CHAPTER 2: Genetics

MULTIPLE CHOICE

1. Chromosomes are
   a. composed of ribonucleic acid.
   b. attached to organelles.
   c. replicated during cell division.
   d. made of proteins.

   ANS: C DIF: Easy
   REF: Cell Division and the Role of Chromosomes in Inheritance
   OBJ: Explain how Mendel's laws follow from the machinery of cell replication.
   MSC: Remembering

2. A cross between true-breeding plants bearing yellow seeds produces offspring bearing
   a. all yellow seeds.
   b. 1/2 yellow and 1/2 green seeds.
   c. 3 yellow seeds and 1 green seed.
   d. all green seeds.

   ANS: A DIF: Easy
   REF: Cell Division and the Role of Chromosomes in Inheritance
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Understanding

3. Cross-breeding the offspring of true-bred green and yellow peas led to _____ in the second generation.
   a. only green individuals surviving the first days of life
   b. a 3:1 ratio of yellow to green offspring
   c. yellowish green individuals
   d. half the offspring being green and the other half yellow

   ANS: B DIF: Medium
   REF: Cell Division and the Role of Chromosomes in Inheritance
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Applying

4. Gametes
   a. are not involved in the transmission of genes.
   b. are the sex cells, or eggs and sperm.
   c. do not differ between male and female animals.
   d. were discovered by Darwin.

   ANS: B DIF: Easy REF: Mendelian Genetics
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Remembering

5. Mendel's first principle (of segregation) states that
   a. characteristics from the parents blend together to produce intermediate offspring.
   b. characteristics from the parents do not blend together in offspring.
   c. only paternally derived characteristics segregate into gametes during meiosis.
   d. only maternally derived characteristics segregate into gametes during meiosis.

   ANS: B DIF: Medium REF: Chromosomes and Mendel's Experimental Results
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Understanding

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6. Mendel's second principle (of independent assortment) states that
   a. eggs and sperm are formed independently of one another.
   b. transmission includes both blending and particulate inheritance.
   c. particles inherited from the mother and the father are equally likely to be transmitted to offspring.
   d. particles inherited from the mother are more likely to be transmitted to female offspring and particles inherited from the father are more likely to be transmitted to male offspring.

   ANS: C DIF: Hard REF: Chromosomes and Mendel's Experimental Results
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Remembering

7. Chromosomes are contained in
   a. the gametes of prokaryotes.
   b. the nuclei of eukaryotes.
   c. the ribosomes.
   d. the mitochondria.

   ANS: B DIF: Medium REF: Mitosis and Meiosis
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Understanding

8. Homologous chromosomes
   a. come in pairs.
   b. move together into the gametes during meiosis.
   c. are found only in mammals.
   d. have three codons.

   ANS: A DIF: Easy REF: Mitosis and Meiosis
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Remembering

9. Mitosis
   a. results in half the number of chromosomes in the daughter cells.
   b. results in either sperm or egg.
   c. results in a daughter cell that has the exact copy of the chromosomes of its parent.
   d. results in an egg only.

   ANS: C DIF: Easy REF: Mitosis and Meiosis
   OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
   MSC: Remembering

10. Reduction of chromosome number occurs during
    a. recombination.
    b. meiosis.
    c. somatic cell formation.
    d. linked genes.

    ANS: B DIF: Medium REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

11. A pea plant with only green seeds is
    a. homozygous recessive.
    b. always tall.
    c. an example of blending inheritance.
    d. heterozygous.

    ANS: A DIF: Medium REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

12. If you have two parents with the genotype Aa, what is the chance that they will have an offspring with the genotype AA?
    a. 1/8
    b. 1/2
    c. 1/4
    d. 1/16

    ANS: C DIF: Medium REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Applying

13. The possible genotype(s) of a pea plant with yellow seeds is
    a. AA.
    b. aa.
    c. Aa.
    d. both a and c.

    ANS: D DIF: Medium REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

14. In diploid organisms
    a. chromosomes occur in homologous pairs.
    b. chromosomes occur in homologous triplets.
    c. meiosis produces diploid gametes.
    d. mitosis produces haploid cells.

