***Genetic Analysis: An Integrated Approach, 3e* (Sanders)**
Chapter 2 Transmission Genetics

2.1 Multiple-Choice Questions

1) Genetic crosses in which F_1 plants heterozygous for a given allele are crossed to generate a 3:1 phenotypic ratio in the F_2 generation are known as _____.
A) replicate crosses
B) reciprocal crosses
C) test crosses
D) monohybrid crosses
E) dihybrid crosses
Answer: D
Section: 2.2
Skill: Remembering/Understanding
LO: S2.2a, S2.2b

2) In peas, the smooth allele is dominant over the wrinkled allele. A plant with round peas was crossed to a plant with wrinkled peas and all of the resulting plants had smooth peas. What are the genotypes of the parents in this cross?
A) *RR* × *rr*
B) *RR* × *Rr*
C) *Rr* × *rr*
D) *Rr* × *Rr*
E) *rr* × *rr*
Answer: A
Section: 2.2
Skill: Applying/Analyzing
LO: S2.2c

3) In peas, the yellow allele is dominant over the green allele. A plant with yellow peas was crossed to a plant with green peas. The resulting plants were 50% yellow and 50% green. What are the genotypes of the parents in this cross?
A) *YY* × *yy*
B) *YY* × *Yy*
C) *Yy* × *yy*
D) *Yy* × *Yy*
E) *yy* × *yy*
Answer: C
Section: 2.2
Skill: Applying/Analyzing
LO: S2.2c

4) What genotypic ratio would you expect to observe among the progeny of a monohybrid cross?
A) 1:3
B) 9:3:3:1
C) 1:2:1
D) 1:3:2:1
E) 3:1
Answer: C
Section: 2.2
Skill: Applying/Analyzing
LO: S2.2b

5) You count 1000 F2 seeds from a monohybrid cross. How many seeds do you expect to display the dominant phenotype?
A) 1000
B) 750
C) 500
D) 250
E) 0
Answer: B
Section: 2.2
Skill: Applying/Analyzing
LO: S2.2b

6) Assuming independent assortment, what phenotypic ratio would you expect to see if an individual with the genotype *RrGg* is self-crossed?
A) 1:3
B) 9:3:3:1
C) 1:2:1
D) 1:3:2:1
E) 3:1
Answer: B
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3a

7) In peas, axial (*A*) flower position is dominant to terminal *(a*), tall (*L*) is dominant to short (*l*), and yellow (*Y*) is dominant to green (*y*). If a plant that is heterozygous for all three traits is allowed to self-fertilize, how many of the offspring would show the dominant phenotype for all three traits?
A) 3/64
B) 9/64
C) 27/64
D) 32/64
E) 64/64
Answer: C
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3d

8) In peas, axial (*A*) flower position is dominant to terminal (*a*), and tall (*L*) is dominant to short (*l*). If a plant that is heterozygous for both traits is allowed to self-fertilize, how many of the offspring would also be heterozygous for both traits?
A) 9/16
B) 1/4
C) 3/16
D) 1/8
E) 1/16
Answer: B
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3b

9) What phenotypic ratio would you expect as a result of a test cross between two individuals where one that is homozygous recessive for alleles at two independent loci?
A) 3:1
B) 1:2:1
C) 1:1:1:1
D) 9:3:3:1
E) 9:4:2:1
Answer: C
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3a

10) If a plant with purple, axial flowers and green, inflated pods is heterozygous for all four genes, how many different types of gametes can it produce?
A) 1
B) 4
C) 8
D) 9
E) 16
Answer: E
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3e

11) In Guinea pigs, short hair (*S*) is dominant over long hair (*s*), rough coat (*R*) is dominant over smooth coat (*r*), and black hair (*B*) is dominant over white hair (*b*). Which of the following individuals could produce these (and only these) four possible gametes: *SRb*, *Srb*, *sRb*, *srb*.
A) *SSRRbb*
B) *ssRrBB*
C) *SsRrbb*
D) *SsRrBb*
E) *SSRrBb*
Answer: C
Section: 2.3
Skill: Applying/Analyzing
LO: G3, S2.3e

