

# Molecular Genetics

Biology 50 Fall 1996  
MWF 9-9:50 106 Berryhill Hall

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Office Hours: Monday 2-4 PM  
Wednesday 11 - 1 P M  
or by appointment

## Course Description and Goals

Within the past few years, much media attention has been given to the subject of genes. We often hear on the national news that scientists have found a "cancer" gene or a fat" gene. DNA is talked about in the context of criminal trials. Even the human genome project can grab a headline occasionally. So what is all the excitement about? What are genes and why should we care what is being done with them? This course on molecular genetics is designed to provide students with a learning experience through which they will answer the following questions: what are genes, how they are studied, how they are expressed in organisms ranging from bacteria to humans, and what are the practical applications of genetic research.

More specifically, as a participant in this course you will be able to do the following:

- Define, explain, and correctly use terms and concepts used to describe gene organization and expression in prokaryotic and eukaryotic cells
- Evaluate cause and effect relationships in cell dynamics.
- Explain the biological basis of molecular biological research methods and describe how molecular biology has revolutionized the study of cells and human disease
- Read biological research publications, analyze data, form conclusions, develop models, and design experiments to answer scientific questions (in short, begin to think like a scientist).
- Assess the role that molecular or cellular biology has in the real world by describing how the study of genes of cells has influenced any one of the following areas: medicine, law, entertainment government, or agriculture

## Prerequisites

Students coming into this course must have had at least one college-level general biology and introductory chemistry course. Other classes which may be helpful but are not required are cell biology and biochemistry. Although most students are biology or chemistry majors, interested non-majors are welcome to take this course provided that they have met the prerequisites. This course is designed to be an introduction to molecular genetics; however, you will be required to read research publications about genes and gene expression, which can be difficult on a first try. You are not expected to understand everything, but rather get a sense of what question the scientists were trying to answer and how they attempted to answer it.

## Reading

There is one required text for this course: Klug, W. S. and Cummings, M. R. Concepts of Genetics (1994).

Other readings, magazine, newspaper, and journal articles, have been compiled into a course pack which is available for purchase (\$10.00) in the genetics program office in MacNider Hall.

## Course Requirements and Evaluation

Evaluation for this course will be based upon the successful completion of a variety of in-class and take home assignments. At the end of each week there will be a short 15 minute quiz to test you on the concepts covered during

the week. The quiz is designed to reinforce the material, but it also gives me a chance to see if there are any major problems before moving on to new topics. Besides the weekly in-class quizzes, you **will** complete one take home assignment per week which will stress problem solving, reading comprehension, data analysis, and/or written skills. The weekly quizzes and take home assignments will form the basis of two 1 hour in-class exams. Another component of the course requirements is a group project on a topic about the influence of science on society as a whole. For the group project, you will prepare assignments, including a preliminary abstract, a final written paper and oral in-class presentation (see Group Project for details). Lastly, you will take a cumulative final exam which will consist of two parts. Part one will be a take home test similar to the weekly take home assignments, and part two **will** be an in-class exam during the scheduled final exam time.

Although some of your evaluation **will** depend on how well you perform in a test-taking situation (weekly quizzes, exams, and final), other assignments will focus on learning as a process of trial-and-error, re-reading and re-thinking. Therefore, the weekly take home assignments and parts of the group project can be submitted for comments, discussed during office hours, and revised prior to the due date. Evaluation of these assignments leans toward a mastery approach because I am more interested that you acquire analytical and communication skills which will enable you to be successful in any field, rather than memorize genetic trivia. I will distribute specific criteria for evaluating each assignment when it is assigned in class.

Quizzes, assignments, the group project and exams with their respective weights and points towards the final course grade appear below:

Weekly in-class quizzes (12 total)	10%	100 pts. (drop lowest two)
Take home assignments (12 total)	20%	200 pts. (drop lowest two)
In-class exams (2 total)	30%	300 pts.
Group project: Science in Society	20%	200 pts.
Final exam	20%	200 pts.
<b>TOTAL</b>		<b>1000 pts.</b>

Grades will be assigned based on how many points you earn according to the following point distribution:

900-1000 pts.	A
899-800	B
799-700	C
699-600	D
less than 599	F

### **Group Project**

Because I believe what you learn in class is not exclusive of what is going on in the world, there will be a group project in this course which will allow you to research one aspect of the influence of science on society. General areas in which you may focus your research include medicine, law, agriculture, entertainment, etc.