    ANS: A DIF: Medium REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

15. In mitosis
    a. a haploid cell divides into two diploid cells.
    b. a diploid cell divides into two haploid cells.
    c. a haploid cell divides into two diploid cells.
    d. a diploid cell divides into two diploid cells.

    ANS: D DIF: Medium REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

16. Which of the following is true of mitosis?
    a. Mitosis produces identical daughter cells.
    b. Mitosis produces nonidentical daughter cells.
    c. Mitosis produces cells with different chromosomes.
    d. Mitosis produces haploid gametes.

    ANS: A DIF: Easy REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

17. In meiosis,
    a. haploid cells are produced from a single diploid cell.
    b. haploid cells are produced from two diploid cells.
    c. diploid cells are produced from a single diploid cell.
    d. diploid cells are produced from two haploid cells.

    ANS: A DIF: Easy REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

18. Which of the following is true of meiosis?
    a. Daughter cells contain one chromosome from each homologous pair.
    b. Daughter cells contain both chromosomes from each homologous pair.
    c. Meiosis produces somatic cells.
    d. Meiosis produced diploid cells.

    ANS: A DIF: Easy REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

19. Gametes
    a. contain both homologous chromosomes.
    b. are responsible for normal body growth of organisms.
    c. can be eggs or sperm.
    d. are diploid.

    ANS: C DIF: Easy REF: Mitosis and Meiosis
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

20. The genotype of an individual refers to
    a. the alleles it carries.
    b. its visible characteristics.
    c. the number of chromosomes in its sex cells.
    d. the number of chromosomes in its body cells.

    ANS: A DIF: Easy REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

21. The phenotype of an individual refers to
    a. its visible characteristics.
    b. the number of homologous pairs of chromosomes.
    c. the number of chromosomes in its body cells.
    d. the number of chromosomes in its sex cells.

    ANS: A DIF: Easy REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

22. An individual with two identical alleles at a locus is
    a. an independent phenotype.
    b. a homozygote.
    c. a heterozygote.
    d. dominant.

    ANS: B DIF: Easy REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Remembering

23. A heterozygote is an individual with
    a. the same paternal and maternal allele at a particular locus.
    b. a different paternal and maternal allele at a particular locus.
    c. a recessive allele.
    d. a dominant allele.

    ANS: B DIF: Easy REF: Chromosomes and Mendel's Experimental Results

OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Remembering

24. What genotype do true-breeding plants bearing yellow seeds have?
    a. aa
    b. aA
    c. Aa
    d. AA

    ANS: D DIF: Easy REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

25. When Mendel crossed true-breeding plants bearing yellow seeds with true-breeding plants bearing green seeds, what was the phenotypic ratio among the offspring?
    a. All aa individuals
    b. All AA individuals
    c. Half yellow and half green individuals
    d. All yellow individuals

    ANS: D DIF: Medium REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

26. What genotype do true-breeding plants bearing green seeds have?
    a. aa
    b. aA
    c. Aa
    d. AA

    ANS: A DIF: Easy REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

27. When a true-breeding plant bearing yellow seeds produces gametes, what alleles are represented among those gametes?
    a. Only A alleles
    b. Only a alleles
    c. Both a and A alleles, in equal frequencies
    d. Both a and A alleles, but mostly A alleles

    ANS: A DIF: Easy REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Understanding

28. When Mendel crossed true-breeding plants bearing yellow seeds with true-breeding plants bearing green seeds, what was the genotypic ratio among the offspring?
    a. 100% aa individuals
    b. 100% AA individuals
    c. 100% Aa individuals
    d. 3 to 1 yellow to green individuals

    ANS: C DIF: Medium REF: Chromosomes and Mendel's Experimental Results
    OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
    MSC: Applying

