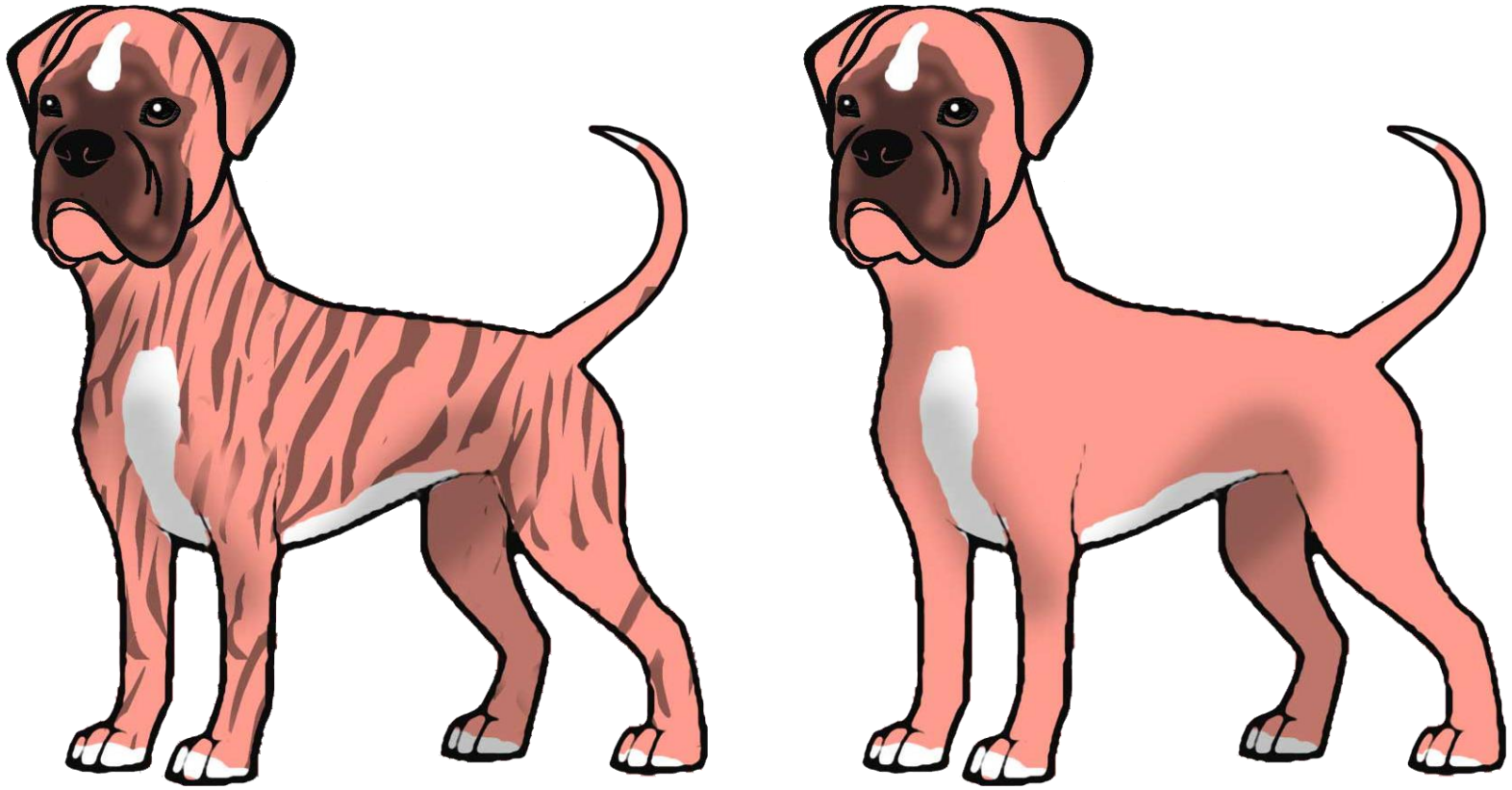
Colour genetics of the Boxer

A short introduction

The Boxer has two ground colours, fawn and brindle

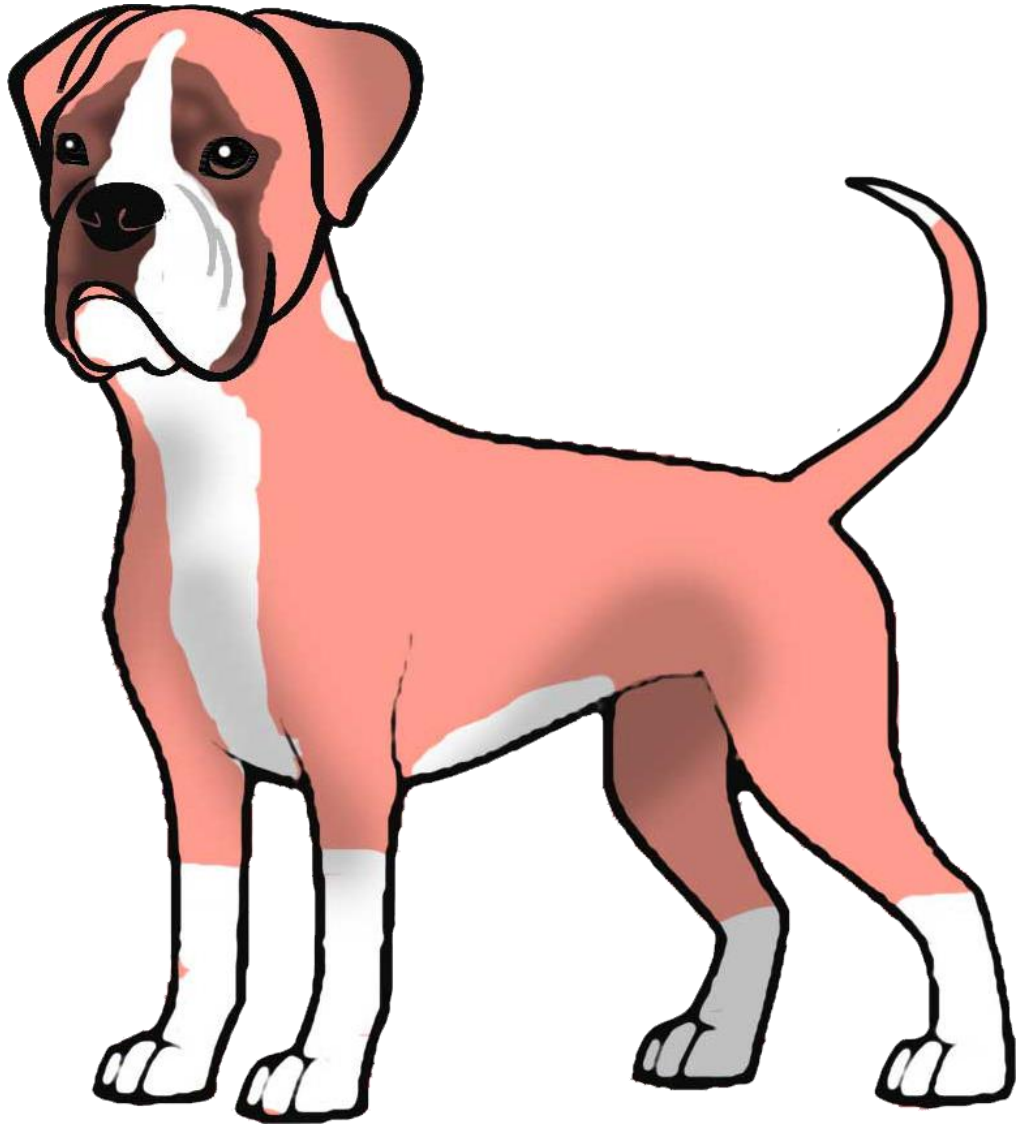


From the standard:

The brindle variety : fawn background of varying shades has dark or black stripes running parallel to ribs. Stripes must contrast distinctly to ground colour.

From the standard:

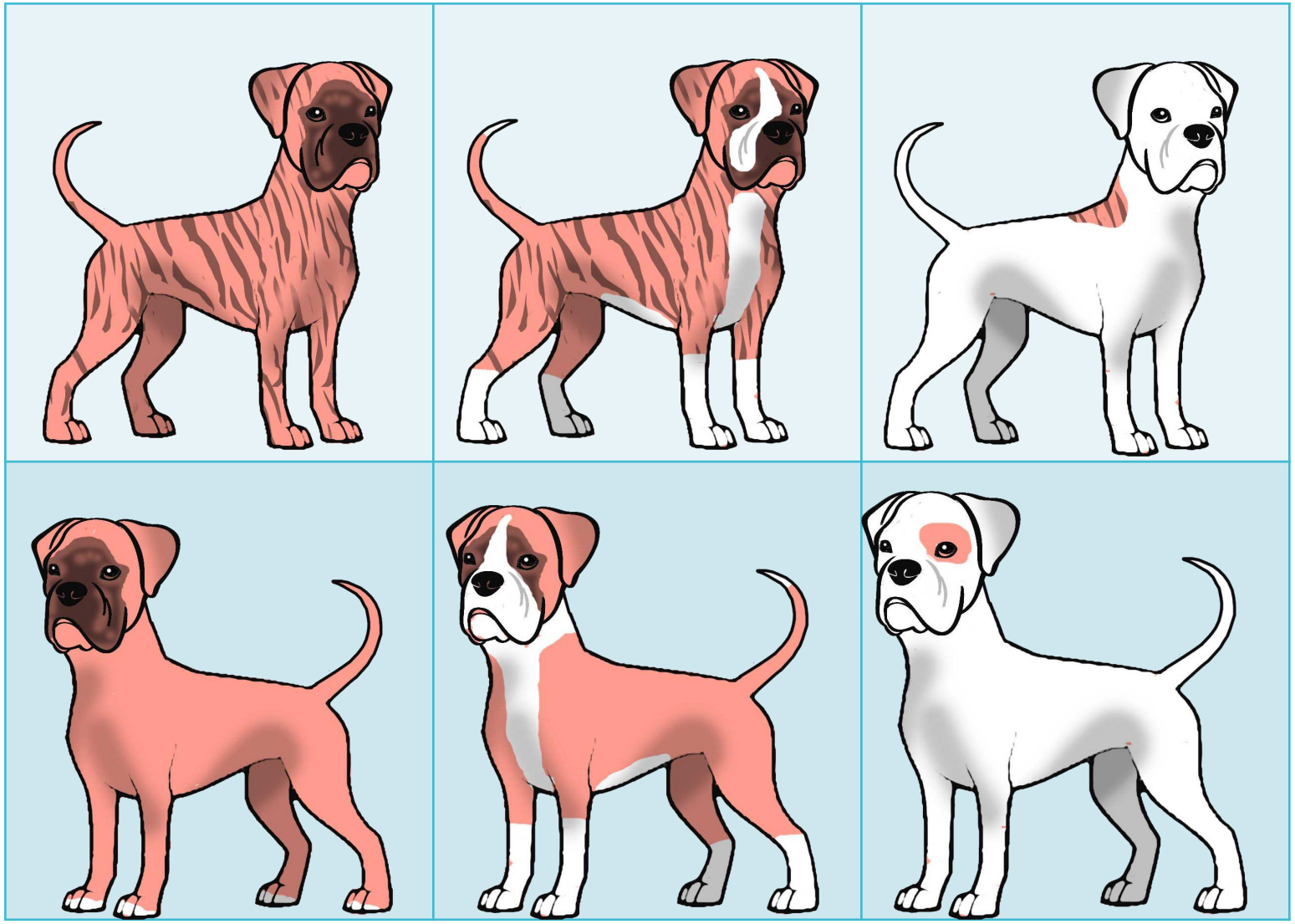
Fawn comes in various shades from light fawn to dark deer red but the most attractive shades are in the middle range (red fawn). Black mask.



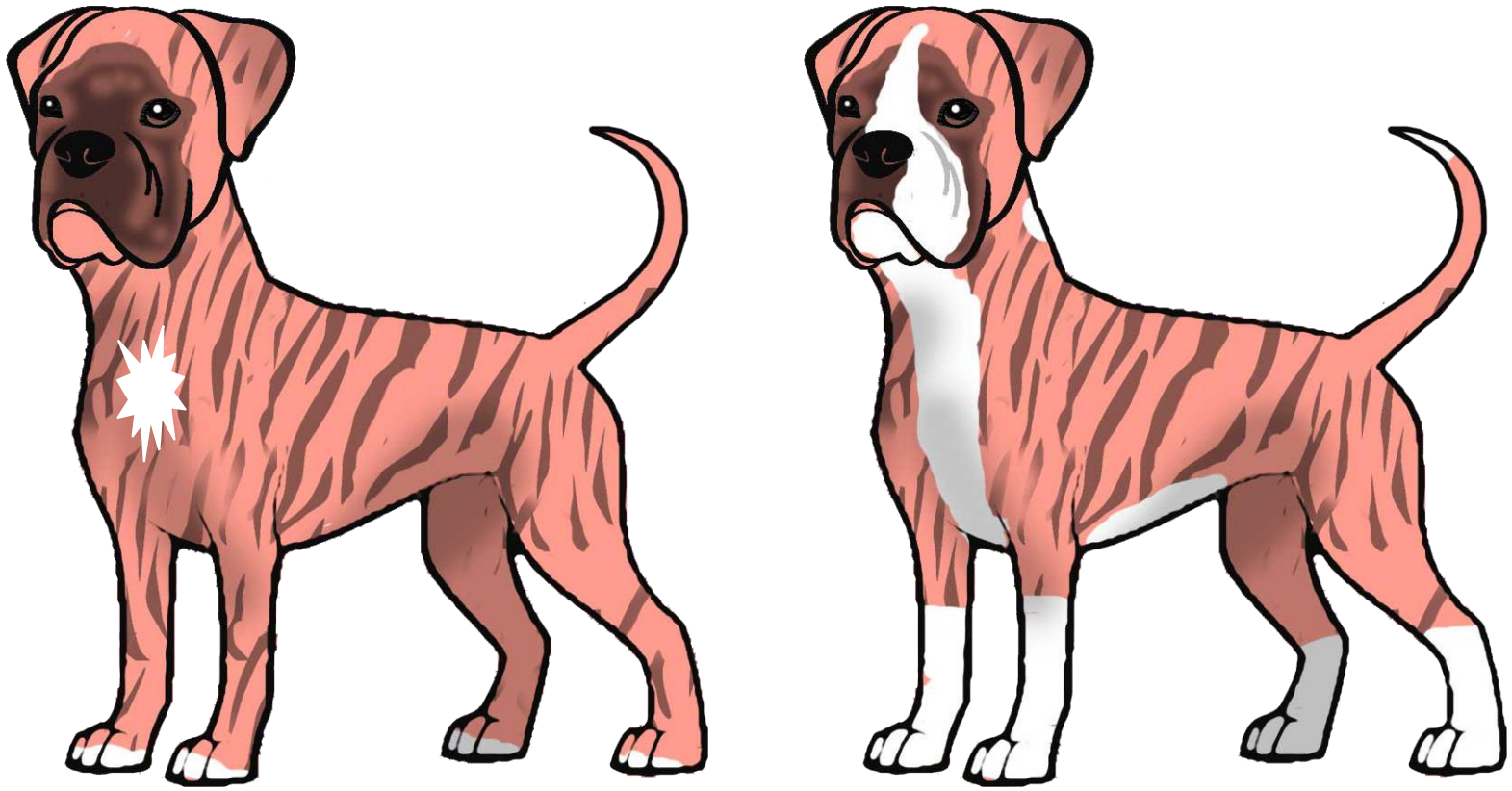
From the standard:

White markings should not be discarded. They can be quite pleasant.

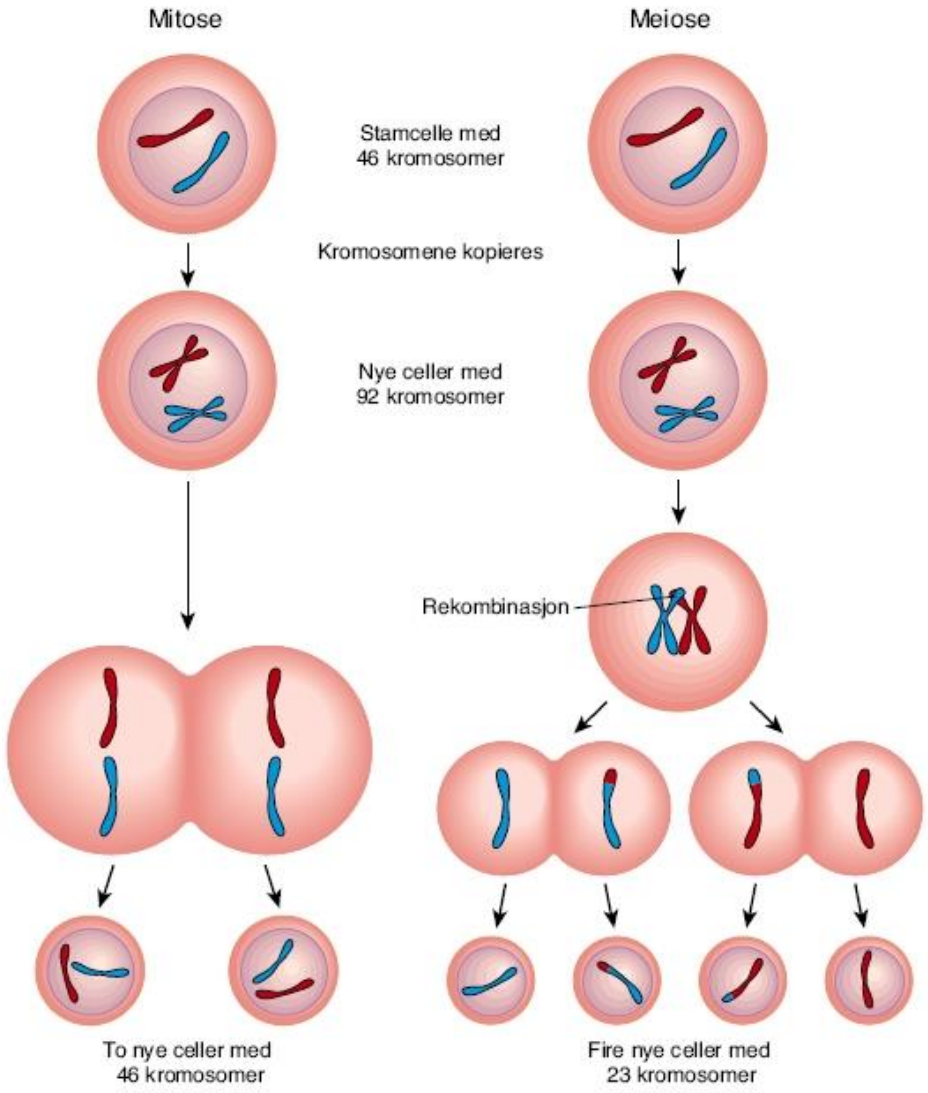
The white markings of the boxer covers parts of the fawn or brindle ground colour.
There are two gene variants for this, and together they produce three different patterns.



