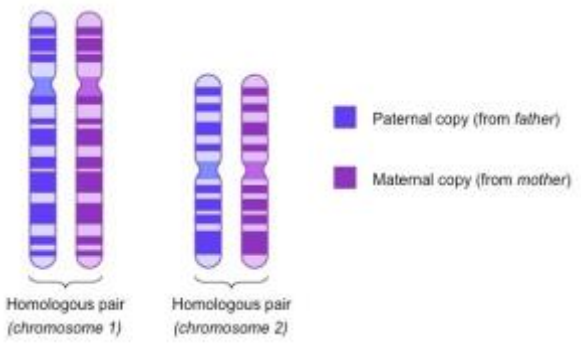
Boxer fanciers in Munich, 1896.

The genetics and history of white boxers

- and why breeding from them should be no concern

To understand both the controverse and discussions regarding whites and breeding, it is necessary to understand the history of the white markings, but to understand that it really is important to understand the genetics behind it. So let's move to "Genetics 101" first. This probably is pretty basic to some, but to understand the discussions, the rationale behind breeding from whites and why it is so easy to dismantle the myths about white boxers, it can't be skipped. And, we are sorry to say, experience has told us that too many really don't understand these simple genetic principles.

In school, you learned that genes come in pairs. That is: it is chromosomes that come in pairs – one from mother and one from father. Chromosomes are tremendously long DNA mole cules, and here and there along these long molecules there are spots called genes that –through some intricate mechanisms –affect some trait in the animal. Since chromosomes come in pairs, genes will too, and it is the combined action of the genes in a pair that decides the outcome. Some traits - like HD - are influenced by several pairs, while others are influenced by only one pair of genes.



1 - Chromosomes come in pairs, with one from father and one from mother. Along them there are regions called "genes"

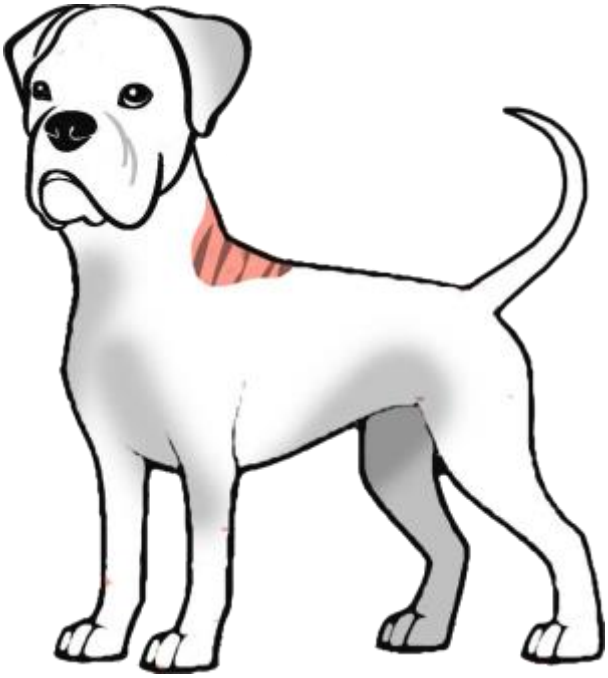
Ground colour

So, somewhere on one pair of chromosomes there is a spot – a gene – that decides what ground colour a boxer will have. As you know, boxers are either red or brindle, because in the breed there only exist two gene varieties ("brindle" and "red") that can occupy this precise spot. The two genes in the pair work together like this: if both chromosomes carry the brindle gene or both carry the red gene, the boxer will be brindle or red, of course. If there is one chromosome with the brindle gene, while the other chromosome carries the red gene, the outcome will be a brindle boxer, because the brindle gene is said to be dominant over the red one. This one, of course, still carries the red gene and can have red puppies.

Most important in this discussion is that since only these two genes for ground colour exist in the breed, brindle and red are the only ground colours a boxer can have. Thus, when you see a "white" boxer, you will know that the white that you see is not it's ground colour.

2 - One of the two possible gound colours in the boxer is brindle

3 - Red is the other possible ground colour



4 - The ground colour of this boxer is not white. You can see from the patch on its back that it is brindle.

White markings

Somewhere, on another pair of chromosomes, there is a spot – a gene – that affects the size and distribution of white markings. These are in addition to the ground colour, and white can be seen as markings that cover the ground colour. What really is taking place here, is that the genes in this spot limit where there can be cells with pigment in them.

