BIOL 12: HUMAN GENETICS

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2023
Units:	4
Hours:	4 lecture per week (48 total per quarter)
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Area VII: Lifelong Learning
Transferable:	CSU/UC
Grade Type:	Letter Grade Only
Repeatability:	Not Repeatable

Student Learning Outcomes

- Demonstrate an ability to use Mendelian principles to predict genetic inheritance.
- Demonstrate an ability to interpret a DNA fingerprint.

Description

An introduction to the nature of human inheritance. The molecular basis of inheritance, Mendelian genetics, population genetics, common human genetic diseases, factors affecting human diversity, and the social and moral implications of recent advances in genetics. Intended for both majors and GE students.

Course Objectives

The student will be able to:

a. Define genetics and describe key historical events in genetics and biology
b. Describe the scientific method and discuss the role and limits of science in making political, social, and personal decisions
c. Describe the characteristics of life and discuss problems with defining when life begins and ends
d. Discuss the levels of organization within the context of human genetics
e. Use population data to calculate the absolute and relative risk of human genetic disease
f. Explain the cell theory and describe the functions of eukaryotic cellular structures
g. Explain the chromosomal theory of inheritance and describe the human cell cycle
h. Describe Mendel's work and use basic rules of probability and inheritance to solve problems in human genetics
i. Identify different modes of inheritance using pedigree data
j. Differentiate between single gene, chromosomal, and multifactorial inheritance
k. Describe the human life cycle and discuss environmental causes of birth defects
l. Explain the role of DNA, RNA, genes, and mutations in the hereditary process
m. Describe genetic traits and disorders that provide examples of modern applications of genetics in the fields of cytogenetics, recombinant DNA technology, reproductive technology, gene therapy, genetic screening, presymptomatic screening, genomics, forensic science, anthropology, and medicine
n. Describe the techniques used in cytogenetics and explain their medical applications (overlaps with objective 13)
o. Describe the techniques used in recombinant DNA technology and their application for genetic mapping, prenatal and presymptomatic testing, gene therapy, and forensic science (overlaps with objective 13)
p. Explain how allele frequencies vary among populations and how these frequencies can be influenced by natural selection, chance, isolation, and other factors (overlaps with objective 13)
q. Explain the chromosomal basis of sex determination (overlaps with objective 13)
r. Explain the role that genetics plays in cancer, immunity, and/or behavior
s. Critically evaluate the medical, legal, and ethical implications of modern genetics (weaved throughout the course)
t. Describe the risk factors for cardiovascular disease and cancer; critically evaluate their lifestyle with respect to these risk factors (overlaps with objectives 13 and 18)

Course Content

a. Genetics and human heredity
    i. Definition
    ii. Early misconceptions about human inheritance
    iii. Key theories of the 18th century
        1. Theory of natural selection
        2. Cell theory
        3. Mendel's theory of inheritance
    iv. DNA profiling and other modern applications of genetics
b. Basic science
    i. Rationale and application of the scientific method
    ii. Limitations of the scientific method
c. Defining life
    i. Attributes of living organisms
    ii. Problems with defining when life begins and ends
d. Levels of organization within the context of genetics
    i. Reductionism and emergent properties
    ii. DNA, genes, chromosomes, genomes, pedigrees, gene pools
    iii. Karyotypes and pedigree charts
    iv. Tissues, organs, and organ systems of the human body
e. Risk assessment
    i. Empiric risk
    ii. Absolute risk
    iii. Relative risk
f. Cells
    i. Cell theory
    ii. Prokaryotes and eukaryotes
    iii. Structure and function of organelles
g. Chromosomes and the cell cycle
    i. Chromosomal theory of inheritance
    ii. Chromosome structure
    iii. Identification and classification of human chromosomes
    iv. Cell cycle: interphase, nuclear division, and cytokinesis

- v. Mitosis and meiosis
- vi. Checkpoint systems and the role of P3 in cancer

h. Mendel's principles of inheritance
- i. Biographical details
  1. Education and text anxiety
  2. Why he switched from mice to garden peas
- ii. Experimental data
  1. Monohybrid crosses and the principle of segregation
  2. Dihybrid crosses and the principle of independent assortment
- iii. Chromosomal basis of Mendel's principles

i. Pedigree analysis and different modes of inheritance
- i. Single gene traits
  1. Autosomal and sex linked
  2. Dominant and recessive
  3. Partial dominance
     a. Incomplete dominance
     b. Codominance

j. Most traits are not determined by single genes
- i. Chromosomal abnormalities
- ii. Multifactorial traits
  1. Environmental influences
  2. Polygenic effects

k. Reproduction and development
- i. Spermatogenesis and oogenesis
- ii. Fertilization and embryogenesis
- iii. Fetal development
- iv. Critical periods and the environmental causes of birth defects
  1. Thalidomide and the importance of pilot studies in drug testing
  2. Measles and the public health cost of not vaccinating for measles

