

APPLYING THE CONCEPTS

Genetics Problems. These practice problems and questions are intended to sharpen your ability to apply critical thinking and analysis to biological concepts covered in this chapter.

Crosses Involving One Trait:

44. When two plants with red flowers are mated together, the offspring always are red, but if two purple-flowered plants are mated together, sometimes some of the offspring have red flowers. Which flower color is dominant?

45. In sheep, white (B) is dominant to black (b). Give the F_2 phenotypic and genotypic ratios resulting from the cross of a pure-breeding white ram with a pure-breeding black ewe.

46. If you found a white sheep and wanted to determine its genotype, what color animal would you cross it to?

47. Squash may be either white or yellow. However, for a squash to be white, at least one of its parents must also be white. Which color is dominant?

48. In peas, yellow seed color is dominant to green. Give the expected proportion of each color in the offspring of the following crosses: (a) a heterozygous yellow with a heterozygous yellow; (b) a heterozygous yellow with a green; and (c) a green with a green.

49. If tall (D) is dominant to dwarf (d), give the genotypes of the parents that produce $3/4$ tall plants and $1/4$ dwarf plants among their progeny.

Crosses Involving Two Traits:

50. In pigs, mule hoof (fused hoof) is dominant (C) while cloven foot is recessive (c). Belted coat pattern (S) is dominant to solid color (s). Give the F_2 genotype and phenotype ratios expected from the cross $CCSS \times ccss$.

51. In the F_2 generation of the previous question, what proportion of the cloven-hoofed, belted pigs would be homozygous?

52. Flat tail (F) is dominant to fuzzy tail (f), and toothed (T) is dominant to toothless (t). Give the results of a cross between two completely heterozygous parents.

53. In rabbits, black (B) is dominant to brown (b), and spotted coat (S) is dominant to solid coat (s). Give the genotypes of the parents if a black, spotted male is crossed with a brown, solid female and all the offspring are black and spotted.

54. In the preceding problem, give the genotypes of the parents if some of the offspring were brown and spotted.

55. In cattle, having horns (p) is recessive to hornless or polled (P). Coat color is controlled by incompletely dominant genes RR for red, rr for white, and RR' for roan. If two heterozygous roan-polled cattle are mated, what kinds of offspring are expected?

56. If a yellow guinea pig is crossed with a white one, the offspring are cream-colored.

a. What is the simplest explanation for this result?

b. What kinds of offspring are expected if two cream-colored guinea pigs mate?

57. In carnations, red or white phenotypes are dependent on homozygous genotypes, while the heterozygotes are pink. Give the F_1 and F_2 genotypic and phenotypic ratios expected from a cross: red x white.

Crosses Involving Sex-Linked Traits:

58. A normal woman whose father was a hemophiliac has children with a normal man. What are the chances of hemophilia occurring in their children?

59. Another woman with no history of hemophilia in her family has children with a normal man whose father was a hemophiliac. What are the chances of hemophilia occurring in their children?

60. Colorblindness (c) is a sex-linked recessive trait, while normal color vision (C) is dominant.

a. If two normal-visioned parents have a colorblind son, what are the parents' genotypes?

b. What are the chances that their daughter will be colorblind?

61. In cats, yellow is due to gene B , and black to its allele b . These genes are sex-linked. The heterozygous condition results in tortoiseshell. What kinds of offspring (sex and color) are expected from a cross of a black male with tortoise-shell female?

62. In fruit flies, normal long wings are dominant (V) and vestigial (shortened) wings are recessive (v). These genes are autosomal. The sex-linked gene controlling red eye color (W) is dominant to white eyes (w). A male with red eyes and normal wings mates a white-eyed vestigial-winged female. Give the expected ratio of phenotypes in the F_2 generation.

Crosses Involving Gene Interactions:

63. In poultry, there are two independently assorting gene loci, each with two alleles that affect the shape of a chicken's comb. One locus has a dominant allele (R) for rose comb while its recessive allele (r) produces single comb. The other locus has a dominant gene (P) for pea comb while its recessive allele (p) also produces single combs. When the two dominant genes occur together ($R-P-$), a walnut comb is produced. So, $R-P-$ = walnut, $R-pp$ = rose, $rrP-$ = pea, and $rrpp$ = single. Give the expected phenotypic ratios of offspring from the following matings:

a. $RRPP \times rrpp$ _____

b. $RrPp \times rrpp$ _____

c. $Rrpp \times rrPp$ _____

d. $RrPP \times RrPp$ _____

e. $rrPp \times RrPP$ _____

64. In humans, deafness can be the result of a recessive allele affecting the middle ear (dd = deaf), or another recessive allele (ee = deaf) that affects the inner ear. Suppose two deaf parents have a child that can hear. Give the genotypes of all three individuals.

65. If two hearing people, heterozygous at both loci ($DdEe$) for deafness have children, what are the chances that their first child would be normal hearing? What is the chance of deafness in this child?

Crosses Involving Multiple Alleles:

66. Mallard ducks show a multiple allele pattern of inheritance in which M^R produces "restricted mallard" coloring and is dominant over M for mallard coloring, and both of these alleles are dominant over m for "dusky mallard" coloring. Give the phenotypic ratios expected among offspring from the following crosses:

a. $M^R M \times M^R m$ _____

b. $M^R M \times M m$ _____

c. $M m \times m m$ _____

Crosses Involving Multiple Genes:

67. If there are two pairs of genes involved in producing skin color in black x white crosses, and if the five phenotypic classes are black, dark, medium, light, and white, give the expected F_2 results of a white x black mating.

68. Give the darkest phenotype possible among the offspring of the following matings:

a. black x dark _____

b. black x medium _____

c. black x white _____

d. dark x medium _____

e. dark x white _____

f. medium x light _____

g. light x light _____

h. light x white _____

Short Answer:

69. Occasionally, a family occurs in which both parents have recessive albinism but all of their children have normal amounts of skin pigmentation. Propose a genetic explanation for the inheritance of albinism in these families.

70. Referring to blood transfusions in humans, briefly explain why blood type O is the "universal donor" (which means that type O red blood cells can be given to anyone in an emergency situation) and blood type AB is the "universal recipient" (which means that a type AB person can receive anyone's red blood cells in an emergency without harm).

71. In some families where one parent is an albino (a recessive condition lacking in melanin pigment in the hair, skin, and eyes) and the other parent has normal pigmentation, none of the children have albinism, even if large numbers of children are produced. In other families where one parent is albino and the other parent is normal, half of their children have albinism. Explain the difference in the types of children produced in each type of family.

72. Understanding the role of chance in determining the outcome of genetics crosses is similar to understanding the role of chance in the outcome of coin tosses. If you were to flip two coins enough times, you would find that both coins land heads-up 25% of the time, and that one coin lands heads-up and the other lands tails-up 50% of the time. Can you explain these outcomes?

73. Mendel used peas in his experiments to gain an understanding of the rules of inheritance. Why are peas better subjects for genetics studies than humans?

74. Narcolepsy occurs due to different genetic defects in dogs and mice. How does that relate to how narcolepsy occurs genetically in humans?

Use the Case Study and the Web sites for this chapter to answer the following questions.

75. Huntington Disease is a neurologic disorder, first described in the 1870's. What are the clinical symptoms of the disease? Is there a treatment for Huntington Disease?
