Washtenaw Community College Comprehensive Report

BIO 208 Genetics
Effective Term: Spring/Summer 2019

Course Cover

Division: Math, Science and Engineering Tech
Department: Life Sciences
Discipline: Biology
Course Number: 208
Org Number: 12110
Full Course Title: Genetics
Transcript Title: General Genetics
Is Consultation with other department(s) required: No
Publish in the Following: College Catalog , Time Schedule , Web Page
Reason for Submission: Course Change
Change Information:
Consultation with all departments affected by this course is required.
Rationale: I would like to update the requisites, based on recommendations of our transfer partners.
Proposed Start Semester: Winter 2019
Course Description: In this course, students will explore the basic principles of genetics and their application to viruses, bacteria, plants, fungi, and animals, including humans. Classical and molecular genetic mechanisms are covered. Laboratory experiments demonstrate genetic principles and include classical and molecular techniques. Students who have taken one year of high school chemistry with a lab and earn a grade of C or better may have the college-level chemistry prerequisites waived.

Course Credit Hours

Variable hours: No
Credits: 4
Lecture Hours: Instructor: 45 **Student:** 45
Lab: Instructor: 45 **Student:** 45
Clinical: Instructor: 0 **Student:** 0

Total Contact Hours: Instructor: 90 **Student:** 90
Repeatable for Credit: NO
Grading Methods: Letter Grades
Audit
Are lectures, labs, or clinicals offered as separate sections?: NO (same sections)

College-Level Reading and Writing

College-level Reading & Writing

College-Level Math

Level 4

Requisites

Prerequisite
BIO 162
minimum grade "C"
or
Prerequisite
BIO 161
Minimum grade of "C"

or
Prerequisite
AP BIO, score of 4 or 5
or
Prerequisite
Permission of the Instructor and
Prerequisite
Math Level 4 or equivalent

General Education

MACRAO
MACRAO Science & Math
MACRAO Lab Science Course
General Education Area 4 - Natural Science
Assoc in Applied Sci - Area 4
Assoc in Science - Area 4
Assoc in Arts - Area 4
Michigan Transfer Agreement - MTA
MTA Lab Science

Request Course Transfer

Proposed For:
Central Michigan University
College for Creative Studies
Eastern Michigan University
Ferris State University
Grand Valley State University
Jackson Community College
Kendall School of Design (Ferris)
Lawrence Tech
Michigan State University
Oakland University
University of Detroit - Mercy
University of Michigan
Wayne State University
Western Michigan University

Student Learning Outcomes

1. Describe the laws, concepts and mechanisms involved in classical Mendelian genetics; solve problems, predict outcomes, and interpret relevant literature readings.
   Assessment 1
   Assessment Tool: Selected questions
   Assessment Date: Winter 2019
   Assessment Cycle: Every Three Years
   Course section(s)/other population: All sections
   Number students to be assessed: All students in all sections
   How the assessment will be scored: Item analysis will be made from answers in exams, homework, lab reports and/or assignments
   Standard of success to be used for this assessment: 70% of students scoring 75% or higher on each item analyzed
   Who will score and analyze the data: Biology faculty

2. Describe the mechanisms involved in molecular genetics; solve problems, predict outcomes; interpret relevant literature readings; and evaluate related ethical concerns.
   Assessment 1

Assessment Tool: Selected questions
Assessment Date: Winter 2019
Assessment Cycle: Every Three Years
Course section(s)/other population: All sections
Number students to be assessed: All students in all sections
How the assessment will be scored: Item analysis will be made from answers in exams, homework, lab reports and/or assignments
Standard of success to be used for this assessment: 70% of students scoring 75% or higher on each item analyzed
Who will score and analyze the data: Biology faculty

3. Describe the laws and concepts involved in population and quantitative genetics; solve problems and predict outcomes.

Assessment 1

Assessment Tool: Selected exam questions
Assessment Date: Winter 2019
Assessment Cycle: Every Three Years
Course section(s)/other population: All sections
Number students to be assessed: All students in all sections
How the assessment will be scored: Item analysis will be made from answers in exam
Standard of success to be used for this assessment: 70% of students scoring 75% or higher on each item analyzed
Who will score and analyze the data: Biology faculty

4. In the lab, perform selected classical and molecular genetic techniques, interpret data, and propose and carry out student-designed experiments with appropriate controls.

