**SOLVING GENETICS PROBLEMS (DIHYBRID)**

**Subject:** Genetics and Biotechnology

**Topic:** Mendelian Genetics

**Date:** December 3, 2012

Genetics problems are in many ways similar to word problems in algebra. The approach to solving them is identical: (1) analyze the problem carefully; (2) translate words into symbols and define each symbol precisely; and (3) choose and apply a specific technique to solve the problem. The first two steps are the most critical. The third step is largely mechanical.

The simplest problems state all necessary information about a P1 generation and ask you to find the expected ratios of the F1 and F2 genotypes and/or phenotypes. Always follow these steps when you encounter this type of problem:

(a) Determine insofar as possible the genotypes of the individuals in the P1 generation.

(b) Determine what gametes may be formed by the P1 parents.

(c) Recombine the gametes by the Punnett square or the forked-line method, or if the situation is very simple, by inspection. From the genotypes of the F1 generation, determine the phenotypes. Read the F1 phenotypes.

(d) Repeat the process to obtain information about the F2 generation

Determining the genotypes from the given information requires that you understand the basic theory of transmission genetics. Consider this problem:

*A recessive mutant allele, black, causes a very dark body in Drosophila when homozygous. The normal wild-type color is described as gray. What F*1 *phenotypic ratio is predicted when a black female is crossed to a gray male whose father was black?*

To work out this problem, you must understand dominance and recessiveness, as well as the principle of segregation. Furthermore, you must use the information about the male parent’s father. Here is one logical approach to solving this problem:

The female parent is black, so she must be homozygous for the mutant allele (*bb*). The male parent is gray and must therefore have at least one dominant allele (*B*). His father was black (*bb*), and he received one of the chromosomes bearing these alleles, so the male parent must be heterozygous (*Bb*). From this point, solving the problem is simple. (refer to the illustration at the right)

Apply the approach we just studied last week to the following problems.

Mendel found that full pea pods are dominant over constricted pods, while round seeds are dominant over wrinkled seeds. One of his crosses was between full, round plants and constricted, wrinkled plants. From this cross, he obtained an F1 generation that was all full and round. In the F2 generation, Mendel obtained his classic 9:3:3:1 ratio. Using this information, determine the expected F1 and F2 results of a cross between homozygous constricted, round and full, wrinkled plants.

**Solution:**

1. First, assign gene symbols to each pair of contrasting traits. Use the lowercase first letter of each recessive trait to designate that trait, and use the same letter in uppercase to designate the dominant trait. Thus, *C* and *c* indicate full and constricted pods, respectively, and *W* and *w* indicate the round and wrinkled phenotypes, respectively. (see illustration at the right)
2. Determine the genotypes of the P1 generation, form the gametes, combine them in the F1 generation, and read off the phenotype(s).

You can immediately see that the F1 generation expresses both dominant phenotypes and is heterozygous for both gene pairs. Thus, you expect that the F2 generation will yield the classic Mendelian ratio of 9:3:3:1. Let’s work it out anyway, just to confirm this expectation, using the forked-line method and alternative method. Both gene pairs are heterozygous and can be expected to assort independently, so we can predict the F2 outcomes from each gene pair separately and then proceed with the forkedline method or the method you learned last time.

The F2 offspring should exhibit the individual traits in the following proportions: (see illustration at the right)

1. Solve for F2 using one of the following:

|  |  |  |
| --- | --- | --- |
|  | **FORKED-LINE METHOD** | **ALTERNATIVE METHOD** |
|  | Thus: | Thus:  (*3C- + 1cc*) (*3W- + 1ww*)=?  *3C- + 1cc*  *3W- + 1ww* |
|  | **Answer:**  9 full, round  3 full, wrinkled  3 constricted, round  1 constricted, wrinkled | **Answer**  9C-W- full, round  3ccW- constricted round  3C-ww full, wrinkled  1ccww constricted, wrinkled |

*\*forked-line method was derived from Concepts of Genetics, 10th Ed. By: Klugg et al.*

**Try this:**

Assuming that the pea plants’ contrasting traits are used in validating Mendelian experiment, determine the phenotypic ratio of the cross between two heterozygous round, yellow seeds.

Steps:

1. Gene symbols or genotype of the parents (P1): \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Gametes that may be formed by the parents:

Parent \_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_

Parent \_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_

1. Recombine the gametes using the two methods:

|  |  |
| --- | --- |
| **FORKED-LINE METHOD** | **ALTERNATIVE METHOD** |
|  |  |

1. Using the data obtained, answer the problem.

**PAMANTASAN NG LUNGSOD NG VALENZUELA**

**GENETICS AND BIOTECHNOLOGY**

**NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE: \_\_\_\_\_\_\_\_\_\_**

***Solve the following genetics problems:***

1. How many different kinds of gametes could the following individuals produce?
2. aaBb
3. CCDdee
4. AABbCcDD
5. MmNnOoPpQq
6. UUVVWWXXYYZz
7. Short hair in rabbits (*S*) is dominant over long hair (*s*). The following crosses are carried out, producing the progeny shown. Give all possible genotypes of the parents in each cross:

Parents Progeny Genotypes

1. short x short 4 short and 2 long \_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_
2. short x short 8 short \_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_
3. short x long 12 short \_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_
4. short x long 3 short and 1 long \_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_
5. long x long 2 long \_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_
6. In cucumbers, orange color (*R*) is dominant over cream fruit color (*r*). A cucumber plant homozygous for orange fruits is crossed with a plant homozygous for cream fruits. Give the phenotypic and the genotypic ratio of the F1 and F2 progenies.
7. Give the genotypic ratio of the cross between BbSs x bbSs using the forked-line method.
8. For this item, use the binomial method (alternative). If two DdIi (deep irregular) plants are crossed, what fraction of the offspring will be:
9. DDIi
10. ddII
11. Ddii