1. In summer squash, colorless fruit is due to a dominant gene (W). Colored fruit is due to its recessive allele (w). What offspring may be expected from a cross between a pure breeding plant with colored fruit, and a pure breeding plant with colorless fruit?

2. In cocker spaniels, solid coat color is determined by a dominant gene (S), while white spotting is determined by the recessive allele (s). A homozygous solid coated animal is crossed with a spotted animal. What are the chances of this pair of animals having a spotted pup?

3. In humans, migraine, a type of headache condition, is due to a dominant gene (M). The normal condition is recessive (m). If both of your parents are heterozygous for migraine headaches, what are the chances that you will have migraine headaches as well?

4. A mouse breeder has a strain of black mice that breed true. He also has another strain of brown mice that breed true. A cross between a black mouse and a brown mouse always produces black mice.
   a. What is the dominant characteristic?
   b. If two heterozygous black mice are mated, what will be the appearance of their offspring?

5. A spotted rabbit was mated with a solid-colored rabbit and produced all spotted offspring. When these F1 rabbits were crossed among themselves, they produced 23 spotted rabbits and 8 solid colored rabbits.
   a. Which of these characteristics depends upon a dominant gene?
   b. What are the genotypes of the original parents?
   c. About how many of the 23 spotted rabbits in the F2 generation would be homozygous?

6. In peas, the gene for tallness (T) is dominant to the gene for shortness (t). What offspring phenotypes would be expected from the following crosses and in what proportions?
   a) Heterozygous tall X short
   b) Heterozygous tall X Heterozygous tall

7. If blue eye color in man is recessive (b) to other colors, could:
   a) Brown-eyed parents have a blue-eyed child?
   b) Blue-eyed parents have a brown-eyed child? Show the crosses involved.

8. Construct pedigree charts for the following families, giving the possible genotypes for each member. Represent males with a square and females with a circle, and write the genotype inside the symbol. The situations are based on the ability to taste a chemical called PTC, which is dominant (T) to not being able to taste the chemical (t).
   a) A man and his wife are both tasters and they have two taster sons, a taster daughter, and a non-taster daughter. One of the sons is married to a non-taster
   b) A taster man has a taster son, a non-taster son, and a taster daughter by his first marriage and two non-taster daughters by his second marriage. His first wife was never tested but his second wife was a non-taster. The daughter of his first marriage subsequently married a non-taster and produced eight children, all of whom were tasters.

9. In sheep, white is due to a dominant gene (W). Black is due to its recessive allele (w). A white ewe mated to a white ram produces a black lamb. If they produce another offspring, could it be white? If so, what are the chances of its being white? Show the cross.

10. In humans, normal skin pigmentation is due to a dominant gene (N) and albinism to its recessive allele (n). A normal man marries an albino woman and their first child is an albino. What are the genotypes of all three persons? If there were more children what would they probably be like? Show the cross.

11. A normally pigmented man whose father was an albino marries an albino woman, whose parents were normally pigmented. They have three children, 2 normally pigmented and one albino. List the genotypes of all these persons and show the crosses.
12. Albinism frequently skips a generation in human pedigrees while polydactyly (extra fingers) does not. How do you explain these facts?

13. In cattle, a recessive lethal gene (l) causes calves to be born "amputated" with malformed limbs and head and internal abnormalities that soon causes death. The normal situation is caused by a dominant gene (L).
   a) Show the possible results of a cross between two animals both heterozygous for this allele.
   b) Could two animals both homozygous normal produce an amputated calf? Show the cross.

14. In poultry, rose comb is dependent upon a dominant gene (R) and single comb upon its recessive allele (r). Birds of the Wyandotte breed are required to have rose combs. In certain strains of Wyandottes, single comb birds occasionally occur. Why is this? Show the cross.

15. Wyandotte breeders never use a single comb bird for breeding. When one appears in a flock, it is discarded. Will this practice eliminate the gene for single comb in the flock? Explain.

