

Course: Modern Genetics / BIO 262

Credits: 4 hrs. Credits (3hours of lectures and 3hours of lab each week)

Text: Concepts of Genetics, 8<sup>th</sup> Edition, William S. Klug & Micheal R. Cummings, Prentice Hall Publishers.

Description of the Course:

A) Catalogue Description: An introductory course on the basic principles, theories, and laws of heredity. Topics to be covered will include: the cell cycle of growth, mitosis, meiosis, DNA and RNA and their role in protein synthesis, genes, chromosomes and recombinant DNA technology, as well as, Mendelian and Human genetic principles. *Laboratory experiences will incorporate the use of the fruit fly to examine ways that traits are inherited and transmitted from generation to generation. Gel electrophoresis and recombinant DNA procedures will be used to explore modern concepts of cytogenetics.*

Prerequisites: BIO 121 and BIO 122, MAT 186 or Higher, CHE 111 or CHE 121 & CHE 122 required. Or BIO 121, MAT 137, CHE 111, and written permission of the instructor.

B) General Course Objectives: to aid the student in developing;

- 1) critical thinking skills.
- 2) an understanding of basic genetic principles as they apply to a variety of life forms.
- 3) an understanding of the effects that the environment has on genes and gene expression.
- 4) an understanding of some important implications of genetics on the welfare of humans.
- 5) an understanding of the interrelationship between genetics and other areas of science.
- 6) an understanding of the vast amounts of research that is done in genetics and the vast amount of unanswered questions that still exist.

Class Attendance Policy:

Attendance of all class activities in lecture and laboratory is required. Absences are counted from the first meeting of class. More than four consecutive or more than six accumulative absences could result in a student receiving a "F" grade in this course. An explanation of the cause of all absences should be given to your instructor.

Academic and Classroom Misconduct:

The instructor has primary responsibility for control over classroom and/or laboratory behavior and maintenance of academic integrity, and can request the temporary removal or exclusion from the classroom or laboratory of any student engaged in conduct that violates the general rules and regulations of the institution. Or any student engaged in conduct deemed hazardous in the laboratory. Extended or permanent exclusion from lecture or laboratory activities or further disciplinary action can only be effected through appropriate procedures of the institution.

Plagiarism, cheating on quizzes or tests, or any form of academic dishonesty is strictly prohibited. Students guilty of academic dishonesty directly or indirectly will receive a zero for the exercise or quiz or test and may receive a "F" grade for the course in addition to other possible disciplinary sanctions which maybe imposed through the regular institutional procedures. Any student that believes that he or she has been erroneously accused may appeal the case through the appropriate institutional procedures if their grade was affected.

Procedure for Dropping the Course: \*\*\* College's Withdrawal Policy\*\*\*

Any student who finds it necessary to discontinue this course MUST complete a withdrawal form in the Registrar's Office at the time of the withdrawal. Students may withdraw from the course any time during the first 14 weeks, of class to receive a W grade for the course.

(\* Deadline will be announced. )

Students who do not withdraw, but stop attending will be assigned an "F" grade in this course. Verbal withdraws CANNOT be accepted. If you are unable to withdraw in person, you may call the Registrar's Office and provide them with the appropriate information. **Once you withdraw from the course you are no longer eligible to attend class or take any remaining quizzes or test.**

Tests:

There will be nine scheduled quizzes (additional pop quizzes may also be given), all quizzes are given during the first ten minutes of class. (No make-ups for quizzes). Three unit test, one lab test, one lab report, a oral and written report for lecture and a comprehensive final exam will also be given. Unit tests are scheduled in advance and the test scores will be posted by your student I.D. number. Students are allowed to review the test during office hours only in the presence of the instructor. **Note taking will not be permitted.** All unit tests will be reviewed by your instructor before the final exam is given.

Grade Determination:

$\frac{1}{2}$  of the semester's average,  $\frac{1}{4}$  of the lab grade,  $\frac{1}{4}$  of the score on the comprehensive final exam will determine the final course grade.