Assessment 1

Assessment Tool: Selected lab reports and/or lab exam questions
Assessment Date: Winter 2019
Assessment Cycle: Every Three Years
Course section(s)/other population: All sections
Number students to be assessed: All students in all sections
How the assessment will be scored: Item analysis will be made from answers in lab exam and/or lab reports
Standard of success to be used for this assessment: 70% of students scoring 75% or higher on each item analyzed
Who will score and analyze the data: Biology faculty

Course Objectives

1. Mitosis and Meiosis - Describe, draw, and/or label the overview of mitosis and meiosis for a diploid cell. - Describe how cancer and aneuploidy arise when control over mitosis and meiosis, respectively, are lost. -Describe the stages of mitosis and meiosis and describe the differences between plant and animal cytokinesis. -Compare and contrast mitosis and meiosis and identify the unique aspects of meiosis. -Define and/or label on drawings: gene, chromosome, centromere, haploid, diploid, triploid, spindle, centrioles, centrosomes, autosomes, sex chromosomes, telomere, p and q arms, sister and non-sister chromatids, homologous chromosomes, and crossover (chiasmata). -Define apoptosis, karyotype, chromatin, and genome. -Differentiate between prokaryotes and eukaryotes and also between somatic cells and gametes. -Describe, draw and/or label mitosis, meiosis, and fertilization in the life cycles of humans and other organisms. -Explain how independent assortment of chromosomes, random fertilization and meiotic recombination give genetic variation. -Relate the definitions of genetics, eugenics, positive and negative eugenics, and bioethics. - Draw, and/or label the overview of mitosis and meiosis for cells of ploidies other than diploid.
2. Transmission Genetics -Explain why pedigree analysis is useful in the study of human genetics. -Distinguish between haploid, diploid, and triploid genotypes. Given an organism's phenotype for one or two characters, infer the genotype of organisms and the gametes they can produce. Given the genotype of an organism for one or two characters, predict the phenotype. -Distinguish between: genes and alleles, dominant and recessive alleles, phenotype and genotype, and homozygous and

heterozygous alleles. Define haplosufficient. -Explain monohybrid and dihybrid crosses, both testcrosses, and the reciprocal cross using the terms P, F1 and F2 generations. -Identify Mendel's laws of inheritance and describe his classic studies. -Relate Mendel's laws to the behavior of chromosomes in meiosis and fertilization. -Define extranuclear inheritance, maternal effect and heteroplasmy; identify examples of polygenic, maternal, or paternal inheritance. -Solve problems of the following types: monohybrid crosses, dihybrid crosses, trihybrid crosses, probability analysis, and pedigree analysis. -Solve problems of the following types: incomplete dominance, co-dominance, multiple alleles, recessive and dominant lethal alleles, epistasis, complementation, and recessive and dominant sex-linked traits. -As a class, interpret secondary science literature readings on four genetic diseases.

