

How to use a Punnett Square

Created by: Caitlin King

A **Punnett Square** is a helpful tool that helps to predict the variations and probabilities that can come from cross breeding. This includes predicting crossing plants, animals, even humans with each other. Typically, Punnett Squares are used with Mendelian Inheritance: Mendel was the scientist who helped pioneer genetics and give us our basic, fundamental understanding of how traits work.

Key Terms:

Genotype: The genetic makeup of the organism, what you can find when you look at the DNA

Phenotype: The physical makeup of the organism, the characteristics you can see

Note: Genotype and Phenotype are **not** the same! What you see with the phenotype maybe different in the genotype, that's why the Punnett is important to see that!

Homozygous: When both alleles are the same type, either both dominant or both recessive

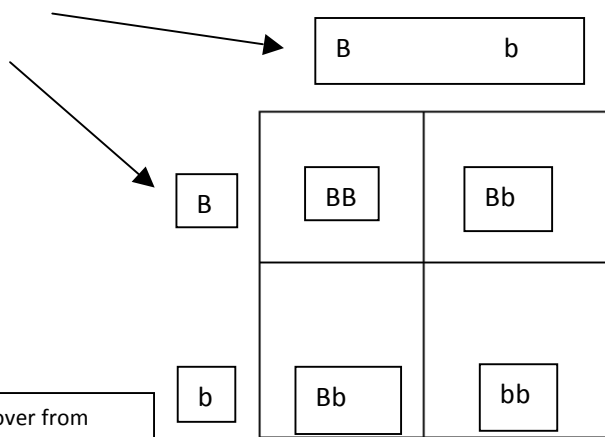
Heterozygous: When the alleles differ in type, with one being dominant and one being recessive. Dominant alleles will almost always mask recessive alleles.

Dominant allele: The trait that has a higher probability of occurring and more likely to be seen

Recessive allele: The trait that has a lower probability and may not be seen physically

How a Punnett Square Works: (In this example, let's use a heterozygous couple with eye color)

Here is where I write down the letters that represent my couple. Because they are heterozygous, I use one capital letter and one lower letter since they have both traits in their genes.



Here I am making a legend to help me visualize which trait is Dominant and which is Recessive. Dominant is always a capital letter and Recessive is always a lower-case letter.

Legend:
B: blue eyes
b: brown eyes

Now, I'm gonna carry each letter over from either the top or the side until I have two letters in one box. This creates my predicted results! From here you must use a little math as seen on the other page.

Now, based on our Punnett Square, we have determined the **genotype** of the possible children. So, we have:

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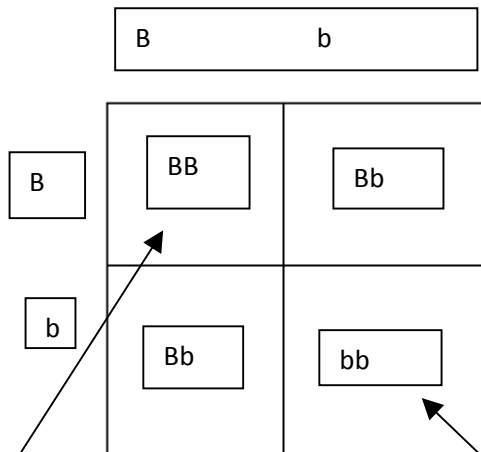
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1 out of 4 squares was BB: this means $\frac{1}{4}$ will have two dominant alleles (homozygous)

2 out of 4 squares was Bb: this means $\frac{1}{2}$ will have a dominant and recessive allele (heterozygous).

1 out of 4 squares was bb: this means $\frac{1}{4}$ will have two recessive alleles (homozygous)

Now let's look at the same square but determine the **phenotype** of the children:



Here I am going to keep the same legend to help me remember what each letter means and paying attention to what the physical trait is. Remember, upper case means **Dominant** and lower case means **Recessive**.

Legend:
B: blue eyes
b: brown eyes

Since upper case letters represent my dominant traits I know they will appear as the physical trait. In this case since **both** letters are dominant no alleles are competing, making the physical trait **blue eyes**

Since lower case letters represent my recessive traits I know that they will usually be hidden by other dominant traits. **HOWEVER**, because both alleles are recessive, nothing will mask either recessive allele. Therefore, the eyes will appear **brown**

So, what about this box? This represents a heterozygous combination, meaning that there is one dominant allele and one recessive allele. Remember that a dominant trait will always mask a recessive trait, so while you may have each allele, it will be the dominant trait that you see. Therefore, in this case what you will see are **blue eyes** even though there is an allele containing brown eyes.

Bb

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Now we can say our **phenotype** is:

1 out of 4 squares was bb, meaning that the physical trait is brown eyes

3 out of 4 squares were BB or Bb, and since the capital letter is dominant, we will physically see blue eyes

Sometimes we write our predicted squares as fractions, thus you get:

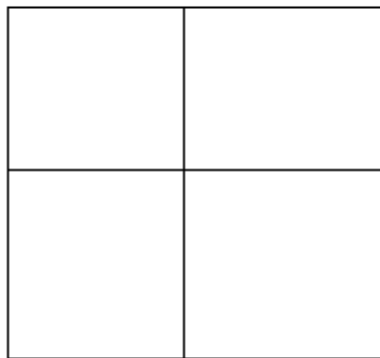
Genotype:	Phenotype:
1 /4 BB	3 /4 Blue eyes
1 /2 Bb	1 /4 Brown eyes
1 /4 bb	

While the couple can have three different genotypes for kids, there are only two phenotypes they can have, with a majority **predicting** the child will have blue eyes. So why highlight predict? Well life is messy and sometimes the predictions aren't perfect, but we use this as a basic tool to help us figure out traits.

Fun fact: this example is a *monohybrid*, meaning you are only predicting with one trait, but did you know you can predict two linked traits at once? That's called *dihybrid*, and it's like doing eye and hair color at the same time!

CHECK TIME! See if you can solve the following scenario!

Consider the traits of hair color with black hair seen as a dominant trait and red hair as a recessive trait. A father has black hair but is heterozygous for both traits, while the mother is homozygous for the trait of red hair. Predict the potential genotypes and phenotypes for the offspring they can have.



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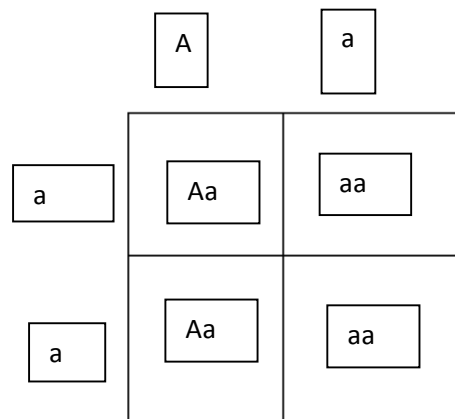
Answer:

Father: One capital, One lower case letter (Aa)

Mother: Two lower case letters (aa)

Genotype: 2 out of 4 boxes will be heterozygous (Aa), 2 out of 4 will be homozygous recessive (aa)

Phenotype: 2 of the 4 children will have black hair, 2 out of 4 will have red hair



Now you know how to do a Punnett Square!