29. Mendel crossed true-breeding plants bearing yellow seeds with true-breeding plants bearing green seeds. He then crossed the offspring from that mating with each other (F_1 generation). What was the genotypic ratio among the offspring of the F_1 generation?
    a. All Aa or aA
    b. 25% aa, 50% Aa/aA, and 25% AA

c. All AA or aa
d. 33.3% aa, 33.3% Aa/aA, and 33.3% AA

ANS: B DIF: Medium REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Applying

30. Mendel crossed true-breeding plants bearing yellow seeds with true-breeding plants bearing green seeds. He then crossed the offspring from that mating with each other (F_1 generation). What was the phenotypic ratio among the offspring?
a. All yellow
b. 1/2 green and 1/2 yellow
c. 3/4 yellow and 1/4 green
d. 3/4 green and 1/4 yellow

ANS: C DIF: Medium REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Applying

31. When Mendel crossed heterozygote pea plants for two different traits, he recorded a phenotypic ratio of
a. 1:2:1.
b. 4:8:4.
c. 9:3:3:1.
d. 12:4.

ANS: C DIF: Medium REF: Chromosomes and Mendel's Experimental Results
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Understanding

32. Recombination and crossing over are very important in the genetic process because they produce
a. variation.
b. a new somatic cell.
c. DNA.
d. linked chromosomes.

ANS: A DIF: Easy REF: Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Understanding

33. What is the probability that an Aa individual will produce a gamete with an A allele?
a. 100%
b. 75%
c. 50%
d. 25%

ANS: C DIF: Easy REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Understanding

34. Consider a cross between tall and short plants in which all of the offspring are tall. This suggests that
a. the allele for tall is recessive.
b. the allele for tall is dominant.
c. the alleles for tall and short are codominant.
d. None of the above.

ANS: B DIF: Medium REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Understanding

35. Mendel crossed AABB with aabb individuals, where B = smooth, b = wrinkled, A = yellow, and a = green. What was the genotypic ratio of the F_1 generation?
a. All AAbb
b. 1/2 AAbb and 1/2 aaBB
c. All AaBb
d. All AABB

ANS: C DIF: Medium REF: Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Understanding

36. Imagine a cross between AA and Aa individuals. What is the genotypic ratio among the offspring?
    a. 1/2 AA and 1/2 aa
    b. 1/2 Aa and 1/2 aa
    c. 1/2 AA and 1/2 Aa
    d. All AA

ANS: C DIF: Easy REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Understanding

37. Under which circumstance does Mendel's principle of independent segregation hold?
    a. Only when traits are tightly linked (close together) on the same chromosome
    b. Only when traits are on different chromosomes
    c. Only when there is crossing over
    d. Only when the traits are not influenced by selection

ANS: B DIF: Medium REF: Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Understanding

38. The law of independent segregation states that
    a. the fact that a gamete has an A rather than an a allele does not influence the probability that it will have a B rather than a b allele.
    b. alleles on different chromosomes do not influence each other as they assort into gametes.
    c. dominant alleles act independently of recessive alleles.
    d. both a and b are correct.

ANS: D DIF: Medium REF: Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Understanding

39. Which of the following is true of chromosomes?
    a. Hereditary material is contained in the chromosomes.
    b. Chromosomes come in tetrads.
    c. Two chromosomes from each homologous pair are passed on to daughter cells during meiosis.
    d. One chromosome from each homologous pair is passed on to daughter cells during mitosis.

ANS: A DIF: Easy REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Remembering

40. Imagine two loci on one chromosome. At one locus the genotype is Aa, and at the other locus the genotype is Bb. After meiosis, what are all of the possible genotypes of the gametes?
    a. AB and ab gametes
    b. All AB gametes
    c. AB, ab, Ab, and aB gametes
    d. Ab and aB gametes

ANS: C DIF: Hard REF: Linkage and Recombination
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Analyzing

41. Crossing over

a. can occur between loci on nonhomologous chromosomes.
b. can occur between alleles on the same chromosome.
c. increases genetic variation.
d. decreases genetic variation.

