Concepts of Genetics, 10e **(Klug/Cummings/Spencer/Palladino)**
Chapter 3 Mendelian Genetics

1) Which of the following groups of scientists were influential around the year 1900 in setting the stage for our present understanding of transmission genetics?
A) Beadle, Tatum, Lederberg
B) Watson, Crick, Wilkins, Franklin
C) deVries, Correns, Tschermak, Sutton, Boveri
D) Darwin, Mendel, Lamarck
E) Hippocrates, Aristotle, Kolreuter
Answer: C
Section: 3.5

2) Name the single individual whose work in the mid-1800s contributed to our understanding of the particulate nature of inheritance as well as the basic genetic transmission patterns. With what organism did this person work?
A) Gregor Mendel; *Pisum sativum*
B) George Beadle; *Neurospora*
C) Thomas Hunt Morgan; *Drosophila*
D) Calvin Bridges; *Drosophila*
E) Boris Ephrussi; *Ephestia*
Answer: A
Section: Introduction

3) A recessive allele in tigers causes the white tiger. If two normally pigmented tigers are mated and produce a white offspring, what percentage of their remaining offspring would be expected to have normal pigmentation?
A) 25%
B) 50%
C) about 66%
D) 75%
E) about 90%
Answer: D
Section: 3.2

4) Polydactyly is expressed when an individual has extra fingers and/or toes. Assume that a man with six fingers on each hand and six toes on each foot marries a woman with a normal number of digits. Having extra digits is caused by a dominant allele. The couple has a son with normal hands and feet, but the couple's second child has extra digits. What is the probability that their next child will have polydactyly?
A) 1/32
B) 1/8
C) 7/16
D) 1/2
E) 3/4
Answer: D
Section: 3.2

5) Tightly curled or wooly hair is caused by a dominant gene in humans. If a heterozygous curly-haired person marries a person with straight hair, what percentage of their offspring would be expected to have straight hair?
A) 25% curly
B) 50% straight
C) 75% curly
D) 100% straight
E) It is impossible to predict the outcome.
Answer: B
Section: 3.2

6) Which types of phenotypic ratios are likely to occur in crosses when dealing with a single gene pair for which all the genotypic combinations are of equal viability?
A) 9:3:3:1, 27:9:9:9:3:3:3:1
B) 1:2:1, 3:1
C) 1:4:6:4:1, 1:1:1:1
D) 12:3:1, 9:7
E) 2:3, 1:2
Answer: B
Section: 3.2

7) Assume that a black guinea pig crossed with an albino guinea pig produced 5 black offspring. When the albino was crossed with a second black guinea pig, 4 black and 3 albino offspring were produced. What genetic explanation would apply to these data?
A) albino = recessive; black = recessive
B) albino = dominant; black = incompletely dominant
C) albino and black = codominant
D) albino = recessive; black = dominant
E) None of the answers listed is correct.
Answer: D
Section: 3.2

8) The fundamental Mendelian process that involves the separation of contrasting genetic elements at the same locus would be called _____.
A) segregation
B) independent assortment
C) continuous variation
D) discontinuous variation
E) dominance or recessiveness
Answer: A
Section: 3.2

9) The Chi-square test involves a statistical comparison between measured (observed) and predicted (expected) values. One generally determines degrees of freedom as _____.
A) the number of categories being compared
B) one less than the number of classes being compared
C) one more than the number of classes being compared
D) ten minus the sum of the two categories
E) the sum of the two categories
Answer: B
Section: 3.8

10) Assume that in a series of experiments, plants with round seeds were crossed with plants with wrinkled seeds and the following offspring were obtained: 220 round and 180 wrinkled.a) What is the most probable genotype of each parent?
(b) What genotypic and phenotypic ratios are expected?
(c) Based on the information provided in part (b), what are the expected (theoretical) numbers of progeny (400 total) of each phenotypic class?
Answer:
(a) assuming that round *(W)* is dominant to wrinkled *(w)*: *Ww* × *ww*
(b) 1:1
(c) 200
Section: 3.2

11) In peas, gray seed color is dominant to white. For the purposes of this question, assume that Mendel crossed plants with gray seeds with each other and the following progeny were produced: 320 gray and 80 white.

(a) What is the most probable genotype of each parent?
(b) What genotypic and phenotypic ratios are expected in the progeny of such a cross?
Answer:
(a) assuming the following symbols: *G* = gray and *g* = white, *Gg* × *Gg*
(b) genotypic = 1:2:1, phenotypic = 3:1
Section: 3.2

12) Assume that you have a garden and some pea plants have solid leaves and others have striped leaves. You conduct a series of crosses [(a) through (e)] and obtain the results given in the table.

