8.15

Using Punnett squares to predict genotype and phenotype

IMPORTANT Anki Vocab

- **Gene —** A section of DNA that codes for a trait.
- **Allele —** Different versions of the same gene.
- **Genotype —** The alleles an organism has (expressed as letters).
- **Phenotype —** The physical expression (trait) of the combination of alleles that an organism has.
- **Dominant allele —** A version of a gene that will always be expressed when present (represented by a capital letter).
- **Recessive allele —** A version of a gene that will only be expressed when two copies are present (represented by a lowercase letter).
- **Homozygous trait —** Having two identical alleles (AA or aa) for a particular gene
- **Heterozygous trait —** Having two different alleles (Aa) for a particular gene

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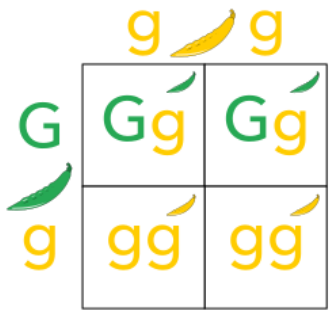
What is a 'Punnett square'?

A Punnett square is a type of diagram, which we use to:

- Predict possible genotypes of the offspring of two parents
- Predict possible phenotypes of the offspring of two parents

A Punnett square shows us *the different ways* in which the alleles from two parents could combine during fertilisation.

Example 1. A punnet square outlining the potential offspring of a green and yellow banana



Queries

1. What does the capital 'G' indicate versus the lowercase 'g' in **Example 1**?
2. What trait is being predicted in **Example 1**?

Constructing a Punnett square for two parents

Remember, the purpose of a Punnett square is to illustrate *all of the possible genotypes* and *phenotypes* of the offspring of two parents:

1. **Choose a trait**
   We start by choosing a trait that we want to focus on. In this case, let's choose *eye colour.*

2. **What does the trait look like for each parent?**
   Now that we've chosen our trait, let's see what that trait looks like in each of our parents:

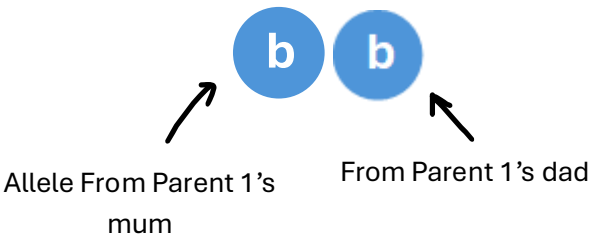
Parent 1's eye colour = Blue

Parent 2's eye colour = Brown

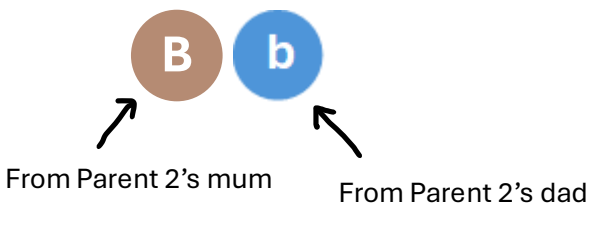
Okay, so our parents have different expressions (Phenotypes) for the eye colour trait.

3. **Look at each parent's alleles (genotype) that resulted in the trait (phenotype)**
   To understand why this is, we need to look at each parent's eye colour *genes,* more specifically, which two versions of those eye colour gene (alleles) they inherited from each of their parents (their genotype):

Parent 1's eye colour alleles



Parent 2's eye colour alleles



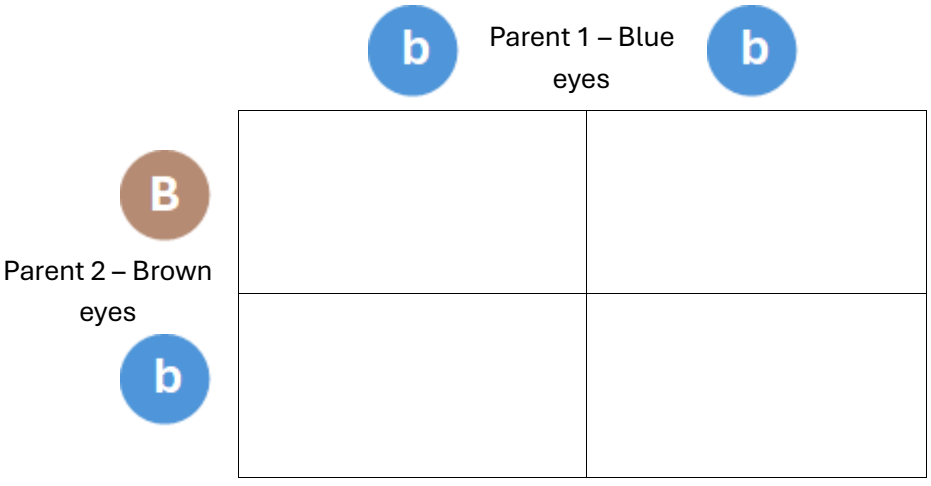
Since we represent dominant alleles with capital letters ('B') and recessive alleles with lowercase letters ('b'), we can see that the blue eye allele is a recessive allele, whilst the brown eye allele is a dominant allele.