12) The gene L determines hair length in rabbits. The gene B determines hair color. A rabbit with long, black hair is crossed to a rabbit with short, white hair. All the offspring have long, black hair. What are the genotypes of the parents?
A) *LLBB* × *llbb*
B) *LlBb* × *LlBb*
C) *LlBb* × *llbb*
D) *Llbb* × *llBb*
E) Impossible to determine from the information given
Answer: A
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3d

13) In rabbits, long hair and black fur are produced by the dominant alleles L and B, which assort independently. The genotype ll produces short hair and the genotype bb produces white fur. A cross between a male with short, black fur and a female with long, white fur produces four offspring with short, black fur, four offspring with long, white fur, four offspring with short, white fur, and four offspring with long, black fur. What are the genotypes of the parents?
A) *llBB* × *LLbb*
B) *LlBb* × *LlBb*
C) *llBb* × *Llbb*
D) *LLBB* × *llbb*
E) Impossible to determine from the information given.
Answer: C
Section: 2.3
Skill: Applying/Analyzing
LO: S2.3d

14) A couple has four children. What is the probability that they have four boys?
A) 1/2
B) 1/4
C) 1/8
D) 1/16
E) 1/32
Answer: D
Section: 2.4
Skill: Applying/Analyzing
LO: G4, S2.4

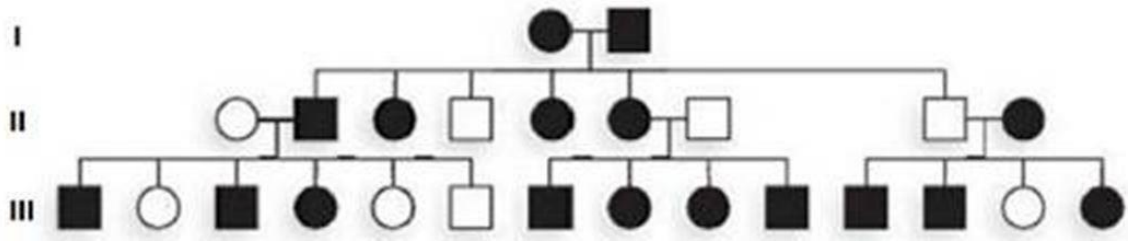
15) By convention, when an OBSERVED experimental outcome has a probability of occurrence of less than 5% (<0.05), the experimental results are considered to be _____.
A) within normal expected range
B) statistically significant and different from the expected outcome
C) not significant
D) less than one standard deviation from the mean
E) equal to the mean
Answer: B
Section: 2.5
Skill: Remembering/Understanding
LO: G4, S2.5

16) The statistical interpretation of a chi-square value is determined by identifying the _____.
A) mean
B) degrees of freedom
C) average
D) *P* value
E) joint probability
Answer: D
Section: 2.5
Skill: Remembering/Understanding
LO: G4, S2.5

17) The *P* value is a quantitative expression of the probability that the results of another experiment of the same size and structure will DEVIATE FROM EXPECTED RESULTS AS MUCH AS OR MORE THAN BY CHANCE. The greater the difference between observed and expected results of an experiment, _____.
A) the lower the $\chi 2$ value and the lower the P value
B) the greater the $\chi 2$ value and the greater the P value
C) the greater the $\chi 2$ value and the lower the P value
D) the lower the $\chi 2$ value and the greater the P value
E) the greater the $\chi 2$ value; but the P value is unaffected
Answer: C
Section: 2.5
Skill: Remembering/Understanding
LO: G4, S2.5

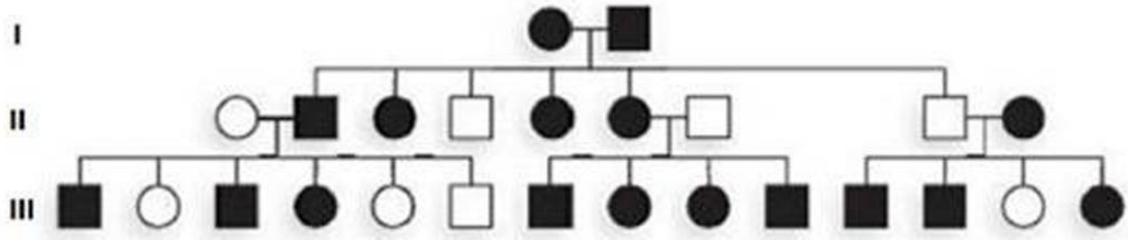
18) Humans have a gene, *T*, that is involved in muscle formation of the tongue. Individuals homozygous for one allele can roll their tongues, while individuals homozygous for the other allele cannot. If both parents can roll their tongues, but their child cannot, what can be said about the mode of inheritance?
A) Tongue rolling is dominant.
B) Tongue rolling is recessive.
C) The parents were both homozygous, but the child was heterozygous.
D) Tongue rolling is dominant, and both parents were heterozygous (*Tt*).
E) Tongue rolling is recessive, and both parents were heterozygous (*Tt*).
Answer: D
Section: 2.6
Skill: Applying/Analyzing
LO: S2.6a, S2.6b

