BIO-2060: PRINCIPLES OF GENETICS

Cuyahoga Community College

Viewing: BIO-2060 : Principles of Genetics

Board of Trustees:
March 2022

Academic Term:
Fall 2022

Subject Code
BIO - Biology

Course Number:
2060

Title:
Principles of Genetics

Catalog Description:
Introductory level course. Topics include: structure and function of DNA, patterns of inheritance, gene expression and mutations, population genetics and gene technology.

Credit Hour(s):
3

Lecture Hour(s):
3

Lab Hour(s):
0

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
BIO-1500 Principles of Biology I or BIO-2341 Anatomy and Physiology.

Outcomes

Course Outcome(s):
Differentiate the nature, structure, and function of genetic materials in different biological systems.

Objective(s):

1. Compare and contrast the structure of prokaryotic and eukaryotic (animal, plant, and fungal) genomes and cellular reproduction.
2. Explain how viral structure and multiplication differs from cell structure and reproduction.
3. Describe the phases of the eukaryotic cell cycle and explain how it is regulated.
4. Explain the experiments that identified DNA as the genetic material and determined DNA structure.
5. Describe the molecular and cellular mechanisms involved in DNA replication.
6. Know the stages of meiosis, indicate what is happening in each stage, and the significance of reducing the chromosome number.

Course Outcome(s):
Apply the process of scientific inquiry to explain the mechanisms by which an organism's genome is passed on to the next generation.

Essential Learning Outcome Mapping:
Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Discuss the methodology and analyze the data used in the development of Mendel's Laws.
2. Explain how meiosis relates to Mendel's Laws.
3. Use examples from model organisms and Punnett squares to calculate genotypic and phenotypic probabilities of offspring.
4. Analyze patterns of Mendelian and non-Mendelian inheritance including sex linkage using pedigrees.
5. Describe genetic linkage and the role of homologous recombination in allele transmission and gene mapping.
6. Describe the inheritance patterns of chloroplasts and mitochondria.

Course Outcome(s):

Relate how the expression of genetic information contributes to an organism's structure and function.

Objective(s):

1. Describe how the genetic code relates the transcription of DNA and translation of RNA into an amino acid sequence.
2. Discuss how different factors can influence the relationship between genotype and phenotype (ex. incomplete penetrance, variable expressivity, sex-limited phenotypes, and environmental).
3. Explain the relationship between chromosomes and sex determination.
4. Explain how mutations affect phenotype.
5. Explain the effect of abnormal chromosome number and dosage on development and phenotype.
6. Relate the deregulation of the cell cycle to the development of cancer.

Course Outcome(s):

Illustrate how gene activity can be altered in the absence of DNA changes and how it relates to normal development and function of an organism.

Objective(s):

1. Discuss the roles of non-coding RNAs in expressing genetic information.
2. Describe the similarities and differences in eukaryotic and prokaryotic gene expression including regulatory mechanisms.
3. Explain the differences in packaging of heterochromatin and euchromatin in the context of histone modification and DNA modification.
4. Discuss the potential roles of DNA modification, histone modification, and non-coding RNA in epigenetic inheritance (both germline and somatic).
5. Describe how differential histone modification modulates gene activity and is utilized in developmental progression.
6. Explain how polarity is established in a developing embryo using gene expression gradients.

Course Outcome(s):

Utilize evidence to support how populations change genetically over time.

Objective(s):

1. Apply Hardy-Weinberg equilibrium to population genetics.
2. Explain how mutations and genetic recombination result in genetic diversity.
3. Explain how independent assortment during meiosis contributes to genetic diversity.
4. Differentiate among the evolutionary forces that result in changes in allele frequencies in a population.
5. Explain the significance of horizontal gene transfer in the evolution of populations.
6. Explain the role of chromosome variation in plants.

Course Outcome(s):

Discuss the significance and application of biotechnology, genomics, and proteomics in modern society.

Objective(s):

1. Explain examples of techniques of molecular genetic analysis and their application in the modern world.
2. Describe techniques used to obtain and analyze genomic and proteomic information.
3. Describe methods used for gene editing and gene therapy (ex. CRISPR).
4. Describe the methods and applications of genetic testing.

Course Outcome(s):
Identify and critique scientific issues relating to ethics in genetics.

Objective(s):
1. Discuss potential discrimination based on genetic information.
2. Discuss the controversial policies surrounding the use of genetically modified organisms.
3. Examine the potential opportunities for the misuse of genetic information and materials.
4. Debate the pros and cons of personalized medicine and genetic testing.
5. Investigate the potential misuses of biotechnology including cloning, stem cells, and gene editing.

