Common 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. Co-requisites: None
5. MnTC Goal: 3

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. This course meets a requirement for the Biology (Minnesota State Transfer Pathway) AS-P degree. Lecture 3 hours per week; Lab 3 hours per week.

B. Date last revised: August 2019

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. (2a, 3a)
2. Use critical thinking skills to understand, evaluate, and analyze processes of inheritance. (2a, 2b, 2c, 3a)
3. Demonstrate ability to apply relevant statistical tests to genetic data. (2c, 2d, 3b)
4. Formulate a hypothesis, and conduct and analyze an experiment with a model organism. (2a, 2b, 2c, 2d, 3b)
5. Organize, draft, edit, and revise formal scientific writing. (3c)
6. Read, interpret, incorporate, and cite information and ideas from primary literature into writing. (2a, 2c, 3a, 3c)
7. Utilize and understand the application of a genetic technology. (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. (2b, 2c, 2d, 3d)

E. Methods for Assessing Student Learning

A variety of evaluation and assessments methods will be used including, but 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. Oral presentations
9. Laboratory reports
10. A final comprehensive exam

F. Special Information

The laboratory portion of the course is delivered in the Biology Learning Center (BLC). The BLC has its own set of operating policies and procedures. An instructor will include the most recent version of the Departmental and Biology Learning Center Policies in the 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.