The genes in this spot have names with S in them. There are several S-genes, but only two exist in our breed. That is S (let us call this the “plain” gene) and Sw (let us call that the “white” gene). So,

the “whiteness” of a boxer is mainly decided by whether the pair of chromosomes carry two S genes, one of each or two Sw genes.

If both genes in the pair are S (or plain), the boxer will be what is called unmarked or plain. It still can have a little bit of white, but generally the muzzle is black and the white is limited to a splash on the chest and a little bit on the toes.

If there is one S gene and one Sw gene in the pair, the S will only dominate partially over the Sw – it is said to be semi dominant. These dogs will have the typical flashy markings - or “show markings” as some people call them – white on the muzzle, white socks and white on the neck.

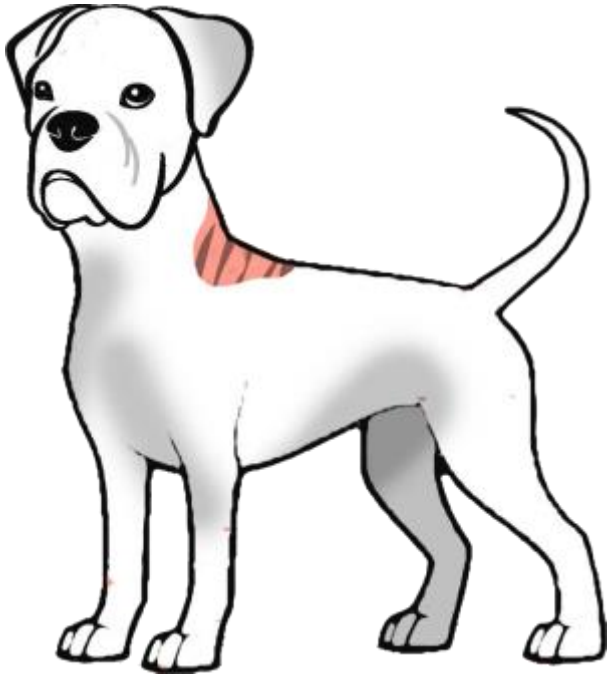
When both genes in the pair are Sw, the white markings will cover most of the body, and the dog will be perceived as white, perhaps with some red or brindle patches. These will typically be located on the head, or near the spine on the body. These simple concepts have been known for many years. Dr Bruce Cattanach discussed this in an an article in the Magazine "Boxerama" as early as in 1974. In 2007, this was confirmed by molecular genetical methods when researchers found out where the S genes are located on the chromosomes.

Important take home lesson: whether the dog is "plain", "flashy" or "white " is decided by these two genes only, and this is the only trait that these genes affect!

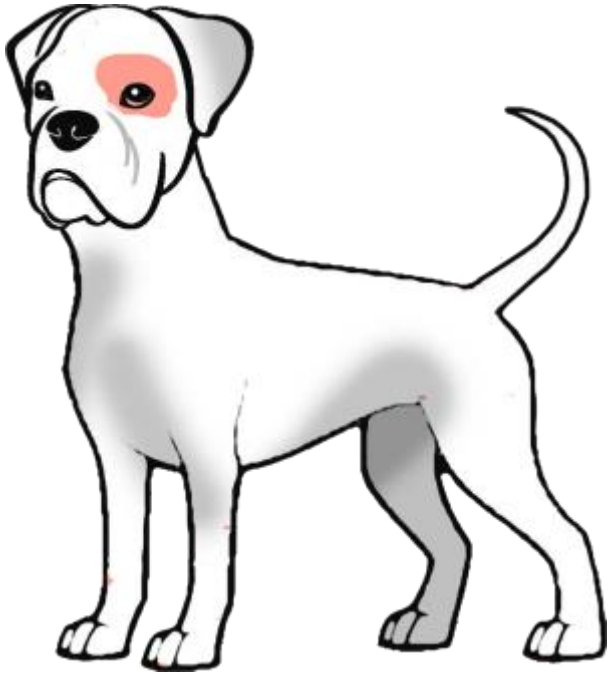
Of course, we have all seen that a flashy boxer can have large markings or small ones, a plain boxer can be from entirely without white hairs to borderline flashy, and a white can be completely white or have patches of varying size. These variations are caused by other genes that are inherited independently of the S genes.