Methods of Evaluation:
1. Quizzes
2. Exams
3. Written reports
4. Research papers
5. Projects (individual or group)
6. Presentations (individual or group)
7. Article discussions/reviews/summaries
8. Discussion boards
9. Homework assignments
10. Case studies

Course Content Outline:
1. CONCEPTS
    a. Prokaryotic and eukaryotic cell structure and genome
    b. Chromosomes, chromatids, and homologues
    c. Eukaryotic chromosomes and chromosome number
    d. Prokaryotic cell division
    e. Eukaryotic cell cycle and mechanisms of control
    f. Mitosis and cytokinesis
    g. Meiosis and crossing-over
    h. Sexual reproduction
    i. Segregation and independent assortment of chromosomes
    j. Alleles
    k. Patterns of inheritance
    l. Phenotype versus genotype
    m. Monohybrid, dihybrid, and test crosses
    n. Sex determination
    o. Sex chromosomes
    p. Sex-linked inheritance
    q. Dosage compensation and X inactivation
    r. Dominant and recessive alleles
    s. Codominance and incomplete dominance
    t. Heterozygote advantage
    u. Sex influence and sex-limited inheritance
    v. Penetrance and expressivity
    w. Lethal alleles
    x. Multiple alleles
    y. Pleiotropy
    z. Epistasis
    aa. Polygenic inheritance
    bb. Multifactorial traits
    cc. Extranuclear inheritance
    dd. Genomic imprinting
    ee. Maternal effect
    ff. Assortment and recombination of linked and non-linked genes

gg. Genetic linkage mapping
hh. Chromosomal mutations
ii. Aneuploidy
jj. Polyploidy
kk. Mitotic and meiotic nondisjunction of chromosomes
ll. Conjugation
mm. Transformation
nn. Transduction
oo. Plasmids
pp. Viral structure and genome
qq. Viral multiplication
rr. DNA and RNA structure
ss. DNA packaging in prokaryotic and eukaryotic cells
tt. Prokaryotic and eukaryotic replication of DNA
uu. Telomeres
vv. Homologous recombination
ww. Prokaryotic and eukaryotic gene expression
xx. The genetic code
yy. Post-translational modification
zz. Operons
aaa. Levels of prokaryotic and eukaryotic gene regulation
bbb. Epigenetics
ccc. Non-coding RNAs
ddd. Evolutionary importance of mutations
eee. Types of mutations and their phenotypic effects
fff. DNA repair mechanisms
ggg. Gene cloning and gene amplification
hhh. Reproductive cloning and stem cells
iii. DNA sequencing and analysis
jjj. Gene editing
kkk. Blotting methods
lll. Genomics
mmm. Human genome project
nnn. Functional genomics including microarrays and gene knockouts
ooo. Genetic testing and screening
ppp. Gene therapy
qqq. Loss of cell cycle control and cancer
rrr. Hardy-Weinberg equation
sss. Agents of evolution, including natural selection, mutation, genetic drift, gene flow, and nonrandom mating
ttt. Horizontal gene transfer

2. SKILLS
   a. Determining haploid and diploid number of cells.
   b. Differentiate between sister chromatids and homologous chromosomes.
   c. Construct Punnett squares to predict genotypic and phenotypic probabilities of offspring.
   d. Use the product rule to solve independent assortment problems.
   e. Identify patterns of inheritance using a pedigree.
   f. Solve Mendelian genetics problems.
   g. Interpret a karyotype to determine gender and chromosomal abnormalities.
   h. Transcribe a DNA sequence and translate an RNA sequence.
   i. Determine how mutations in DNA sequence alter protein structure.
   j. Determine genotypic and phenotypic frequencies using the Hardy-Weinberg equation.
   k. Evaluate peer-reviewed articles on current genetic topics.
3. ISSUES
   a. Genomes and cellular reproduction
   b. Patterns of inheritance
   c. Molecular aspects of gene expression
   d. Phenotype as related to genetic mechanisms

e. Genetic diversity
f. Multilevel gene regulation
g. Conserved DNA elements
h. Epigenetics
i. Population genetics
j. Biotechnology in modern society
k. Genetics and ethical issues
l. Mutational analysis
m. Landmark experiments
n. Evolutionary conservation of genetic mechanisms

Resources

Brooker, Robert J. *Concepts of Genetics*. 4th ed. New York: McGraw-Hill, 2022.

Griffiths, et. al. *An Introduction to Genetic Analysis*. 12th ed. New York: MacMillian Higher Education, 2020.

Lewis, Ricki. *Human Genetics*. 12th ed. New York: McGraw-Hill, 2017.

Pierce, Benjamin. *Genetic Essentials: Concepts and Connections*. 5th ed. New York: Freeman, 2021.

Urry, et. al. *Campbell: Biology in Focus*. 3rd ed. New York: Pearson, 2020.

Resources Other

Websites:

1. Virtual Cell Animation Collection - http://vcell.ndsu.edu/animations/
2. Learn Genetics - http://learn.genetics.utah.edu/
3. Howard Hughes Medical Institute Biointeractive - http://www.hhmi.org/biointeractive/ (https://www.biointeractive.org/)
4. PBS - http://www.pbs.org
5. NOVA - http://www.pbs.org/wgbh/nova/
6. NSF National Center for Case Study Teaching in Science - https://sciencecases.lib.buffalo.edu (https://sciencecases.lib.buffalo.edu/)

Journals:

1. *Science*
2. *Nature*

Instructional Services

OAN Number:

Ohio Transfer 36 TMNS

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