TFT Genetics
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Part 6: TFT Coat Color – Dominant/Recessive Relationships

In the previous essay I introduced some basic principles as they relate to coat color in TFTs. In this essay I will expand on those principles to discuss the concept of dominant/recessive relationships in the genes that control coat color. In the next essay I will provide a more detailed genetic analysis. I will warn you of two things: 1) the material in this essay is not intuitively obvious and, in fact, seems counterintuitive; and 2) the material in the next essay will not be for the faint-hearted. The analyses involved are quite complex and I know of no way to simplify them beyond what I have tried to do.

Before we get into the dominant/recessive relationship among coat color genes we should probably reiterate some of the basic genetic principles that were discussed in the first essay (Genetics 101). To do that I will summarize the example I used in that essay involving human eye color. For the complete discussion I invite you to re-read that essay in its entirety. To fully comprehend the concepts of **dominant/recessive** relationship I will again use the basic human eye colors (brown; blue) as my example. In this example we have a gene (locus) for eye color with two possible alleles: one for brown; one for blue. For any autosomal characteristic, such as eye color, each individual inherits two alleles that control that characteristic. One allele is located on the set of chromosomes inherited from the male parent and one allele is on the set of chromosomes inherited from the female parent. If the two alleles are the same (either both brown or both blue) the individual is said to be **homozygous**. If the alleles are different (one brown and one blue) the individual is said to be **heterozygous**. The **phenotype** or outward visible appearance (in this case the color of the eyes) of the individual will depend on the **genotype** (i.e. what alleles an individual possesses) and, in heterozygous individuals, on the relationship between the alleles (i.e. which is dominant and which is recessive). In the case of human eye color, brown is dominant and blue is recessive. How do we know this? The classic way to determine which of two alleles is recessive is to examine the offspring that result from matings of individuals of the same phenotype. The clearest indication that blue is recessive to brown comes from examining the offspring of two brown-eyed individuals who each had one brown-eyed parent and one blue-eyed parent. Even though both individuals are brown-eyed they can produce blue-eyed offspring. However, when two blue-eyed individuals who each had one brown-eyed parent and one blue-eyed parent are mated they will only produce blue-eyed children, never brown-eyed children. In fact, two blue eyed individuals regardless of the eye color of their parents will only produce blue-eyed children, This, by the definition of **recessive** {alleles}set out by Gregor Mendel in his genetic experiments with pea plants, indicates that blue-eyes are recessive (i.e. the characteristic can be hidden or masked by the presence of the dominant allele). The dominant allele, on the other hand is always expressed if it is present. This can be symbolized as follows:

B (upper case) = the **dominant allele** for brown eyes

b (lower case) = the **recessive allele** for blue eyes

BB = the **genotype** of individuals that are **homozygous** for the **dominant** allele; the **phenotype** of these individuals will be brown-eyed

Bb = the **genotype** of individuals that are **heterozygous**; the **phenotype** of these individuals will also be brown-eyed because they have at least one dominant (brown; B) allele;

they cannot be blue-eyed despite having a blue (b) allele because the presence of the brown (B) allele, which is dominant, masks the presence of the blue (b) allele which is recessive.

bb = the **genotype** of individuals that are **homozygous** for the **recessive** allele; the **phenotype** of these individuals will be blue-eyed; they cannot be brown-eyed because they do not have a dominant (brown; B) allele

Remember also the cardinal rule of genetics:

You cannot give to your offspring what you do not have

An individual who is homozygous for an allele such as the B (brown) allele (i.e. their genotype is BB) can only pass that allele to their offspring. They cannot pass the blue allele (b) because they do not have one. On the flip side, an individual who is homozygous for the b (blue) allele (i.e. their genotype is bb) can only pass that allele to their offspring. They cannot pass the brown allele (B) because they do not have one. Finally, an individual who is heterozygous (i.e. their genotype is Bb) can pass either allele to their offspring. In fact, the principles of probability suggest that approximately 50% of the offspring should get the recessive allele from a heterozygous parent while 50% should get the dominant allele. **Remember** that if a parent is **heterozygous** there is no difference in frequency of inheritance in their offspring between the dominant and recessive alleles. The dominant/recessive relationship **ONLY** affects the **phenotype** (outward physical appearance) of heterozygous individuals and has no bearing on either frequency of occurrence of the alleles in a population or frequency of inheritance of the alleles among offspring.

