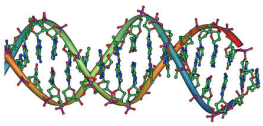
Syllabus for Bio 105 – Molecular Biology

Spring, 2011



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Class Meetings: **Tuesdays, Thursdays 10:30-11:45** (block D+) in **Barnum 104**
Optional recitation on **Mondays** (**9:30-10:20**) in **Barnum 114**

Office Hours: **Professor McVey: Mondays 3-4 PM**, **Thursdays 1-2 PM**
Adam Thomas: Tuesdays 2-3:30 PM
To arrange a different time, please send either of us an e-mail.

Textbook: Molecular Biology of the Gene, 6th edition, by Watson *et al.*
A copy of the textbook will be on 3-hour reserve in Tisch library.
Additional handouts and papers will be posted on the Bio105 Blackboard site.

Course Prerequisite: Bio 41 (Genetics) or the equivalent. This class assumes that you have a working knowledge of basic molecular genetics. If your background in this is limited, you may want to find a copy of a good genetics textbook for reference.

Course Description: Molecular biology deals with 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, 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, RNA polymerase dynamics, and regulation of gene expression by small RNAs.

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Course Objectives: By the end of the semester, you should be able to do the following:

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 proteins, nucleic acids, and their interactions. Identify limitations of these techniques.
3. Given a particular biological question, identify which of these experimental techniques is 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 affects the processes of DNA replication, repair, and transcription.
6. Give examples of DNA and histone modifications and predict how they will affect gene expression.
7. Describe mechanisms by which DNA can be damaged and describe the molecular mechanisms by which protein complexes repair different forms of DNA damage.
8. Provide examples of how homologous recombination, site-specific recombination, and transposition can promote both genome stability and genetic diversity.
9. Describe how RNA splicing occurs and explain how alternative splicing generates 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 small RNAs.
12. Interpret and critique data from primary research articles.
13. Write a review about a primary research article.

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GRADING POLICIES		
	Exams, two highest scores	**45%**
	Exam, lowest score	**15%**
	Journal club paper reviews	**30%**
	Class participation	**10%**

Exams: There will be three exams comprised of a combination of multiple choice, short answer, and short essay questions. The questions will largely be drawn from annotated lecture slides, in-class activities, and journal club discussions. Your lowest exam grade will count as 15% of your final grade, and the other two exams will each count 22.5%. **No make-up exams will be given.** If you know in advance that you will miss an exam, please notify me at least one week ahead of time so that we can make alternate arrangements. If you miss an exam due to a documented health or family-related emergency, your other two exams will each count 30% of your total grade. Requests for re-grades must be made in writing within one week after the day the exam is returned.

Exam #1	**Tuesday, February 15**
Exam #2	**Thursday, March 17**
Exam #3	**Tuesday, April 26**

Journal club paper reviews: Several of the class meetings are reserved for in-class 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. In addition, for each paper, you will be asked to write a short (**~2 page**) review describing the main findings of the paper and the implications of the research. Instructions for these reviews will be posted on Blackboard and distributed in class.

Your reviews should be submitted using the Digital Dropbox feature of Blackboard prior to the discussion. For journal clubs 1 & 3, you will turn in an individual review. For journal clubs 2 and 4, you will submit a group review. The groups will be determined in class.

Journal Club #1	**Thursday, February 10**
Journal Club #2	**Tuesday, March 8**
Journal Club #3	**Tuesday, April 12**
Journal Club #4	**Wednesday, May 11 (3:30-5:30 PM)**

Class participation: Your class participation grade will be determined by your attendance record, level of involvement during in-class activities, and by the quantity and quality of your contributions during journal club presentations and discussions.

Academic honesty: You are encouraged to work with each other to do the problem sets and to discuss the journal articles—science is a collaborative affair. However, your journal club paper reviews and exams should be your intellectual property only. 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.

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RESOURCES FOR YOU

Bio105 Blackboard web site: Problem sets, journal club articles, handouts for class, and additional resources will be posted on the course web site http://blackboard.tufts.edu/.

Lectures: Lecture slides will be posted on Blackboard 1-2 days prior to the lecture. These will serve as a guide to what you should focus on in the assigned readings. I will annotate these slides during lecture. Because I frequently provide outlines, additional notes, and in-class activities during lectures, the on-line slides by themselves will not adequately prepare you for exams.

Recitations: Yes, Monday morning at 9:30 is early, but recitations provide an opportunity for you to clarify questions from the previous week's lectures, try your hand at sample exam questions, and get key insights into the next journal club paper. We make it worthwhile for anyone who attends.