The white markings are found on fixed places on the body, and will spread from those points.
The first places to become white are the tips of the toes, a small white spot on the chest, a narrow white line in the face and a white tail tip.
Later places to get white are the ventral side of the body and a spot in the neck and .



The genetics



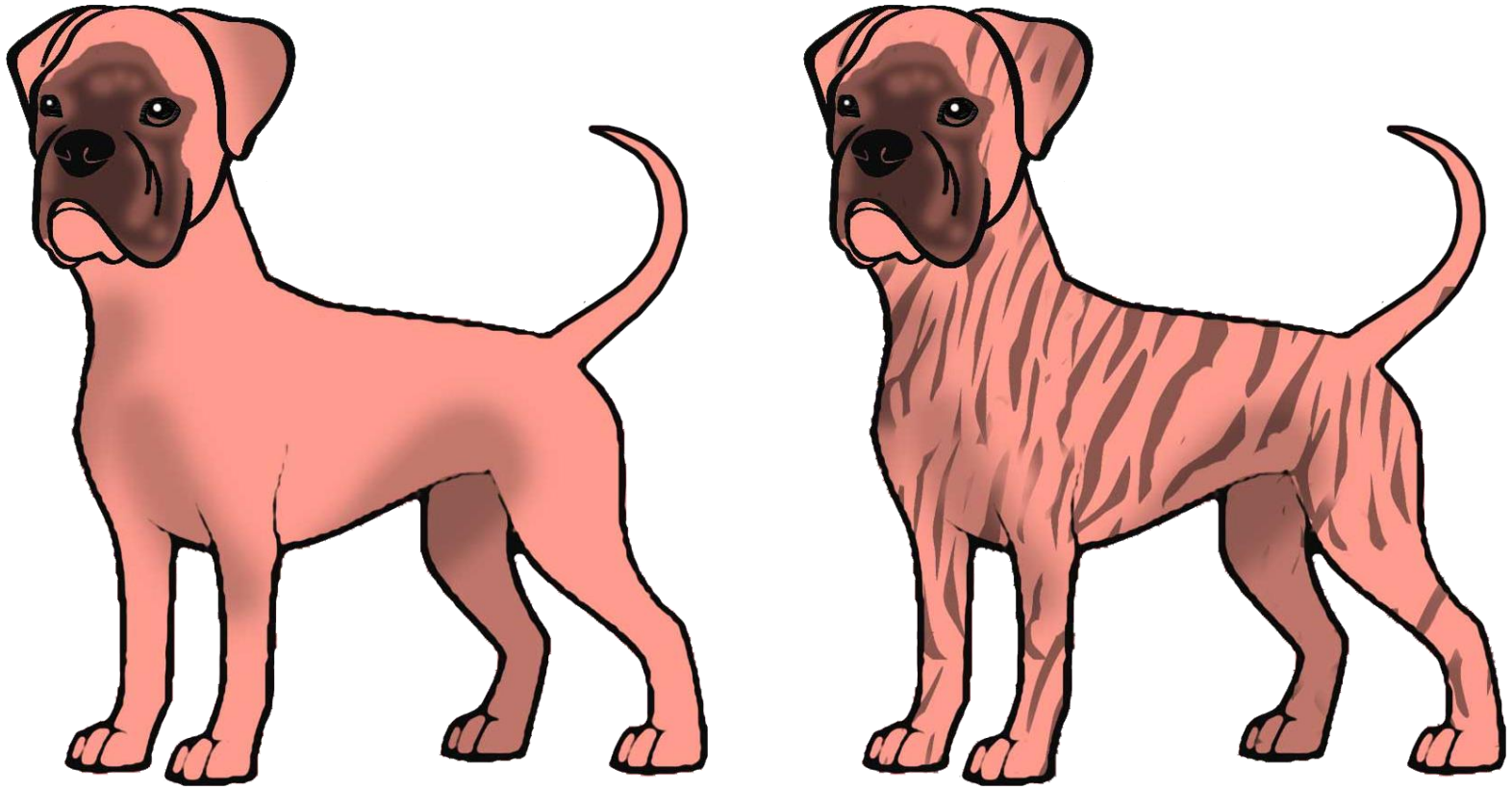
Celldivision

This model shows human celldivision, the dog has 78 chromosomes

In cell biology, mitosis is a part of the cell cycle when replicated chromosomes are separated into two new nuclei. This happens when cells replicate in the body to grow skin, organs and so on.