19) In mice, black coat color is dominant to white coat color. In the pedigree below, mice with a black coat are represented by darkened symbols, and those with white coats are shown as open symbols.



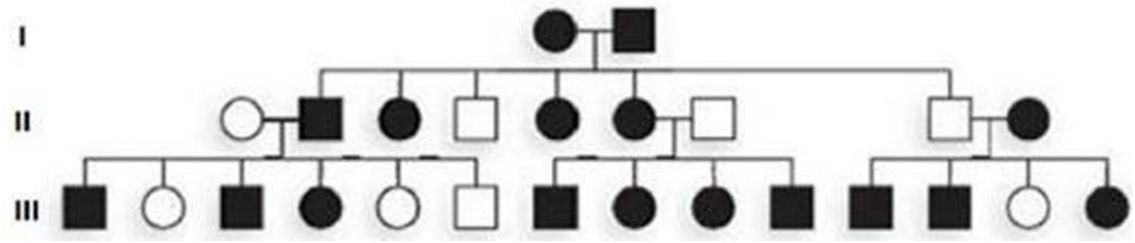
What is the genotype of III-1?
A) homozygous dominant or heterozygous
B) heterozygous
C) homozygous dominant
D) heterozygous or homozygous recessive
E) homozygous recessive
Answer: B
Section: 2.6
Skill: Applying/Analyzing
LO: G3, S2.6b

20) In mice, black coat color is dominant to white coat color. In the pedigree below, mice with a black coat are represented by darkened symbols, and those with white coats are shown as open symbols.



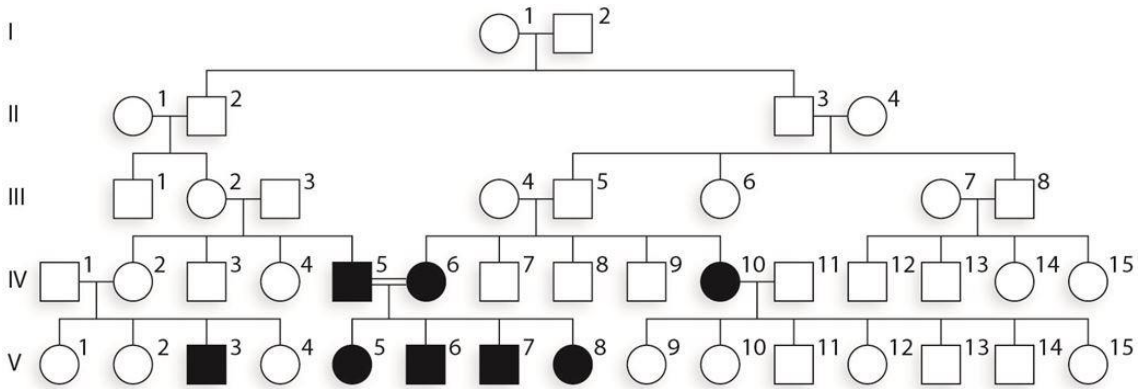
What is the probability that I-1, I-2, II-2, AND III-1 are all heterozygous?
A) 0
B) 1/4
C) 1/2
D) 2/3
E) 1
Answer: E
Section: 2.6
Skill: Applying/Analyzing
LO: G3, G4, S2.6b, S2.6c

21) In mice, black coat color is dominant to white coat color. In the pedigree below, mice with a black coat are represented by darkened symbols, and those with white coats are shown as open symbols.



