

**JEFFERSON COLLEGE**

**COURSE SYLLABUS**

**Bio 201**

**Genetics**

**4 Credit Hours**

**Prepared by:  
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# Bio 201 Genetics

## I. Catalogue Description

Prerequisites: BIO 101, General Biology or Bio 205 General Botany or Bio 206 General Zoology and CHM 111, General Chemistry I. Genetics explores the molecular basis for life. Included are the structure/function and means of expression of the gene and its basis as the unit of heredity. Classical Mendelian genetics as well as modern molecular biological techniques and interpretations of genetic data will be considered, particularly as they apply to humans, plants and animals. 4 credit hours (3 credit hours lecture, 1 credit hour lab). (D)

## II. Course General Objectives

1. Outline the process by which the genetic information stored in DNA is actualized in protein.
2. Diagram the cell cycle and list the different general steps that occur during meiosis and mitosis.
3. Given sufficient numbers of alleles, perform Mendelian monohybrid, dihybrid and trihybrid crosses.
4. Interpret the significance of non-Mendelian phenotypic ratios with regard to, but not limited to, such factors as linkage and co-dominance.
5. Discuss the role that mutagens and teratogens play in DNA damage, oncogenesis and human disease as well as the DNA repair mechanisms commonly utilized by organisms to correct such genetic damage.
6. Discuss different possible means of gene regulation such as those found in the lac and trp operons.
7. Diagram the process of DNA cloning and explain how it relates to biotechnology.

## III. Course Outline (course content will be drawn from this)

### I. Unit 1

- A. Introduction
  1. Chemistry
    - a. chemical bonds
    - b. intermolecular forces
  1. Biomolecules (general)
  2. Classical breeding
  3. Biotechnology
- B. Cell cycle
  1. Mitosis
  2. Meiosis
- C. Classical genetics and variation
  1. Patterns of inheritance

- a. mono, di and trihybrid crosses
- b. pedigrees
- 2. Probability and chi squared analysis
- D. Non-Mendelian genetic variation
  - 1. Allelic variations and phenotypic expression
    - a. codominance
    - b. incomplete dominance
    - c. lethals
    - d. sex-linkage
  - 2. Extranuclear inheritance
- E. Sex determination and sex chromosomes
- F. Polygenic inheritance

## II. Unit 2

- A. Chromosomal mutations
  - 1. Chromosomal non-disjunction
    - a. monosomy and trisomy
    - b. polyploidy
  - 2. Mutations due to structure and arrangement
    - a. deletions
    - b. duplications
    - c. inversions
    - d. fragile sites
- B. Chromosome mapping and linkage
  - 1. Eukaryotes
    - a. crossing over
    - b. lod score analysis
  - 2. Prokaryotes and genetic recombination
    - a. conjugation
    - b. transformation
    - c. transduction
- C. DNA structure and analysis
  - 1. Scientific developments leading to DNA a genetic material
    - a. Structure leads to function in DNA
    - b. RNA as material for heredity (retroviruses)
  - 2. Chromosomal structure
    - a. Bacterial and viral
    - b. Eukaryotic

## III. Unit 3

- A. DNA replication and synthesis
  - 1. Semi-conservative model
  - 2. Controls in synthesis
    - 1. Replication in Prokaryotes
    - 2. Replication in Eukaryotes
- B. Transcription
  - 1. Discovery of the genetic code
  - 2. Mechanism of transcription

- C. Translation
  - 1. Prokaryotes
  - 2. Eukaryotes
  - 3. One gene-one enzyme-one polypeptide
  - 4. Post-translational modification of polypeptides
- D. Regulation of gene expression
  - 1. Prokaryotic systems
    - a. *lac ZYA* operon
    - b. *trp* operon
  - 2. Eukaryotic systems
  - 3. Post transcriptional modification
- E. Mutation and DNA repair
  - 1. Means of mutagenesis/mutagenic agents
  - 2. Mechanisms of DNA repair
    - a. photoreactivation repair
    - b. excision repair
    - c. mismatch repair
    - d. SOS repair

#### IV. Unit 4

- A. Recombinant DNA technology
  - 1. Construction of a clone
  - 2. Cloning in prokaryotes
  - 3. Cloning in Eukaryotes
  - 4. Tools to facilitate cloning
- B. Applications and ethics in Biotechnology
  - 1. Pharmacogenomics
  - 2. Disease diagnosis
  - 3. Gene Therapy
  - 4. Ethical concerns
- C. Population Genetics
  - 1. Gene pools and allelic frequencies
  - 2. Hardy-Weinberg Law
  - 3. Natural Selection
  - 4. Genetic drift
- D. Genes and Development

### IV. Unit Objectives

#### Unit 1

- 1. Students will explain the significant roles played by chemical bonds and intermolecular forces in the transmission of heredity.
- 2. Students will list 3 similarities and 3 differences between classical breeding and modern biotechnology
- 3. Given diagrams of a cell at different stages in the cell cycle and cell division, students will label each stage and comment on the significant events taking place during that stage.
- 4. Students will explain the significance of a check-point or control point in the cell cycle.
- 5. Given sufficient alleles, students will construct a Punnett's square and perform a mono, di or trihybrid cross.