5 - This brindle boxer is a typical plain, or unmarked, one, with the gene combination SS

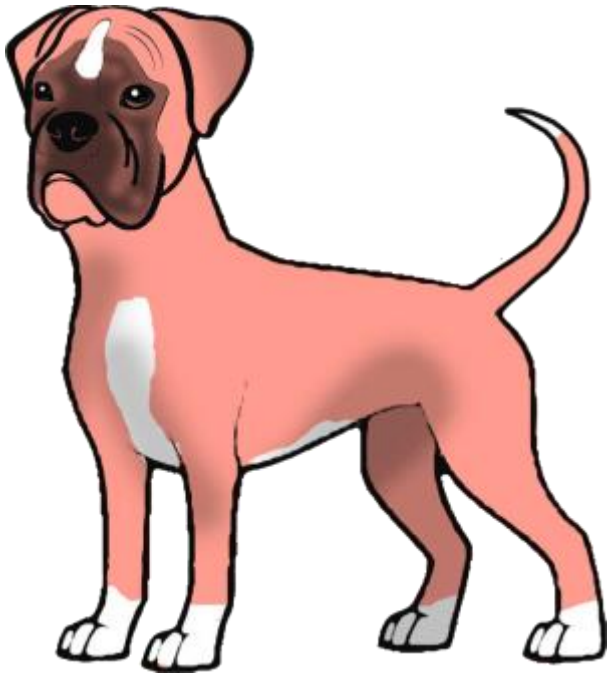
6 - This red boxer has a bit more white than the brindle one, but probably still is a SS boxer



7 - This boxer has brindle as its ground colour, but its white markings cover most of its body. This is typical for a dog With the gene combination Sw Sw



8 - You can that see this boxer, too, has the gene combination Sw Sw, but as you can see from the patch around its eye this is a red dog.



9 - These four boxers are what we call flashy, they all have one chromosome with the S gene and one with the Sw gene

10 - It is important to know that the detailed size and distribution of the white markings in these dogs are controlled by other genes, not the S genes!

11 - When the white markings are too big, it is because we have bred from other boxers with large markings, not because a parent is white.

12 - Of course, since this is the marking pattern many prefer, it is impossible to remove the "white colour" by removing the white dogs.

A flashy boxer is a white parent to half its children

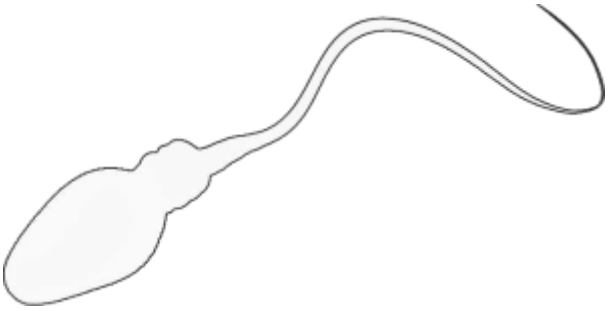
This important concept follows directly from the simple genetics explained above, and it's the key to understanding why there really is nothing dramatic or new in breeding from white boxers.

All the cells in a body contain the same pairs of chromosomes, but when the body makes gametes – sperm cells or egg cells – the pairs are split up. Half of the gametes will get one of the chromosomes in a pair, the other half of the cells will get the other one.

Of course, when a white boxer, which has the genetic combination Sw Sw, makes gametes, all eggs or sperm cells will get a chromosome that carries the Sw gene. In a flashy boxer, where one chromosome in each pair carries the S gene and the other chromosome carries the Sw gene, half of the gametes will get the chromosome with the S gene, the other half will get the one with the Sw gene. And here is the key: As far as white markings are concerned, there is no difference between the Sw gametes from the flashy boxer and the gametes from a white. In other word: if you could pick up an egg or sperm and saw that it contained a chromosome with the Sw gene on it, there would be no way for you to decide if that cell came from a flashy or a white boxer. The consequence of that is the heading of this section: each time one of the 50% of the gametes from a flashy boxer that contains the "white" gene is used in fertilization, technically and genetically it is the same as breeding from a white. Therefore, since we always have bred from flashy boxers, it also is a consequence that we always for all practical purposes have been breeding from whites, and that there is nothing new, dramatic or experimental by using a boxer with the SwSw combination for breeding.