ANS: C DIF: Medium REF: Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Understanding

42. When two loci are very close together on a chromosome,
a. they are linked.
b. a crossing-over event between them is less likely than when two loci are far apart.
c. they can blend into a single gene.
d. both a and b are correct.

ANS: D DIF: Medium REF: Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Applying

43. Molecular genetics
a. links biology to geophysics.
b. has explained the way the solar system works.
c. has demonstrated that humans descended from chimpanzees.
d. provides data for reconstructing the evolutionary history of species.

ANS: D DIF: Easy REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Remembering

44. Analysis of DNA sequences tells us that
a. humans and chimpanzees share a more recent common ancestor than either shares with gorillas.
b. the last common ancestor of chimpanzees and humans were gorillas.
c. humans left Asia about 1 million years ago.
d. humans left Asia and went to Africa.

ANS: A DIF: Medium REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Understanding

45. The structure of DNA is that
a. of a series of intertwining chromosomes.
b. of a double-stranded molecule, consisting of four bases.
c. of a series of bases: adenine, guanine, thymine, and cytosine.
d. both b and c are correct.

ANS: D DIF: Medium REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Understanding

46. Which of the following statements is true?
a. DNA has a nonrepeating four-base structure.
b. DNA is contained in chromosomes.
c. DNA stands for determining nuclear acid.
d. DNA does not tell us why heredity leads to the patterns Mendel described in pea plants.

ANS: B DIF: Easy REF: Genes Are DNA
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Remembering

47. Exact replication of DNA is possible because
    a. the low number of possible nucleotides.
    b. base-pair complementarity.
    c. the sequence of nucleotides along the DNA, which is always the same.
    d. both a and c are correct.

    ANS: B DIF: Easy REF: Genes Are DNA
    OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
    MSC: Understanding

48. Sickle-cell anemia
    a. is on the decline.
    b. is caused by the change in two amino acids that make up the hemoglobin molecule.
    c. results when hemoglobin molecules do not fold correctly, reducing their ability to bind to oxygen.
    d. increases an individual's susceptibility to malaria.

    ANS: C DIF: Medium REF: Some Genes Code for Proteins
    OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
    MSC: Applying

49. Unlike a eukaryote, a prokaryote
    a. does not have DNA.
    b. has many introns and exons.
    c. has a large number of chromosomes.
    d. does not have a nucleus.

    ANS: D DIF: Medium REF: Some Genes Code for Proteins
    OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
    MSC: Remembering

50. Alternative splicing
    a. allows the same DNA sequence to code for more than one protein.
    b. allows prokaryote exons to be included in the genome of eukaryotes.
    c. allows only certain sections of DNA to be copied.
    d. allows a maximum of four exons to be attached to mRNA.

    ANS: A DIF: Hard REF: Some Genes Code for Proteins
    OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
    MSC: Applying

51. Some biologists hypothesize that introns are maintained in eukaryotes because their population sizes are much smaller than in prokaryotes. _____ is the random, nonadaptive evolutionary process that explains this phenomenon.
    a. Genetic drift
    b. Natural selection
    c. Protein synthesis
    d. Transcription

    ANS: A DIF: Hard REF: Some Genes Code for Proteins
    OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
    MSC: Analyzing

52. If the DNA codon for an amino acid is ACC, what are the mRNA and its tRNA anticodon, respectively?

a. TGG; UCC
b. GGT; CCA
c. GTG; CAC
d. UGG; ACC

ANS: D DIF: Medium REF: Genes Are DNA
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Applying

53. Which of the following is true of DNA transcription/translation?
a. A codon corresponds to an amino acid.
b. A DNA sequence codes for a protein.
c. A protein consists of a series of codons.
d. Both a and b are true.