16. It is assumed that the probability of a child being of a particular sex is 1/2. If a couple has 2 children, both boys, what is the probability that their third child will be a boy?

17. The ability to roll the tongue in humans is dominant (R) while non-rolling is recessive (r).
   a) Could two "tongue-rollers produce a "non-rolling child? Show the cross.
   b) What would be the possible results if a homozygous roller and a non-roller have children? Show the cross.

18. The gene for yellow seed (Y) coat in peas is dominant to its allele for green seed coat (y). What offspring phenotypic ratio would be expected from a cross between a pea plant known to be heterozygous for coat color and one that produced green seeds? Show the cross.

19. The polled or hornless condition (P) in cattle is dominant over the horned condition (p). A certain polled bull is mated to three cows.
   a) With cow A, which is horned, a polled calf is produced.
   b) White cow B, also horned, a horned calf is produced.
   c) Cow C is polled and a horned calf is produced. What are the genotypes of all animals involved. Show the crosses.

20. In sheep, white wool is produced by a dominant gene (W) and black wool by its recessive allele (w). If a homozygous white sheep were crossed with a black sheep
   a) What would the result be?
   b) What would the F2 result be?

21. In the fruit fly, red eyes are produced by the dominant gene (R) and sepia eyes by its recessive allele (r). If 2 heterozygous organisms are crossed, what will be the probable results?

22. In fruit flies, the gene for long wing (L) dominates over its allele for vestigial wing (l). In a cross between a heterozygous long winged male and a homozygous long winged female, what will be the probable results?

23. In Holstein cattle, the spotting of the coat is due to a recessive gene (s) while a solid color coat is dominant (S) What will be the probable results if 2 spotted animals are crossed?

**Dihybrid Genetics Problems**

1. In summer squash, white fruit is due to a dominant gene and colored fruit is due to its recessive allele. Disc shaped fruit is dominant over sphere shaped fruit.
   a. How many different genotypes may squash plants have in regard to color and shape of fruit?
   b. How many phenotypes result from these genotypes?
   c. How many homozygous genotypes are possible?
2. In cocker spaniels, black is due to a dominant gene \((B)\), red to its recessive allele \((b)\). Solid color is dependent on a dominant gene \((S)\) and white spotting on its recessive allele \((s)\). A red male was mated to a black and white female. They had five puppies: one black, one red, two red and white, and one black and white. What were the genotypes of the two parents?

3. In cattle the allelic genes red \((R)\) and white \((r)\) show absence of dominance, the heterozygous animal having a roan coat color. Curly coat \((s)\) is recessive to straight coat \((S)\).
   a. In a cross between a curly red bull and a pure-breeding straight white cow, what would be the expected offspring phenotype?
   b. What genotype(s) would they be?
   c. Show by the Punnett square method the possible offspring genotypes of a cross between one of the offspring in (a) and a curly-haired, roan mate.

4. In poultry, black color is due to a dominant gene \((E)\) and red to its recessive allele \((e)\). Crested head is due to a dominant gene \((C)\) and plain head to its recessive allele \((c)\). A red crested male is mated to a black plain female. They produce many offspring, half of which are black crested and half of which are red crested. What were the genotypes of the parents?
   a) Two black crested birds are mated. They produce 13 offspring as follows: 7 black crested; 3 red crested; 2 black plain; 1 red plain. What were the genotypes of the parents?

Multiple Alleles

1. A man is suing his wife on the grounds of infidelity. The first and second child, whom they both claim, are blood groups O and AB respectively. The third child, whom the man disclaims, is blood type B. Can this information be used to support the man’s case?

2. Plumage color in mallard ducks is dependent upon a set of three alleles: MR for restricted mallard pattern, M for mallard, and m for dusky mallard. The dominance hierarchy is MR > M > m. Determine the genotypic and phenotypic ratios expected in the following crosses:
   a. MRMR X MRM
   b. MRm X Mm
   c. MRMR X MRm

3. A case was brought before a judge in which a woman of blood group O presented a baby of group O, which she claimed as her child, and brought suit against a man of group AB whom she claimed was the father of the child. What bearing might the blood type information have on this case?

