Fall 2024

Bio 256
General Genetics

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Dean's Review:

Dean's Signature: _____Date Reviewed: ___/___/_____

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Bio 256
General Genetics

COURSE OUTLINE

Prerequisites:

Bio 101 and Bio 102 or equivalent

Course Description:

Explores the principles of genetics ranging from classical Mendelian inheritance to the most recent advances in the biochemical nature and function of the gene. Includes experimental design and statistical analysis.

Goal of the Course:

This course is designed as an introduction to genetics and the techniques used for genetic analysis at the biochemical, organismal and population levels. This course has both a lecture and lab component where students are exposed to many different techniques used to assess and apply genetic information to given scenarios. This course is designed to fulfill a second-year laboratory requirement and provide students with a foundation in how genes function, how they are inherited and how we study them.

Semester Credits: 4 **Lecture Hours: 3 Lab/Recitation Hours: 3**

Course Outcomes

At the completion of this course, the student should be able to:

Scientific Literacy:

Evaluate different perspectives, opinions, and statements about biological issues in terms of their logic, content, scientific merit, and biases.

Quantitative Reasoning:

Perform accurate calculations, interpret scientific data and graphs, and use results to support conclusions.

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Analyze data collected through experiments in the lab. Present and discuss the findings and conclusions derived from data, with chart/spreadsheet and graphs.

Critical Thinking:
Discriminate among degrees of credibility, accuracy, and reliability of inferences drawn from given data, determine whether certain conclusions or consequences are supported by the information provided and use problem solving skills.

Major Course Topics and Content Specific Learning Outcomes

Unit 1: Nature of a Gene

1.1 Describe the molecular structure of DNA and RNA and indicate similarities and differences.
1.2 Describe the mechanisms used by the cell for DNA replication
1.3 Describe the pathway connecting the information in a gene, through its expression, to a phenotype
1.4 Describe the various types of mutations, including causes, consequences
1.5 Describe how DNA damage is detected and repaired and determine the appropriate repair pathway for specific types of damage
1.6 Analyze problems in DNA replication, transcription, translation and determine their outcomes phenotypically.

Unit 2: Gene Expression and Regulation

2.1 Describe mechanisms regulating various stages of gene expression in both prokaryotes and eukaryotes.
2.2 Explain how epigenetic changes can alter gene expression without changing the underlying DNA
2.3 Describe how regulating changes in gene expression are essential for development, cell identity, and sex determination
2.4 Analyze anomalies in gene expression and predict their phenotypic outcomes.

Unit 3: Eukaryotic Cell Cycle

3.1 Describe the cellular and chromosomal events that occur during the cell cycle and gamete formation
3.2 Explain how meiosis and random fertilization contribute to genetic variation
3.3 Explain the chromosomal basis of inheritance
3.4 Describe normal chromosomal structure
3.5 Describe abnormalities in chromosome structure and number and explain how these anomalies arise and are detected.

3.6 Connect abnormalities in chromosome structure and number back to sex determination and describe expected phenotypic outcomes

Unit 4: Mendelian Genetics

4.1 Use Punnett squares to predict offspring ratio for different inheritance patterns
4.2 Use probability and statistics to predict outcomes and conclude if actual outcomes are expected
4.3 Predict the types and frequencies of offspring in Mendelian crosses
4.4 Analyze progeny numbers to determine mode of inheritance
4.5 Use a pedigree to determine the mode of inheritance for a gene
4.6 Analyze a pedigree and use probability to determine carrier status or progeny outcomes

Unit 5: Non-Mendelian Genetics

5.1 Describe how different types of dominance affect phenotypes
5.2 Explain how genes can be linked and how this affects inheritance patterns
5.3 Use Punnett squares and probability to predict offspring ratio for different inheritance patterns
5.4 Calculate the location of a gene on a chromosome
5.5 Describe the process of gene mapping in Eukaryotes

Unit 6: Population Genetics

6.1 Describe importance of genetic variation for evolution
6.2 Apply Hardy-Weinberg Equilibrium principles to a population to determine if evolution is occurring
6.3 Analyze population data using hardy-Weinberg equilibrium principles to predict carriers of mutations and mating outcomes.
6.4 Describe and apply various evolutionary tests
6.5 Differentiate between different types of selection

Unit 7: Molecular Genetics

7.1 Describe methods used to isolate, amplify and study genes of interest
7.2 Describe methods used to identify and alter genes of interest
7.3 Compare genome sequencing approaches and applications
7.4 Discuss the limitations of genetic research
7.5 Interpret a basic phylogenetic tree

