

**Principles of Biology: Molecules, Cells, and Development (BIO 203)**  
**Spring 2006**  
**Prof. Margaret Saha**

**Purview of the Course:**

*Principles of Biology: Molecules, Cells, & Development (BIO 203)* will cover the fundamentals of biochemistry, cell biology, molecular biology, and developmental biology. There will be a strong emphasis on understanding *how* scientists obtain and evaluate knowledge in these fields and how this knowledge can be applied to a variety of other endeavors, particularly contemporary medicine.

**Objectives of the Course:**

1. To instill a thorough understanding of the fundamentals of modern biochemistry, and cellular, molecular, and developmental biology. This will entail an analysis of: the molecules which comprise (and are essential to) living organisms; the biochemical interactions of these molecules and the mechanisms by which they mediate basic metabolic processes; the process by which cells harvest energy, divide, and communicate with one another; the means by which cells (and organisms) transform genotype into phenotype following the tenets of the “central dogma”; the mechanisms underlying embryonic development.
2. To develop an understanding of **how** we know what we know in modern molecular and cellular biology, that is, an understanding of the process by which scientists obtain, evaluate, and synthesize information. The rationale for this objective is that the field of molecular and cellular biology is changing at an unprecedented pace with new techniques and novel discoveries continually being reported. Given that much of the information in your text may soon be outdated (or, at the very least, superceded), it is essential that you understand how to interpret, evaluate, and synthesize new information in the field.
3. To improve your skills in organizing, interpreting, and synthesizing large amounts of (sometimes conflicting) information. This involves: distilling “the important” from “the trivial”; synthesizing diverse information in novel ways, that is, making new connections among seemingly unrelated data; and, applying the information to new situations in order to solve problems.
4. To instill an understanding of the relevance of modern molecular and cellular biology to modern medicine, environmental issues, and larger issues of “global problems” and public policy.

**Schedule of Lecture Topics:**

*INTRODUCTION TO BIO 203:*

- 1/18: Spinal Cord Injury, Stem Cells, Evolution, Genes, and Development:  
An Overview of BIO 203

### *IDENTIFYING THE “MOLECULES OF LIFE”*

*(This unit will review the fundamental molecules that comprise living organisms).*

- 1/20: The Atoms and Molecules of Ancient Earth (Ch. 2: 20-45)
- 1/23: Protein Structure .... (Ch. 3: 46-62)
- 1/25: ... and Protein Function (Ch. 2: 62-73)
- 1/27: Nucleic Acids: DNA (Ch. 3: 74-83)
- 1/30: Nucleic Acids: RNA (Ch. 3: 83-89)
- 2/1: Carbohydrates (Ch. 5: 90-102)
- 2/3: Lipids (Ch. 6: 103-113)
- 2/6: From Lipid to Membrane to Cell (Ch. 6: 113-126)
- 2/8: Exam #1

### *THE BASIC UNIT OF LIFE: CELLS*

*(This section will examine cell structure and how the various cellular components mediate important processes including harvesting energy, cell division, and cell-cell communication).*

- 2/10: Inside the Cell: The Basic Components (Ch. 7: 128-158)
- 2/13: How Cells Convert Light Energy to Chemical Energy (Ch. 10: 202-226)
- 2/15: How Cells Harvest Chemical Energy I (Ch. 9: 177-197)
- 2/17: How Cells Harvest Chemical Energy II (Ch. 9: 197-200)
- 2/20: How Cell Communicate I: An Overview (Ch. 8: 159-172)
- 2/22: How Cell Communicate II: Signal Transduction Mediated by Enzyme-linked Receptors and G Protein Coupled Receptors (Ch. 8: 171-176)
- 2/24: How Cell Communicate III: Signal Transduction Mediated by Intracellular Receptors (Ch. 8: 171-176)
- 2/27: How Cells Reproduce: The Molecular Mechanisms of Cell Division (Ch. 11: 227-246)
- 3/1: Exam #2

### *GENOTYPE TO PHENOTYPE: HOW CELLS AND ORGANISMS TRANSMIT INFORMATION*

*(This section will analyze how cells and organisms, following the tenets of the “central dogma,” employ the “information” contained in DNA to create a cellular phenotype; gene regulation at all levels, including the role of epigenetics, will be emphasized. Finally, this unit will focus on how contemporary biotechnology employs this information to understand and manipulate the molecular-cellular mechanisms governing basic life processes).*

- 3/3: DNA Synthesis (Ch. 14: 303-324)
- 3/13: How Genes Work: An Overview (Ch. 15: 325-337)
- 3/15: Transcription (Ch. 16: 338-342)
- 3/17: Post-Transcriptional Processing (Ch. 16: 342-345)
- 3/20: Translation (and Beyond) (Ch. 16: 345-361)
- 3/22: Exam #3
  
- 3/24: Control of Gene Expression in Bacteria (Ch. 17: 362-381)
- 3/27: Transcriptional Control of Gene Expression in Eukaryotes (Ch. 18: 382-391)
- 3/29: Post-transcriptional Control of Gene Expression in Eukaryotes (Ch. 18: 392-400)
- 3/31: Analyzing and Engineering Genes (Ch. 19: 401-425)
- 4/3: Analyzing and Engineering Genes (Ch. 19: 401-425)

4/5: Genomics (Ch. 20: 426-444)  
(Exam #4 will be on 4/10)

