

Instructor: Dr. Sara Fenske **Course:** Genetics

Academic Year: 2008-2009

Course Philosophy: Genetics is the study of how DNA controls our development, function and behavior. This is not your typical genetics course. In this course you will learn the concepts and techniques of modern genetics, as well as discuss the impact that genetics has on our societies. We will explore the impact of genetic diseases, the history of genetics and the current controversies in genetics. We will do this through a mixture of lecture, labs, reading, discussion, and debate. The success of this course depends on your enthusiasm and participation.

Course Requirements: 1) Principles of Genetics 4th edition, by Snustad and Simmons

- 2) Binder for Handouts and paper for notes
- 3) Pencil or Pen (blue or black)
- 4) All handouts
- 5) Access to the Internet

Grading Procedure: Grades are based on a combination of two Major Exams (at least 100 points each), Tests and Quizzes (at least 25 points each), and Writing Assignments (including lab reports) (25-100 points).

Grading Scale: As stated in the Student Handbook, letter grades are determined based on the following scale:

A- to A+: 90-100 D- to D+: 60-69
B- to B+: 80-89 F: 0-59
C- to C+: 70-79

Homework/ Classwork Policies:

1. Problem sets, research papers, and reading assignments must be completed by the assigned date. Any long-term projects should be worked on daily so that the task is completed on time and will earn the best grade.
2. Two major exams will be given, one in the first trimester, and one in the third trimester. Both will be cumulative. Quizzes will be given every week to two weeks. At least one test will be given per trimester in addition to the major exams and quizzes. Pop quizzes may be given at any time.
3. All assignments should be turned in on the due date during the class period. The maximum score for any late assignments will decrease by 10% for every day late until the grade reaches a maximum score of 50%. Any work not turned in will receive a 0.
4. All work must be legibly written or typed, and grammatically correct.
5. Keep all handouts, homework, returned homework and exams in a binder.

6. Ask questions about any instructions that are not clear.

Classroom Policies:

1. Daily, *prepared* attendance is mandatory. The school's attendance policy will be strictly enforced.
2. You are solely responsible for any material covered or announcements made during your absence.
3. You are expected to treat everyone with respect at all times. Debates and discussions can become heated. It is fine to disagree. It is not okay to be rude.
4. Cheating or plagiarism will result in a 0 grade for that assessment.
5. Finally, you are expected to ask questions about any material that is not clear. Do not worry about a question being too simple. If you don't understand, chances are others don't also (Yes, this is really true).

Tentative Schedule:

Week	Topics	Chapters
1	Introduction to Genetics Review: Chemistry of Life	Ch.1
2	Prokaryotic & Eukaryotic cells, Model Organisms	Ch. 2
3	Central Dogma: History of Central Dogma DNA, RNA, Proteins	Ch. 9, Ch. 11, Ch.12
4	Cell Cycle, Meiosis & Gametogenesis	Ch. 2
5	DNA & the Molecular Structure of Chromosomes: Watson & Crick	Ch. 9
6	Replication of DNA and Chromosomes	Ch. 10
7	Transcription & RNA Processing	Ch. 11
8	Translation & the Genetic Code: Genetics without DNA - Prions	Ch. 12
9	Mutation, DNA Repair, & Recombination	Ch. 13

10	Mutation, Disease, and Evolution	
11	History of the Definitions of the Gene	Ch. 14
12	Review/ Exam Week	
13	Mendelism: Basic Principles of Inheritance Gregor Mendel: Genetic Testing, Counseling	Ch. 3
	Thanksgiving Break	
14	Extensions of Mendelism	Ch. 4
15	Inheritance of Complex Traits: Cardovascular Disease, Autism	Ch. 25
16	Chromosomal Basis of Mendelism: Sex Selection	Ch. 5
	Christmas Break	
17	Variation in Chromosome Number & Structure	Ch. 6
18	Linkage, Crossing Over, & Chromosome Mapping in Eukaryotes	Ch. 7
19	The Genetics of Microorganisms: Antibiotic Resistance	Ch. 8
20	Transposable Genetic Elements: Barbara McClintock	Ch. 18
21	The Genetics of Mitochondria & Chloroplasts Human Disease & Evolution	Ch. 19
22	The Techniques of Molecular Genetics	Ch. 15
23	Genomics	Ch. 16
24	Applications of Molecular Genetics	Ch. 17

