Genetics: Monohybrid Cross

Using Punnett Squares to Predict the Outcome

The possible gene combinations that result from a genetic cross can be determined by drawing a diagram called a Punnett square. It shows the genes (represented by letters) in the parents' gametes along the top and left side of a square and the possible gene combinations within the square.

Monohybrid Crosses

Crosses that involve one trait, such as pod color, are called monohybrid crosses. The dominant and recessive alleles for the genes controlling the traits in Mendel's pea plants are shown in this chart.

Trait	Dominant allele	Recessive allele
Pod shape	Smooth (*N*)	Constricted (*n*)
Pod color	Green (*G*)	Yellow (*g*)
Flower position	Axial (*A*)	Terminal (*a*)
Plant height	Tall (*T*)	Short (*t*)

Sample Problem

A plant that is heterozygous for green pods is crossed with a plant that has yellow pods. What are the probable genotypic and phenotypic ratios in the offspring resulting from this cross?

Step 1: Determine the possible alleles that the parents can pass on

The two alleles of any gene are segregated during the formation of gametes (meiosis). Thus the green-pod parent (*Gg*) will produce two kinds of gametes – *G* and *g*. The yellow-pod parent (*gg*) will produce all *g* gametes.

Step 2: Enter the possible alleles at the top and side of the Punnett square

The Punnet square for this problem would look like this:

	G	g
g		
g		

Step 3: Complete the Punnett square by combining the alleles in the appropriate boxes

This step represents the alleles from each parent combining in an offspring. To predict all possible offspring genotypes, each type of possible allele from one parent is combined with each possible type of allele from the other parent.

The completed Punnett square would look like this:

As you can see, ½ of the offspring are genotype *Gg* and ½ are *gg*.

	G	g
g	*Gg*	gg
g	Gg	gg

Step 4: Determine the phenotypes of the offspring

Green (*G*) is dominant over yellow (*g*), so offspring that have at least one *G* in their genotypes have green pods. Only offspring with genotype *gg* have yellow pods. In this example, ½ are green pods and ½ are yellow pods.

Step 5: Determine the genotypic and phenotypic ratios

In this example, the genotypic ratio is 2 *Gg* to 2 *gg*, or 1:1. The phenotypic ratio is 2 green to 2 yellow, or 1:1.

Problems

1. In rabbits, black fur (B) is dominant to white fur (b). Perform the following crosses. For each cross, give the phenotype and genotype of all offspring.

A. BB x bb
B. Bb x Bb
C. BB x Bb

2. In foxes, red coat color is determined by the dominant gene *R*; silver-black coat color is determined by the recessive gene *r*. A homozygous (pure) red male is crossed with a silver-black female.

a. What are the genotypes of the male _____ and the female _____?

b. What are the *genotype* percentages of their offspring? _____

c. What are the *phenotype* percentages of their offspring? _____

3. If this F_1 generation of foxes mated with each other they would produce offspring with a genotype ratio of _____ and a phenotype ratio of _____

4. In pea plants, yellow seed color is dominant to green seed color. If a heterozygous pea plant is crossed with a plant that is homozygous recessive for seed color, what is the probability that the offspring will have green seeds? _____

For questions 5-7: B = brown eyes b = blue eyes

5. A pure brown-eyed man and a blue-eyed woman have children. What are the chances of getting a homozygous brown-eyed child? _____ How about a heterozygous brown-eyed child? _____ How about a homozygous blue-eyed child? _____

6. A heterozygous brown-eyed man and a blue-eyed woman have children. What are the chances there will be a homozygous brown-eyed offspring? _____ What are the chances of having any kind of brown-eyed offspring? _____

7. A brown-eyed man, whose mother was blue-eyed, has children with a blue-eyed woman. What are the phenotypes (and percentages) of the offspring?

_____

8. A calf is born with horns (*h*) from parents with no horns (*H*). What is the genotype of the parents? _____ & _____

What is the genotype of the calf? _____

9. If this calf were mated with a cow whose genotype was *Hh*, what is the probability that their offspring would have horns? _____

10. If all of the offspring of a particular cross of peppers have the genotype Gg, what must the genotype of the parents be? _____ & _____

11. A rare blue-flowered daisy was accidentally pollinated by pollen from a common white-flowered plant of the same species. All the offspring of this cross were white-flowered. What color was recessive? _____ What was the genotype of the F_1 offspring? _____ Use a Punnett square to show how to produce another blue-flowered daisy from the F_1 white offspring.

12. The gene for no eyes in fruit flies is recessive; the gene for normal eyes is dominant. An eyeless male is crossed with a female who is homozygous for normal eyes. They produce 200 offspring, which are crossbred with each other and produce 3000 offspring. Determine the probabilities of these four outcomes.

a. How many of the 200 offspring (F_1) are blind? _____

b. How many of the 3000 offspring (F_2) have normal vision? _____

c. How many of the 200 offspring (F_1) are heterozygous? _____

d. How many of the 3000 offspring (F_2) are heterozygous? _____