EXAMPLE: (Semester's Average)  $\frac{1}{2}$  (90) = 45  
(Lab Grade)  $\frac{1}{4}$  (92) = 23  
(Final Exam Score)  $\frac{1}{4}$  (96) = 24  
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The best seven quiz scores will be added together plus the score for the written/oral presentation and divided by eight to determine the quiz average. The quiz average and the three unit tests scores will be added together and divided by four to determine the semester's average. The lab grade will be determined by averaging the lab test score and the lab report score. The comprehensive final exam will consist of at least hundred questions, total possible points 100.

Grade Scale: There will be NO grading on the normal distribution curve.

100.00 - 94.00 = A  
93.49 - 90.00 = A-  
89.49 - 87.50 = B+  
87.49 - 84.00 = B  
83.49 - 79.50 = B-  
79.49 - 77.50 = C+  
77.49 - 74.50 = C  
74.49 - 69.50 = C-  
69.49 - 63.50 = D+  
63.49 - 59.50 = D  
58.49 - 55.00 = D-  
54.49 - 00.00 = F

### Exemption Policy:

The instructor will determine who is to be exempted from taking the final exam, not the student. Exemption is an earned *privilege* not an inherited right. Any student that is exempted from taking the final exam will be notified in writing. Students being considered for exemption MUST meet all of the following requirements: (No exceptions for any reason!)

- 1) Good classroom conduct.
- 2) Only 1 absence from lecture or laboratory (excused or non-excused).
- 3) No more than three tardies during course of the semester in lecture or laboratory.
- 4) All unit tests and lab tests must be taken when scheduled (no make-ups).
- 5) No unit test score lower than **88**. (The average of the best seven quizzes cannot be lower than **90**)
- 6) The minimum lab test score is **90**.
- 7) Must have an overall semester's average of **95** or higher. (*Without rounding off*).
- 8) Must have a semester's lab test average of **95** or higher. (*Without rounding off*).
- 9) Intangibles.

### Make-ups:

Any assignment missed can be obtained from the instructor. \*Lab work maybe made up during free lab time within a week of the missed assignment if the lab is available. Quizzes, scheduled or pop, cannot be made up for any reason. Unit tests can only be made up by special arrangement with the instructor. Makeup tests will be granted on an individual basis only following a conference with the instructor; where the reason(s) for missing the test must be determined mitigating circumstances beyond the control of the student such as, illness, death in the family, or change in condition of employment. All make-up tests will be scheduled during the week of the final exams. If two unit tests are missed during the semester and/or if the final exam is missed the student will receive a "F" grade if he or she is failing other parts of the course or an "I" if the student is passing all other parts of the course.

- ***Lab exercises or lab work that utilizes live bacteria or other perishable materials cannot be made up for any reason.***

### Revisions to the Syllabus:

Students are responsible for learning all of the objectives and all of the items in the course outline whether they are discussed in lecture and/or laboratory or not. The instructor reserves the right to revise the objectives, topical outline, or academic schedule contained in this syllabus without notice. However, if the revisions affect scheduled unit tests a 48-hour notice will be given for the new test date.

### Cellular phones and beepers:

***Cellular phones and beepers are only allowed in class or lab if they are turned off or in silent mode. Under no circumstance are phones to be answered in class. When there are extenuating circumstances that require that a student be available by phone or beeper, that student must speak to the instructor prior to class, so that together they can arrive at an agreement.***