	Cross	***Progeny***	
		solid	***striped***
(a)	solid × striped	55	60
(b)	solid × solid	36	0
(c)	striped × striped	0	65
(d)	solid × solid	92	30
(e)	solid × striped	44	0

Define gene symbols and give the possible genotypes of the parents of each cross.
Answer:
(a) From cross (d), assume that solid *(S)* is dominant to striped *(s)*: *Ss* × *ss.*
(b) *SS* × *SS* or *SS* × *Ss*
(c) *ss* × *ss*
(d) *Ss* × *Ss*
(e) *SS* × *ss*
Section: 3.2

13) The phenotype of vestigial (short) wings *(vg)* in *Drosophila melanogaster* is caused by a recessive mutant gene that independently assorts with a recessive gene for hairy *(h)* body. Assume that a cross is made between a fly with normal wings and a hairy body and a fly with vestigial wings and normal body hair. The wild-type F_1 flies were crossed among each other to produce 1024 offspring. Which phenotypes would you expect among the 1024 offspring, and how many of each phenotype would you expect?
Answer: Phenotypes: wild, vestigial, hairy, vestigial hairy
Numbers expected: wild (576), vestigial (192), hairy (192), vestigial hairy (64)
Section: 3.3

14) Two organisms, *AABBCCDDEE* and *aabbccddee*, are mated to produce an F_1 that is self-fertilized. If the capital letters represent dominant, independently assorting alleles:

(a) How many different genotypes will occur in the F_2?
(b) What proportion of the F_2 genotypes will be recessive for all five loci?
(c) Would you change your answers to (a) and/or (b) if the initial cross occurred between *AAbbCCddee* × *aaBBccDDEE* parents?
(d) Would you change your answers to (a) and/or (b) if the initial cross occurred between *AABBCCDDEE* × *aabbccddEE* parents?
Answer:
(a) $3^5 = 243$
(b) 1/243
(c) no
(d) yes
Section: 3.4

15) How many different kinds of gametes can be produced by an individual with the genotype *AABbCCddEeFf*?
Answer: $2^3 = 8$
Section: 3.4

16) Albinism, lack of pigmentation in humans, results from an autosomal recessive gene *(a).* Two parents with normal pigmentation have an albino child.

(a) What is the probability that their next child will be albino?
(b) What is the probability that their next child will be an albino girl?
(c) What is the probability that their next three children will be albino?
Answer:
(a) 1/4
(b) 1/4 × 1/2 = 1/8
(c) 1/4 × 1/4 × 1/4 = 1/64
Section: 3.2

17) *Dentinogenesis imperfecta* is a rare, autosomal, dominantly inherited disease of the teeth that occurs in about one in 8000 people (Witkop 1957). The teeth are somewhat brown in color, and the crowns wear down rapidly. Assume that a male with *dentinogenesis imperfecta* and no family history of the disease marries a woman with normal teeth. What is the probability that

(a) their first child will have *dentinogenesis imperfecta*?
(b) their first two children will have *dentinogenesis imperfecta*?
(c) their first child will be a girl with *dentinogenesis imperfecta*?
Answer:
(a) 1/2
(b) 1/2 × 1/2 = 1/4
(c) 1/2 × 1/2 = 1/4
Section: 3.2

18) A certain type of congenital deafness in humans is caused by a rare autosomal (not X-linked) dominant gene.

(a) In a mating involving a deaf man and a deaf woman (both heterozygous), would you expect all the children to be deaf? Explain your answer.
(b) In a mating involving a deaf man and a deaf woman (both heterozygous), could all the children have normal hearing? Explain your answer.
(c) Another form of deafness is caused by a rare autosomal recessive gene. In a mating involving a deaf man and a deaf woman, could some of the children have normal hearing? Explain your answer.
Answer:
(a) No. In a mating involving heterozygotes, three genotypic classes are expected in the offspring: fully dominant, fully recessive, and heterozygous.
(b) Assuming that the parents are heterozygotes (because the gene is rare), it is possible that all of the children could have normal hearing.
(c) Since the gene in question is recessive, both of the parents are homozygous and one would not expect normal hearing in the offspring.
Section: 3.2

19) Among dogs, short hair is dominant to long hair and dark coat color is dominant to white (albino) coat color. Assume that these two coat traits are caused by independently segregating gene pairs. For each of the crosses given below, write the most probable genotype (or genotypes if more than one answer is possible) for the parents. It is important that you select a realistic symbol set and define each symbol below.

