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!

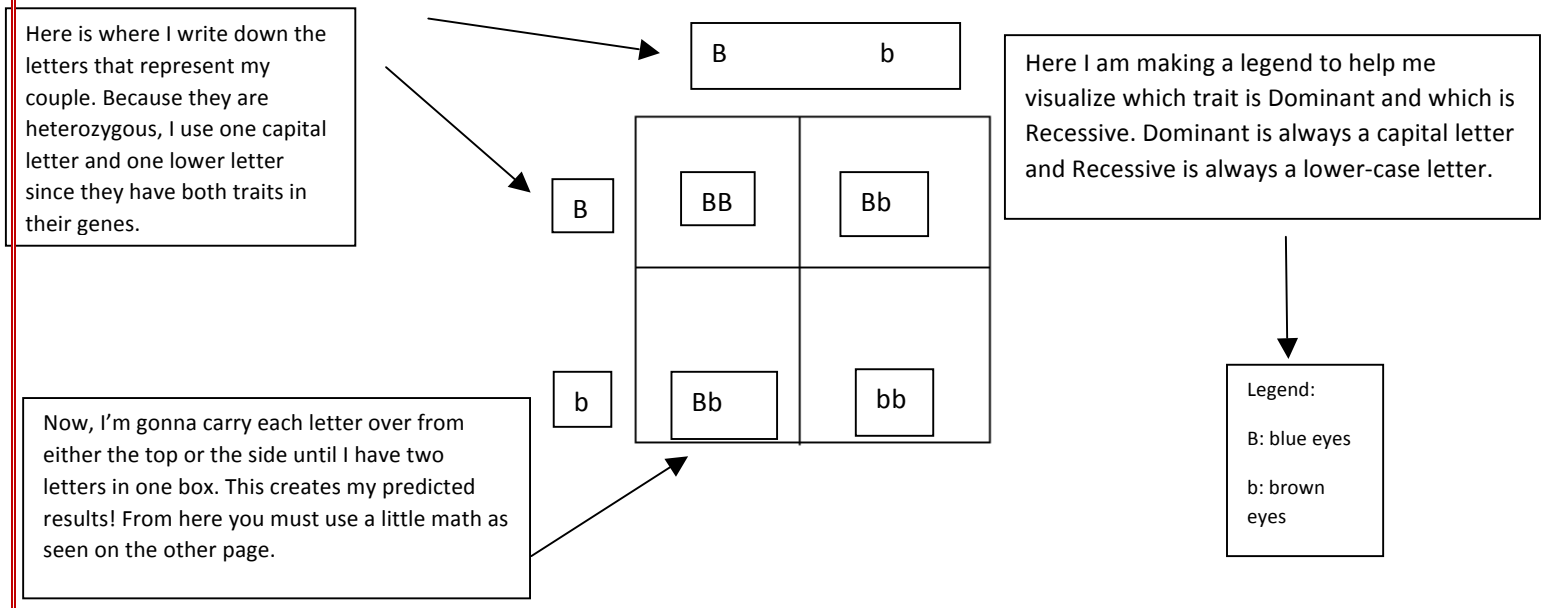
Homozygous: When both alleles are the same type, either both dominant or both recessive