25	Forensic Science	
26	Gene Therapy, Gene Doping, Eugenics	
27	Genetically Modified Crops	
	Spring Break	
28	Regulation of Gene Expression in Prokaryotes and Their Viruses	Ch. 20
29	Regulation of Gene Expression in Eukaryotes	Ch. 21
30	The Genetic Control of Animal Development: Reproductive Technology, Stem Cell Research	Ch. 22
31	The Genetic Control of the Vertebrate Immune System: HIV and Genetics, Vaccines	Ch. 23
32	The Genetic Basis of Cancer	Ch. 24
33	Population Genetics & Evolutionary Genetics: Race and Genetics	Ch. 26 & Ch. 27
34	Population Genetics & Evolutionary Genetics: Race and Genetics	Ch. 26 & Ch. 27
35	Final Exam Week	

Genetics Outline:

- I. Introduction to Genetics
 - i. What is Genetics?
 - ii. How do we use Genetics?
- II. Review of Chemistry of Life
 - i. Elements and Compounds
 - ii. Types of Chemical Interactions
 - iii. Role of Water
 - iv. Acids, Bases, and pH
 - v. Molecules in Biology
 1. Carbohydrates
 2. Lipids
 3. Proteins
 4. Nucleic Acids
- III. Eukaryotic and Prokaryotic Cells
 - i. Prokaryotic Cellular Structures and Environment
 - ii. Prokaryotic Chromosome
 - iii. Eukaryotic Cellular Structures and Environment
 - iv. Eukaryotic Chromosomes
- IV. Introduction to Model Organisms in Genetics
 - i. E. Coli
 - ii. S. cerevisiae
 - iii. Drosophila melanogaster
 - iv. Arabidopsis thaliana
 - v. Humans
- V. Central Dogma
 - i. DNA : Basic Structure
 - ii. RNA: Basic Structure
 - iii. Protein: Basic Structure
 - iv. Role of DNA, RNA, and Proteins in Cells
 1. Experimental Proof that Genetic Information is Stored in DNA
 - v. Basic Overview of Transcription and Translation
- VI. Mitosis, Meiosis, and Gametogenesis
 - i. Prokaryotic Mitosis

- ii. Eukaryotic Mitosis
 - iii. Eukaryotic Meiosis I and II
- VII. DNA and the Molecular Structure of Chromosomes
 - i. Structures of DNA and RNA
 - 1. History: Watson & Crick
 - ii. Chromosome Structure in Prokaryotes and Viruses
 - iii. Chromosome Structure in Eukaryotes
 - iv. Eukaryotic Genomes: Repeated DNA sequences
- VIII. Replication of DNA and Chromosomes
 - i. Basic Features of DNA Replication *In Vivo*
 - 1. Conservative vs. Semiconservative vs. Discontinuous Replication
 - ii. DNA Polymerases and Synthases
 - iii. Replication Apparatus
 - iv. Unique Aspects of Eukaryotic Chromosome Replication
- IX. Transcription and RNA Processing
 - i. Types of RNA molecules
 - ii. Process of Gene Expression
 - iii. transcription in Prokaryotes
 - iv. Transcription and RNA Processing in Eukaryotes
 - 1. RNA Polymerase
 - 2. Introns and Exons
- X. Translation and the Genetic Code
 - i. Protein Synthesis
 - ii. The Genetic Code
 - iii. Genetics without DNA: Prions
- XI. Mutation, DNA Repair, and Recombination
 - i. Process of Mutation
 - ii. Phenotypic Effects
 - iii. Molecular Basis of Mutation
 - iv. Screening Chemicals for Mutagenicity
 - v. DNA Repair Mechanisms
 - vi. DNA Recombination Mechanisms
- XII. Mutation, Disease, and Evolution
 - i. Role of Mutation in Disease