l. Molecular genetics
- i. DNA
  1. Structure
  2. Replication
  3. Repair
     a. p53
     b. XP (xeroderma pigmentosum)
     c. HNPCC (hereditary nonpolyposis colon cancer)
- ii. RNA and protein synthesis
  1. Transcription
     a. mRNA, post-transcription processing, and regulatory sequences
     b. tRNA, three dimensional shape, amino acid attachment, and anticodon
     c. rRNA, shape and content of ribosomes
  2. Translation
     a. Genetic code
     b. Ribosome binding sites: mRNA, A, P, and E
     c. Initiation, elongation, and termination
- iii. DNA damage and mutations
- iv. Point mutations and sickle cell anemia

m. Use of modern genetics to understand human traits and disorders
- i. Autosomal recessive traits
  1. Cystic fibrosis, gene therapy, and heterozygote advantage with typhoid fever
  2. Tay-Sachs disease, preimplantation therapy, and bottleneck effects
  3. Albinism, non-random mating, cultural inheritance, and cultural anthropology
  4. Phenylketonuria, cost-benefit analysis for genetic screening, and heterozygote advantage with ochratoxin A
- ii. Autosomal dominant traits
  1. Huntington disease, DNA profiling, and the role of serendipity in science
  2. Achondroplasia, lethal alleles, spontaneous mutations, recombinant DNA technology, and human growth hormone
  3. Marfan syndrome and pleiotropy
  4. Neurofibromatosis, variable expressivity, influence of gene size on mutation rate, growth factors, and control of cell division
- iii. Codominant and incomplete dominant traits
  1. Sickle Cell Anemia and heterozygote advantage with malaria
  2. Blood types, multiple alleles, and epistasis
  3. Familial Hypercholesterolemia and prevention of cardiovascular disease
- iv. Sex-linked traits
  1. Chromosomal basis of sex determination
     a. Prenatal development
     b. Barr bodies and dosage compensation
     c. Androgen insensitivity, pseudohermaphroditism, true hermaphroditism
     d. Sex-linked, sex-influenced, and sex-limited genes
  2. X-linked recessive traits
     a. Muscular dystrophy, multiple alleles, gene size, discovery of dystrophin
     b. Hemophilia B, recombinant DNA technology, synthetic factor VIII, and blood borne pathogens
  3. X-linked dominant traits
  4. Y-linked traits
- v. Mitochondrial inheritance
- vi. Chromosomal abnormalities
  1. Numerical abnormalities
     a. Nondisjunction and aneuploidy
     b. Polyploidy
     c. Downs, Edward, and Patau syndromes
     d. Klinefelter, triplo-X, Turner, Jacob syndromes
  2. Structural abnormalities
     a. Deletions and duplications (Fragile X syndrome, anticipation, and allelic expansion)
     b. Translocations (reciprocal, Robertsonian, Philadelphia chromosome)
     c. Inversions
- vii. Multifactorial traits
  1. Cancer
  2. Obesity
  3. Cardiovascular disease

n. Genetics of cancer
- i. Oncogenes and tumor suppressor genes
- ii. Faulty DNA repair systems and inherited cancer predispositions
- iii. Cancer prevention

o. Genetics of immunity

i. Immune system, inflammatory response, and immune response
ii. Blood types
iii. Bombay phenotypes
iv. HLA types
v. Immune disorders

p. Behavioral genetics
i. Nervous system and nerve function
ii. Addictions
iii. Mood disorders
iv. Schizophrenia

q. Population genetics
i. Genetic diversity
ii. Natural selection
iii. Human origins and evolution

r. Modern genetics
i. Recombinant DNA technology, including cloned genes, genetic mapping, DNA fingerprinting, prenatal and presymptomatic testing
ii. Gene and protein therapy
iii. Reproductive technology
iv. Human genome project

Lab Content

Not applicable.

Special Facilities and/or Equipment

1. Fully equipped multi-media classroom. Students need internet access.
2. When taught via Foothill Global Access, on-going access to computer with email software and hardware; email address.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Quizzes, midterms, and comprehensive final exam
Homework and lecture exercises designed to develop critical thinking, computation, writing, and communication skills
Essays and/or poster presentations

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture
Discussion
Cooperative learning exercises
Electronic discussions/chat
Independent study
Homework and worksheet activities

Representative Text(s) and Other Materials

Lewis, Ricki. Human Genetics, Concepts and Applications, 13th ed.. 2021.

Cummings, Michael R.. Human Heredity, Principles and Issues, 11th ed.. 2016.

A newer edition of the Cummings textbook is not available.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

a. Reading assignments
i. Weekly reading assignments from text
ii. Use the online Mendelian Inheritance of Man to locate information on genetic diseases
iii. Supplemental readings from web sources relevant to course material

b. Content writing assignments
i. Weekly assignment to answer objective set questions and define vocabulary
ii. Describe the function and structure of organelles, tissues, and organ systems
iii. Worksheets on chromosome structure, cell cycle, and translation

c. Essay assignments
i. 300 word essay on self assessment of learning styles
ii. 500 word essay describing cardiovascular disease prevention
iii. 500 word essay self assessment of cardiovascular risk
iv. 500 word essay describing cancer prevention
v. 500 word essay self assessment of cancer risk

d. Computation and writing
i. Calculate and critically evaluate risk assessment
ii. Calculate and critically evaluate inheritance problems using Mendelian principles

Discipline(s)

Biological Sciences