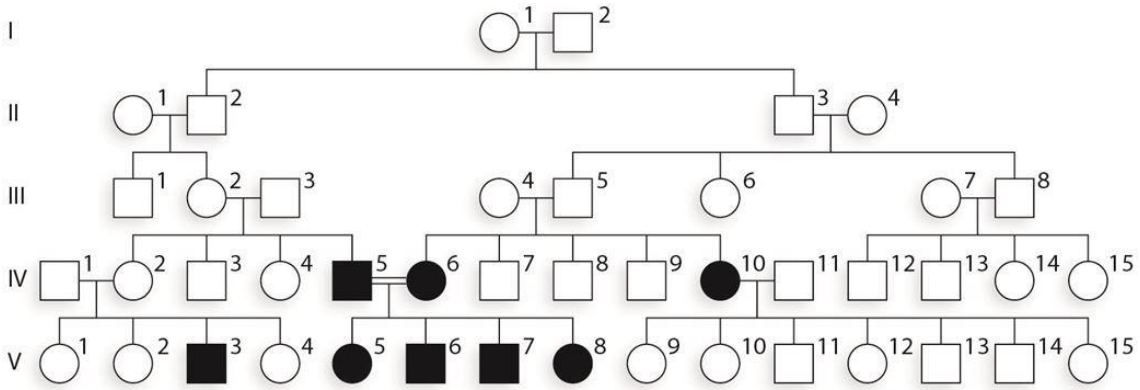
What could you conclude regarding the genotype of mouse II-3 if a testcross resulted in 5 mice with black coat color and 6 mice with white coat color?
A) The genotype of II-3 could be homozygous recessive or heterozygous.
B) The genotype of II-3 could be homozygous dominant or heterozygous.
C) The genotype of II-3 must be homozygous dominant.
D) The genotype of II-3 must be heterozygous.
E) The genotype of II-3 must be homozygous recessive.
Answer: D
Section: 2.6
Skill: Applying/Analyzing
LO: G2, G3, G4, S2.2a, S2.6b

22) In the accompanying figure, the chance that individual III-5 is a heterozygous carrier is _____.



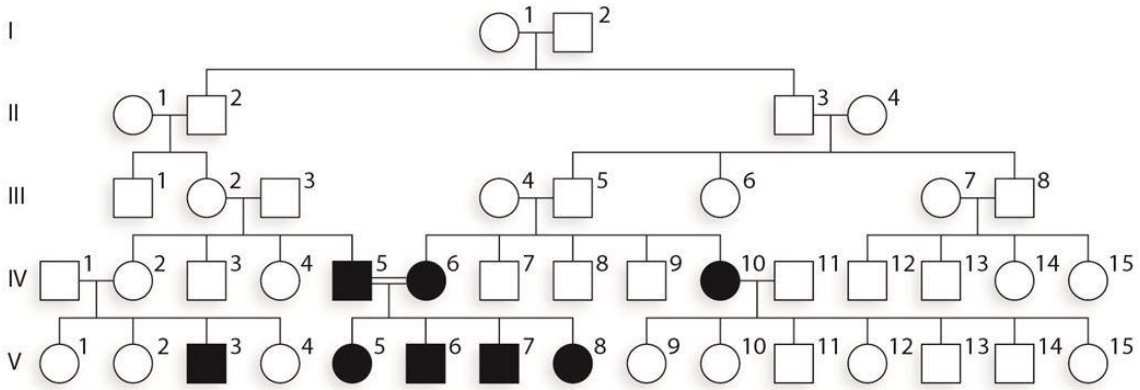
A) 0%
B) 25%
C) 50%
D) 75%
E) 100%
Answer: E
Section: 2.6
Skill: Applying/Analyzing
LO: G3, G4, S2.6b, S2.6c

23) In the accompanying figure, the chance that individual IV-7 is a heterozygous carrier is _____.



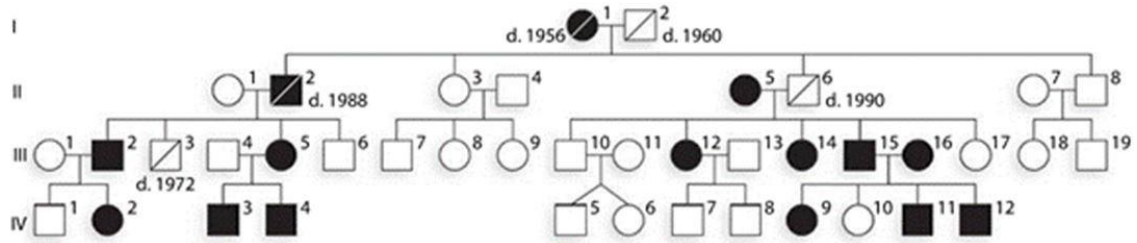
A) 1/4
B) 1/3
C) 1/2
D) 2/3
E) 3/4
Answer: D
Section: 2.6
Skill: Applying/Analyzing
LO: G3, G4, S2.6b, S2.6c

24) In the accompanying figure, if individual IV-7 has three children with individual IV-2 what is the probability (to the nearest hundredth) that they would have exactly two affected offspring?



