Course Outline for: BIOL 2205 Genetics

A. Course Description

1. Number of credits: 4
2. Lecture hours per week: 3
   Lab hours per week: 3
3. Prerequisites: BIOL 1502 (C or higher)
4. Corequisites: None
5. MnTC Goal: #3 Natural Sciences

This course is designed for students majoring in biology. Students will explore major concepts in Mendelian, molecular, and population genetics, with emphasis on prokaryotic and eukaryotic gene expression, recombination, gene mapping, and chromosome analysis. Students will engage in techniques appropriate to genetic analysis and gain experience in experimental design, data analysis and interpretation, and the communication of results. Lecture 3 credits, 3-hour lab 1 credit.

B. Date last reviewed/updated: April 2023

C. Outline of Major Content Areas

Lecture: Subtopics listed under each main topic may vary due to recent developments in the field and current events.

1. Introduction to genetics
   a. Identification of the major issues within the field of genetics
   b. Impact of genetics in medicine, agriculture, and society.
2. Mendelian inheritance
   a. Mendel's principles of dominance, segregation, and independent assortment
   b. Pedigree analysis
   c. Statistical analysis of genetic data
3. Cell reproduction
   a. Prokaryotic and eukaryotic cells
   b. Chromosomes and their function
   c. The cell cycle, mitosis, and meiosis
4. Chromosomal basis of Mendelism
   a. The chromosome theory of inheritance
   b. Sex chromosomes and sex determination
   c. Sex linkage
   d. Dosage compensation of X-linked genes
5. Extensions of Mendelism
   a. Multiple alleles and different dominance relations
   b. Gene interactions and modified Mendelian ratios

    c. The environment and gene expression: penetrance and expressivity
6. Genetic mapping in eukaryotes
    a. Linkage, recombination, and crossing-over
    b. Chromosome mapping: two-and-three-point crosses
7. Variation in chromosomes number and structure
    a. Cytological techniques
    b. Abnormal chromosome number and structure
8. DNA and the molecular structure of chromosomes
    a. Evidence that the genetic information is stored in the DNA
    b. The chemical composition and structure of nucleic acids
    c. Chromosome structure in prokaryotes and eukaryotes
9. DNA replication
    a. Semiconservative DNA replication
    b. Molecular model of DNA replication
    c. Unique aspects of eukaryotic DNA replication
    d. Polymerase chain reaction (PCR) and its applications
10. Transcription and RNA processing
    a. The genetic control of metabolism
    b. The central dogma
    c. Transcription in prokaryotes
    d. Transcription and RNA processing in eukaryotes
11. Translation and the genetic code
    a. Protein structure
    b. The nature of the genetic code
    c. Protein synthesis and protein sorting
12. Regulation of gene expression
    a. Regulation of gene expression in prokaryotes: The *lac* and *trp* operons
    b. Levels of control of gene expression in eukaryotes
    c. Gene regulation in development and differentiation in eukaryotes
13. DNA mutation and repair
    a. Mutation as the source of genetic variability
    b. Types of mutations
    c. The molecular basis of mutations
    d. DNA repair mechanisms
14. Genetics of cancer
    a. Cancer and the cell cycle
    b. Genes and cancer: oncogenes and tumor-suppressor genes
    c. The multi-step nature of cancer
15. Cloning and manipulation of DNA
    a. DNA cloning and DNA recombinant libraries
    b. Genomics
    c. Production of eukaryotic proteins in bacteria
    d. Genetically modified organisms; economic, ecological, and evolutionary concerns
    e. Gene therapy
16. Extranuclear genetics
    a. Organization of extranuclear genomes

b. Rules of extranuclear inheritance
c. The origin and evolution of mitochondria and chloroplast

17. Population genetics
    a. The Hardy-Weinberg principle
    b. Genetic variation in natural populations
    c. Natural selection
    d. Bacterial Transformation
18. Developmental genetics
    a. Cell differentiation
    b. Cell signaling
    c. Pattern formation
    d. Hox genes

Laboratory: Students will actively participate in lab by completing studies related to:

1. Dyhibrid cross
2. Estimation of recombination sequence
3. DNA extraction
4. Sequencing and cloning
5. Gel electrophoresis
6. Western blot
7. Micropipetting
8. Cell division
9. ELISA

D. Course Learning Outcomes

Upon successful completion of the course, the student will be able to:

1. Explain and apply fundamental concepts related to the storage, transfer, and expression of genetic information at the cellular, organismal, and population level. (Goal 2a, 3a)
2. Use critical thinking skills to understand, evaluate, and analyze processes of inheritance. (Goal 2a, 2b, 2c, 3a)
3. Demonstrate ability to apply relevant statistical tests to genetic data. (Goal 2c, 2d, 3b)
4. Formulate a hypothesis and conduct and analyze an experiment with a model organism. (Goal 2a, 2b, 2c, 2d, 3b)
5. Organize, draft, edit, and revise formal scientific writing and communicate that written material in an oral presentation. (Goal 3c)
6. Read, interpret, incorporate, and cite information and ideas from primary literature into writing and oral presentations. (Goal 2a, 2c, 3a, 3c)
7. Utilize and understand the application of a genetic technology. (Goal 2a, 3d)
8. Identify, summarize, and critique key debates and arguments about current societal, ethical, and political issues that are relevant to genetics such as human cloning, stem cell research, genetically modified organism, etc. (Goal 2b, 2c, 2d, 3d)

E. Methods for Assessing Student Learning

A variety of evaluation and assessment methods may include, but are not limited to, the following:

1. Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)
2. Writing assignments
3. Quizzes
4. Graphing exercises
5. Work sheets
6. Individual oral quizzing on laboratory activities.
7. Term papers
8. Group activities and projects
9. Oral presentations
10. Laboratory reports
11. A final comprehensive exam

F. Special Information

Instructors will include the most recent version of the Departmental Expectations document in their course syllabus.

The laboratory portion of the course is delivered in the Biology Learning Center (BLC). Instructors will include the most recent version of the Biology Learning Center (BLC) Expectations document in their course syllabus.

One or more labs require the use of Biosafety Level 2 standards.

Laboratory procedures require handling, treatment and freezing of fruit flies and the genetic modification of bacteria; there are no exceptions or alternate activities.