6. Given the results of a mono, di or trihybrid cross, students will discriminate between the genotypic and phenotypic ratio.
5. Given the phenotypic results of a cross, students will propose an explanation to account for any non-Mendelian results.
6. Given a set of alleles, students will use probability theory to predict the outcome of a potential cross.
7. Given genetic data, students will employ chi squared analysis to check its significance.
8. Students will recognize the uniqueness of sex chromosomes in determining the gender of an organism and give examples of their contrasting role in different organisms.

#### Unit 2

1. Students will define polyploidy and discuss its role and inherent organism- dependent benefits and dangers.
2. Students will recognize and describe the mechanism of formation for common chromosomal aberrations including chromosomal non-disjunction, deletions, duplications, inversions and fragile sites.
3. Students will define the term linkage and discuss its role in trait heritability.
4. Students will pictorially or mechanically describe the process of crossing over and discuss its role in genetic variability.
5. Given sufficient data, students will determine the extent of linkage between two genes by performing lod analysis.
6. Students will discuss the role of linkage in human disease, such as hemophilia.
7. Students will describe the three common methods of bacterial transformation.
8. Students will recognize and describe the three common structures of DNA.
9. Students will outline the experiments leading to the recognition of DNA as the material of heredity on most organisms.
10. Students will discuss the significant reasons as to why DNA is the preferred bio-molecule for heredity.
11. Students will describe the role played by RNA in some organisms as the molecule of heredity.
12. Students will compare/contrast the general structure of prokaryotic versus eukaryotic chromosomal organization.

#### Unit 3

1. Students will diagram the semi-conservative model of DNA replication.
2. Students will discuss the experimental evidence that supports the semi-conservative model and debunks both the conservative and dispersive models.
3. Students will place in correct order the events, including checkpoints that lead to the replication of DNA.
4. Students will contrast the means of DNA replication in prokaryotes and eukaryotes.
5. Students will discuss the major experimental results leading to deciphering of the genetic code.
6. Students will outline the steps involved in transcription for both prokaryotes and eukaryotes.
7. Students will outline the process of translation.
8. Students will contrast the significant differences between translation in prokaryotes and eukaryotes.
9. Students will describe the role played by post-transcriptional modification in control of gene expression.
10. Students will describe the role played by post-translational modification in control of gene expression and enzyme functioning.
11. Students will compare and contrast the nature of gene regulation in inducible versus repressible systems.
12. Given a given a specific genetic system, e.g. *lac* operon or *trp* operon, students will make predictions regarding the change in the level of transcription expected based upon a change in an environmental condition.
13. Students will list three types of mutagenic insults.
14. Students will list four different common types of mutations.

15. Students will distinguish between the different repair mechanisms and identify what type of damage each corrects.
16. Students will discuss the probable functional consequence of each of the different common types of genetic mutation: frame-shift, mismatch, thymine dimer etc.

#### Unit 4

1. Students will outline the process of generating a genetic clone.
2. Students will discuss the unique differences inherent with cloning and gene expression in prokaryotic versus eukaryotic organisms.
3. Students will list various different tools utilized in biotechnology and indicate their purpose.
4. Given an organism, students will propose a reasonable method by which to clone a specific gene including an analysis of precautions and pitfalls.
5. Students will list 3 applications of biotechnology.
6. Students will outline the steps involved in three different biotechnological techniques and their purpose, such as PCR, DNA fingerprinting, southern blotting etc.
7. Students will evaluate the ethical nature of genetic research.
8. Students will discuss the potentials and pitfalls of biotechnological research and its application.
9. Given sufficient information, the student will calculate allelic frequencies for a given gene in a population
10. Students will define genetic drift and discuss its role in allelic variability.
11. Students will list the tenets of the Hardy-Weinberg Law.
12. Students will use the Hardy-Weinberg Law to calculate expected genotypic ratios based upon allelic frequencies in the general population.
13. Students will discuss the role played by natural selection in altering allelic frequencies in a population.
14. Students will discuss the effects that each of the following will have on genetic diversity within a population: mutation, migration, genetic drift and non-random mating.
15. Students will list the different genetic factors that influence zygotic and organismal development.

#### V. Method(s) of Instruction

- Lecture
- Group discussion
- Video
- Assisted small group work
- Computer driven web based exercises.

#### VI. Required Textbook(s) (with publication information)

**Essentials of Genetics**, 5<sup>th</sup> ed. (2005), Klug, William S. and Michael R. Cummings, Prentice Hall, Upper Saddle River, New Jersey, 07458. pp. 568.  
**Genetics Laboratory Investigations**, 12<sup>th</sup> ed. (2001), Mertens, Thomas, R. and Robert L. Hammersmith, Prentice Hall, Upper Saddle River, New Jersey, 07458. pp. 282.

#### VII. Required Materials (student)

Textbook, notebook paper, pens/pencils, scientific calculator

#### VIII. Supplemental References: None

#### IX. Method of Evaluation (student outcomes assessment)

Exam 40%, Quizzes 15%, Term Paper 10%, Problem Sets 15%, Final 20%