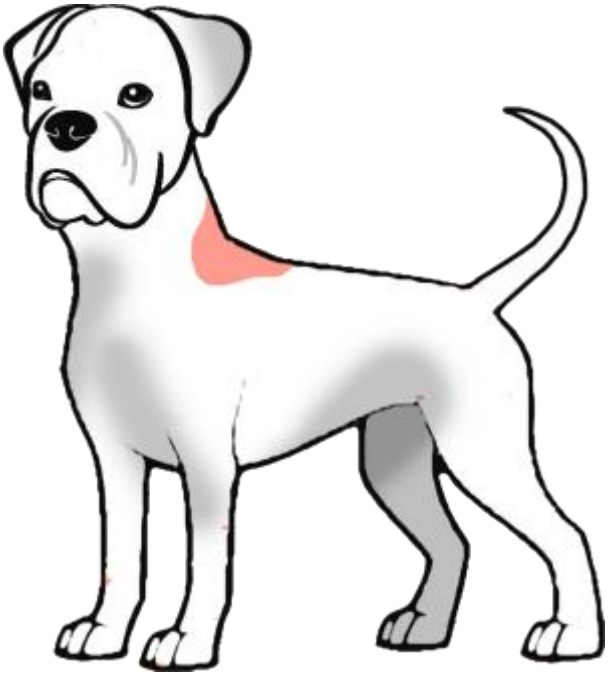
Of course, when an unmarked boxer – the SS variety – produces gametes, all of them will contain the S gene. Therefore, all its puppies will inherit that gene and none of them can be white. When you breed a plain boxer with a white one, all the puppies will get one chromosome with the S gene and one chromosome with the Sw gene. They will all be the flashy S Sw variety, and there is no way you can tell if that flashy puppy has a white parent or not – there is no difference.

13 - This flashy brindle dog will produce two types of sperm cells.

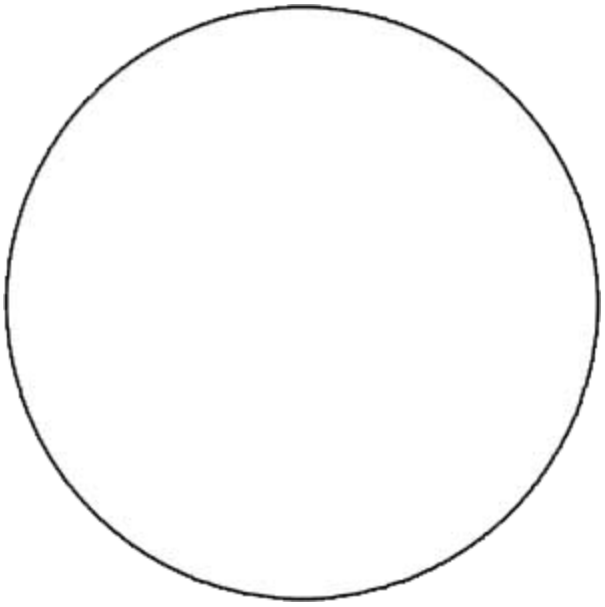


14 - Half of his sperms will contain a chromosome with the Sw/white gene.

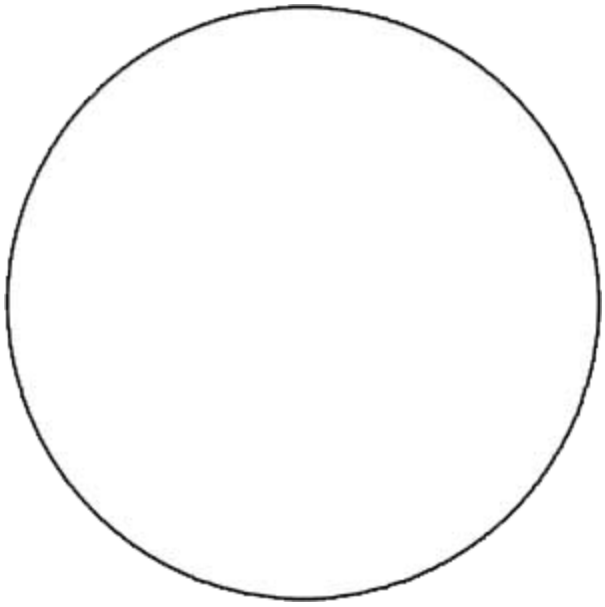
15 - The other half will carry the S/"non white" gene.



16 - All her eggs will be the same...

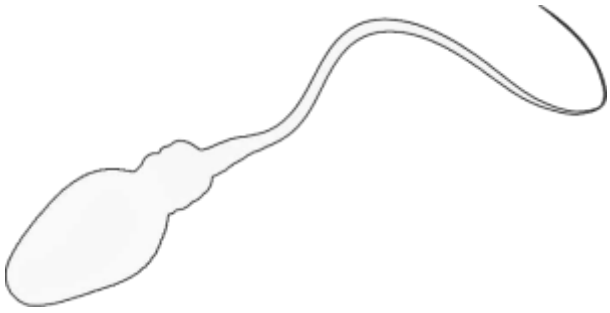


17 - ..50% will contain the Sw gene...

