thursday). Feel free to collaborate with your colleagues on these quizzes.

Problem Sets and Gradescope: Each week, we will provide you with a set of multiple choice and short-answer questions that engage you in critical thinking and analysis. These questions are like the problems that you will encounter on the unit assessments. You can access the problem set assignments through a link to Gradescope on Canvas. You should complete these problem sets and submit them via Gradescope by 11 PM on Sunday evening. You can collaborate with your colleagues on the problem sets. You will receive an email to access Gradescope before the class begins.

Journal clubs and Perusall: Three of the weeks are reserved for discussion of primary research papers. During these journal clubs, we will focus on the data presented in the figures and tables, and small groups will be asked to present figures from the paper. Prior to reading the paper, you will be asked to annotate a .pdf of the paper using a free, online collaboration tool called Perusall. You can access this tool by clicking on the 'Perusall' button in Canvas. You will be taken to the assignments page, where you can take a guided tour to learn more about how Perusall works and what you will be expected to do for each paper. You can also access information about Perusall at this link.

Unit assessments: There will be 3 unit assessments composed of a combination of multiple choice, short answer, and short essay questions. The questions will be drawn from the videos and readings, online problem-solving sessions, and journal club discussions. Your two highest scores on these assessments will each contribute to 15% of your final grade and the other will contribute 10%. You will have 3 hours to complete each assessment (during a 30 hour period) after it is released on Gradescope. If you are unable to complete one of the unit assessments for any reason, then each of the other two will count 20% of your final grade.

Unit assessment #1	Released Th 10/8 at 5 PM, due S 10/11 by 11 PM
Unit assessment #2	Released Th 11/5 at 5 PM, due S 11/8 by 11 PM
Unit assessment #3	Released Th 12/10 at 5 PM, due S 12/13 by 11 PM

How do we ensure that everyone has an equal opportunity to succeed in the class?

Academic Support at the StAAR Center: The StAAR Center (formerly the Academic Resource Center and Student Accessibility Services) offers a variety of resources to all students (both undergraduate and graduate) in the Schools of Arts and Sciences, and Engineering, the SMFA, and The Fletcher School; services are free to all enrolled students. Students may make an appointment to work on any writing-related project or assignment, attend subject tutoring in a variety of disciplines, or meet with an academic coach to hone fundamental academic skills like time management or overcoming procrastination. Students can make an appointment for any of these services by visiting go.tufts.edu/TutorFinder, or by visiting go.tufts.edu/StAARCenter.

Accommodations for Students with Disabilities: Tufts University values the diversity of our body of students, staff, and faculty and recognizes the important contribution each student makes to our unique community. Tufts is committed to providing equal access and support to all qualified students through the provision of reasonable accommodations so that each student may fully participate in the Tufts experience. If a student has a disability that requires reasonable accommodations, they should please contact the StAAR Center (formerly Student Accessibility Services) at StaarCenter@tufts.edu or 617-627-4539 to make an appointment with an accessibility representative to determine appropriate accommodations. Please be aware that accommodations cannot be enacted retroactively, making timeliness a critical aspect for their provision.

Academic Dishonesty: As your instructors, we are responsible for ensuring that all students compete on a level playing field. A student who is academically dishonest is claiming an advantage not available to other students. If you ever have a question about the expectations concerning a particular assignment or project in this course, be sure to ask Professor McVey or Tokio for clarification.

You are encouraged to work with your colleagues to do the Canvas quizzes, problem sets, and to discuss the journal articles—science is a collaborative affair. However, your unit assessments should be your intellectual property only (or that of your group, if it is a group assignment). If you use information from review papers or other articles, be sure to properly cite your sources. Any type of plagiarism or cheating will be dealt with harshly, including a grade of ‘zero’ on the assignment and possible other penalties as detailed in Tufts’ written policies.

