

CONCEPT 2

Punnett squares show the probability of offspring inheriting specific traits.

Activity

What Do You Know about Probability?

Probability is the chance that a given event will occur. If you flip a coin ten times, what is the probability that it will land on heads each time? Discuss your ideas with a partner, then test them. How might the heads-or-tails result of a coin flip be similar to alleles on homologous chromosomes?



A genetic cross is any type of deliberate breeding between a genetic male and a genetic female to produce offspring that carry the genetic material of each parent. When the parents differ in one particular trait that is being studied, the cross is called a *monohybrid cross*. A hybrid is an offspring of parents that have different traits. Often, scientists represent simple genetic crosses using the abbreviated form shown in **Figure 1.13**.

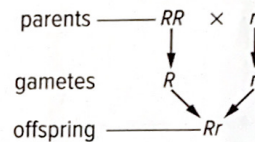


Figure 1.13 A monohybrid cross between a homozygous dominant individual and a homozygous recessive individual. Each parent contributes one type of allele to the offspring. The symbol “×” represents the word *cross*.

Punnett Squares

A *Punnett square* is another way to represent the inheritance of traits in monohybrid crosses. This model is a simple grid that shows the possible genotypes of offspring based on the genotypes of the parents. The Punnett square shown in **Figure 1.14** represents a monohybrid cross to study the inheritance of hair colour in horses. The allele for black hair (B) is dominant to the allele for red hair (b). The cross shown is between a black-haired female with the genotype Bb and a red-haired male with the genotype bb . The female gametes can contribute either a B allele or a b allele. The male gamete can contribute only the b allele, since its genotype is bb . All possible genotypes of the offspring are shown in the grid. In this case, offspring will have either a Bb genotype or a bb genotype.

A Punnett square can also indicate how often genotypes are predicted to appear in the offspring. Since the Bb genotype appears in two of the four squares, it is predicted that two quarters—or one half—of the offspring will have that genotype. The same frequency is predicted for offspring with the genotype bb . In this case, the frequency of the phenotypes in offspring, called the *phenotypic ratio*, is predicted to be the same as the genotypes. Half are predicted to have black hair and half are predicted to have red hair. The steps for how to use a Punnett square to analyze monohybrid crosses are outlined in **Figure 1.15**.

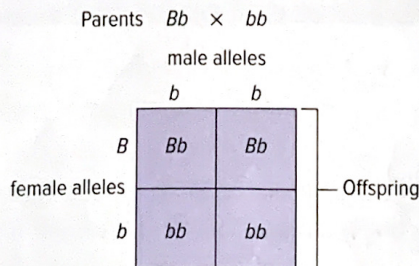
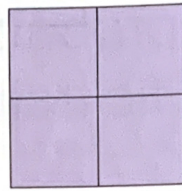
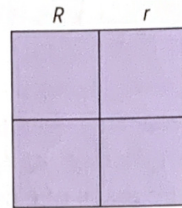


Figure 1.14 In this cross, the female horse can contribute either a B allele or a b allele to offspring. The male horse can contribute only the b allele. The genotypes of the offspring are all possible combinations of alleles that can occur when the gametes combine at fertilization.

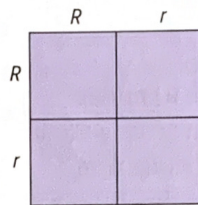
Figure 1.15 Steps for drawing and using a Punnett square.



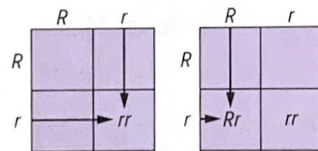
Step 1: Draw a box and divide it into four squares.



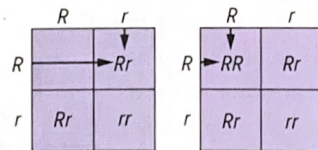
Step 2: Above the top squares, write the genotype of one parent. Place the letter for one allele above each square. Each of these represents the alleles present in that parent's gametes. The example on the left is for a parent that contributes the R and r alleles.



Step 3: Beside the squares on the left side of the grid, write the genotype of the other parent. Place the letter for one allele beside each square. Each of these represents the alleles present in that parent's gametes. The example here is for a parent that contributes the R and r alleles.



Step 4: In each square of the grid, write the symbols for the alleles above it and beside it. Each two-letter pair is the genotype of an offspring that would result from fertilization of gametes with the alleles listed above and beside the square.



Step 5: Determine the number of different genotypes and express each as a ratio and/or a fraction. This represents the expected ratio of offspring with that genotype for that cross.

Ratio: $1RR:2Rr:1rr$

Fraction: $\frac{1}{4}RR:\frac{1}{2}Rr:\frac{1}{4}rr$

Activity

Working with Punnett Squares

Draw a Punnett square that represents a monohybrid cross between a female with genotype Rr and a male with genotype RR . What fraction of offspring is predicted to have the dominant trait?



Before you leave this page . . .

1. A monohybrid cross produces half the offspring with one genotype and half the offspring with another genotype. Express this in the form of a ratio.
2. What do the alleles that are written along the top and beside a Punnett square represent?