- ii. Role of Mutation in Evolution
- XIII. Definition of the Gene
 - i. Definitions based on Function
 - ii. Definitions based on Structure
 - iii. Operational definition
 - iv. Complex Gene-Protein Relationships
- XIV. Mendelism: Basic Principles of Inheritance
 - i. Mendel's Study of Heredity
 - ii. Applications of Mendel's Principles
 - 1. Punnett Square
 - 2. Probability
 - iii. Formulating and Testing Genetic Hypotheses
 - iv. Mendelian Principles in Human Genetics
 - v. History: Life of Gregor Mendel
 - vi. Controversy: Genetic Testing and Counseling
- XV. Extensions of Mendelism
 - i. Allelic Variation and Gene Function
 - ii. Gene Action: From Genotype to Phenotype
- XVI. Inheritance of Complex Traits
 - i. Complex Patterns of Inheritance
 - 1. Quantitative Traits
 - 2. Threshold Traits
 - ii. Analysis of Quantitative Traits
 - iii. Analysis of Inbreeding and Co-Ancestry
 - iv. Correlation between Relatives
- XVII. The Chromosomal Basis of Mendelism
 - i. Chromosomes
 - ii. Chromosome Theory of Heredity
 - iii. Sex-Linked genes in Human Beings
 - iv. Sex Chromosome and Sex Determination
 - v. Controversy: Sex Selection
- XVIII. Variation in Chromosome Number and Structure
 - i. Cytological Techniques
 - ii. Polyploidy
 - iii. Aneuploidy

- iv. Rearrangements of Chromosome Structure
- XXIX. Linkage, Crossing Over, and Chromosome Mapping in Eukaryotes
 - i. Linkage, Recombination and Crossing Over
 - ii. Chromosome Mapping
 - iii. Cytogenetic Mapping
 - iv. Linkage Analysis in Humans
 - v. Recombination and Evolution
- XX. The Genetics of Microorganisms
 - i. The Genetics of Viruses
 - ii. Genetics of Bacteria
 - iii. Mechanisms of Genetic Exchange in Bacteria
 - iv. Current Issue: Antibiotic Resistance
- XXI. Transposable Genetic Elements
 - i. Transposable Elements in Bacteria
 - ii. Transposable Elements in Eukaryotes
 - iii. Retroviruses and Retrotransposons
 - iv. Transposons and Evolution
 - 1. History: Barbara McClintock
- XXII. Genetics of Mitochondria & Chloroplasts
 - i. Classical Genetics of Organelles
 - ii. Molecular Genetics of Mitochondria
 - iii. Molecular Genetics of Chloroplasts
 - iv. Mitochondrial DNA and Human Disease
 - v. Origin and Evolution of Mitochondria and Chloroplasts
- XXIII. Techniques of Molecular Genetics
 - i. Basic Techniques used to Identify, Amplify and Clone Genes
 - ii. DNA libraries
 - iii. Manipulation of DNA Sequences *In Vitro*
 - iv. Molecular Analysis of DNA, RNA, and Proteins
 - v. Molecular Analysis of Genes and Chromosomes
- XXIV. Genomics
 - i. The Human Genome Project
 - ii. RNA and Protein Assays of Genome Function
- XXV. Application of Molecular Genetics
 - i. Identifying Human Genes

- ii. Molecular Diagnosis of Human Diseases
 - iii. Controversy: Forensic Science
 - iv. Controversy: Gene Therapy, “Gene Doping”, and Eugenics
 - v. Controversy: Genetically Modified Crops
- XXVI. Regulation of Gene Expression in Prokaryotes and Viruses
- i. Constitutive, Inducible, and Repressible Gene Expression
 - ii. Positive and Negative Control of Gene Expression
 - iii. Operons

- XXVII. Regulation of Gene Expression in Eukaryotes
 - i. Spatial and Temporal Regulation of Eukaryotic Genes
 - ii. Ways of Regulating Eukaryotic Gene Expression
 - iii. Environmental and Biological Factors in Transcriptional Activity
 - iv. Molecular Control of Transcription in Eukaryotes
 - v. Gene Expression and Chromosome Organization
- XXVIII. Genetic Control of Animal Development
 - i. Process of Development in Animals
 - ii. Controversy: Reproductive Technologies, Stem Cell Research
- XXIX. Genetic Control of Vertebrate Immune System
 - i. Overview of Immune Response
 - ii. Components of Mammalian Immune System
 - iii. Adaptive Immunity
 - iv. Current Issue: HIV and Genetics
- XXX. The Genetic Basis of Cancer
 - i. Overview of Cancer
 - ii. Oncogenes
 - iii. Tumor Suppressor Genes
- XXXI. Population Genetics and Evolutionary Genetics
 - i. Theory of Allele Frequencies
 - ii. Natural Selection
 - iii. Random Genetic Drift
 - iv. Populations in Genetic Equilibrium
 - v. Molecular Evolution
 - vi. Controversy: Race and Genetics