3. Sex Determination -Compare and contrast spermatogenesis and oogenesis in animals. -Define isogamy, double fertilization, and XX/XY (we cover humans, yeast, drosophila and flowering plants), and sex determination. -Define/draw the normal human chromosome complement. -Define aneuploidy, describe symptoms and genotypes of individuals with Down, Kleinfelter and Turner syndromes, and explain the role of meiotic nondisjunction in producing them. -Define monosomy, trisomy, triploidy and tetraploidy and explain which aneuploidies can survive to adulthood in humans. -Relate the structure of the Y chromosome, including PAR's and MSY, and explain the function of the SRY gene in sex determination. -Relate the sex ratio for humans at birth and explain why the ratio is not 1:1. -Define dosage compensation and describe at a molecular level what is happening. -Define Barr body, Lyon hypothesis, XIC. -Draw and/or label the overview of meiosis that produces aneuploidy cells. -Solve problems involving Barr bodies and X-inactivation in X-linked traits.
4. Chromosomal Mutations -Define penetrance, expressivity, onset, genetic anticipation, genomic imprinting and polygenic traits and identify examples. -Define polyploidy, monoploidy, autopolyploidy, and allopolyploidy and describe how they affect agriculture. -Define deletion, duplication, insertion, inversion, and fragile X and explain how each affects gamete production, fertility, and viability of affected individuals. -Summarize Ohno's gene duplication hypothesis and describe how it can lead to evolution of new genes. -Draw and explain how chromosomal deletion, duplication, insertion, inversion, and fragile X affects fertility and viability of affected individuals. -Solve problems of plant autopolyploidy and allopolyploidy.
5. Linkage and Mapping -Make inferences and predict NCO:SCO ratios for unlinked vs. linked genes. -Define linkage group, crossover, chiasmata, terminalization. Identify what a chiasmata looks like and what it represents. -Explain what Morgan's and Sturtevant's work shows about linkage. -Describe human gene mapping involving somatic cell hybridization. -Predict and draw products of NCO, SCO and two, three, and four-strand DCOs. -Solve problems involving: two-point or three-point mapping to determine gene order and map distances, and interference calculations. -Solve problems using results from a somatic cell hybridization experiment.
6. Mapping in Bacteria and Bacteriophages -Define bacterial conjugation and describe the mechanism. Describe how conjugation occurs in F+ and Hfr strains. -Define sex pilus, binary fission, plasmid origin, F factor and R plasmids. -For a standard bacterial growth curve, label lag phase, log phase and stationary phase. -Define bacterial transformation and describe the mechanism. Define heteroduplex. Explain why transformation occurs in nature. -Describe Boveri's and Sutton's Cell Theory and explain why biologists do not consider viruses to be alive. -Define transduction and describe the mechanism. Describe the normal T4 phage structure and life cycle. -Explain why conjugation, transformation and transduction occur in nature. -Solve mapping problems involving conjugation, transfection or transformation.
7. DNA Structure and Function -Describe or label the structure and components of DNA and list the functions of the genetic material. -Define nucleotide, deoxyribose, ribose, phosphate, purine, pyrimidine, A, T, G, C, U, phosphodiester bond, covalent bond, hydrogen bond, double helix, major and minor grooves, macromolecule, monomer, polymer, polymerization, dehydration synthesis, and hydrolysis. -Summarize the classic studies and results of the following scientists: Avery, Macleod, and McCarty; Hershey and Chase; Chargaff; and Watson and Crick with Franklin and Wilkins. Summarize how we know DNA is the genetic material and how we know the structure of DNA. -Solve problems based on data interpretation.
8. DNA Replication, Transcription, Translation -Define replication, transcription, and translation and for each process, describe the major steps, the template, the product and the enzyme. List the major differences in these processes between prokaryotes and eukaryotes. -Summarize the classic experiments of Meselson and Stahl showing that DNA replication is semiconservative. -Describe

special problems with DNA synthesis and their solutions, including replication of a circle (prokaryotes), concurrent synthesis, replication of telomeres (eukaryotes). -Describe how recombination occurs; define gene conversion, describe the Holliday structure and its role in recombination. Define synapsis. -Explain why DNA replication is semiconservative, bidirectional, complex, rapid, and accurate. -Describe the genetic code and why it is considered triplet, unambiguous, degenerate, nonoverlapping and nearly universal. -Describe how transcription occurs in prokaryotes, and identify conserved sequences (Pribnow sequences, -35 sequence, and two types of termination), polycistronic messages, and simultaneous transcription and translation. -Describe how transcription occurs in eukaryotes, and identify or define conserved sequences and modifications to mRNA. -Identify the main players in translation. Identify types of post-translational modifications that are made. -Define protein domains and explain how exon shuffling might allow for evolution of new genes. -Describe the function of proteins and the four levels of protein structure. -Solve problems based on data interpretations.