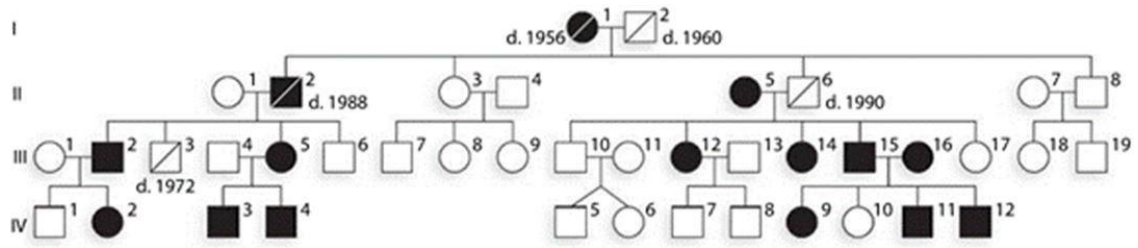
A) 0.02
B) 0.07
C) 0.17
D) 0.67
E) 0.44
Answer: B
Section: 2.6
Skill: Applying/Analyzing
LO: G3, G4, S2.6b, S2.6c

25) Huntington's disease is an autosomal dominant trait. Given the pedigree below, if individual IV-2 has three children with a normal man, what is probability that exactly two of the three children would have the disorder?



A) 0
B) 1/8
C) 1/2
D) 3/8
E) 7/8
Answer: D
Section: 2.6
Skill: Applying/Analyzing
LO: G3, G4, S2.4, S2.6b, S2.6c

26) Huntington's disease is an autosomal dominant trait. Given the pedigree below, if individual IV-4 has three children with a normal woman, what is probability that they would have at least one child with the disorder?



A) 0
B) 1/8
C) 1/2
D) 3/8
E) 7/8
Answer: E
Section: 2.6
Skill: Applying/Analyzing
LO: G2, G3, G4, S2.4, S2.6b, S2.6c

27) The genes responsible for some of the traits that Mendel observed have been recently identified and have helped in determining how molecular variation produces morphologic variation in pea plants. Allelic variation in the Sbe1 gene, which produces starch-branching enzyme 1, is responsible for which trait in peas?
A) smooth and wrinkled pea shape
B) yellow and green pea color
C) purple and white flowers
D) tall and short plant height
E) axial and terminal flower position
Answer: A
Section: 2.6
Skill: Remembering/Understanding
LO: S2.1

28) In 1997, a gene called *Le* was discovered by two research groups led by David Martin and Diane Lester. Allelic variation in the *Le gene*, which controls elongation of the plant stem between branches, is responsible for which trait in peas?
A) inflated and constricted pod shape
B) yellow and green pod color
C) purple and white flowers
D) tall and short plant height
E) axial and terminal flower position
Answer: D
Section: 2.6
Skill: Remembering/Understanding
LO: S2.1

2.2 Short Answer Questions

1) Mendel performed numerous controlled genetic crosses to obtain strains that consistently produced a single phenotype without variation. What are these strains that consistently produce the same phenotype called?
Answer: pure-breeding or true-breeding strains
Section: 2.1
Skill: Remembering/Understanding
LO: S2.1

2) In a test cross, a pure-breeding plant is crossed with a plant suspected to be heterozygous (*Aa*). What is the genotype of the pure-breeding plant?
Answer: *aa*
Section: 2.1
Skill: Applying/Analyzing
LO: S2.1

3) Why did Mendel cut off the nascent anthers during the process of artificial cross-fertilization?
Answer: to prevent self-fertilization or to prevent uncontrolled crosses
Section: 2.1
Skill: Remembering/Understanding
LO: G1, S2.1