Now let's apply these concepts to the two basic coat color combinations found in TFTs: white & tan (w/t) and tri-color (white, black & tan; w/b/t). Here are some observations:

- w/b/t mated with w/b/t always produces w/b/t; never w/t
  (One or two long-time breeders have told me that they have occasionally/rarely produced a w/t puppy from two mated w/b/t dogs. However, they could offer no specific examples. Furthermore, in my own experience with our TFTs and with those belonging to others that I am familiar with and also in extensive pedigree analysis I have never come across this. If anyone has a documented case backed up with pedigree and pictures I would like to see it. I would also like to see a DNA analysis that would prove parentage, to rule out an accidental multi-sire breeding involving at least one w/t male)
- w/b/t mated with w/t can produce litters with any of the following distributions:
  - all w/t
  - all w/b/t
  - a mixture of w/t and w/b/t
- w/t mated with w/t can produce litters with any of the following distributions:
  - all w/t
  - all w/b/t
  - a mixture of w/t and w/b/t

Using the definition established by Mendel, since two w/t individuals can produce w/b/t offspring, the allele controlling w/b/t coloration is hidden and therefore is defined as **recessive**.

OK, by now some of you are saying “this person is crazy; there are many more w/b/t TFTs that w/t TFTs so w/b/t must be dominant”. This misconception is why I said this material is counterintuitive. However, before you dismiss what I am saying let me explain why frequency of occurrence is not an indication of dominance. First let me give you two non-TFT examples. One of the best examples involves a relatively rare condition known as **polydactyly** in people. People with this condition have six fingers and/or toes on each hand or foot instead of the normal five. This is caused by a **dominant** allele (i.e. **heterozygous** individuals have 6 fingers/toes). Only those homozygous for the normal allele have the normal 5 fingers/toes. So, polydactyly is dominant but of very low frequency in the population. Most of us probably have never even seen a case of polydactyly. A second example is the central nervous system disorder known as Huntington’s disease. This is also caused by a **dominant** allele, yet it is a relatively rare occurrence. So dominance and recessiveness have nothing to do with frequency of occurrence.

Assuming for the moment that this is true, then how can the higher frequency of w/b/t TFTs in the population over w/t TFTs be explained? The explanation goes back to the history of TFTs in the UKC. For many years, decades really, w/b/t dogs were preferred over w/t dogs in the show ring because w/t’s were thought to be more timid in their personalities and therefore, less inclined to show well. This was even reflected in previous versions of the UKC breed standard. Whether this was, in fact, true is irrelevant. It was perceived to be true so many breeders refused to breed w/t TFTs. They bred only w/b/t dogs and produced only w/b/t dogs. This is termed **selective breeding**. When you select for a particular characteristic (w/b/t) and against another characteristic (w/t) the characteristic selected for increases in the population while the characteristic selected against decreases. It has nothing to do with the dominant/recessive relationship among alleles. That w/t TFTs were not entirely eliminated is due to the fact that some breeders liked them and maintained them despite their non-preferred status. The most recent version of the UKC TFT standard has eliminated the non-preferred status of the w/t. Between that and the AKC breed standard which does not list a preference for or against w/t TFTs the frequency of w/t dogs appears to be on the rise.

Now that we have established the dominant/recessive relationship between the w/t coloration and the w/b/t coloration we can, in the next essay, discuss the complex genetic analysis behind these and other color phenotypes such as white & black (w/b; no tan markings) and chocolate (actually white, chocolate & tan; w/c/t) TFTs. Also, while it is theoretically possible to have a white & chocolate TFT (w/c; no tan markings), I have not heard of any. The relatively low frequency in the population of the alleles producing the basic w/b phenotype and the chocolate phenotype, respectively, at their separate, distinct loci probably means that the combination needed for a w/c TFT has never occurred or it has occurred so rarely that the occurrence of such individuals is virtually unknown.

Finally, in the next essay we will also discuss the complex set of modifier genes that control the extent of body coloration in TFTs in the hopes of making it somewhat easier to stay under the 50% body color restriction in the TFT standard while maintaining some variety in body color spotting patterns.