Unit 06: Heredity

Content Area: **Science**
Course(s): **AP Biology**
Time Period: **January**
Length: **4 weeks**
Status: **Published**

Transfer Skills

This unit focuses on heredity and the biological concepts and processes involved in ensuring the continuity of life. Students learn that the storage and transmission of genetic information via chromosomes from one generation to the next occur through meiosis. Meiotic division ensures genetic diversity, which is crucial to the survival of a species. In this unit, students gain a deeper understanding of Mendelian genetics and learning how non-Mendelian genetics describes those patterns of inheritance that seem to violate Mendel's laws. This unit also teaches the role played by chromosomal inheritance, environmental factors, and nondisjunction on an individual's phenotype. In Unit 7, students move on to learn about gene expression and regulation.

In this unit students need to analyze and construct models of chromosomal exchange, using them to predict the results of a given scenario, such as a mistake in crossing over or the haploid results of meiosis. Students also need to calculate genotypic and/or phenotypic ratios. Be sure students understand the difference in these two types of ratios, as confusion between them is a common student error on the exam. Additionally, students should expect to calculate a chi-square value and explain the meaning in context of a given scenario. On the exam, students commonly fail to identify the null hypothesis rather than an alternate hypothesis; thus, they will need multiple and varied opportunities to practice this skill. Building their skills in experimental design throughout the course will help address this misconception. Emphasis should be on helping students understand when to reject or fail to reject the null hypothesis.

Enduring Understandings

Heritable information provides for continuity of life.

Organisms are linked by lines of descent from common ancestry

Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential Questions

How is our understanding of evolution influenced by our knowledge of genetics?

Why is it important that not all inherited characteristics get expressed in the next generation?

How would Mendel's laws have been affected if he had studied a different type of plant?

How does the diversity of a species affect inheritance?

Content

Learning Objectives

IST-1.F Explain how meiosis results in the transmission of chromosomes from one generation to the next.
IST-1.G Describe similarities and/ or differences between the phases and outcomes of mitosis and meiosis.
IST-1.H Explain how the process of meiosis generates genetic diversity.
EVO-2.A Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms.
IST-1.I Explain the inheritance of genes and traits as described by Mendel's laws.
IST-1.J Explain deviations from Mendel's model of the inheritance of traits.
SYI-3.B Explain how the same genotype can result in multiple phenotypes under different environmental conditions.
SYI-3.C Explain how chromosomal inheritance generates genetic variation in sexual reproduction.

Standards

IST-1.F.1 Meiosis is a process that ensures the formation of haploid gamete cells in sexually reproducing diploid organisms—
a. Meiosis results in daughter cells with half the number of chromosomes of the parent cell.
b. Meiosis involves two rounds of a sequential series of steps (meiosis I and meiosis II).
IST-1.G.1 Mitosis and meiosis are similar in the way chromosomes segregate but differ in the number of cells produced and the genetic content of the daughter cells.
IST-1.H.1 Separation of the homologous chromosomes in meiosis I ensures that each gamete receives a haploid (1n) set of chromosomes that comprises both maternal and paternal chromosomes.
IST-1.H.2 During meiosis I, homologous chromatids exchange genetic material via a process called "crossing over" (recombination), which increases genetic diversity among the resultant gametes.
IST-1.H.3 Sexual reproduction in eukaryotes involving gamete formation—including crossing over, the random assortment of chromosomes during meiosis, and subsequent fertilization of gametes—serves to increase variation.
X *The details of sexual reproduction cycles in various plants and animals are beyond the scope of the course and the AP exam.*
EVO-2.A.1 DNA and RNA are carriers of genetic information.
EVO-2.A.2 Ribosomes are found in all forms of life.
EVO-2.A.3 Major features of the genetic code are shared by all modern living systems.
EVO-2.A.4 Core metabolic pathways are conserved across all currently recognized domains.
IST-1.I.1 Mendel's laws of segregation and independent assortment can be applied to genes that are on different chromosomes

IST-1.I.2 Fertilization involves the fusion of two haploid gametes, restoring the diploid number of chromosomes and increasing genetic variation in populations by creating new combinations of alleles in the zygote—

a. Rules of probability can be applied to analyze passage of single-gene traits from parent to offspring.

b. The pattern of inheritance (monohybrid, dihybrid, sex-linked, and genetically linked genes) can often be predicted from data, including pedigree, that give the parent genotype/phenotype and the offspring genotypes/phenotypes.

IST-1.J.1 Patterns of inheritance of many traits do not follow ratios predicted by Mendel's laws and can be identified by quantitative analysis, where observed phenotypic ratios statistically differ from the predicted ratios—

a. Genes that are adjacent and close to one another on the same chromosome may appear to be genetically linked; the probability that genetically linked genes will segregate as a unit can be used to calculate the map distance between them.

IST-1.J.2 Some traits are determined by genes on sex chromosomes and are known as sexlinked traits. The pattern of inheritance of sex-linked traits can often be predicted from data, including pedigree, indicating the parent genotype/phenotype and the offspring genotypes/phenotypes.

IST-1.J.3 Many traits are the product of multiple genes and/or physiological processes acting in combination; these traits therefore do not segregate in Mendelian patterns.

IST-1.J.4 Some traits result from non-nuclear inheritance—

a. Chloroplasts and mitochondria are randomly assorted to gametes and daughter cells; thus, traits determined by chloroplast and mitochondrial DNA do not follow simple Mendelian rules.

b. In animals, mitochondria are transmitted by the egg and not by sperm; as such, traits determined by the mitochondrial DNA are maternally inherited.

c. In plants, mitochondria and chloroplasts are transmitted in the ovule and not in the pollen; as such, mitochondria-determined and chloroplast-determined traits are maternally inherited.

SYI-3.B.1 Environmental factors influence gene expression and can lead to phenotypic plasticity. Phenotypic plasticity occurs when individuals with the same genotype exhibit different phenotypes in different environments.

SYI-3.C.1 Segregation, independent assortment of chromosomes, and fertilization result in genetic variation in populations.

SYI-3.C.2 The chromosomal basis of inheritance provides an understanding of the pattern of transmission of genes from parent to offspring.

SYI-3.C.3 Certain human genetic disorders can be attributed to the inheritance of a single affected or mutated allele or specific chromosomal changes, such as nondisjunction.

Resources

College Board AP Central: https://apcentral.collegeboard.org/courses/ap-biology/course

College Board AP Biology course and exam description manual: https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf

AP Biology Lab Manual:

https://apcentral.collegeboard.org/pdf/ap-biology-teacher-lab-manual-fall-2019.pdf?course=ap-biology

AP Biology Classroom Resources: https://apcentral.collegeboard.org/courses/ap-biology/classroom-resources?course=ap-biology

Khan Academy AP Biology: https://www.khanacademy.org/science/ap-biology

Bozeman Science AP Biology videos: http://www.bozemanscience.com/ap-biology

HHMI Biointeractive: https://www.biointeractive.org/