So, it makes sense that Parent 2 has brown eyes, because even though they have one brown eye allele and one blue eye allele, the brown eye allele is *dominant,* whilst the blue eye allele is recessive, and if you put a dominant and recessive allele together, **only the dominant allele gets expressed** (so Parent 2 ends up with brown eyes).
It also makes sense that Parent 1 has blue eyes, because they have two blue eye alleles, which are both recessive – so there's no fighting over which one gets expressed, because neither allele is dominant, so Parent 1 ends up with blue eyes.

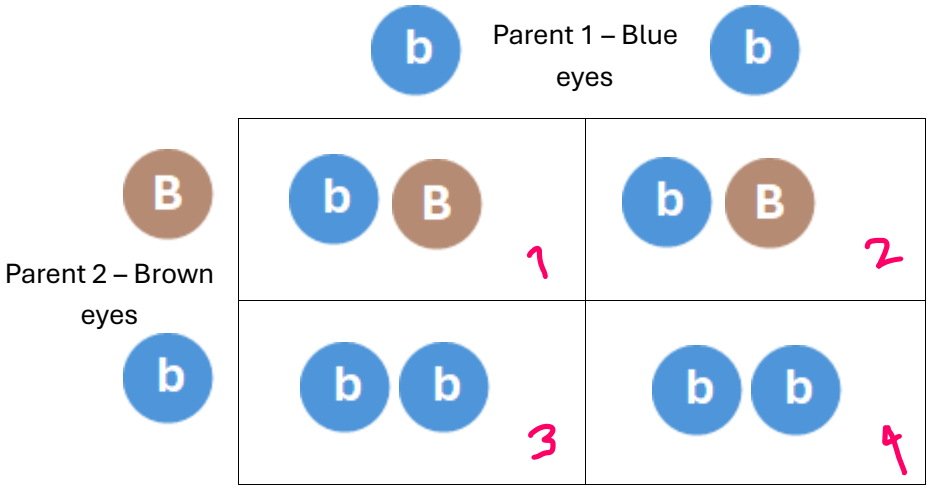
4. **Create the 2x2 Punnett square**
Now that we know each parent's alleles for the eye colour gene, we can create our Punnett square and use this information to determine what potential eye colour(s) their child/offspring could have, and how likely each of the possibilities are:

   a. **Draw a 2x2 grid**

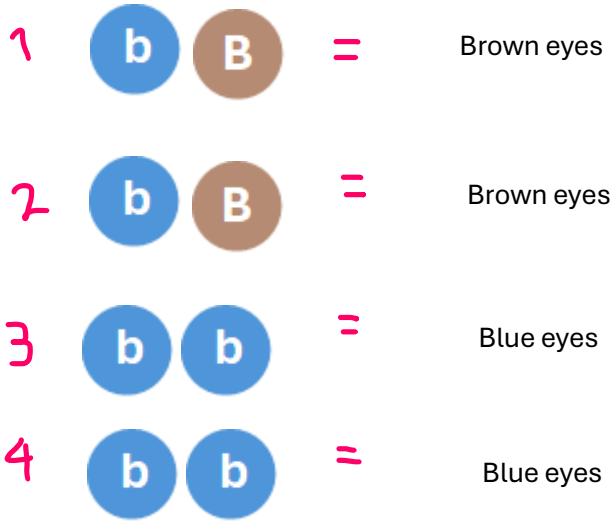
   b. **Add the parent's alleles to the x (top) and y (left) axis**



c. **Fill in all of the possible combinations of alleles that the parents could give to a child** (this is the easy part!)



d. **Figure out what trait each of the combinations of alleles would result in**



e. **Figure out the likelihood of the child inheriting each possible trait**
In this case, there are two possible eye colour traits for the child of Parent 1 and Parent 2 to inherit – blue or brown eyes.

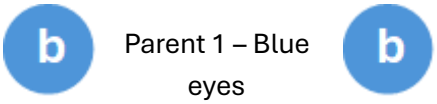
As we saw in **d),** out of 4 ways for the alleles to combine, there are 2 ways that result in brown eyes, and 2 that result in blue eyes.

Brown eyes = 2/4 ways = 50% chance of expression
Blue eyes =2/4 ways = 50% change of expression

Having a 'homozygous' versus 'heterozygous' trait

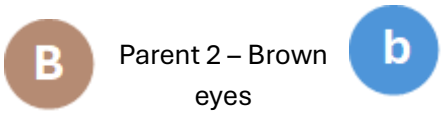
As defined in **Anki Vocab,** a *homozygous* trait is one which results from an individual having two of the same alleles for a particular gene (which means that their mother and father each gave this individual the same allele).

Parent 1 from our previous example is *homozygous* for the trait of blue eyes, because their blue eyes resulted from two blue eye alleles:



As defined in **Anki Vocab,** a *heterozygous* trait is one which results from an individual having two *different* alleles for a particular gene (which means that their mother and father each gave this individual different alleles).

Parent 2 from our previous example is *heterozygous* for the trait of brown eyes, because their brown eyes resulted from one brown eye allele and one blue eye allele.



Exercise

Given the information below, construct a **Punnett square** for Parent 1 and Parent 2, and determine the **likelihood** that their offspring inherits each potential trait variant.

Trait – Hair Colour

Types of alleles:

Black hair

Orange hair (lower case)

Parent 1

What colour is Parent 1's hair?

_____

Parent 2

What colour is Parent 2's hair?

_____