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 been seen

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

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



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

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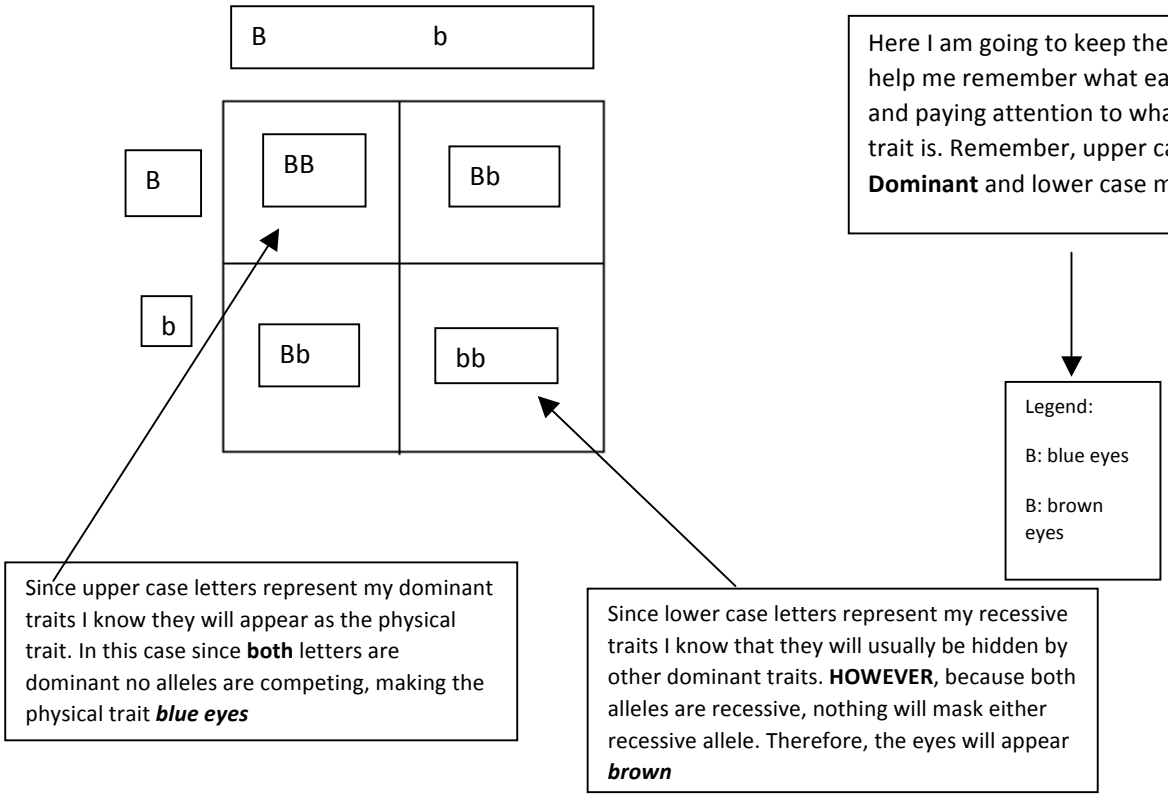
1 out of 4 squares was BB: this means ¼ will have two dominant alleles (homozygous)

2 out of 4 squares was Bb: this means ½ will have a dominant and recessive allele (heterozygous).

1 out of 4 squares was bb: this means ¼ will have two recessive alleles (homozygous)

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



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:

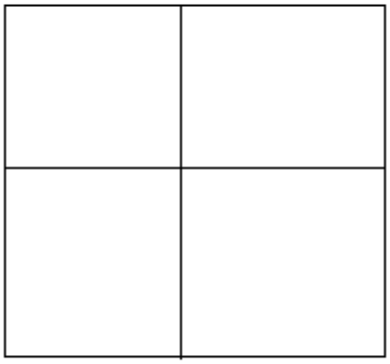
Genotype:	Phenotype:
1 /4 BB	3 /4 Blue eyes
1 /2 Bb	1 /4 Brown eyes
1 /4 bb	

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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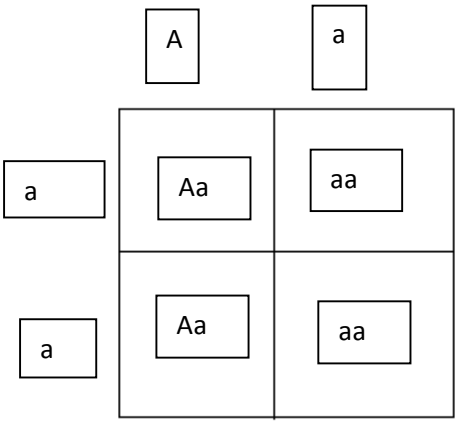
Answer:

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!