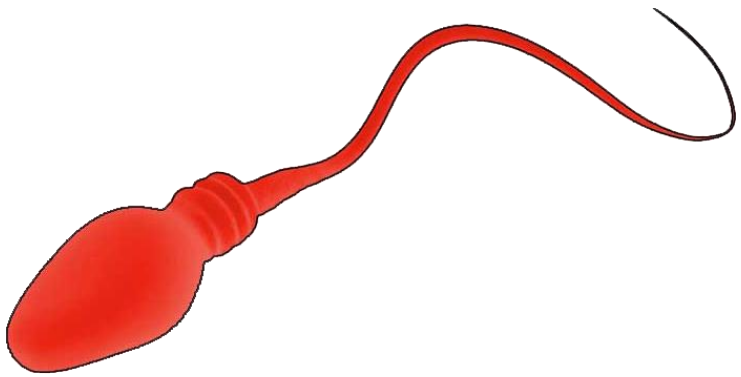
In meiosis, DNA replication is followed by two rounds of cell division to produce four potential daughter cells, each with half the number of chromosomes as the original parent cell. This celldivision happens when egg and sperm is created

First the ground colour



We know that fawn is recessiv. This means that the fawn boxer only has the gene variant for fawn and will only produce germ cells with this variation of the ground colour.

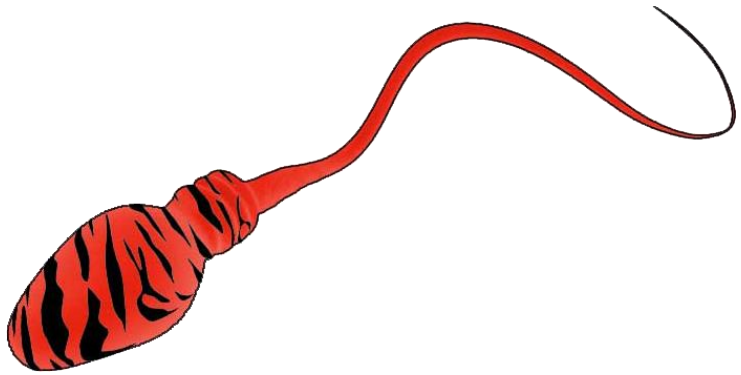
Spermcell with the gene variant for fawn



Eggcell with the gene variant for fawn

Brindle is dominant. This means that the dog can either have two of the gene variant for brindle, and will only produce germcells with this gene variant