4) In some of Mendel's experiments, a cross in which one plant provides the pollen and another with the same genotype provides the egg is followed be another cross in which the first plant provides the egg while the second provides the pollen. During his experiments, these _____ crosses produced identical results.
Answer: reciprocal
Section: 2.1
Skill: Remembering/Understanding
LO: G1, S2.1

5) What simple type of cross that investigates the inheritance of only one trait could be used to illustrate Mendel's law of segregation?
Answer: monohybrid cross
Section: 2.2
Skill: Remembering/Understanding
LO: S2.2a

6) A cross between a short pea plant and a tall pea plant results in a 1:1 genotypic AND phenotypic ratio in the offspring. What are the genotypes of the parent plants?
Answer: *Ss* × *ss* (heterozygous × homozygous recessive)
Section: 2.2
Skill: Applying/Analyzing
LO: S2.2c

7) The law of independent assortment predicts that crossing of dihybrid F1 plants to one another would produce nine genotypes in a _____ ratio among F2 progeny.
Answer: 9:3:3:1
Section: 2.3
Skill: Remembering/Understanding
LO: S2.3a

8) What is the probability of rolling one six-sided die and obtaining a 1 or a 2?
Answer: 1/6 + 1/6 = 2/6 = 1/3
Section: 2.4
Skill: Applying/Analyzing
LO: S2.4

9) What is the probability of rolling one six-sided die and obtaining any number but 6?
Answer: 1 - 1/6 = 5/6
Section: 2.4
Skill: Applying/Analyzing
LO: S2.4

10) What is the probability of rolling two six-sided dice and obtaining two 4's?
Answer: 1/6 × 1/6 = 1/36
Section: 2.4
Skill: Applying/Analyzing
LO: S2.4

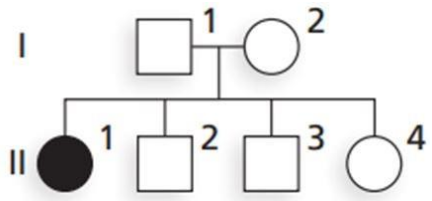
11) What is the probability of rolling two six-sided dice and obtaining at least one 3?
Answer: Probability of die 1 being a 3 and die 2 not: 1/6 × 5/6 = 5/36
Probability of die 2 being a 3 and die 1 not: 1/6 × 5/6 = 5/36
Probability of die 1 and 2 being a 3: 1/6 × 1/6 = 1/36
Probability of any of these possibilities = addition rule: 5/36 + 5/36 + 1/6 = 11/36
Section: 2.4
Skill: Applying/Analyzing
LO: S2.4

12) What is the probability of rolling two six-sided dice and obtaining an odd number on at least one die?
Answer: 9/36 + 9/36 + 9/36 = 27/36 = 3/4
Probability of rolling odd number the first die only = 3/6 (odd) × 3/6 (even) = 9/36
Probability of rolling odd number the second die only = 3/6 (even) × 3/6 (odd) = 9/36
Probability of rolling odd number both dice = 3/6 (odd) × 3/6 (odd) = 9/36
Probability of any one of these three possible scenarios = addition rule
Section: 2.4
Skill: Applying/Analyzing
LO: S2.4

13) Geneticists must be able to compare the outcomes they obtain in their experiments to the outcomes that might be expected to occur. Which test would they use to confirm that the difference between observed and expected outcomes could be attributed to chance?
Answer: chi-square test
Section: 2.5
Skill: Remembering/Understanding
LO: G4, S2.5

14) If an affected individual is born to parents who are unaffected, what is the likely mode of inheritance?
Answer: autosomal recessive
Section: 2.6
Skill: Remembering/Understanding
LO: S2.6a

15) The pedigree suggests which mode of inheritance for an allele on chromosome 15?