Policy on sharing: This course is designed for everyone to feel comfortable participating in discussion, asking questions, learning, and facilitating the learning of others. In order for that atmosphere to be maintained, the recordings of our conversations will only be shared with the enrolled students in the class (not posted publicly), and it is prohibited for any of us who have access to the video to share it outside the course. Similarly, I have specifically designed the syllabus, exams, handouts, and lectures for the people who are enrolled in the course this term and those may not be shared outside this course. It is against Tufts policy for anyone to share any content made available in this course including course syllabi, reading materials, problems sets, videos, handouts, and exams with anyone outside of the course without the express permission of the instructor. This especially includes any posting or sharing of videos or other recordings on publicly accessible websites or forums. Any such sharing or posting could violate copyright law or law that protects the privacy of student educational records.

Tentative Schedule of Bio 105 Topics

Week	Topics	Reading/assignment
Unit 1	**How do nucleic acids and proteins interact in a genomic context?**	
Week 1 9/8-9/11	Nucleic acids Tools for nucleic acid analysis	MBPP 6.1-6.4 Canvas Quiz 1 due 9/11 by 11 PM Problem set 1 due 9/13 by 11 PM
Week 2 9/14-9/18	Genomic approaches to nucleic acid analysis Proteins	MBPP 7.1-7.2 (to p.232), pp.244-45 MBPP 4.1-4.4 Canvas Quiz 2 due T/Th Problem set 2 due 9/20 by 11 PM
Week 3 9/21-9/25	Tools for protein analysis Interactions between nucleic acids and proteins	MBPP pp.232-41 MBPP 5.1,19.2, pp.242-4, pp.700-1 Canvas Quiz 3 due T/Th Problem set 3 due 9/27 by 11 PM
Week 4 9/28-10/2	DNA topology and chromatin	MBPP 9.2-9.3, 10.1-10.3 Canvas Quiz 4 due T/Th Problem set 4 due 10/4 by 11 PM
Week 5 10/5-10/9	Journal club # 1	Perusall annotations due Unit 1 assessment due 10/11, 11PM
Unit 2	**What processes affect the integrity and stability of genomes?**	
Week 6 10/12-10/6	DNA replication	MBPP 11.1-11.5 Canvas Quiz 5 due T/Th Problem set 5 due 10/18 at 11 PM
Week 7 10/19-10/23	DNA damage and repair Homologous recombination	MBPP 12.1-12.3 MBPP 13.1-13.4 Canvas Quiz 6 due T/Th Problem set 6 due 10/25 by 11 PM
Week 8 10/26-10/30	Site-specific recombination and transposition Genome editing	MBPP 14.1, pp.496-504 MBPP 246-248, other readings Canvas Quiz 7 due T/Th Problem set 7 due 11/1 by 11 PM
Week 9 11/2-11/5	Journal club # 2	Perusall annotations due Unit 2 assessment due 11/8 by 11 PM

Week	Topics	Reading/assignment
Unit 3	**What are different ways that organisms regulate gene expression?**	
Week 10 11/9-11/13 No class 11/10	Transcription in bacteria Transcription in eukaryotes	MBPP 15.1-15.2 MBPP 15.3, 16.1, 21.1 Canvas Quiz 8 due T/Th Problem set 8 due 11/15 by 11 PM
Week 11 11/16-11/20	RNA splicing and processing The genetic code and protein synthesis	MBPP 16.2, 16.3 MBBP 17.1, 18.1-18.2 Canvas Quiz 9 due T/Th Problem set 9 due 11/22 by 11 PM
Week 12 11/23-11/24 Both groups attend 11/24 No class 11/26	Translation	MBPP 18.3-18.5 Canvas Quiz 10 due T Problem set 10 due 11/29 by 11 PM
Week 13 11/30-12/4	Principles of regulation of gene expression Examples of regulation of gene expression	MBPP 19.1 MBPP pp.702-715 MBPP pp.736-39, 22.4 Canvas Quiz 11 due T/Th Problem set 11 due 12/6 by 11 PM
Week 14 12/7-12/11	Journal Club # 3	Perusall annotations due Unit 3 assessment due 12/13at 5PM
Week 15	Final class meeting W 12/16, 3:30-5:30 PM	Journal Club #3 group assignment due Zoom call with authors