The entire class will be divided into groups of 5 or 6 by next week and each group will determine the topic of the project I will be available to offer suggestions, but it will be up to the group to make the final decision. To ensure that you do not wait to begin this assignment and that you are on the right track, an abstract of your project, including the methods you plan to use for your research must be submitted by Friday, September 13. The group projects will conclude with a 20-minute in-class oral presentation and final written report. Evaluation criteria and more specific instructions for the abstract will be handed out after the groups have been formed, and criteria/instructions for the oral presentation and written report will be handed out following the acceptance of your abstract.

### **Other Policies and Missed Work**

Class attendance, while not mandatory, is required if you want to succeed in this course. Some of the material we will cover is not in the text, and some material is not sufficiently covered. Therefore, class time will be used to expand and discuss material in the text, not simply restate it.

Since you are able to drop the two lowest scores on the quizzes and take home assignments, there will be no make-up quizzes or take home assignments-NO EXCEPTIONS. If you miss a quiz or take home assignment, you will receive a zero, which will certainly be one of the two quizzes/assignments you can drop.

Missed exams can be made up in cases of extreme circumstances (prolonged illness or death in family) or travel related to university activities. If you know you will miss an exam, arrangements must be made at least one week in advance and the exam will be taken prior to when the other students take the exam.

## Course Schedule

### Week 1: What is GENETICS?

Wednesday, August 21	Introduction to the class and class survey
Friday, August 23	Introduction to Molecular Genetics/Flow of Information Reading: Chapter 1 in <u>Concepts of Genetics</u> pp. 1 -15

## UNIT 1: Cells and Molecules

### Week 2: Cell Structure and Cell Division

- Identify cellular components and organelles in prokaryotes and eukaryotes
- Compare and contrast mitotic and meiotic cell division
- Evaluate the role of meiosis in terms genetic variation

Reading: Chapter 2 in Concepts of Genetics pp. 19-38 (skip pp. 39-43)

Monday, August 26	Viruses, Prokaryotes, and Eukaryotes
Wednesday, August 28	Mitosis
Friday, August 30	Meiosis - Quiz 1
Monday, September 2 - NO CLASS:	Labor Day!

### Week 3: DNA: Genetic Material, Chemistry, and Structure

- Describe early experiments that proved that genetic material in prokaryotes and eukaryotes was DNA
- Evaluate the contributions of the following scientists to solving the structure of DNA: Chargaff, Franklin, Watson, and Crick
- Describe how covalent bonds are different from hydrogen bonds
- Identify components of a nucleotide and diagram two dinucleotides which are complementary and antiparallel and indicate hydrogen bonding

Reading: pp. 241-264 from Chapter 8 in Concepts in Genetics

Wednesday, September 4	DNA as Genetic Material - Take Home Assignment (THA) 1 Due
Friday, September 6	DNA Chemistry and Structure I - Quiz 2
Monday, September 9	DNA Chemistry and Structure 11 - THA 2 Due

### Week 4: RNA and Nucleic Acid Analysis

- List differences and similarities between RNA and DNA
- Name the three major kinds of RNA and describe how each participates in the flow of genetic information

- Describe on a molecular level what is happening during nucleic acid denaturation
- Correlate  $T_m$  to base composition; compare two sequences on the basis of  $T_m$

Reading: Assigned course pack readings (RNA) and pp. 265-271 from Chapter 8 in Concepts in Genetics (nucleic acid analysis)

Wednesday, September 11      RNA: The Other Nucleic Acid  
 Friday, September 13        Nucleic Acid Analysis - Quiz 3 and Group Project Abstracts

### Week 5: DNA Replication and Synthesis

- Compare the 3 theoretical modes of DNA replication and describe experiments which proved the semiconservative mode of DNA replication
- List requirements of in vitro DNA synthesis by DNA polymerase I and assess the significance of the polA1 mutation
- Indicate why Okazaki fragments are present during DNA synthesis by DNA polymerase III
- Given abnormal cellular characteristics from mutant bacteria, predict which enzyme or function involved with DNA synthesis has been affected
- Explain the need for telomerase in eukaryotic DNA synthesis

Reading: Assigned course pack readings and pp. 281-300 from Chapter 9 in Concepts in Genetics

Monday, September 16        DNA Replication and Synthesis I - Introduction - THA3 Due  
 Wednesday, September 18    DNA Synthesis 11 - Prokaryotes  
 Friday, September 20        DNA Synthesis III - Eukaryotes and Telomerase - Quiz 4

### Week 6: DNA Organization in Eukaryotic Cells: Chromosomes to Genes

- Explain why DNA organization in eukaryotic cells is more complex than viruses and prokaryotes
- Predict how the proteins in chromatin might alter DNA transcription
- Diagram and label the components of a eukaryotic gene; describe what each component is and why it is important

