LAB EXERCISE: Genetics Problem Solving

The study of genetics enables one to understand how biological characteristics encoded on the chromosomes can be transmitted from parent to offspring, and how variability in these characteristics occurs. In this exercise you will study the results of genetic crosses, examine some of the ways in which genes express themselves and solve a variety of genetics problems.

Genes controlling the same trait occur at corresponding positions (gene loci) on homologous chromosomes; thus diploid organisms contain at least a pair of genes (one maternal, one paternal) for any given trait. There may be two or more expressions for a characteristic (eye color may be blue, brown, etc.). These alternate forms of a gene at a particular locus are called alleles (you have two alleles per gene). In a heterozygous individual, the alleles that code for a trait are different, which means that an individual developed from an embryo formed by the fusion of gametes bearing dissimilar alleles for that gene. In the heterozygous condition a dominant allele may totally mask the presence of the other, recessive, allele. If the pair of alleles in an individual is identical, the individual is said to be homozygous for that trait.

In this exercise you will practice solving relatively simple problems in genetics. You may work individually and/or in a group to develop your answer. Organize your solution carefully so that you can follow your thinking sometime later.

Problems

1. Diabetes has been found to be inherited (in many cases) through a recessive allele (d). Two parents who are non-diabetic have a diabetic child. Write the genotypes of all three persons.

2. In corn, there are two alleles for the gene for sugar content. High sugar content (su) is recessive to low sugar content (Su). Give the phenotypes for each of the following individuals: Susu, susu, SuSu.

3. Skin color in a fish is inherited via a single gene with four different alleles. How many different genotypes would be possible in this system? List them.

4. Achondroplasia, a form of dwarfism, is inherited as a dominant condition. Two dwarfs, both of whom had one parent of normal height, marry and plan to have a child. Their first child is born and is a dwarf. What is the probability that this child is heterozygous?

5. A pair of dominant alleles influence coat color in cattle wherein homozygotes for one allele have red coats, homozygotes for the other allele have white coats, and heterozygotes have roan coats that are produced by an intermix of both red and white hairs.
Suppose that you start with a herd of 20 red cows, 40 roan cows, 20 white cows, one red bull, two roan bulls, and one white bull. How you would manage your herd to achieve the following goals: (you can choose which bulls will mate with which cows)

a. Maximize the number of roan calves produced.
   (Could you achieve 100%?)

b. Minimize the number of roan calves produced.
   (Could you achieve 0%?)

c. Produce only roan and red calves.

6. Male pattern baldness is a recessive sex-linked trait on the X chromosome. A woman, whose father had male pattern baldness, marries a man with this trait. What is the probability that any son born will have pattern baldness?

7. In humans, normal skin color (A) is dominant over albino (a). A diabetic albino man marries a normal woman whose mother was an albino and whose father was diabetic. What are the genotypes of the man and the woman? What proportion of their children would be expected to be both non-diabetic and have normal color?

8. A person with Rh+ blood has a specific protein in his/her blood. Persons with Rh- blood do not have this particular protein in their blood. Rh + is dominant to Rh-. Also, normal insulin production dominates abnormal insulin production. If two individuals are heterozygous for Rh+ and normal insulin production, what probable phenotypes might their children be?

9. Crosses between long and oval shaped radishes produced 159 long and 156 oval types. Crosses between oval and round gave 203 oval and 199 round. However, crosses between oval and oval gave 121 long, 243 oval and 119 round. How can you explain these results?

10. A man with group A blood marries a woman with group B blood. Their child has group O blood. What are the genotypes of these individuals? What other genotypes and in what frequencies would you expect in offspring from this marriage?