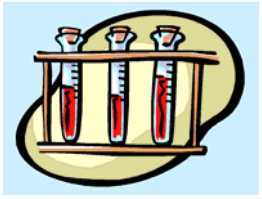

# Syllabus for Bio 105 – Molecular Biology
Spring 2012

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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 1:30-2:30 PM**, **Thursdays 3-4 PM**
**Nealia House: Tuesdays 12-1 PM**
To arrange a different time, please send either of us an e-mail.

**Textbook**: Molecular Biology: Principles and Practice, 1st edition, by Cox *et al.*
A copy of the textbook is on 3-hour reserve in Tisch library.
Additional handouts and papers will be posted on the Bio105 Trunk site.

**Course Prerequisite**: Bio 41 (Genetics) or the equivalent. We assume 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 different types of 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 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 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 pre-mRNA 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.

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|---|---|
| Exam #1 | **Thursday, February 16** |
| Exam #2 | **Thursday, March 15** |
| Exam #3 | **Tuesday, April 24** |

**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 (**~2-3 page**) review describing the main findings of the paper and the implications of the research. Instructions for these reviews will be posted on Trunk and distributed in class.

Prior to the discussion, your reviews should be submitted using Trunk. For journal clubs 1 & 3, you will submit a group review. For journal club 2, you will submit an individual review. The groups will be determined in class.

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|---|---|
| Journal Club #1 | **Tuesday, February 14** |
| Journal Club #2 | **Tuesday, March 27** |
| Journal Club #3 | **Thursday, May 10 (12-2 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 Trunk web site**: Problem sets, journal club articles, handouts for class, and additional resources will be posted on the course web site http://trunk.tufts.edu/.

**Lectures**: Lecture slides will be posted on Trunk 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 Trunk website. 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. We 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 we will pose 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, we 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** | **How do nucleic acids and proteins interact in a genomic context?** | |
| Th Jan 19 | Current topics in molecular biology | Browse websites |
| M Jan 23 | Recitation – how to read a scientific paper | |
| T Jan 24 | Nucleic acids and tools for analysis | MBPP 6.1-6.4 (to pg 204), 248-50 |
| Th Jan 26 | Proteins and tools for analysis | MBPP 4.1-4.4, pages 240-244 |
| M Jan 30 | Recitation | |
| T Jan 31 | Interactions between nucleic acids and proteins | MBPP 5.1 & 5.3, 19.2, pages 244-248, 704-705 |
| Th Feb 2 | Genes, genomes, and proteomes | MBPP 7.1-7.2, 8.1 (to pg 266),8.2 |
| Th Feb 2 | **Last day to add classes** | |
| M Feb 6 | Recitation – how to write a paper review | |
| T Feb 7 | DNA topology | MBPP 9.1-9.3 |
| Th Feb 9 | Chromatin modifications and gene expression | MBPP 10.1-10.3 |
| M Feb 13 | Recitation | |
| T Feb 14 | Journal Club #1, **Paper review #1 due** | Adkins and Tyler paper |
| Th Feb 16 | **Exam 1** | Material through 2/14 |
| **Unit 2** | **How do organisms copy and protect their genomes?** | |
| M Feb 20 | Tufts holiday – *No recitation* | |
| T Feb 21 | Cell cycle and DNA replication | MBPP 11.1-11.3 |
| Th Feb 23 | Tufts Monday – *Recitation held* | |
| Th Feb 23 | **Last day to withdraw without recortd of enrollment** | |
| M Feb 27 | *No recitation* | |
| T Feb 28 | Initiation, termination, and regulation of replication | MBPP 11.4-11.5 |
| Th Mar 1 | DNA damage and repair I | MBPP 12.1-12.3 |
| M Mar 5 | Recitation | |
| T Mar 6 | DNA damage and repair II | MBPP 13.1, 13.4 |
| Th Mar 8 | Homologous recombination | MBPP 13.2, 13.3 |
| M Mar 12 | Recitation | |
| T Mar 13 | Site-specific recombination & transposition | MBPP 14.1-14.2 |
| Th Mar 15 | **Exam 2** | Material through 3/13 |
| March 19-23 | **Spring Break** | |
| M Mar 26 | Recitation – prep for Journal Club #2 | |
| T Mar 27 | Journal Club #2, **Paper review #2 due** | Dmitrieva *et al.* paper |

## Unit 3 What are different ways that organisms regulate gene expression?

| Date | Topic | Assignment before class |
|---|---|---|
| Th Mar 29 | Mechanisms of transcription | MBPP 15.1-15.3 |
| M Apr 2 | Recitation | |
| T Apr 3 | RNA processing in eukaryotes | MBPP 16.1, 16.3-16.4 |
| Th Apr 5 | RNA splicing and alternative splicing | MBPP 16.2, 22.1 |
| M Apr 9 | Recitation | |
| T Apr 10 | Mechanisms of translation | MBPP 17.1, 18.1-18.6 |
| Th Apr 12 | Regulation of gene expression: basic principles | MBPP 19.1-19.3 |
| M Apr 16 | *No recitation – Tufts holiday* | |
| T Apr 17 | Regulation of gene expression in bacteria | MBPP 20.1-20.2 |
| Th Apr 19 | Regulation of gene expression in eukaryotes | MBPP 21.1, 21.2 (to page 746), pages 751-756, 22.2 |
| M Apr 23 | Recitation | |
| T Apr 24 | **Exam 3** | Material through 4/19 |
| Th Apr 26 | Regulation of gene expression by small RNAs | MBPP 22.4, page 754 |
| M Apr 30 | Recitation – prepare for journal club #3 | |
| M Apr 30 | **Last day to withdraw with grade of 'W'** | |
| Th May 10 | Journal Club #3, **Group paper review #3 due** 12-2 PM | Bruno *et al*. paper |