Problem sets: Problem sets containing practice problems and questions representative of exam material will be posted on the Blackboard web site. They are designed to highlight the important concepts from lecture and to give you practice with the types of questions found on exams. Some of these problems will be the focus of the recitations, but I recommend that you first attempt these problems on your own as the topics are addressed in lecture, and then discuss your answers in the context of a study group.

"Brain thaw" papers: Several times during the semester, I will hand out a "brain thaw" question in class. These questions pertain to difficult concepts and are intended to mitigate the "brain freeze" that often accompanies these types of questions. They also help you to prepare for the exams. For each question, I will ask for a typed, **one-page** (no more!) answer. These papers are entirely optional, but for each answer that you submit, you may earn 1 percentage point of extra credit towards your final grade.

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Disclaimer: The instructor retains the right to modify this syllabus based on extenuating circumstances including but not limited to extreme weather events, influenza pandemics, global warming, or an unexpected lottery windfall.

Tentative Schedule of Bio 105 Topics

Date	Topic	Assignment before class
Unit 1	**Nucleic acids, proteins, and chromatin structure**	
Th Jan 20	Introduction – The "Dark Matter" of the genome	Handouts
M Jan 24	Recitation – how to read a scientific paper	Handouts
T Jan 25	Nucleic acid & protein structure	MBG 71-94, 101-116, 127-132
Th Jan 27	Techniques for analysis of nucleic acids & proteins	MBG 739-746, 764-782
M Jan 31	Recitation	Problem set 1, #1-4
T Feb 1	Cloning genes, sequencing genomes	MBG 746-764, handouts
Th Feb 3	DNA topology and chromatin	MBG 117-126, 157-174
Th Feb 3	**Last day to add classes**	
M Feb 7	Recitation – how to write a paper review	Problem set 1, #5-12
T Feb 8	Chromatin modification and gene expression	MBG 174-187, 620-626
Th Feb 10	Journal Club #1, **Paper review #1 due**	Gavin *et al*. paper
M Feb 14	Recitation	Problem set 1, #13-15
T Feb 15	**Exam 1**	Material through 2/10
Unit 2	**Genome integrity**	
Th Feb 17	Cell cycle and DNA replication	MBG 144-154,187-191,195-230
M Feb 21	Tufts holiday – *No recitation*	
T Feb 22	Initiation, termination, and regulation of replication	MBG 230-254
Th Feb 24	Tufts Monday – *Recitation held*	Problem set 2, #1-8
Th Feb 24	**Last day to withdraw without record of enrollment**	
M Feb 28	*No recitation*	
T Mar 1	DNA damage and repair	MBG 257-281
Th Mar 3	Prepare for Journal Club #2	outline for review paper
M Mar 7	Recitation	Problem set 2, #9-12
T Mar 8	Journal club #2, **Group paper review #2 due**	Delmas *et al*. paper
Th Mar 10	Homologous recombination	MBG 283-317
M Mar 14	Recitation	Problem set 2, #13-15
T Mar 15	Site-specific recombination & transposition	MBG 319-364
Th Mar 17	**Exam 2**	Material through 3/15
March 21-25	**Spring Break**	

<u>Unit 3</u> **Regulation of gene expression**

M Mar 28	Recitation - go over exam 2	
T Mar 29	Transcription in bacteria	MBG 377-396
Th Mar 31	Transcription in eukaryotes & RNA processing	MBG 396-412, 452-453
M Apr 4	Recitation	Problem set 3, #1-5
T Apr 5	RNA splicing and alternative splicing	MBG 415-448
Th Apr 7	Mechanisms of translation	MBG 457-503, 514-517
M Apr 11	Recitation	Problem set 3, #6-11
T Apr 12	Journal Club #3, **Paper review #3 due**	Mowrer and Wolfe paper
Th Apr 14	Regulation of gene expression I	MBG 547-568, 589-620
M Apr 18	*No recitation – Tufts holiday*	
T Apr 19	Regulation of gene expression II	MBG 503-514, 633-640
Th Apr 21	Regulation of gene expression by small RNAs	MBG 641-658
M Apr 25	Recitation	Problem set 3, #12-17
T Apr 26	**Exam 3**	Material through 4/21
Th Apr 28	New frontiers in molecular biology	To be announced
M May 2	Recitation – prepare for journal club #4	MBG 703-731
M May 2	**Last day to withdraw with grade of 'W'**	
W May 11 3:30-5:30 PM	Journal Club # 4, **Group paper review #4 due**	Heo and Sung paper