### Course Objectives – BIO 262 Modern Genetics

1. The student will develop “critical thinking skills” and learn to develop sound scientific conclusions by the analysis of scientific data.
2. The student will demonstrate knowledge of the scientific method through examples.
3. The student will develop an understanding of how genetics relates to other fields of science and its relevance to human civilizations.
4. The student will learn and demonstrate knowledge of the differences between the genetics of prokaryotic and eukaryotic cells.
5. The student will demonstrate knowledge of the cell’s cycle of growth and how the cycle is regulated.
6. The student will be able to explain mitosis in terms of the phases and explain the major events that occur during each phase.
7. The student will be able to explain meiosis in terms of the phases and explain in detail the major events that occur during each phase.
8. The student will be able to relate the process of meiosis to gametogenesis in both plant and animal cells.
9. The student will demonstrate knowledge of the chemistry of genes and chromosomes.
10. The student will be able to explain the role of genes in inheritance and how genes are passed from one generation to another.
11. The student will be able to define or explain various terms related to genetics such as allele, genotype, phenotype, dominance, recessiveness, epistasis, homologous, homozygous, heterozygous, hybrid.
12. The student will demonstrate knowledge of the Mendelian Laws of Genetics.
13. The student will learn to develop and use the appropriate punnett for various genetics crosses such as monohybrid, test, back, dihybrid, sex linked, and polyhybrid.
14. The student will be able to explain the relationship between genetics and probability.
15. The student will demonstrate knowledge of the various forms of gene interactions and gene expression.
16. The student will be able to describe how chromosomes control the inheritance of sex in a variety of organisms.
17. The student will be able to describe the patterns of sex-linked traits.
18. The student will be able to explain how gender can influence traits.
19. The student will be able to explain qualitative inheritance.

20. The student will be able to demonstrate quantitative inheritance using mathematical processes.
21. The student will be able to explain the relationship between linked genes and crossing over.
22. The student will be able to define chromosomal variations and explain their effects on inheritable traits.
23. The student will be able to define non-disjunction, list various forms of non-disjunctions and explain their consequences on the different organisms.
24. The student will be able to discuss some common forms of Human genetic diseases as related to abnormal chromosome number or chromosomal aberrations.
25. The student will be able to explain the chemistry of DNA and RNA and list the different types of RNA.
26. The student will be able to explain the differences between exons and introns.
27. The student will be able to explain the process of DNA replication in both the leading and lagging strands of DNA.
28. The student will be able to explain the genetic mechanisms in viruses and bacteria.
29. The student will develop an understanding of the biosynthesis of proteins in viral infected cells in terms of RNA and DNA viruses.
30. The student will be able to describe DNA and RNA and explain their role in bacterial genetics.
31. The student will be able to explain various forms of gene regulations in prokaryotes.
32. The student will be able to explain the “Operon Theory” as it relates to bacteria.
33. The student will be able to develop an understanding of recombinant DNA in viruses and bacteria.
34. The student will be able to list and explain various factors that regulate the action of gene in eukaryotes.
35. The student will be able to explain the role of DNA and RNA in protein synthesis.
36. The student will be able to describe the process of transcription and translation in protein synthesis.
37. The student will be able to describe forms of genetic modifications and mutations.
38. The students will be able to explain the interrelationship between genetics and cancer.
39. The student will demonstrate knowledge of extra chromosomal inheritance.
40. The student will be able to describe the relationship of genetics to the development, evolution and physiology of eucaryotes.
41. The student will gain an understanding of population genetics.

42. The student will be able apply the Hardy-Weinberg Theory to population genetics.
43. The student will able explain how genetic variation influences evolution.
44. The student will be able to describe the impact of humans on natural selection.
45. The student will be able to describe some of the theories of recombinant DNA technology.
46. The student will develop an understanding of cytogenetic technology and its impact on the world at large.

## TOPICAL OUTLINE (LECTURE) BIO 262 MODERN GENETICS

### Unit 1

#### I) Introduction

- A) What is Science?
  1. Critical thinking and the scientific method
  2. Science and Technology
- B) What is Genetics?
  1. Genetics and the Geneticist
  2. Early beliefs about heredity
  3. Common questions about heredity
- C) Cells, Genes and Chromosomes
  1. Prokaryotic cells
  2. Eukaryotic cells
  3. The Chemistry of DNA
  4. The Chemistry of RNA
  5. Nucleoproteins
  6. Genes
  7. Chromosomes
    - a) euchromatic region
    - b) heterochromatic region
    - c) centrosome
    - d) centromeres

