

AP BIO GENETICS PROBLEMS

MONOHYBRID

1. Two *Drosophila* with normal wings are crossed. Among 123 progeny, 88 have normal wings and 35 have "dumpy" wing.
 - a. What inheritance pattern is shown by the normal and "dumpy" alleles?
 - b. What were the genotypes of the two parents?
2. If a dumpy-winged female (from above) is crossed with her father, how many normal-winged flies will be expected among 80 offspring?
3. In human beings, brown eyes are dominant over blue eyes. Suppose a blue-eyed male marries a brown-eyed woman whose father was blue-eyed. What proportion of their children would you predict will have blue eyes?

DIHYBRID

4. How many unique gametes can organisms produce with each of the following genotypes? $rrss$, $RRss$, $RrSS$, $RrSs$?
- 5a. In tomato plants, the gene for purple stems (A) is dominant to its allele for green stems (a), while the gene for red fruit (R) is dominant to its allele for yellow fruit (r). If two tomato plants heterozygous for both traits are crossed, what proportion of their offspring are expected to have:
 - a. purple stems and yellow fruits
 - b. green stems and red fruits
 - c. purple stems and red fruits
- 5b. In tomato plants, what would be the expected genotypic and phenotypic frequencies if a heterozygous purple stemmed, yellow fruit bearing plant was crossed with a green stemmed, heterozygous red fruit bearing plant?
6. In sesame plants, the one-pod condition (P) is dominant to the three-pod condition (p), and normal leaf (L) is dominant to wrinkled leaf (l). These traits are inherited independently. Determine the genotypes for the two parents for all possible matings producing the following offspring:
 - a. 323 three-pod normal, 106 three-pod, wrinkled
 - b. 150 one-pod, normal, 147 one-pod wrinkled, 51 three-pod, normal, 47 three-pod, wrinkled.
7. A peony plant with straight stamens and red petals was crossed with another plant having straight stamens and streaky petals. The seeds were collected and germinated, and the following offspring were obtained:

62 straight stamens, red petals	59 straight stamens, streaky petals
18 incurved stamens, red petals	22 incurved stamens, streaky petals

 - a. Which allele in each pair (straight vs. incurved stamens, streaky vs. red petals) is dominant?
 - b. What were the genotypes of the parental plants?
 - c. What further crosses would you have to make in order to get a definite answer for part a?

CODOMINANCE/INCOMPLETE DOMINANCE

8. Pooh had a colony of tiggers whose stripes went across the body. His American pen-pal, Yogi, sent him a tigger whose stripes ran lengthwise. When Pooh crossed it with one of his own animals, he obtained plaid tiggers. Interbreeding among the plaid tiggers produced litters with a majority of plaid members, but some crosswise- and lengthwise-striped animals were also produced. Diagram the crosses that Pooh made, showing the genotypes of the tiggers which account for the coat patterns observed.
9. In some flowers, a true-breeding red flowered strain gives all pink flowers when crossed with a white-flowered strain: RR (red) \times $R'R'$ (white) \rightarrow RR' (pink). Flower position is determined by the dominant axial (base of the branch) gene (A) and the recessive terminal (tip of the branch) gene (a).
 - a. What will be the ratios of phenotypes and genotypes of the offspring resulting from the following cross: Axial-red (homozygous) \times terminal-white?
 - b. What will be the ratios of phenotypes and genotypes in the F₂ generation?

10. In cattle, the gene for straight coat (S) is dominant to its allele for curly coat (s). The alleles for coat color (R = red and white = R') show an absence of dominance; heterozygotes (RR') have a roan coat (red lightened by intermixed white hairs).
- If a curly red cow is mated to a homozygous straight white bull, what will the genotype and phenotype of the calf be?
 - If the calf is mated to a roan animal with curly hair, what are the possible phenotypic ratios?

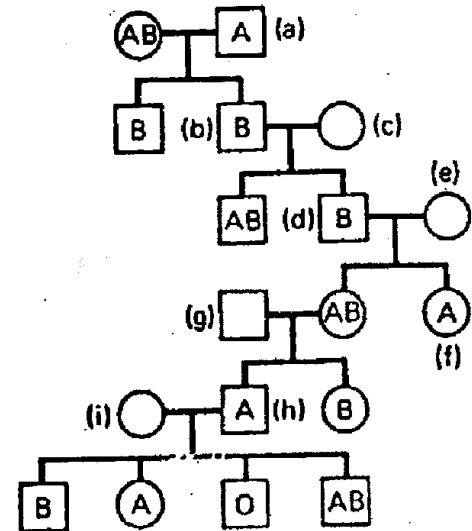
MULTIPLE ALLELES

11. Blood typing is often used as evidence in paternity cases, when the blood type of the mother and child may indicate that a man alleged to be the father could not have fathered the child. For the following mother and child combinations, indicate which blood groups of potential fathers would be exonerated.