4. a. Show the possible offspring phenotypes and genotypes of a marriage between a woman of group A, and a man of group AB. What blood groups could not appear among the children?

5. A multiple allelic series is known to govern the intensity of pigmentation in the mouse such that 
   \(D =\) full color; \(d =\) dilute color; and \(dl =\) lethal when homozygous. The dominance order is \(D > d > dl\).
   A full color mouse carrying the lethal is mated to a dilute colored mouse also carrying the lethal. What will be the expected results?

6. The coat colors of many animals exhibit the "agouti" pattern that is characterized by a yellow band near the tip of the hairs. In rabbits a multiple allele series is known where the genotypes EDED and EDe produce only black (non-agouti), but the heterozygous genotype EDE produces black with traces of agouti. The genotypes EE or Ee produces full color and the recessive genotype ee produces red yellow. What phenotypic and genotypic ratios would be expected in the F1 and F2 from the cross: EDED X Ee

9. The genetics of rabbit coat colors is shown in the table below:

<table>
<thead>
<tr>
<th>Phenotypes</th>
<th>Possible Genotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td>full color</td>
<td>CC, Cc, C, c, Cc</td>
</tr>
<tr>
<td>chinchilla</td>
<td>c, c, c, c</td>
</tr>
<tr>
<td>light grey</td>
<td>c, c, c, c</td>
</tr>
<tr>
<td>Himalayan</td>
<td>c, c, c</td>
</tr>
<tr>
<td>albino</td>
<td>c</td>
</tr>
</tbody>
</table>
Determine the genotypic and phenotypic ratios expected from mating full colored males of genotype Ccch to light gray females of genotype cchc.

**Sex Linkage Problems**

1. Color blindness is sex-linked and recessive (Xn) to normal vision (XN). Suppose a color blind male and a carrier female have children. What will be the probable results?

2. Why is it impossible for a man to pass on a sex-linked gene (like the one for color blindness) to his son?

3. A normal sighted woman whose father has red-green color blindness married a man with normal vision. What are the expected results in their children?

4. In cats, the genotype BB is black, Bb is tortoise shell, and bb is yellow. The gene is carried only on the X chromosome. A tortoise shell female is mated with a black male.
   a) Would you expect to see a tortoise shell male? Explain.
   b) What offspring would be expected?

5. The gene for yellow body color \( y \) in *Drosophila* is recessive and sex linked. Its dominant allele \( y^+ \) produces wild type body color. What phenotypic ratios are expected from the following crosses?
   a) yellow male X yellow female
   b) carrier female X wild male

6. If a woman heterozygous for a recessive, sex-linked gene marries a man who does not show the trait what is the probability that
   a. The gene will be passed on to any child that she might have?
   b. She will have a child who will show the trait?
   c. any of her sons will show the trait?

7. In man hemophilia is sex linked and recessive. What offspring phenotypic ratios would be expected from a marriage between
   a. a hemophiliac man and a carrier woman?
   b. a normal man and a carrier woman?

8. Queen Victoria had a hemophiliac son, Leopold, Duke of Albany, and three normal sons, among whom was Edward VII. Her husband, Prince Albert was not a hemophiliac.
   a. What was the queen’s genotype with respect to this gene?
   b. Could she have had hemophiliac daughters? Explain.

9. What advice would a practicing counselor on genetics offer to a woman who, while having no hemophiliac symptoms herself, informed him that her father was a hemophiliac? She is married to a normal man but is concerned about this disease being passed along to her children.

10. If a sex linked gene is a recessive lethal, causing death and reabsorption of the embryo at an early stage,
    a. What proportion of the offspring would be expected to be females
    b. And what proportion of the offspring would be expected to be carriers of the gene from a mating between two mammals, the female of which carries the gene in its heterozygous state?