SUGGESTED SKILL

Concept Explanation

1.B

Explain biological concepts and/or processes.

AVAILABLE RESOURCES

- AP Biology Lab Manual > Meiosis Lab

TOPIC 5.1
Meiosis

Required Course Content

ENDURING UNDERSTANDING

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
IST-1.F Explain how meiosis results in the transmission of chromosomes from one generation to the next.	**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 Describe similarities and/or differences between the phases and outcomes of mitosis and meiosis.	**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.

TOPIC 5.2
Meiosis and Genetic Diversity

SUGGESTED SKILL

Questions and Methods

3.A

Identify or pose a testable question based on an observation, data, or a model.

AVAILABLE RESOURCES

- AP Biology Lab Manual> Meiosis Lab

Required Course Content

ENDURING UNDERSTANDING

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.H

Explain how the process of meiosis generates genetic diversity.

ESSENTIAL KNOWLEDGE

IST-1.H.1

Separation of the homologous chromosomes in meiosis I ensures that each gamete receives a haploid (1*n*) 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.

EXCLUSION STATEMENT—*The details of sexual reproduction cycles in various plants and animals are beyond the scope of the course and the AP Exam.*

SUGGESTED SKILLS

Argumentation

6.E.c

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on data.

Statistical Tests and Data Analysis

5.C

Perform chi-square hypothesis testing.

TOPIC 5.3
Mendelian Genetics

Required Course Content

ENDURING UNDERSTANDING

EVO-2

Organisms are linked by lines of descent from common ancestry.

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
EVO-2.A Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms.	**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 Explain the inheritance of genes and traits as described by Mendel's laws.	**IST-1.I.1** Mendel's laws of segregation and independent assortment can be applied to genes that are on different chromosomes.

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LEARNING OBJECTIVE

IST-1.I

Explain the inheritance of genes and traits as described by Mendel's laws.

ESSENTIAL KNOWLEDGE

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.

RELEVANT EQUATION

Laws of Probability—

If A and B are mutually exclusive, then:

$P(A \text{ or } B) = P(A) + P(B)$

If A and B are independent, then:

$P(A \text{ and } B) = P(A) \times P(B)$

SUGGESTED SKILLS

Statistical Tests and Data Analysis

5.A.b
Perform mathematical calculations, including means.

5.C
Perform chi-square hypothesis testing.

ILLUSTRATIVE EXAMPLES

- Sex-linked genes reside on sex chromosomes.
- In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males.
- In certain species, the chromosomal basis of sex determination is not based on X and Y chromosomes (such as ZW in birds, haplodiploidy in bees).

TOPIC 5.4
Non-Mendelian Genetics

Required Course Content

ENDURING UNDERSTANDING

IST-1
Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.J
Explain deviations from Mendel's model of the inheritance of traits.

ESSENTIAL KNOWLEDGE

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 sex-linked 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.

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LEARNING OBJECTIVE

IST-1.J

Explain deviations from Mendel's model of the inheritance of traits.

ESSENTIAL KNOWLEDGE

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.

SUGGESTED SKILL

Concept Explanation

1.C

Explain biological concepts, processes, and/or models in applied contexts.

ILLUSTRATIVE EXAMPLES

- Height and weight in humans
- Flower color based on soil pH
- Seasonal fur color in arctic animals
- Sex determination in reptiles
- Effect of increased UV on melanin production in animals
- Presence of the opposite mating type on pheromone production in yeast and other fungi

TOPIC 5.5

Environmental Effects on Phenotype

Required Course Content

ENDURING UNDERSTANDING

SYI-3

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

LEARNING OBJECTIVE

SYI-3.B

Explain how the same genotype can result in multiple phenotypes under different environmental conditions.

ESSENTIAL KNOWLEDGE

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.

TOPIC 5.6 Chromosomal Inheritance

Required Course Content

ENDURING UNDERSTANDING

SYI-3

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

LEARNING OBJECTIVE

SYI-3.C

Explain how chromosomal inheritance generates genetic variation in sexual reproduction.

ESSENTIAL KNOWLEDGE

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.

SUGGESTED SKILL

Argumentation

6.E.b

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.

ILLUSTRATIVE EXAMPLES

SYI-3.C.3

- Sickle cell anemia
- Tay-Sachs disease
- Huntington's disease
- X-linked color blindness
- Trisomy 21/Down syndrome