Answer: autosomal recessive
Section: 2.6
Skill: Applying/Analyzing
LO: G3, S2.6a

2.3 Fill-in-the-Blank Questions

1) One key to Mendel's success was choosing to observe _____ traits, which exhibit one of two possible phenotypes.
Answer: dichotomous
Section: 2.1
Skill: Remembering/Understanding
LO: S2.1

2) A ratio of 9:3:3:1 is expected among the F_2 progeny of a dihybrid cross as a result of _____ of alleles at two loci.
Answer: independent assortment
Section: 2.3
Skill: Remembering/Understanding
LO: S2.3a

3) In a cross between individuals who are both heterozygous (carriers) for a recessive disease, such as albinism, you would like to determine the risk of one or more children inheriting the recessive phenotype. _____ probability can be used to calculate the probability of a particular combination of events that each have two alternative outcomes?
Answer: Binomial
Section: 2.4
Skill: Remembering/Understanding
LO: S2.4

4) You have self-fertilized a plant with round seeds that is heterozygous, and you want to determine what proportion of the offspring will be dominant and true breeding. _____ probability can be used to calculate the probability of obtaining a particular outcome when specific information about that outcome modifies the probability calculation?
Answer: Conditional
Section: 2.4
Skill: Remembering/Understanding
LO: S2.4

5) The *P* value is dependent on the number of _____, which is equal to the number of independent variables in an experiment.
Answer: degrees of freedom (df)
Section: 2.5
Skill: Remembering/Understanding
LO: S2.5

2.4 Essay Questions

1) Describe the traits that make *Pisum sativum* an ideal organism for genetic studies.
Answer: There are many varieties of peas with distinct, heritable features in the form of dichotomous phenotypes that can be easily observed and quantified. In addition, mating of plants can be closely controlled. Since each pea plant has both sperm-producing (stamens) and egg-producing (carpels) organs, they can be self-crossed to generate true-breeding plants. After creating these true-breeding plants, Mendel could test for dominant or recessive inheritance patterns by cross-pollination (fertilization between different plants).
Section: 2.1
Skill: Evaluating/Creating
LO: G2, G8, S2.1

2) Describe the blending theory of heredity and how Mendel's results help to reject this theory.
Answer: The blending theory viewed the traits of progeny as a mixture of the characteristics possessed by the two parental forms. Under this theory, progeny were believed to display characteristics that were approximately intermediate between those of the parents. Mendel reasoned that if the blending theory were true, he would see evidence of it in each trait. If no blending was seen in individual traits, the blending theory would be disproven. F_1 experimental results reject the blending theory of heredity because all F_1 progeny have the same phenotype (i.e., the dominant phenotype) that is indistinguishable from the phenotype of one of the pure-breeding parents. This specifically contradicts the blending theory prediction that the F_1 would display a mixture of the parental phenotypes. The persistence of the dominant phenotype and the reemergence of the recessive phenotype in the F_2 also contradict the blending theory.
Section: 2.1
Skill: Evaluating/Creating
LO: G2, G8, S2.1

3) What are Mendel's first and second laws of inheritance, and what do they state?
Answer: *First Law: Law of Segregation*—The two alleles for each trait will separate from one another during gamete formation, and each allele will have an equal probability (1/2) of inclusion in a gamete. Random union of gametes at fertilization will unite one gamete from each parent to produce progeny in ratios that are determined by chance.
Second Law: Law of Independent Assortment—During gamete formation, the segregation of alleles at one locus is independent of the segregation of alleles at another locus.
Section: 2.2 and 2.3
Skill: Remembering/Understanding
LO: S2.2b, S2.3a

4) In Guinea pigs, short hair (S) is dominant over long hair (s), rough coat (R) is dominant over smooth coat (r), and black hair (B) is dominant over white hair (b). List all the different possible gametes that can be produced by each of the individuals below.

a. *SSRRbb*
b. *ssRrBB*
c. *SsRrbb*
d. *SsRrBb*

Answer:

a. *SSRRbb: SRb*
b. *ssRrBB: sRB, srB*
c. *SsRrbb: SRb, Srb, sRb, srb*
d. *SsRrBb: SRB, SRb, SrB, Srb, sRB, sRb, srB, sr*

Section: 2.3
Skill: Applying/Analyzing
LO: S2.3e

5) A geneticist is investigating the inheritance of two autosomal recessive genes in mice, one for obesity (LEP) and another for autism (oprm1). The table below provides the number of offspring observed, for each phenotype, when dihybrid mice are crossed:

Phenotype	Observed(O)	Expected (E)	O-E	(O-E)2	(O-E)2/E
wild-type	154				
obese	69				
autistic	58				
obese, autistic	23				
					$\sum (O-E)^2/E=$