9. Genome Organization -Identify the main characteristics of the genomes of viruses, eubacteria, and eukaryotes. -Describe the genomes of mitochondria and chloroplasts and explain how the endosymbiont theory explains their origins. -Define nucleosome, solenoid, looped domains, chromatids and explain how these words related to DNA contraction. -Describe how compacted DNA is remodeled for gene expression. -Define euchromatin and heterochromatin. Define highly repetitive DNA and middle repetitive DNA and cite examples. -Draw or label diagrams of genetic material from a variety of organisms.
10. Mutation and Repair -Describe types of mutations, detection of mutations, the molecular basis for mutations, and agents of mutation (chemical, transposable elements, irradiation). -Describe 3 DNA repair systems, including mismatch repair. -Do problems, identifying types of mutations or predicting outcomes of mutations including terminal and intercalary deletions, pericentric and paracentric inversion; define crossover suppression.
11. Gene Expression -Explain regulation of gene expression in prokaryotes. -Define operon, repressor, constitutive expression, operator, promoter, structural genes. Explain how the lac operon works as an inducible operon and how the trp operon works as a repressible operon. -Identify regulation of gene expression in eukaryotes. Identify transcriptional regulation as a major point of control of gene expression in eukaryotes. Identify chromatin remodeling, regulation of transcription, RNA processing and transport, regulation of translation, and post-translational controls as points of control. -Define nucleosome, solenoid, looped domains, chromatids and related them to DNA compaction. -Describe how compacted DNA is remodeled for gene expression. -Label regions of prokaryotic and eukaryotic genes involved in gene expression. -Work problems involving the lac and trp operons.
12. Cancer -Define cancer, benign tumor, malignant tumor, metastasis, and cancerous transformation. -Summarize effects of the three checkpoints normally controlling the cell cycle. -Describe how cancer cells can be defective in genomic stability, DNA repair, cell cycle regulation, and cell adhesion. -Relate the role of viruses, inheritance and environmental agents in development of cancer. -Describe, cite an example, and explain the inheritance pattern for both tumor suppressor genes and proto-oncogenes. Explain how a proto-oncogene becomes an oncogene. -Explain how someone may inherit a predisposition for cancer. Explain the inheritance of RB and familial colon cancer. -Describe why cancers tend to occur later in life and why cancer is considered a disease at the level of the genes.
13. Recombinant DNA Technology -Define restriction enzymes, DNA ligase, vectors, origins, polylinkers, selectable markers, screenable markers, radioactive probes, and clones. Describe how they are each used. -Describe the essential steps of and the results obtained from the techniques of restriction mapping, Southern blot analysis, Northern blot analysis, DNA sequencing, PCR, and construction of DNA libraries. Describe how they are each used.
14. Genomics, Proteomics, Forensics -Define genomics. Explain how genomic analysis is performed and what results you can obtain. -Describe the genomes of Eubacteria, Achaea, and Eukaryotes, describing genome size, chromosome type and number, and genome organization. -Describe how the human genome sequenced and list the overview of the results. -State the minimum gene content required for life. List how genomes might evolve. -Explain what the following have to do with genome evolution: mutation, symbiogenesis, whole genome duplication, gene transfer, autopolyploidization, allopolyploidization. -Define a multigene family and provide an example. -Define proteomics. Explain how you might study the proteome and what we have learned from for diploid colonies by complementation, and proteomics. -Define RFLP’s and STR’s. -Describe the

essential steps of DNA profiling using STR's including use of 13 STR's and statistical analysis. Explain when DNA profiling is used. -List the major methods and results of the human genome project; define haplotype; describe some possible results of personal genomics testing.

