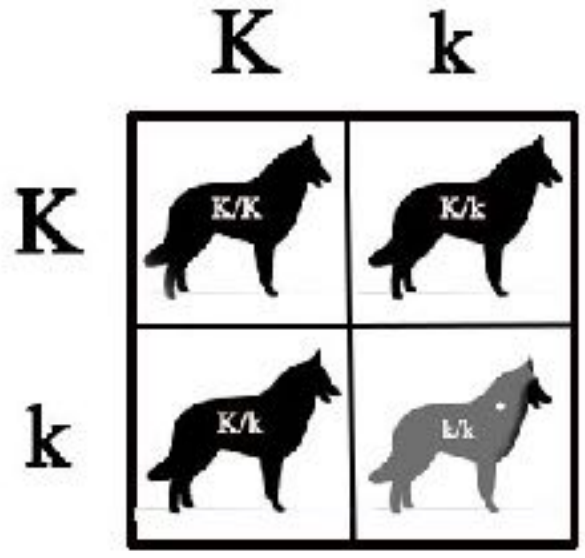
# *Basic Belgian Groenendael Color Genetics*

***By Cathy Sheeter ~ © 2017***

If you are new to genetics, please take some time to review the basic genetic information found at http://doggenetics.co.uk/, as the information there will help you more fully understand what is being talked about regarding this article.

Within Belgian Groenendaels there are two main genes that we are generally interested in looking at, which create most of the normal coat colors found in our breed. These two genes are the K locus and A (agouti) locus. The scope of this article will not discuss rare modifiers that may be found in a few Belgians, such as blue, brindle, or brown, and which are controlled by additional modifying genes.

There are two causes in Belgians for a dog to phenotypically be black (Groenendael), which are both a Dominant Black and Recessive Black. Recessive Black will be discussed a bit later. Dominant Black, written as *K*, is the most common cause of black Belgians. If a dog has *K* in either heterozygous (one copy of the gene) or homozygous form (two copies of the gene) the dog will be black. A single copy of the *K* gene prevents the agouti gene from showing, so testing is the only way to know what genes a Dominant Black dog has at the agouti locus. Homozygous and Heterozygous K also appear the same, so only testing will tell you if your dog has one or two copies of *K*. If a Belgian Sheepdog is *K/K* it will produce 100% black offspring, no matter what it is bred to, or what the mate carries, since it will always pass on one of its *K* genes. However, if a dog is *K/k* then you have a 50% chance of each of those genes being passed on to each puppy (each puppy will receive either the *K* or the *k* from the parent), and if both parents are *K/k* then statistically about 25% of puppies should inherit the *k* gene from each parent, resulting in a puppy that is *k/k* and will show their agouti gene. The agouti genes are discussed in the next paragraph. Note: Some laboratories use the code *KB*, instead of *K*, to denote dominant black.



* If the dog has at least one copy of Ay agouti

Two copies of recessive *k (*sometimes shown as *ky*) allow the agouti series to be expressed. Tervuren, Malinois, and Laekenois coat color is the

result of *k/k* and at least one *Ay* agouti (all shades from rich red to pale gray are the result of *Ay*), which is generally called sable in the genetics worldThe order of dominance in the agouti series is *Ay* (sable)*, aw* (wild agouti, which is not found in BSD), *at* (black and tan), and *a* (recessive black). So, all Tervuren are *k/k Ay/-,* but the dash could be any other gene on the agouti series *Ay/Ay, Ay/at or Ay/a*. The only way to know what the second agouti gene is, would be through testing. It is important to remember that each parent contributes one gene to every puppy, so any puppy with a Tervuren (or Malinois or Laekenois) parent will always have at least one *k* gene. The rare Black and tan Belgians are *k/k at*/- (they may be *at/at* or *at/a*). It is believed that an intensity gene controls whether a Tervuren is 'gray' (note that the term gray is used for several different colors and genes in other breeds) or red, but it has not yet been isolated by scientists. 'Gray' seems to reproduce as a typical recessive gene in Belgians, but there is no test for the gene is available presently.