Spermcell with the gene variant for brindle

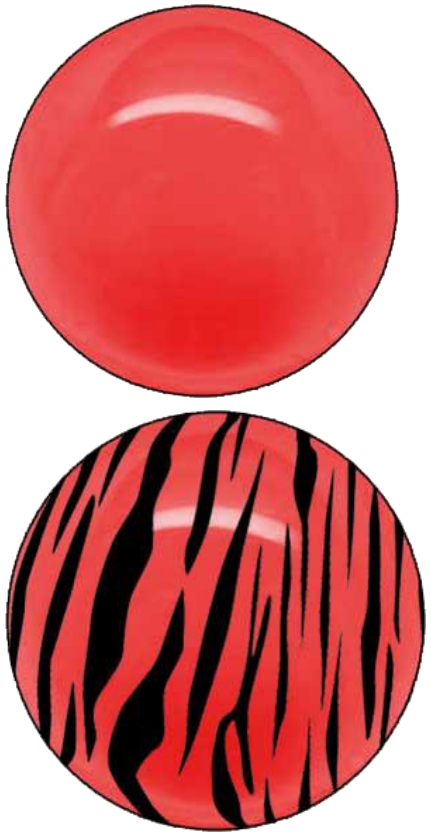


Eggcell with the gene variant for brindle

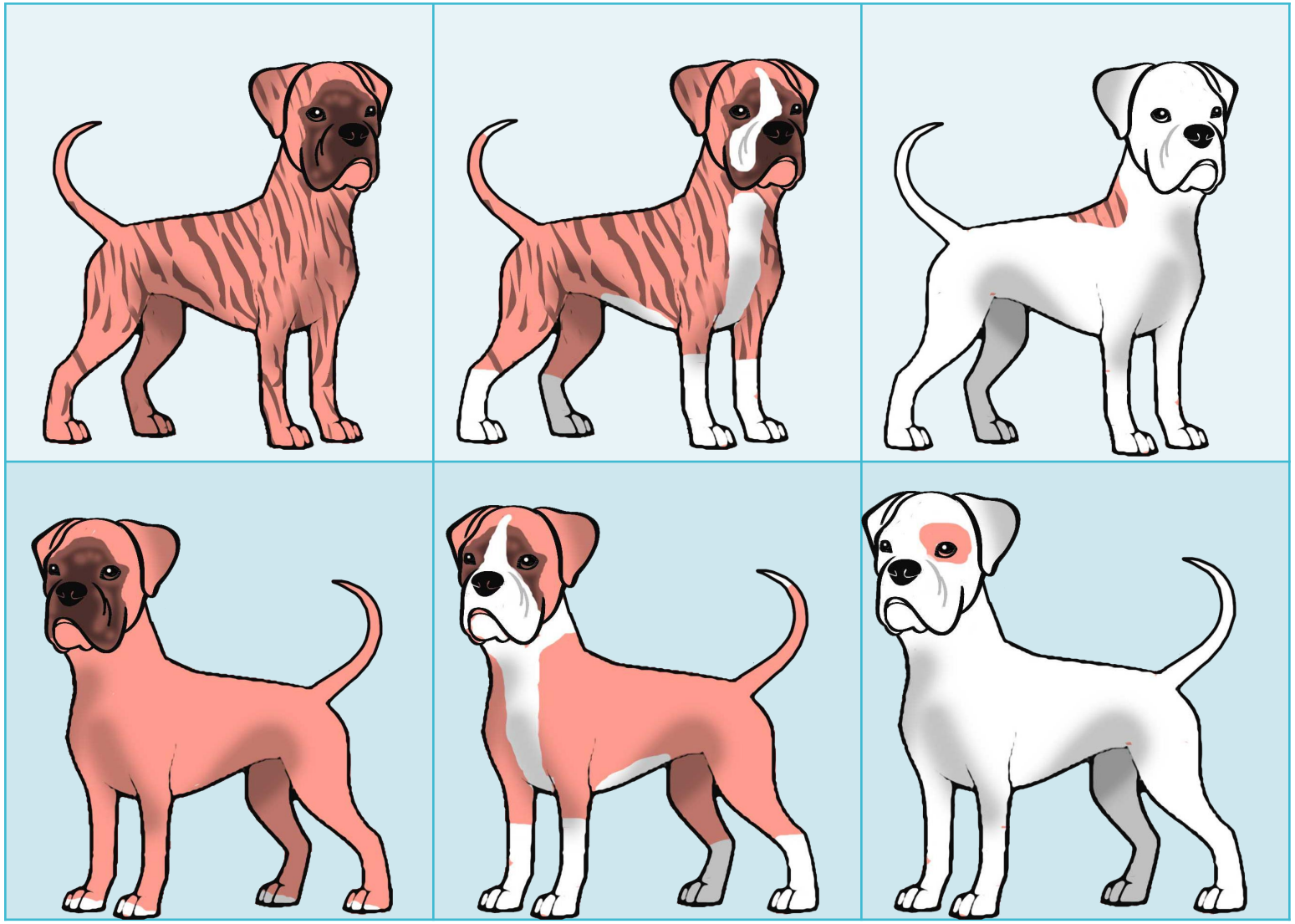
The brindle boxer can also have one of each gene variant, and will produce germcell with both the fawn and the brindle gene variant