Unit 8: Genetics in Society

8.1 Discuss the ethical, legal, medical, and social implications of the study of genetics

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Required Materials:

Textbook:

1. *Genetics, A conceptual Approach* 7th Edition. Benjamin A. Peirce
    a. ISBN:978-1-319-21680-1
2. Access to SaplingPlus

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Topical Description:

Chapter 1: Introduction to Genetics (unit 8)

- Role of Genetics in Biology
- Genetic Diversity and Evolution
- Model Genetic Organisms

Chapter 2: Chromosomes and Cellular reproduction (unit 3)

- Prokaryotic Cell Reproduction
- Eukaryotic Cell Reproduction
- Cell Cycle and Mitosis
- Genetic Consequences of the cell cycle
- Meiosis and sources of variation
- Meiosis in the life cycles of plants and animals

Chapter 3: Basic Principles of Heredity (unit 4)

- Gregor Mendel's experiments
- Molecular nature of alleles
- Predicting outcomes of monohybrid and dihybrid crosse
- Chi square goodness of fit test for predictions

Chapter 4: Sex determination and Sex-linked Characteristics (unit 4)

- Chromosomal Sex determination
- Environmental Sex determination
- Sex linked traits

Chapter 5: Extensions and Modifications of Basic Principles (unit 6)

- Types of dominance
- Penetrance and Expressivity
- Epistasis
- Sex influences and sex-limited characteristics
- Environmental effects on phenotype

Chapter 6: Pedigree Analysis, Applications, and genetic testing (unit 4)

- Pedigree analysis
- Twin studies
- Genetic Counseling
- Adoption studies
- Genetic testing

Chapter7: Linkage, Recombination and Eukaryotic Gene mapping (unit 5)

- Gene Linkage
- Calculating recombination

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- Constructing a Genetic map
- Deletion mapping

Chapter 8: Chromosome Variation (unit 2)

- Chromosome morphology
- Chromosomal Rearrangements
- Types of Aneuploidy
- Polyploidy

Chapter 9: Bacterial and Viral Genetic Systems(unit 1)

- Bacterial Diversity
- Bacterial Genetic exchange
- Bacterial Defense mechanisms
- Gene mapping in Bacteriophages
- Plant and animal viruses

Chapter 10: DNA: The Chemical Nature of the Gene (unit 1)

- RNA as genetic material
- DNA structure

Chapter 11: Chromosome Structure and Organelle DNA (unit 1)

- Chromosomal Structure
- Types of DNA in Eukaryotes
- Mitochondrial and Chloroplast genomes

Chapter 12: DNA Replication and Recombination (unit 1)

- Process of Bacterial DNA Replication
- Process of Eukaryote DNA Replication
- Differences between Prokaryotic and Eukaryotic Replication

Chapter 13: Transcription (unit 1)

- RNA structure
- Bacterial process of Transcription
- Eukaryotic process of Transcription
- Differences between Prokaryotic and Eukaryotic Transcription

Chapter 14: RNA molecules and RNA processing (unit 1)

- Gene organization
- mRNA structure
- tRNA structure
- RNA interference
- Crispr

Chapter 15: The Genetic code and Translation (unit 1)

- Structure and Function of Proteins
- Properties of the genetic code

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- Process of Translation
- Ribosomal Structure

Chapter 16: Control of Gene expression in Bacteria (unit 2)

- Operon structure
- Lac Operon
- Trp operon
- Alternative regulation

Chapter 17: Control of Gene expression in Eukaryotes (unit 2)

- Chromosome alterations
- Transcription factors
- RNA splicing
- SiRNA

Chapter 18: Gene Mutations and DNA repair (unit 1)

- Categories and types of mutations
- Factors causing mutations
- Transposable elements
- DNA repair mechanisms

Chapter 19: Molecular Genetic Analysis and Biotechnology (unit 7)

- Molecular techniques
- Recombinant DNA
- Crispr
- Applications of Biotechnology

Chapter 20: Genomics and Proteomics (unit 7)

- Genetic maps
- Physical maps
- Human Genome project
- Proteomics

Chapter 25: Population Genetics (unit 7)

- Calculating genotype frequencies
- Hardy-Weinberg Equilibrium (HWE)
- Evolutionary forces altering HWE

Chapter 26: Evolutionary Genetics (unit 7)

- Biological evolution
- Speciation
- Phylogenetic trees
- Molecular Evolution

Laboratory Topics

Bioinformatics

Phylogenetic trees
Molecular Genetics Techniques
Mendelian Genetic Crosses
Gene mapping

ADA Statement (PDF)
Title IX Statement (PDF)

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