#### II) The Physical Basis of Heredity

- A) The Cell and Mitosis
  1. The Cell's nucleus
  2. The Cell's cycle of growth
    - a) growth phase 1 (G<sub>1</sub> phase)
    - b) synthesis phase (S phase)
    - c) growth phase 2 (G<sub>2</sub> phase)
  3. The Genetic controls of the cycle and Mitosis
  3. Mitosis defined
  4. The purpose of mitosis
  5. Interphase
  6. The phases of mitosis
    - a) prophase
    - b) metaphase
    - c) anaphase
    - d) telophase
  7. The daughter cells
  8. The major differences between plant and animal cell mitosis

#### III) Cells with a sex Life

- A) Sex Development
- B) Meiosis defined

- C) Reduction Division
  - Meiosis I
    - 1. Prophase I
      - a) leptotene
      - b) zygotene
      - c) pachytene
      - d) diplotene
      - e) diakinesis
    - 2. Metaphase I
    - 3. Anaphase I
    - 4. Telophase I
    - 5. Interphase
  - D) Equational Division
    - Meiosis II
      - 1. Prophase II
      - 2. Metaphase II
      - 3. Anaphase II
      - 4. Telophase II
      - 5. Daughter cells
  - E) Gametogenesis in Animals Cells
    - 1. Spermatogenesis
    - 2. Oogenesis
  - F) Gametogenesis in Plant Cells
    - 1. Microsporogenesis
    - 2. Megasporogenesis
  
- IV) How traits are inherited
  - A) Mendel's studies
  - B) The Law of "Segregation of Gametes"
  - C) Monohybrid crosses
    - 1. Homologous Chromosomes
    - 2. Genes (alleles)
    - 3. Genotype – Homozygous genes (alleles)
    - 4. Genotype – Heterozygous genes (alleles)
    - 5. Dominant genes
    - 6. Recessive genes
    - 7. The punnett square
    - 8. Parent or P<sub>1</sub> generation
    - 9. First filial or F<sub>1</sub> generation
    - 10. Second filial or F<sub>2</sub> generation
    - 11. Genotypical and Phenotypical ratios
    - 12. Human heredity
      - a) genes in families
      - b) inborn errors of enzyme function
      - c) hemoglobin synthesis and development
      - d) isozymes



- D) The Law of “Independent Assortment”
- E) Dihybrid Crosses
  - 1. Gamete classes
  - 2. The punnett square
  - 3. Phenotypical ratio
  - 4. Genotypical ratio
- F) Probability ratios, methods and calculations
- G) Chi-square

## Unit II

### I) Varieties of Gene Expression

- A) Incomplete or intermediate dominance
- B) Codominance
- C) Epistasis and Epistatic genes
  - 1. Single recessive epistasis
  - 2. Duplicate recessive epistasis
  - 3. Single dominant epistasis
  - 4. Duplicate dominant epistasis
  - 5. Intermediate epistasis
- D) Complementary genes
- E) Supplementary genes
- F) Lethal genes
- G) Environmental modification of gene expression
- H) Phenocopies

### II) Sex Determination and Sex Linked Traits

- A) Sex determining chromosomes
  - 1. The genetic basis for sex determination
  - 2. Sex chromosomal configuration in representative diploid forms
- B) Sex-linked Traits
  - 1. Patterns of inheritance of sex linked traits
  - 2. Autosomal traits that are influenced by sex (gender).
- C) Abnormal sex types in Humans
  - 1. Klinefelter’s syndrome
  - 2. Turner’s syndrome
  - 3. Testicular feminization
  - 4. Other types

### III) The measurements of Gene Expression

- A) Qualitative inheritance
- B) Quantitative inheritance
  - 1. Polygenetic inheritance
  - 2. Multiple alleles
    - a) Genetics of human blood groups
    - b) Other examples of traits determine by multiple alleles

IV) Autosomal Linkage, Crossing Over and Chromosome Mapping

- A) Linked genes
- B) Gene linkage and recombination
- C) Chromosomes and double crossing over
- D) Three point test cross
- E) The use of linkage maps
- F) Linkage in Humans
- G) Cytological proof of crossing over
- H) Crossing over in somatic cells