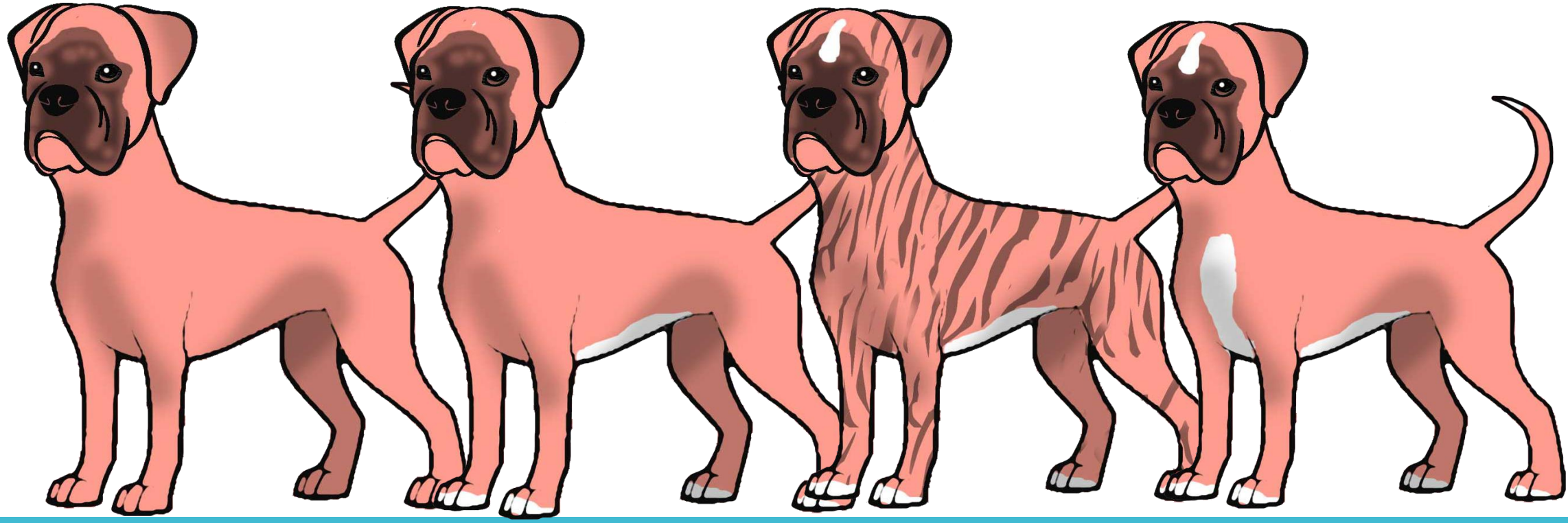
Spermcells with the two gene variants

Eggcells with the two gene variants



Now lets look at the white markings.
There are two gene variant that work together to make three variations of white markings.