Reading: pp. 312-315; 318-333 from Chapter 10 in Concepts in Genetics

Monday, September 23        Eukaryotic DNA: A Packing Problem - THA4 Due  
 Wednesday, September 25    Eukaryotic Gene Structure I  
 Friday, September 27        Eukaryotic Gene Structure 11 - Quiz 5  
 Monday, September 30        REVIEW DAY - THAS Due  
 Wednesday, October 2        HOUR EXAM I on Unit 1 Material

## UNIT 2: DNA Manipulation and Mutation

### Week 7: DNA Cloning and Molecular Biology Techniques

- Define molecular biological terminology including vector, clone, and library
- Describe biological basis of techniques including Northern and Southern blotting, DNA sequencing, PCR, transformation and transfection
- Given a DNA sequence, identify restriction sites and predict sizes of restriction fragments
- Given unexpected results from a cloning experiment, predict the source of the problem

Reading: Assigned readings in course pack and Chapter 12 in Concepts in Genetics

Friday, October 4              Recombinant DNA Technology  
 Monday, October 7            Library Construction and Clone Selection - THA6 Due  
 Wednesday, October 9        Nucleic Acid Blotting and Sequencing

Friday, October 11

Polymerase Chain Reaction - Quiz 6

### Week 8: DNA Recombination, Mutation, and Repair

- Explain what homologous recombination is
- Given a phenotype, predict what cellular component contains a mutation
- Evaluate the mutagenic effects and toxicity of various mutagens
- Contrast the effects of mutation in somatic cells versus germ cells
- Describe mechanisms used by the cell to repair damaged DNA

Reading: Assigned readings from course pack and pp. 300-302 from Chapter 9 and pp. 341-365 from Chapter 11 in Concepts in Genetics

Monday, October 14

Homologous Recombination and DNA Mutation I - THA7 Due

Wednesday, October 16

DNA Mutation II - Quiz 7

Friday, October 18

NO CLASS: Fall Recess!

Monday, October 21

Damage Control: DNA Repair Mechanisms - THA8 Due

## UNIT 3: Gene Expression

### Week 9 and 10: Storage and Expression of Genetic Information

- Using the genetic code, determine the protein sequence from the DNA sequence or RNA sequence
- Compare and contrast prokaryotic and eukaryotic transcription
- Describe splicing mechanisms in eukaryotic RNAs.
- List all initiation components required for translation
- Evaluate current research in eukaryotic transcription and translation and identify key questions

Reading: Assigned readings from course pack and Chapter 14 from Concepts in Genetics

Wednesday, October 23

The Genetic Code

Friday, October 25

Transcription in Prokaryotes - Quiz 8

Monday, October 28

Transcription in Eukaryotes - THA9 Due

Wednesday, October 30

RNA Splicing

Friday, November 1

Ribosomes and tRNA - Quiz 9

Monday, November 4

Translation in Prokaryotes - THA10 Due

Wednesday, November 6

Translation in Eukaryotes

Friday, November 8

REVIEW DAY - Quiz 10

Monday, November 11

HOUR EXAM 11 on Unit 2 and 3 Material

## UNIT 4: Genes and Human Disease

### Week 11: Genetics of Cancer

- Describe the roles and interactions of cell cycle regulatory proteins, kinases and cyclins
- Evaluate the role of tumor suppressor genes
- Distinguish between oncogenes and proto-oncogenes
- Read and evaluate current cancer research publications

Reading: Assigned reading from the course pack and Chapter 18 in Concepts in Genetics

Wednesday, November 13

The Cell Cycle and Cell Cycle Control

Friday, November 15

Tumor Suppressor Genes and Oncogenes - Quiz 11

### Week 12: HIV and AIDS

- Describe the lifecycle of HIV
- Compare and contrast drugs used for HIV; describe how the drug works
- Read and evaluate current HIV research publications

Reading: Assigned reading from the course pack

Monday, November 18	Retroviruses -THAI 1 Due
Wednesday, November 20	HIV and AIDS
Friday, November 22	Groups 1 and 2: Project Presentations - Quiz 12
Monday, November 25	Groups 3 and 4: Project Presentations - THA12 Due
Wednesday, November 27	Groups 5 and 6: Project Presentations
Friday, November 29	NO CLASS: Thanksgiving Recess!
Monday, December 2	Groups 7 and 8: Project Presentations
Wednesday, December 4	Last day of class! Review and Wrap-Up

**FINAL EXAM:** Monday, December 9, 8:00-11:00 AM In 106 BerryhIII Hall

**Take Home Portion of the Final Exam is due when you arrive.**