BLOOD GROUP OF MOTHER	BLOOD GROUP OF CHILD	MAN EXONERATED IF HE BELONGS TO BLOOD GROUPS _____
AB	A	
O	B	
O	O	
B	A	

12. Use the pedigree at the right to determine (when possible) the genotypes of the individuals indicated.

- | | |
|----|----|
| a. | b. |
| c. | d. |
| e. | f. |
| g. | h. |
| i. | |



EPISTASIS

13. In guinea pigs, the gene for production of melanin is epistatic to the gene for the deposition of melanin. The dominant allele M causes melanin to be produced; the recessive allele m causes no pigment to be produced. The dominant allele B causes the deposition of a lot of pigment and produces a black guinea pig, whereas the recessive allele b causes only a small amount of pigment to be laid down, producing a light-brown guinea pig. Without an M allele, no pigment is produced, so the allele B has no effect, and the guinea pig is white. A homozygous black pig is crossed with a homozygous recessive white: MMBB x mm bb. Give the geno- and phenotypes for the F₁ and F₂ generations.

POLYGENES

14. The base height of the weed is 10 cm. However, the height of weed above this 10 cm is the result of polygenic inheritance involving three sets of alleles (A's, B's, C's). Each dominant gene can contribute 5 cm to the height of the plant. Thus, the homozygous state for a dominant allele can contribute 10 cm to the base height of the plant. This means that a plant that is AABBCC would be 40 cm tall, while an aabbcc plant would be 10 cm. tall. If a plant with the genotype (AABBCC) is crossed with a base plant (aabbcc), what will be the genotypes and phenotypes (height) of the offspring? How many phenotypic classes would be present if these offspring were crossbred?

SEX LINKAGE

15. Red-green color blindness is inherited as a sex-linked recessive trait. If a color-blind woman marries a man who has a normal vision, what would be the expected phenotypes of their children with reference to this character?
16. A man and his wife both have normal color vision, but a daughter has red-green color blindness. The man sues his wife for divorce on ground of infidelity. Can genetics provide evidence supporting his case?
17. In cats short hair is dominant over long hair; the gene involved is autosomal. Another gene, B1, which is sex-linked, produces yellow coat color; its allele B2 produces black coat color; and the heterozygous combination B1/B2 produces tortoise-shell color. If a long haired black male is mated with a tortoise-shell female homozygous for short hair, what will the genotypic ratios be for their offspring?

MAPPING

18. The crossover frequency between linked genes A and B is 40%; between B and C, 20%; between C and D, 10%; between C and A, 20%; between D and B, 10%. What is the sequence of the genes on the chromosome?
19. In *Drosophila* the genes for normal bristles and normal eye color are known to be about 20 units apart on the same chromosome. Individuals homozygous for these genes are mated with homozygous recessive individuals. The F1 progeny were then test crossed (mated with homozygous recessive flies). If there were 1000 offspring from the test cross, how many of them would you predict to show the crossover phenotypes?
- 20a. In *Drosophila*, the allele for miniature wing (m) is recessive to the allele for normal wing (M), and the gene for vermilion eye (v) is recessive to the allele for normal eye (V). A female heterozygous for eye and wing was mated to a vermilion-eyed, miniature-winged male. The following offspring were collected.

140 normal wing, normal eyes	3 normal wing, vermilion eyes
151 miniature wing, vermilion eyes	6 miniature wing, normal eyes

 - a. Are these genes assorting independently? Explain.
 - b. What is the crossover rate for these genes?

- 20b. A female *Drosophila* heterozygous for the recessive alleles sable body (s) and miniature wing (m), was mated with a sable-bodied, miniature-winged male and the following offspring were collected:

250 normal body, normal wings	15 normal body, miniature wings
215 sable body, miniature wings	20 sable body, normal wings

 - a. Diagram the linkage groups (i.e. draw the chromosomes, showing which alleles are linked) of the female parent.
 - b. Draw the relative positions of the loci of the v, s, and m alleles using these last two problems.
 - c. What additional cross must be made in order to answer part b. conclusively?

PEDIGREES

21. For each of the pedigrees at the right, indicate whether the trait is dominant or recessive, and autosomal or sex-linked. Explain.