Parental Phenotypes	***Phenotypes of Offspring***			
	Short Dark	***Long Dark***	***Short Albino***	***Long Albino***
(a) dark, short × dark, long	26	24	0	0
(b) albino, short × albino, short	0	0	102	33
(c) dark, short × albino, short	16	0	16	0
(d) dark, short × dark, short	175	67	61	21

Assume that for cross (d), you were interested in determining whether fur color follows a 3:1 ratio. Set up (but do not complete the calculations) a Chi-square test for these data [fur color in cross (d)].
Answer: Let *A* = dark, *a* = albino and *L* = short, *l* = long

(a) *AALl* × *AAll* or *AALl* × *Aall*
(b) *aaLl* × *aaLl*
(c) *AaLL* × *aaLL* or *AaLl* × *aaLL* or *AaLL* × *aaLl*
(d) *AaLl* × *AaLl*

$$x^2 = \sum \frac{(o - e)^2}{e} = (242 - 243)^2/243 + (82 - 81)^2/81$$

Section: 3.3, 3.8

20) Which phenotypic ratio is likely to occur in crosses of two completely dominant, independently segregating gene pairs when both parents are fully heterozygous?
Answer: 9:3:3:1
Section: 3.3

21) Provide simple definitions that distinguish segregation and independent assortment.
Answer: Segregation is the separation of alleles during meiosis; independent assortment states that a member of one gene pair has an equal and independent opportunity of segregating with either member of another gene pair.
Section: 3.3

22) In what ways is sample size related to statistical testing?
Answer: By increasing sample size, one increases the reliability of the statistical test and decreases the likelihood of erroneous conclusions from chance fluctuations in the data.
Section: 3.8

23) In a Chi-square analysis, what condition causes one to reject (fail to accept) the null hypothesis?
Answer: usually when the probability value is less than 0.05
Section: 3.8

24) If one is testing a goodness of fit to a 9:3:3:1 ratio, how many degrees of freedom would be associated with the Chi-square analysis?
Answer: number of classes minus 1 = 3
Section: 3.8

25) Assuming no crossing over between the gene in question and the centromere, when do alleles segregate during meiosis?
Answer: meiosis I, when homologous chromosomes go to opposite poles
Section: 3.2

26) Assuming a typical monohybrid cross in which one allele is completely dominant to the other, what ratio is expected if the F_1s are crossed?
Answer: 3:1
Section: 3.2

27) Under what conditions does one expect a 9:3:3:1 ratio?
Answer: dihybrid cross (F_2) with independently assorting, completely dominant genes
Section: 3.3

28) Under what conditions does one expect a 1:1:1:1 ratio?
Answer: This occurs in a cross involving doubly heterozygous individuals crossed to fully recessive individuals. The genes involved assort independently.
Section: 3.3

29) What is the probability of flipping a penny and a nickel and obtaining one head and one tail?
Answer: 1/2 (apply the "sum law")
Section: 3.7

30) How many kinds of gametes will be expected from an individual with the genotype *PpCcTTRr*?
Answer: 8
Section: 3.4

31) Assume that a Chi-square test was conducted to test the goodness of fit to a 9:3:3:1 ratio and a Chi-square value of 10.62 was obtained. Should the null hypothesis be accepted?
Answer: no
Section: 3.8

32) Assume that a Chi-square test was conducted to test the goodness of fit to a 3:1 ratio and that a Chi-square value of 2.62 was obtained. Should the null hypothesis be accepted? How many degrees of freedom would be associated with this test of significance?
Answer: yes; 1
Section: 3.8

33) Assume that a Chi-square test provided a probability value of 0.02. Should the null hypothesis be accepted?
Answer: no
Section: 3.8

34) In studies of human genetics, usually a single individual brings the condition to the attention of a scientist or physician. When pedigrees are developed to illustrate transmission of the trait, what term does one use to refer to this individual?
Answer: proband
Section: 3.9

35) Albinism, lack of pigmentation in humans, results from an autosomal recessive gene *(a)*. Two parents with normal pigmentation have an albino child. What is the probability that their next child will be albino?
Answer: 1/4
Section: 3.2

36) Albinism, lack of pigmentation in humans, results from an autosomal recessive gene *(a)*. Two parents with normal pigmentation have an albino child. What is the probability that their next child will be an albino girl?
Answer: $1/4 \times 1/2 = 1/8$
Section: 3.2

37) Albinism, lack of pigmentation in humans, results from an autosomal recessive gene *(a*). Two parents with normal pigmentation have an albino child. What is the probability that their next three children will be albino?
Answer: $1/4 \times 1/4 \times 1/4 = 1/64$
Section: 3.2

38) The autosomal (not X-linked) gene for brachydactyly, short fingers, is dominant to normal finger length. Assume that a female with brachydactyly in the heterozygous condition is married to a man with normal fingers. What is the probability that