ANS: D DIF: Medium REF: Some Genes Code for Proteins
OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
MSC: Understanding

54. Because there are 64 possible codons and only 20 amino acids,
a. many mutations have no effect on phenotype.
b. every mutation has some effect on phenotype.
c. each tRNA molecule contains two extra amino acids.
d. each tRNA molecule contains two extra codons.

ANS: A DIF: Medium REF: Some Genes Code for Proteins
OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
MSC: Understanding

55. Which of the following sequences is accurate for transcription and translation?
a. DNA tRNA mRNA protein
b. DNA mRNA protein
c. Protein tRNA DNA
d. Protein tRNA DNA

ANS: B DIF: Medium REF: Some Genes Code for Proteins
OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
MSC: Understanding

56. As DNA codes for proteins, it can be interrupted by noncoding sequences called
a. organelles.
b. proteins.
c. introns.
d. synthetases.

ANS: C DIF: Easy REF: Some Genes Code for Proteins
OBJ: Describe how genes control the structure of proteins and influence the properties of organisms.
MSC: Remembering

57. The presence of repressors and activators in regulatory genes means that there is _____ of gene expression.
a. translation
b. combinatorial control
c. a biochemical pathway
d. primary structure

ANS: B DIF: Hard REF: Regulatory Sequences Control Gene Expression
OBJ: Explain how gene regulation allows the same genes to control the development and function of many different parts of the body. MSC: Understanding

58. The organelles that splice the mRNA in eukaryotes after the introns have been snipped out are called
a. splitosomes.
b. ribosomes.
c. spliceosomes.
d. Golgi bodies.

ANS: C DIF: Medium REF: Not All DNA Codes for Protein
OBJ: Explain how gene regulation allows the same genes to control the development and function of many different parts of the body. MSC: Remembering

59. _____ binds to complementary mRNA molecules and regulates the translation of mRNA into proteins.
a. Transfer RNA
b. MicroRNA
c. Noncoding DNA
d. Mitochondrial RNA

ANS: B DIF: Medium REF: Not All DNA Codes for Protein
OBJ: Explain how gene regulation allows the same genes to control the development and function of many different parts of the body. MSC: Understanding

60. At least _____ of the genome is expressed as noncoding DNA.
a. 50%
b. 25%
c. 75%
d. 5%

ANS: A DIF: Easy REF: Not All DNA Codes for Protein
OBJ: Explain how gene regulation allows the same genes to control the development and function of many different parts of the body. MSC: Remembering

ESSAY

1. How do the results of Mendel's experiments affect our understanding of how variation is preserved?

ANS:
To answer this question fully, students should discuss genotypes and phenotypes; dominant and recessive genes; and heterozygotes, particulate inheritance, and the facts that one gene is inherited from each parent and that each gene/allele is equally likely to be transmitted to gametes and therefore transmitted to the next generation.

For any given phenotype, or physical characteristic, there is at least one genotype (combination of genes or alleles) that codes for that phenotype. Therefore, there can be several variants of genes, which are called alleles. For example, Mendel's pea plants had two alleles for seed color, one for yellow (abbreviated Y) and one for green (abbreviated y). The yellow allele is dominant because plants that are both homozygous for yellow seeds (YY) and heterozygous (Yy) have yellow seeds, whereas for a plant to have green seeds it must be homozygous for green (yy), or homozygous recessive. But Mendel determined that variation is preserved through the selective breeding of the offspring (F_1 generation) of yellow- and green-seeded pea plants that bred true, that is, heterozygotes. The F_2 generation produced both yellow- and green-seeded individuals in a ratio of 3:1. So even though the green variants appeared to be lost in the F_1 generation, this phenotype reappeared in the F_2 generation. This occurrence is connected to the laws of particulate inheritance and independent assortment: random chance determines which allele will be passed on to the offspring, and each allele has an equal chance of being passed on.

DIF: Medium REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Applying

2. Imagine a cross between two AaBb individuals, where A = yellow, a = green, B = smooth, and b = wrinkled. What is the genotypic and phenotypic ratio among the offspring?