15. Evolution -Summarize some of the evidence supporting evolution, such as transitional fossils, changes in protein or DNA sequences, comparative anatomy, and gene substitutions across species. -Explain why scientists propose evolution is a unifying theme for biological changes over time. -Interpret selections from "The Selfish Gene" by Richard Dawkins.
16. Emerging Topics in Genetics (varies, as the field progresses) -Identify epigenetics and alterations to the genome that occur; describe the role of epigenetics in things such as: how imprinting occurs, how cancer develops, how nutrition and environment affect epigenetic changes. -Identify the role of noncoding RNA's in cellular processes such as splicing, translation, gene regulation, viral defense (CRISPR/Cas), and gene silencing. -Describe how personalized medicine can decrease adverse drug reactions and lead to better cancer treatments. -Describe the field of gene therapy. - Research and interpret readings on a genetic disease or process of interest.
17. Population and Quantitative Genetics -Define microevolution, genetic drift, gene flow, mutations, natural selection, and nonrandom mating. List an example of each. List the only one that can lead to adaptation. -Define the 5 conditions which must be met so evolution cannot occur. -Define the terms in the two Hardy-Weinberg equations and relate the overall meaning of the equations. -Define microevolution, genetic drift, gene flow, mutations, natural selection, and nonrandom mating. List an example of each. Explain how each causes microevolution. -Identify polygenic traits that show continuous variation and those that instead are threshold traits. -Define the correlation coefficient for covariance, broad-sense heritability and narrow-sense heritability as used by breeders. -Define monozygotic and dizygotic twins and explain how twin studies allow estimates of heritability in humans. -Solve problems using the Hardy-Weinberg equations. -Solve problems calculating the number of polygenes in a polygenic trait. -Calculate and/or interpret the correlation coefficient for covariance and the narrow-sense heritability to assess whether or not a trait will respond to selection. -Solve problems using monozygotic and dizygotic twin study data to assess heritability for polygenic traits in humans.
18. Lab -Describe, draw and/or label mitosis, meiosis, and fertilization in the life cycles of humans, yeast, fruit flies, plants and other organisms. -Observe, categorize and tabulate results of a monohybrid and a dihybrid cross in maize (corn). Perform a chi-square analysis with interpolation on the data to determine if the results match expected patterns of inheritance. -In a multi-week experiment, manipulate brewer's yeast through the life cycle, mastering concepts of mitotic growth, mating, biochemical pathways, mutations, selection by complementation and use of positive and negative controls. -In a multi-week experiment, design, perform and interpret original experiments to determine exact genotypes of ADE- mutant "unknowns" using complementation tests. Select and use appropriate controls. -Perform a ligation and bacterial transformation. Explain the need for each step in the procedure. Explain the use of appropriate positive and negative controls. -Build a model of DNA. -Perform gel electrophoresis to map DNA with restriction sites. Describe the purpose of the steps in the procedure and the use of appropriate controls. -Explain genetic anticipation and variable onset of Huntington Disease (or similar) using a multi-generational pedigree. Describe the ethical issues surrounding a dilemma involving the disorder. -Model a population in Hardy-Weinberg equilibrium. Design and perform an original experiment to model the effects of genetic drift, migration, mutation, nonrandom mating or natural selection on the population in equilibrium and analyze the results. Use chi-square analysis to determine if the results show a change in allele frequency. -Write two papers/formal lab reports on original experiments.

New Resources for Course

Course Textbooks/Resources

Textbooks

Thompson, E.. *Lab Manual for Genetics (BIO 208)*, 2017-2018 ed. online, 2017

W.S. Klug and M. R. Cummings, Spencer, C.A., Palladino, M.A. . *Essentials of Genetics*, 9e ed. Prentice Hall, 2016

Manuals

Periodicals

Software

Equipment/Facilities

Level III classroom
Testing Center

Reviewer	Action	Date
Faculty Preparer:		
Emily Thompson Ph.D.	*Faculty Preparer*	*Sep 10, 2018*
Department Chair/Area Director:		
Anne Heise	*Recommend Approval*	*Sep 10, 2018*
Dean:		
Kristin Good	*Recommend Approval*	*Sep 11, 2018*
Curriculum Committee Chair:		
Lisa Veasey	*Recommend Approval*	*Oct 07, 2018*
Assessment Committee Chair:		
Shawn Deron	*Recommend Approval*	*Oct 10, 2018*
Vice President for Instruction:		
Kimberly Hurns	*Approve*	*Oct 12, 2018*