### **GENOTYPE TO PHENOTYPE: TRANSMITTING INFORMATION IN FOUR DIMENSIONS**

*(This unit will analyze the basic molecular-cellular mechanisms governing the development of a single cell (i.e. the fertilized egg) into a complex, integrated multicellular organism).*

4/7: Development: An Overview of the Problem (Ch. 21: 446-447; Ch. 22: 470-471, 481-484)  
4/10: Exam #4 (on material covered from 3/24 – 4/5)  
4/12: Oogenesis, Fertilization, and Cleavage (Ch. 21: 447-458, 464-467; Ch. 22: 470-475)  
4/14: Gastrulation (Ch. 21: 458-461)  
4/16: Constructing the Body Plan (Ch. 22: 476-478)  
4/19: Organogenesis (Ch. 22: 484-489)  
4/21: Senescence, Death ... and Regeneration (Reading to be assigned)  
4/24: Birth Defects: Hereditary and Environmental (Reading to be assigned)  
4/26: Stem Cells (Reading to be assigned)  
4/28: Spinal Cord Injury, Stem Cells, Evolution, Genes, and Development:  
An Overview of BIO 203

### **Course Format:**

The course will employ a lecture format, but the lectures will be interspersed with questions (clicker and otherwise) posed to the class in order to encourage “active thinking” about the material being discussed. The questions presented to the class will reflect the types of questions that will appear on the exams. We will employ the Blackboard site throughout the course; you are responsible for checking the site regularly for announcements related to BIO203. Prior to the class period (usually by midnight, the evening before) a PowerPoint outline of the lecture (along with some of the key diagrams and the assigned reading) will be posted on the Blackboard site. If you wish, you should feel free to print this outline and use it for note-taking. Although diagrams from the text will be used whenever possible, lectures will generally include some material not found in the text; this will be particularly true for the second half of the course.

*A brief digression on learning and memory:*

*Current research demonstrates that individuals adopt a wide variety of different strategies to learn new subjects; there is simply no “single” or “correct” way to master a body of material. However, there are certain tenets in the field of learning and memory that are generally accepted.*

- *First, repetition is essential; reviewing material for brief periods each day is far more effective than cramming for an extended period prior to the exam. From the molecular neurobiology point of view, repetition strengthens synapses and new connections.*
- *Second, it is well established that processing information using as many modalities as possible is beneficial to the learning process. Personally, I strongly believe in the importance of taking notes and attempting to process (in writing) the information presented during class. Writing uses different parts of the brain than do reading, hearing, or viewing diagrams.*

- *Third, making associations strengthens memory and learning. The more you are able to “connect” new information with existing information, the better you will understand, synthesize and retain it.*
- *Fourth, active learning is essential for retention and understanding. It is a strategic mistake to (simply) re-read the text or your notes. As you read you should regularly (without looking at the books or notes) succinctly summarize what you just learned and how it relates to other material you have mastered. Continually ask yourself “how does this link to previous material in the course?” Force yourself to re-draw the critical diagrams from memory. Then use your notes and text to “fill in the gaps.”*
- *Fifth, an adequate amount of sleep is essential. While there is convincing body of evidence demonstrating that motor learning is sleep dependent, there are also compelling data suggesting that sleep plays a role in more cognitive aspects of learning and memory. Whatever the outcome of the scientific debate on this issue, centuries of common sense lore dictate that pulling “all-nighters” prior to exams that require reasoning skills is not an advisable strategy.*

### **Grading and Exams:**

Your grade in the class will be based upon a total of 1000 points. The associated Bio203 laboratory will be worth 250 points and the course worth 750 points. The 750 points for the lecture part of the course will be divided as follows: Midterm I (100 pts.), Midterms 2-4 (110 pts. each), Midterm 5 (given on day of final) (110 pts), Final exam (110 pts.), clicker questions (100 pts.). For the exams you will obviously be expected to master the “factual” material, but the exams will test more than your memorization of the facts; the exams will strive to test your *understanding* of the material and your ability to apply and synthesize the material covered in class. The format of the exams will generally consist of both multiple choice and short answer questions. Regrades of specific questions will be considered, however requests must be submitted in writing (typed) to the instructor within one week from the date the exams were returned and supported by well-crafted cogent reasoning. Grading mistakes will be happily corrected, however grade changes based on interpretation of questions will be rare. Extraordinarily compelling arguments must be made for these to occur. Makeup exams will be given only for legitimate reasons (e.g., illness, College-related activities); in general, makeup exams will be given in an essay format. In order to take a makeup you must have a note from the Dean of Students’ Office.

### **Office Hours and Review Sessions:**

Office hours are Mondays and Wednesdays from 2-3, and Thursdays from 9-10. There will be several Teaching Assistants for the course; you will be encouraged to discuss your questions with the course TAs. Students will be **strongly** encouraged to attend the weekly review sessions which will take place every Tuesday from 5-6pm in Millington Rm.117. Not only will you be able to get your questions answered, but you will benefit from the questions and diverse perspectives of other students in the class. In addition, there will be review sessions for each exam the day or evening prior to the exam.

### **Textbook:**

The required textbook is “Biological Science,” (2005, 2nd ed.) by Scott Freeman (ISBN 0-13-140941-7). An instruction classroom response pad is also required for this class.