Fill in the table above and determine:

a. the chi-square (χ^2) value (to the nearest hundredth) for the chance hypothesis that the two genes assort independently

b. the degrees of freedom

c. whether or not you would reject your chance hypothesis that the two genes assort independently, based on your approximate P value, and the justification for why

Answer:

Phenotype	Observed(O)	Expected (E)	O-E	(O-E)2	(O-E)2/E
wild-type	154	171	-17	289	1.690
obese	69	57	12	144	2.526
autistic	58	57	1	1	0.018
obese, autistic	23	19	4	16	0.842
					$\sum (O-E)^2/E=$ 5.08

a. 5.08

b. 3

c. You would fail to reject the chance hypothesis since the observed outcomes have a P value greater than 5% (> 0.05). Therefore, the chance hypothesis that the two genes assort independently cannot be rejected.

Section: 2.5

Skill: Applying/Analyzing

LO: G2, G3, G4, G9, S2.3b, S2.3c, S2.5

6) A geneticist is investigating the inheritance of two autosomal recessive genes in mice, one for obesity (LEP) and another for autism (oprm1). The table below provides the number of offspring observed, for each phenotype, when dihybrid mice are testcrossed:

Phenotype	Observed(O)	Expected (E)	O-E	(O-E)2	(O-E)2/E
wild-type	88				
obese	68				
autistic	64				
obese, autistic	80				
					$\sum (O-E)^2/E=$

Fill in the table above and determine:

a. the chi-square (χ^2) value (to the nearest hundredth) for the chance hypothesis that the two genes assort independently

b. the degrees of freedom

c. whether or not you would reject your chance hypothesis that the two genes assort independently, based on your approximate P value, and the justification for why

Answer:

Phenotype	Observed(O)	Expected (E)	O-E	(O-E)2	(O-E)2/E
wild-type	88	75	13	169	2.533
obese	68	75	-7	49	0.653
autistic	64	75	-11	121	1.613
obese, autistic	80	75	5	25	0.333
					$\sum (O-E)^2/E=$ 4.85

a. 4.85

b. 3

c. You would fail to reject the chance hypothesis since the observed outcomes have a P value greater than 5% (> 0.05). Therefore, the chance hypothesis that the two genes assort independently cannot be rejected.

Section: 2.5

Skill: Applying/Analyzing

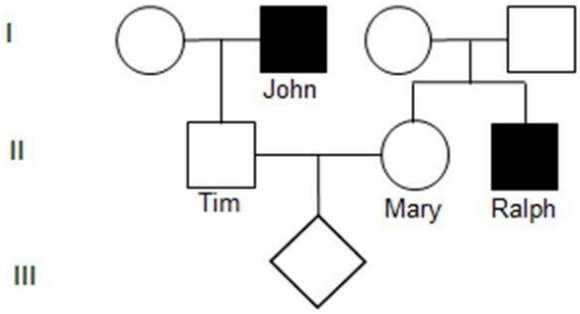
LO: G2, G3, G4, G9, S2.3a, S2.3c. S2.5

7) Tim and Mary are planning to start a familiy. While neither of them have cystic fibrosis, a rare autosomal recessive disease, they are concerned that their children could have the disease since Tim's father, John, AND Mary's brother, Ralph both have the disease.

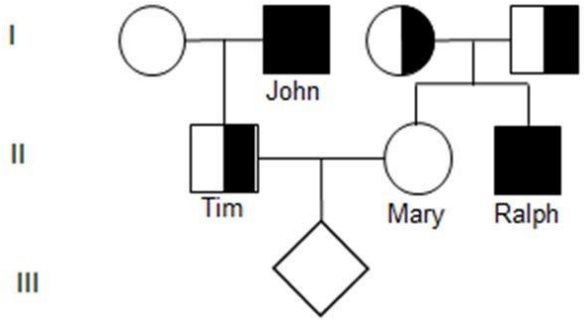
a. Draw a pedigree of the inheritance of the cystic fibrosis allele in this family.
b. On your pedigree, indicate any individuals that must be carriers.
c. What is the probability that Tim will be a carrier for the disease allele?
d. What is the probability that Mary will be a carrier for the disease allele?
e. What is the probability that Tim and Mary will have a child with the disease?

Answer:

a.



b.



c. 1
d. 2/3
e. 1/6

Section: 2.6
Skill: Evaluating/Creating
LO: G2, G3, G4, G5, S2.6b, S2.6c S2.6d