V) Chromosomal Variation

- A) Rearrangement involving fragments of chromosomes
- B) Deletions
- C) Duplications
- D) Inversions
- E) Translocations

VI) Abnormalities in Species Specific Chromosome Numbers

- A) Euploid cells
- B) Aneuploidy
  - 1. Monosomic cells
  - 2. Trisomic cells
- C) Polyploidy
- D) Mosaics

VIII) Human genetic disorders cause by chromosomes aberrations and abnormal numbers

Unit III

I) The Molecular Basis for Genetics

- A) Nucleic Acids
  - 1. The molecular structure of a nucleotide
  - 2. The molecular structure of DNA
  - 3. The double helix
  - 4. DNA replication
  - 5. DNA and the gene
  - 6. The molecular structure RNA (rRNA, tRNA, mRNA)
  - 7. RNA replication
- B) Genetic mechanisms of viruses
  - 1. Viral replication
    - a) DNA viruses
    - b) RNA viruses

- C) Genetic mechanism of bacteria
  - 1. Asexual reproduction processes
  - 2. Conjugation
  - 3. Transduction
  - 4. Transformation
- D) Genetic Mutations
  - 1. Mutation at the molecular level
  - 2. Source and frequency of point mutations
  - 3. Various types of mutations
  - 4. Suppressor mutations
  - 5. Induced mutations
  - 6. Mutators and mutable genes
- E) The Genetic basis for Cancer
- F) The Genetics of Embryogenesis

## II) The Mechanism of Gene Expression

- A) How the gene works – Gene regulation in Eukaryotic cells
  - 1. DNA
  - 2. RNA
    - a) ribosomal RNA
    - b) messenger RNA
    - c) transfer RNA
  - 3. Protein Synthesis
    - a) transcription of RNA
    - b) types of transcribed RNA
    - c) the triplet code (codon)
    - d) the translation of mRNA into protein
- B) Gene regulation in Prokaryotic cells  
The Operon Theory in Bacteria
  - 1. The operator gene
  - 2. The structural gene
  - 3. The regulator gene
- C) The lac operon

- ## III)
- A) The Mechanisms of Recombinant DNA Technology/Gene splicing and Cloning
    - 1. Theories of Recombinant DNA (cDNA) – exons and introns
    - 2. Endonucleases (restriction enzymes)
    - 3. Gel electrophoreses
    - 4. PCR
    - 5. Genetic Vectors
      - a) plasmids
      - b) viruses
      - c) cos-mids
      - d) other types of genetic vectors
    - 6. Genetic Markers
    - 7. DNA probes
    - 8. Tests for recombination
    - 9. Practical applications of recombinant DNA technology and gene cloning

- B) The DNA library and how it is developed
  - C) Cytogenetic Technology
  - D) The Human Genome Project
- IV) Extra Chromosomal (Nuclear) Inheritance
- A) Maternal effects
  - B) Mitochondrial DNA
  - C) Chloroplast DNA
  - D) Cytoplasmic inheritance
    - 1. Kappa particles in paramecium
    - 2. Mammary tumors in mice
  - E) Transmissible plasmids in bacteria
- V) Genetics of Populations
- A) Hardy-Weinberg
  - B) Natural selection
  - C) Fitness and the coefficient
  - D) Zygotic selection
  - E) Migration and gene flow
  - F) Genetic drift
  - G) Inbreeding, out breeding, heterosis, and selection
- V) Genetics and the Origin of Species
- A) The evolutionary process
  - B) Rates of evolution
  - C) Evolution of genetic systems
  - D) The evolution of genes
- VI) Population, Pedigrees and Twins – Methodology in Human Genetics
- A) The study of populations
  - B) The study of families
  - C) Studies of cells and chromosomes
  - D) The study of twins
  - E) Genetics and race
  - F) Genetic counseling and eugenics
- VII) Genetics and Ecology
- A) The nature of ecological genetics
  - B) Pollution and evolution
- VIII) Special Topics in Genetics