(a) their first child will have brachydactyly?
(b) their first two children will have brachydactyly?
(c) their first child will be a brachydactylous girl?
Answer:
(a) 1/2
(b) $1/2 \times 1/2 = 1/4$
(c) $1/2 \times 1/2 = 1/4$
Section: 3.2

39) Tightly curled hair is caused by a dominant autosomal gene in humans. If a heterozygous curly-haired person marries a person with straight hair, what phenotypes (and in what proportions) are expected in the offspring?
Answer: 1/2 curly (because the curly-haired individual is most likely heterozygous); 1/2 straight hair
Section: 3.2

40) A certain type of congenital deafness in humans is caused by a rare autosomal dominant gene. In a mating involving a deaf man and a deaf woman (both heterozygous), would you expect all the children to be deaf? Explain your answer.
Answer: No. In a mating involving heterozygotes, three genotypic classes are expected in the offspring: fully dominant, fully recessive, and heterozygous.
Section: 3.2

41) A certain type of congenital deafness in humans is caused by a rare autosomal dominant gene. In a mating involving a deaf man and a deaf woman, could all the children have normal hearing? Explain your answer.
Answer: Assuming that the parents are heterozygotes (because the gene is rare), it is possible that all of the children could have normal hearing.
Section: 3.2

42) A certain type of congenital deafness in humans is caused by a rare autosomal recessive gene. In a mating involving a deaf man and a deaf woman, could some of the children have normal hearing? Explain your answer.
Answer: Since the gene in question is recessive, both of the parents are homozygous and one would not expect normal hearing in the offspring.
Section: 3.2

43) For the purposes of this question, assume that being Rh^+ is a consequence of *D* and that Rh^- individuals are *dd*. The ability to taste phenylthiocarbamide (PTC) is determined by the gene symbolized *T* (*tt* are nontasters). A female whose mother was Rh^- has the MN blood group, is Rh^+ and a nontaster of PTC, and is married to a man who is MM, Rh^-, and a nontaster. List the possible genotypes of the children. Assume that all the loci discussed in this problem are autosomal and independently assorting.
Answer: *MMDdtt, MMddtt, MNDdtt, MNddtt*
Section: 3.4

44) What conditions are likely to apply if the progeny from the cross *AaBb* × *AaBb* appear in the 9:3:3:1 ratio?
Answer: complete dominance, independent assortment, no gene interaction
Section: 3.3

45) Assume that a cross is made between a heterozygous tall pea plant and a homozygous short pea plant. Fifty offspring are produced in the following frequency:

30 = tall
20 = short

(a) What frequency of tall and short plants is expected?
(b) To test the goodness of fit between the observed and expected values, provide the needed statement of the null hypothesis.
(c) Compute a Chi-square value associated with the appropriate test of significance.
(d) How many degrees of freedom are associated with this test of significance?
Answer:
(a) 1:1 (25 tall and 25 short)
(b) The deviations from a 1:1 ratio (25 tall and 25 short) are due to chance.
(c) $x^2 = 2$
(d) 1
Section: 3.2, 3.8

46) According to Mendel's model, because of _____, all possible combinations of gametes will be formed in equal frequency.
Answer: independent assortment
Section: Introduction

47) Assuming independent assortment, what proportion of the offspring of the cross *AaBbCcDd* × *AabbCCdd* will have the *aabbccdd* genotype?
Answer: zero
Section: 3.4

48) In a statistical sense, as the sample size increases, the average deviation from the expected fraction or ratio is expected to _____.
Answer: decrease
Section: 3.8

49) In a Chi-square test, as the value of the x^2 increases, the likelihood of rejecting the null hypothesis _____.
Answer: increases
Section: 3.8

50) Mendel's postulate of independent assortment is supported by a 1:1:1:1 testcross ratio.
Answer: TRUE
Section: 3.3

51) Mendel's Law of Segregation is supported by a 1:1 testcross ratio.
Answer: TRUE
Section: 3.2

52) Mendel's discoveries were well received and understood by his contemporaries.
Answer: FALSE
Section: 3.5

53) The nonfunctional form of a gene is called a wild-type allele.
Answer: FALSE
Section: 3.5

54) A gene can have a maximum of two alleles.
Answer: FALSE
Section: 3.5

55) To test Mendel's Law of Segregation, the experimenter needs a minimum of two contrasting forms of a gene.
Answer: TRUE
Section: 3.2

56) A 1:1 phenotypic ratio is expected from a monohybrid testcross with complete dominance.
Answer: TRUE
Section: 3.2

57) Assuming complete dominance, a 3:1 phenotypic ratio is expected from a monohybrid sib or self-cross.
Answer: TRUE
Section: 3.2

58) A 9:3:3:1 phenotypic ratio is expected from a dihybrid testcross.
Answer: FALSE
Section: 3.3