ANS:

This question is best answered using a Punnett square, although students may be able to remember the ratios. Having two alleles for two traits results in sixteen possible combinations, assuming independent assortment (the other of Mendel's laws). If two heterozygotes are crossed, the next generation has a phenotype ratio of 9:3:3:1 (9 smooth-yellow; 3 smooth-green; 3 wrinkled-yellow; 1 wrinkled green). The genotype ratio is
1AABB: 2AABb: 1AAbb: 2AaBB: 4AaBb: 2Aabb: 1aaBB: 2aaBb: 1aabb.

DIF: Medium
REF: Chromosomes and Mendel's Experimental Results | Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Applying

3. Compare and contrast mitosis and meiosis. Include in your discussion for each process (a) the number of daughter cells produced and (b) the number of chromosomes each new cell contains. What are recombination and crossing over, and why are they important in the study of evolution?

ANS:
Mitosis occurs in somatic or body cells, requires a single replication of the chromosomes, and results in two daughter cells both with the full complement of chromosomes (in eukaryotes referred to as the diploid number, abbreviated as 2N). In contrast, meiosis occurs in the sex cells or gametes and requires a single replication of chromosomes, but because the cell divides twice, it results in four daughter cells with half of the chromosomes, one copy of each. These cells are haploid, abbreviated as N. Crossing over occurs during meiosis, when the replicating chromosomes line up (tetrad), become damaged, break, and recombine. Therefore, recombination is the result of crossing over. The end result is that the gametes contain, and therefore offspring inherit, a novel combination of genes that is not present in the parent. This is important for evolution because it is a source of variation, upon which natural selection acts.

DIF: Medium REF: Mitosis and Meiosis
OBJ: Describe how experiments by Gregor Mendel's laws follow from the machinery of cell replication. MSC: Understanding

4. Consider a homologous pair of chromosomes with the genotype Aa at one locus and the genotype Bb at another locus. After undergoing meiosis, what are all of the possible genotypes of the gametes produced?

ANS:
The likely genotypes of the gametes will depend on how close these two loci are the closer the loci, the less likely crossing over will result in recombination, and the farther away they are, the more likely crossing over will result in novel combinations in the gametes. Since the question asks for "all possible genotypes," students should include in their response genotypes that occur as a result of recombination. Therefore, AB, Ab, aB, and ab are the possible genotypes of the gametes.

DIF: Hard
REF: Chromosomes and Mendel's Experimental Results | Linkage and Recombination
OBJ: Understand why genes affecting different traits are sometimes linked.
MSC: Analyzing

5. Explain the life cycle of diploid organisms in terms of meiosis and mitosis.

ANS:

A diploid eukaryote begins its life as a fertilized egg, or zygote, which is diploid (2N) and undergoes mitosis, somatic cell division, to become a many-celled diploid organism. Mitosis is used for growth and repair. As the organism begins to produce gametes, meiosis occurs. Haploid sex cells are formed. A gamete from one individual joins a gamete from another to form a diploid zygote, and the cycle begins again.

DIF: Medium REF: Mitosis and Meiosis
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.
MSC: Applying

6. Describe the structure of DNA.

ANS:
DNA is a double helix. It is like a twisted ladder, with the sides of the ladder, or backbone, made of alternating phosphate and sugar molecules. The rungs of the ladder are made up of nucleotide bases, of which there are four: adenine, guanine, cytosine, and thymine. The two sides of the ladder are joined by hydrogen bonds between complementary nucleotides: adenine always bonds to thymine, and cytosine always binds to guanine.