The second, but less common cause of black Belgians in our breed, is caused by a recessive black, which, as mentioned above, is caused by the most recessive agouti gene in the series, and written as *a.* Belgian Groenendael born out of breeding two Tervuren together will always have the genotype of *k/k a/a,* and we would know that both Tervuren parents are *k/k Ay/a* (each parent passing their *k* and *a* gene on to the black puppy). Recessive black Belgians look the same as a dominant black one, but will not produce the same when bred. Breeding two recessive blacks together will result in 100% recessive blacks (as both parents only have *k* and *a* genes to pass on), however if bred to a dominant black dog that also has a copy of *k* (so *K/k*), then a statistical 50% of the puppies will express their agouti gene and be either sable, black and tan, or recessive black (depending on the *K/k* parent's agouti genes). And if the dominant black parent was *K/k Ay/at* then you could get black (genotypes *K/k Ay/a* or *K/k at/a*), sable (*k/k Ay/a*), and black and tans (*k/k at/a*) all in one litter! All offspring produced from a recessive black parent will always have a *k* gene and an *a* gene.

Sometimes we can use parentage or colors of offspring to tell genotype. As previously noted all Belgian Groenendael with a Tervuren parent will have one copy of *k*. If a Groenendael has ever produced a Tervuren offspring in a litter you also know both parents carry at least one *k* (since offspring is *k/k*) and at least one parent has an *Ay*. A Groenendael born out of two sable Tervuren parents is always *k/k a/a*. However, generally, the best and easiest way to know what color genes your Belgian Sheepdog carries is through genetic testing. Testing K and A genes will help you know what color offspring to expect when you breed. There are many places that do color testing, including UC Davis, Animal Genetics, and Paw Print Genetics. It is wise to stick with a well-known laboratory, as some of the smaller labs may not have the license to run the tests and be more prone to errors. Some labs run individual color tests, while others only offer a full color panels. For individual tests most laboratories charge around $40 per test, and full panel tests run around $150-200. Most companies doing DNA testing use a simple cheek swab, which can be used for multiple tests.

Additional tests of interest to Belgian breeders include testing Extension (written as *E* series) which will tell you if the dog carries for dark masking on the face. While this is not so important on a solid black dog, where it wouldn't show, it is useful to know about mask gene if your dog carries at least one copy of *k*, where a Tervuren offspring could possibly be produced. Masking is a dominant gene in the series and written as *Em*. A dog with one or two copies of *Em* will have some degree of masking. A dog with two copies of *E* will have a self-colored head/muzzle, without a dark mask. To my knowledge we do not have recessive *e* in our breed, which is homozygous form creates a solid 'yellow' dog (ranging from dark red to white, like a Golden Retriever). Masks can range from covering the whole head with dark, to being very minimal on the lips. Scientists do not yet know the genes that control the degree of masking a dog has.

Coat length is pretty straight-forward with Groenendael, since long coat is recessive to short coat and wire coat. Breeding two long coated dogs together will always result in more long coat offspring. It is not presently known what additional genes create the variations in the quantity of coat long-coated dogs can show.

White spotting on the chest and toes of Belgian Shepherds is common. This has generally been believed to be residual white, which has little genetic cause. However, some recent testing, as part of a color panel, is showing that some Belgians may carry for Piebald Spotting, which is denoted as *sp*. In most breeds piebald is incomplete dominant, so a dog with one piebald gene will have moderate white, while an individual that is homozygous for the gene usually results in a mostly white dog with dark patches. Interestingly, thus far, this gene does not present this way in Belgians. At least one Belgian Sheepdogs has tested *sp/sp*, yet still only showed minimal white on the toes and chest. One offspring of the homozygous *sp* female did have more white than desirable for our breed (white higher on the front legs, large chest markings, etc.), but this puppy only had one copy of *sp* and none of the littermates, which also had one copy of *sp*, had abnormal white (some being totally black). To my knowledge only a few Belgian Sheepdogs have been tested for this gene, and more research is needed to understand how common the piebald gene is in the breed, and what is suppressing it so that most Belgians only show minimal white, even when they have two copies of the gene. If you have had your Belgian test positive for one or two copies of *sp* I would love to see the results and photos of the dog, which you can email to hawkcall@hotmail.com.

| Genotype | Phenotype |
|---|---|
| *K/K Ay/Ay* | Black |
| *K/K Ay/at* | Black |
| *K/K Ay/a* | Black |

| | |
|---|---|
| *K/K at/at* | Black |
| *K/K at/a* | Black |
| *K/K a/a* | Black |
| *K/k Ay/Ay* | Black |
| *K/k Ay/at* | Black |
| *K/k Ay/a* | Black |
| *K/k at/at* | Black |
| *K/k at/a* | Black |
| *K/k a/a* | Black |
| *k/k Ay/Ay* | Sable (Tervuren) |
| *k/k Ay/at* | Sable (Tervuren) |
| *k/k Ay/a* | Sable (Tervuren) |
| *k/k at/at* | Black and Tan |
| *k/k at/a* | Black and Tan |
| *k/k a/a* | Black (recessive) |