

Inheritance Problems

On separate sheets of paper, neatly provide an answer to each problem. Show all work (crosses, Punnet squares, math, etc.) in a logical, stepwise fashion.

Dominant and Recessive Alleles

- Several black guinea pigs of the same genotype were mated and produced 29 black and 9 white (bb) offspring. What would you predict the genotypes of the parents to be?
- Heterozygous black (Bb) guinea pigs are mated to homozygous recessive (bb) whites. Predict the genotypic and phenotypic ratios expected from backcrossing the black F₁ progeny to:
(a) the black parent; (b) the white parent
- In *Drosophila*, red eye color is dominant to sepia colored eyes. If sepia eyed females are crossed to true-bred red eyed males, what phenotypic and genotypic ratios are expected if the F₂ males are backcrossed to the sepia eyed parental females?
- The lack of pigmentation, called albinism, in humans is the result of a recessive allele (a) and normal pigmentation is the result of its dominant allele (A). Two normal parents have an albino child. Determine the probability that:
(a) the next child is albino; (b) the next two children are albinos; (c) What is the chance of these parents producing two children, one albino and the other normal?
- In foxes, silver-black coat color is governed by a recessive allele b and red color by its dominant allele B. Determine the genotypic and phenotypic ratios expected from the following matings:
(a) pure red x heterozygous red; (b) heterozygous red x silver-black; (c) pure red x silver-black
- In summer squash, white fruit color is governed by a dominant allele (W) and yellow fruit color by the recessive (w). A dominant allele on another chromosome (D) produces disc shaped fruit and its recessive allele (d) yields sphere-shaped fruit. If a homozygous white disc variety is crossed with a homozygous yellow sphere variety, the F₁ are all white disc. If the F₁ generation is inbred, what is the expected phenotypic ratio for the F₂ generation?
- In *Drosophila*, ebony body color is produced by a recessive gene (g) and gray body color by its dominant allele (G). Vestigial wings are governed by a recessive allele (n) and normal wing size by the dominant allele (N). If flies heterozygous for both traits are crossed and produce 256 offspring, how many of these flies are expected in each phenotypic class?
- Short hair in rabbits is governed by a dominant allele (S) and long hair by the recessive (s). Black hair results from the dominant (B) allele and brown from the recessive allele (b).
(a) In crosses between heterozygous short, black and homozygous short, brown rabbits, what genotypic and phenotypic ratios are expected among their progeny?
(b) Determine the expected genotypic and phenotypic ratios in progeny from the cross SsBb x Ssbb.
- In pigs, the mule-footed condition is produced by the dominant allele while the cloven-footed condition is recessive. White coat color is dominant to the black allele. A white, mule-footed sow (female) is mated to a black, cloven-footed boar (male) and produces several litters. Among 26 offspring produced by this mating, all were found to be white with mule feet. (a) What is the most probable genotype of the sow? (b) The next litter produced 8 white, mule-footed offspring and one white cloven-footed pig. Now what is the most probable genotype of the sow?

Sex-linked Inheritance

10. A sex-linked recessive allele (h) produces hemophilia in humans. A woman who is heterozygous for the condition marries a man who does not have hemophilia. What are the expected phenotypic and genotypic ratios for their children.
11. The gene for yellow body color (y) in *Drosophila* is recessive and sex-linked. The dominant allele produces wild type body color. What phenotypic ratios are expected from these crosses: (a) yellow male x yellow female; (b) yellow female x wild type male; (c) wild type female (homozygous) x yellow male; (d) wild type (heterozygous) female x wild type male; (e) wild type (heterozygous) female x yellow male?
12. A sex-linked recessive allele (c) produces red/ green color blindness in humans. A normal woman whose father was color blind marries a color blind man. (a) What is the probability that their first child will be a color blind boy? (b) Of all the girls produced by these parents, what percentage is expected to be color blind? (c) of all the children, what proportion is expected to be normal?