DIF: Easy REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Understanding

7. How does a sequence of DNA produce a protein through transcription and translation?

ANS:
Transcription is the process by which a single strand of DNA is copied. This copy is known as messenger RNA, or mRNA. The sequence of DNA that is copied is made up of "three-letter words" (a series of a combination of three bases). These triplets are known as codons. These codons can mean "start" protein synthesis (known as translation), "stop," or code for specific amino acids, which are the building blocks of protein. After an mRNA copy is made, it travels (outside of the nucleus in eukaryotes) to the ribosome, an organelle, where translation occurs. As the ribosome "reads" the mRNA one codon at a time, another kind of RNA, transfer RNA (tRNA), carries the appropriate amino acid to the mRNA and ribosome and matches up with the mRNA with complementary base pairs (an anticodon). The amino acid and tRNA break apart when the amino acid has attached to the growing chain. Once the stop codon is reached on the mRNA, translation stops and a new protein has been formed.

DIF: Medium REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Applying

8. What is the role of regulatory genes? What is meant by the combinational control of gene expression? Illustrate your answer with an example.

ANS:
Regulatory genes control when protein coding genes are expressed. Combinatorial control of gene expression is the existence of multiple regulatory sequences. Some genes repress protein formation, while others activate it. The example presented in the book is how *E. coli* can switch from using glucose as its energy source to lactose when glucose is in short supply. The genes that allow lactose to be metabolized are regulated by genes that essentially keep the lactose genes turned off when glucose is readily available and turn on the lactose genes when glucose is not available but lactose is readily available.

DIF: Hard REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Understanding

9. How does alternative splicing allow the same DNA sequence to code for more than one protein? Why is alternative splicing important in eukaryotes?

ANS:
To answer this question, students must demonstrate an understanding of introns and exons, as well as transcription.

Not all sequences of DNA are functional codes. The noncoding sequences are called introns and are contrasted with coding sequences, called exons. When transcription occurs, and mRNA is formed, it is first formed with copies of introns, which are then snipped out of the mRNA sequence. The exon-replicating mRNA is then spliced back together before it leaves the nucleus to find the ribosomes and commence translation (protein formation). Sometimes not all of the exons are spliced back together. This changes the amino acid sequence of the protein, altering the protein produced. Alternative splicing allows for single sequences of DNA to create multiple proteins. This may be important for eukaryotes, which have cells that perform different functions: the same DNA can help these specialized cells perform their specific function without requiring additional DNA. Furthermore, this and the maintenance of introns may demonstrate genetic drift, another force of evolution.

DIF: Hard REF: Molecular Genetics
OBJ: Explain how the properties of DNA are consistent with the role of genes in inheritance.
MSC: Analyzing

10. True-bred tall pea plants with violet flowers are crossed with short plants with white flowers. Assume the trait for tall plants (T) is dominant and short plants (t) is recessive. Also assume the trait for violet flowers (V) is dominant and white flowers (v) is recessive.

1. What are the genotypes of the F_1 plants?
2. What are the genotypes of the gametes for the F_1 plants?
3. What are the phenotypes and phenotypic ratios of the F_2 generation and why?

ANS:
1. What are the genotypes of the F_1 plants? 100% TtVv

2. What are the genotypes of the gametes for the F_1 plants? TV, Tv, tV, tv

3. What are the phenotypes and phenotypic ratios of the F_2 generation and why?
9:3:3:1 tall, violet : tall, white : short, violet : short, white.

This question is best answered using a Punnett square, although students may be able to remember the ratios. Having two alleles for two traits results in sixteen possible combinations, assuming independent assortment (the other of Mendel's laws). If two heterozygotes are crossed, the next generation has a phenotype ratio of 9:3:3:1.

To answer this question fully, students should also understand genotypes and phenotypes; dominant and recessive genes; and heterozygotes, particulate inheritance, and the facts that one gene is inherited from each parent and that each gene/allele is equally likely to be transmitted to gametes and therefore transmitted to the next generation.

Students will also need to understand the difference between gamete formation for the F_1 generation and how that determines the genotype of the F_2 generation.

DIF: Medium REF: Chromosomes and Mendel's Experimental Results
OBJ: Describe how experiments by Gregor Mendel revealed the logic of inheritance.

MSC: Analyzing

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