

## The Basics of Genetics

Genetics is the study of the mechanics of heredity. The center of this heredity is the nucleus of a cell which contains DNA, the genetic material. DNA has two anti-parallel strands that make the double helix. All genetic material is organized onto chromosomes. Rabbits have 22 pairs of chromosomes, or 44 total. For the purpose of understanding rabbit genetics, this book will focus on genes, not chromosomes. There are a few definitions to begin with:

Genotype: the genetic makeup of an individual

Phenotype: the physical appearance, or the “expression of genes”

Cross: fusion of male and female gametes

There are also a few basic assumptions. Genes come in pairs, which segregate during gametogenesis (the formation of new gametes) and then independently assort. What this means is that while genes are in pairs, when they are passed on to offspring it is random as to which one the offspring gets, and each different trait is passed on independently of each other. This is what allows us to use probability to determine the possible outcomes of crosses. Here is an example that most are familiar with: Chromosomes behave basically the same way as genes. Males have an X and a Y chromosome, and females have two X chromosomes. Everyone knows that the chances of having a boy or a girl is 50/50. This is because the father can pass on his X or his Y chromosome. The mother can only pass on her X chromosome. We can illustrate this with what is called a Punnett Square. The mom is on the top and the dad is on the left side:

	X	X
X	XX	XX
Y	XY	XY

See? There are two XX and two XY. So the ratio of male to female is 1:1.

In this case, the XX (female) is considered homozygous, meaning that both are the same. The XY (male) is heterozygous, meaning that they are different.

Let's try another example, brown eyes versus blue eyes. Brown eyes are dominant to blue. This means that it only takes one brown-eyed allele to display brown eyes, but it takes two blue-eyed alleles to be blue. Lots of new terms! Let's break them down some. Alleles are different forms of

a gene. Dominant alleles are ones that are displayed if they are present. Recessive alleles are only displayed if two of them are present. Think of dominant alleles like they are an SUV, and recessive alleles like a sub-compact car. If there are two vehicles lined up, you can't see what is behind the SUV. It could be another SUV, or it could be the car. If the car is in front, the only thing that can hide behind it is another car. So, brown eyes are our SUV, our dominant allele. Dominant alleles are denoted with capital letters, so we'll make it B. Blue eyes are our sub-compact car, our recessive allele. Recessive alleles are denoted with a lowercase letter, so we'll make it b. For this example, both will be homozygous.

So we have: BB x bb. Put this in a Punnett Square:

	B	B
b	Bb	Bb
b	Bb	Bb

All of the offspring are heterozygous. They are all brown-eyed but they *carry* blue eyes. Now let's say that two brown-eyed people who carry blue eyes marry and have kids. Here's what their Punnett Square would look like:

	B	b
B	BB	Bb
b	Bb	bb

In this cross, there are three brown-eyed and one blue eyed, or a 3:1 ratio. However, two carry blue-eyed, so the genotypic ratio is 1:2:1

Those are the basics! In order to understand rabbit genetics though, there is a bit more to learn. Genes aren't always "just dominant" or "just recessive". There is an another type of gene. It is called incompletely dominant, which means that it is not always totally dominant over the recessive forms of the genes. An example is the Vienna white gene which causes the blue-eyed-white (BEW) rabbit. A rabbit carrying this gene may show some BEW characteristics, such as white patches of fur or blue eyes.

There are also co-dominant genes, where both traits show. This is seen in things such as the AB blood group, or a roan horse. Lethal alleles also exist, which can be dominant or recessive. In rabbits, the dwarf gene acts as a recessive lethal allele. If there are two present, that is when

“peanuts” are born which often die within the first days of life. Genes can also interact with each other, this is called epistasis. It can give rise to new phenotypes. Genes commonly rely on each other to be expressed properly. This is seen in otters versus tort otters. In order to get the correct otter coloration, the full extension gene is needed. If it is not present, the tan pattern (otter) gene cannot work right.

Alleles (different forms of the same gene) are arranged on loci, which are specific places on a chromosome. Each group of alleles has a certain locus where they reside. The closer that the loci are, the greater the chance they will be passed on together. This is called linkage; some loci, the closer ones, are “linked” more than ones farther away.