Incomplete Dominance / Codominance

13. Yellow coat color in guinea pigs is determined by incomplete dominance. Yellow, cream, and white phenotypes are produced by the genotypes $C^Y C^Y$, $C^Y C^W$, and $C^W C^W$ respectively. What genotypic and phenotypic ratios are matings between cream colored individuals likely to produce?
14. In a variety of chickens color is determined by codominance. When white feathered birds are crossed with black feathered birds, "checkered" (many white and black regions) offspring are the result. (a) Use a Punnett square to demonstrate the cross described above. (b) Do another Punnett square to predict the phenotypic and genotypic ratio for the F_2 offspring.
15. In another variety of chickens, birds with splashed white feathers are crossed with black feathered birds, producing all slate blue (Blue Andalusian) offspring. When Blue Andalusians are crossed among themselves, they produce splashed white, blue, and black offspring in the ratio 1:2:1 respectively. (a) Which pattern of inheritance does this demonstrate? Why? (b) Use Punnett squares to demonstrate the two crosses described.

Multiple Alleles

16. Plumage color in mallard ducks is dependent upon a set of three alleles: M^R for restricted mallard pattern, M for mallard, and m for dusky mallard. The dominance hierarchy is $M^R > M > m$. Determine the genotypic and phenotypic ratios expected for the following crosses: (a) $M^R M \times M^R m$ (b) $M^R m \times M m$ (c) $M m \times m m$.
17. Human blood type is determined by the A (I^A), B (I^B), and O (i) alleles. The A and B alleles are codominant to each other and completely dominant over O. A man with blood type B is being sued by a woman with blood type A for paternity. The woman's child is blood type O. (a) Could this man be the father of the child? Use a Punnett square as proof for your answer. (b) Specify a genotype for this type B man that would make it impossible for him to be the father. (c) If a man was blood type AB, could he be the father of a type O child?
18. The inheritance of coat colors of cattle involves a multiple allelic series with a dominance hierarchy as follows: $S > s^h > s^c > s$. The S allele puts a band of white color around the middle of the animal and is referred to as a Dutch belt; the s^h allele produces a Hereford-type spotting; solid color is a result of the s^c allele; and Holstein-type spotting is due to the s allele. Homozygous Dutch-belted males are crossed to Holstein-type spotted females. The F_1 females are crossed to a Hereford-type spotted male of genotype $s^h s^c$. Predict the genotypic and phenotypic frequencies in the progeny.

Linked Genes & Chromosome Mapping

19. A guinea pig chromosome carries genes affecting foot structure and fur texture. The pollex allele (funky little toe & thumb) is dominant to normal and rough fur allele is dominant to normal. Pigs which are known to have both dominant alleles on one chromosome and both recessive alleles on the other chromosome are crossed with pigs that show the normal phenotypes. Their progeny fell into four phenotypes: 29 rough : 103 normal : 95 rough & pollex : 35 pollex.
 - (a) If NO crossing over had occurred, what would the phenotypic ratio have been?
 - (b) Based on the data gathered, what was the frequency of crossing over between these two genes?
 - (c) How many map units are between the two genes?

20. Two recessive genes in *Drosophila* produce black body and vestigial wings. Wild type flies (homozygous for both genes) are crossed with flies who exhibit both recessive phenotypes. All of the F₁ progeny has the normal phenotype. (a) What is the genotype for the F₁ generation? When the F₁ generation is crossed with black, vestigial flies, they produced 1930 normal : 1880 black & vestigial : 412 black : 370 vestigial. (b) Are these two genes linked? What is your evidence?
 - (c) How many map units are between the genes?

21. In corn, genes for kernel color and shape are located on the same chromosome, 38.6 map units apart. The dominant kernel color allele produces the color aleurone while the recessive one produces no color. The dominant shape allele produces plump kernels while the recessive one produces shrunken kernels due the collapsing of the endosperm. Two plants, both known to be heterozygous for both traits produce different results when crossed with plants that have the recessive phenotypes. 2000 kernels from plant A showed this ratio: 610 aleurone, plump : 380 aleurone, shrunken : 392 colorless, plump : 618 colorless, shrunken. 2000 kernels from plant B had: 382 aleurone, plump : 612 aleurone, shrunken : 616 colorless, plump : 390 colorless, shrunken. Explain this difference in offspring phenotypic ratios.