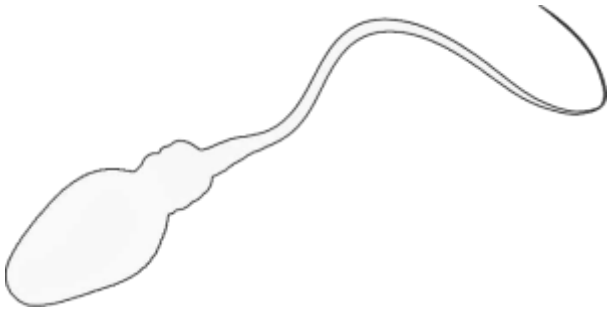


18 - … the other 50% will also contain the Sw gene

Compare the sperms below by moving the slider. One is from a "white" male, the other one is one of the 50% from a flashy one. What is the difference?



19 - This is from a flashy boxer



20 - This is from a white boxer

If you saw no difference: good job!

A brief history lesson and busting some myths!

When the boxer breed was established, the white colour was a part of it. In the first standard, white with coloured patches was described as one of the accepted varieties.

When this variety was excluded as unacceptable in the 30ies, it was mainly because it had become important to have the breed approved for military- and police work, and since white dogs were too

easy to see in the dark to be approved for that kind of work, the colour had to be removed from the breed. This, of course, was before anyone knew much about such things as genes and chromosomes, so the way to do it was just to remove the white dogs. That is, they were killed at birth. Out of sight – out of mind. That practice continued for the decades that followed. While it has become more customary to let white puppies live now, there still are breeders that choose to kill their whites. And to a large extent the "out of sight – out of mind"- attitude is still at play even where whites are allowed to live, they are placed in sc "pet homes", often not registered (some places it is even considered unethical to register whites) and generally not considered a real part of the breed.

After 75 years or so of removing whites, some "truths" have been allowed to be established, mainly about the health of white boxers. Whites are prone to be deaf and blind, and they have more skin problems and allergies. The peculiar thing is that everyone "knew" this, even if whte boxers weren't allowed to live.

Now that more whites are allowed to live, they have been included in health surveys etc. From these we know that white boxers are exactly as healthy or unhealthy as other boxers. Which is what you logically would expect now that you know the simple genetic background for the white markings in boxers.

Some people worry that breeding from whites will result in diluted or washed pigment in the mask and ground colour. They need not to worry. Again, the S genes do not control these traits, there are other genes that decide how black the mask is or how red the ground colour is.

21 - The marking pattern of this beautiful boxer was accepted in the original boxer standard

Why deafness really isn't a concern when breeding from white boxers

Some white boxers are deaf. It is the same kind of deafness that is found in e.g. white bull terriers or dalmatians, who have the same white colour as white boxers. It is caused by a lack of pigment cells in the inner ear of some dogs that have the Sw Sw gene combination.

We don't know for certain what the incidence of deafness in white boxers is (we don't know the incidence among coloured boxers, either). In 2007, geneticists managed to find out where in the chromosomes the S genes are located, and in the article where these results were published the authors writes that only about 2% of white dogs are deaf on both ears. This is the only scientific publication that mentions a figure for this incidence.

The important point here, though, is that unlike in bull terriers and dalmatians, we don't breed whites to whites to produce whites. We will breed whites to plains to produce reds and brindles. When a white boxer is deaf, it's because it's white – the lack of pigment cells – therefore, deafness is of no concern when whites are used for breeding this way.

Breeding from white boxers in Norway

Through most of the breed's history in Norway, there has been no registration limitations or bans on white boxers, which really didn't matter since whites customarily were killed. However, after the acceptance for whites grew during the 1990ies, the leadership of the Norwegian Boxer Club at the time asked our Kennel Club for a breeding ban on whites – and got it in 1998, even if correct procedures hadn't been followed. Since around 2012, a new generation has been in charge of the boxer club and this leadership has worked for several years to clear the ground for a reversal of this ban. In 2016, a great majority at the club's AGM voted yes to apply to the NKC to remove the ban, and NKC accepted the application. This means that since 2016, in Norway you can breed from all registered boxers regardless of the size of their white markings. The Norwegian Boxer Club has added to their regulations for breeding that a white boxer must be bred to a plain one for the mating to be approved. *(Written by Henning Lund. If you have any remarks, write me on* hennlund66@gmail.com*. The wonderful drawings are by Jan Anderschou from Denmark)*