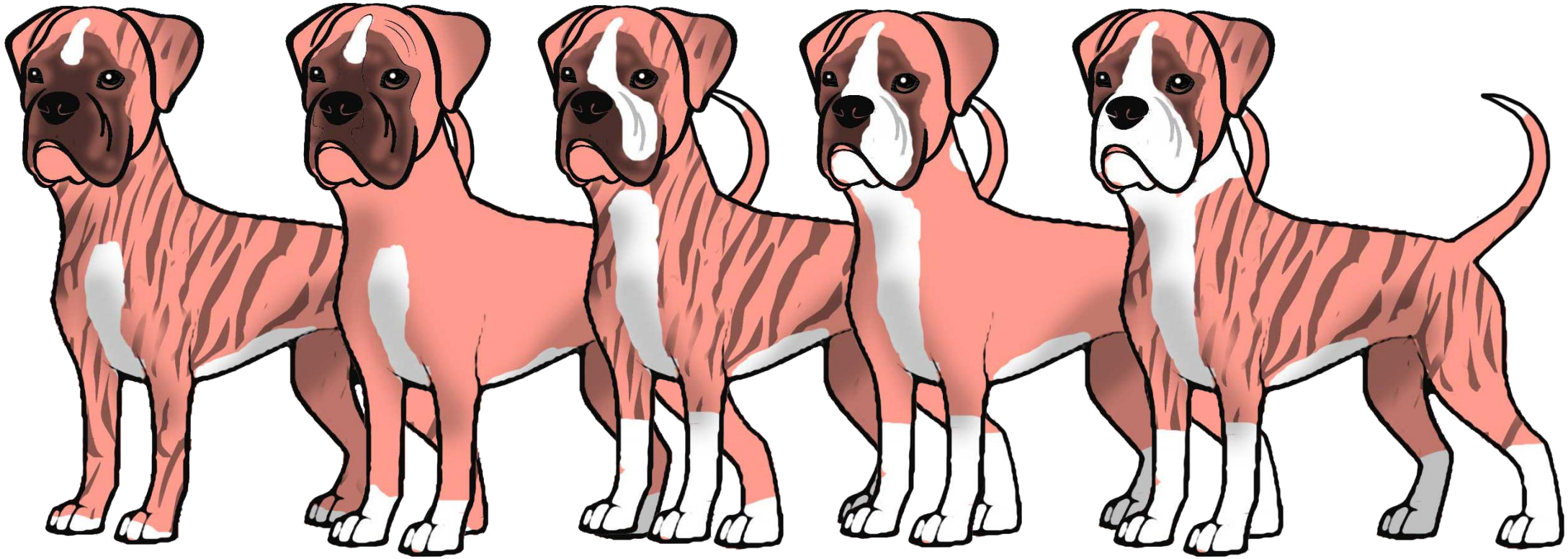




The first variation of white markings is called solid or plain

This is a fawn or brindle boxer with white markings ranging from no white to small white markings on the tips of the toes, a small amount in the face, the tip of the tail and a small spot on the chest.

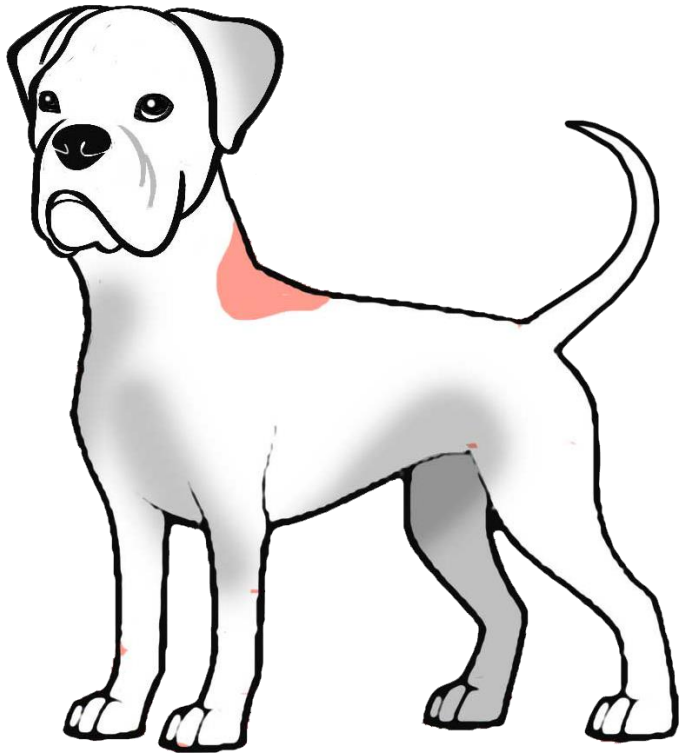
A boxer like this has a pair of the same variant of the gene – the gene for no white - SS

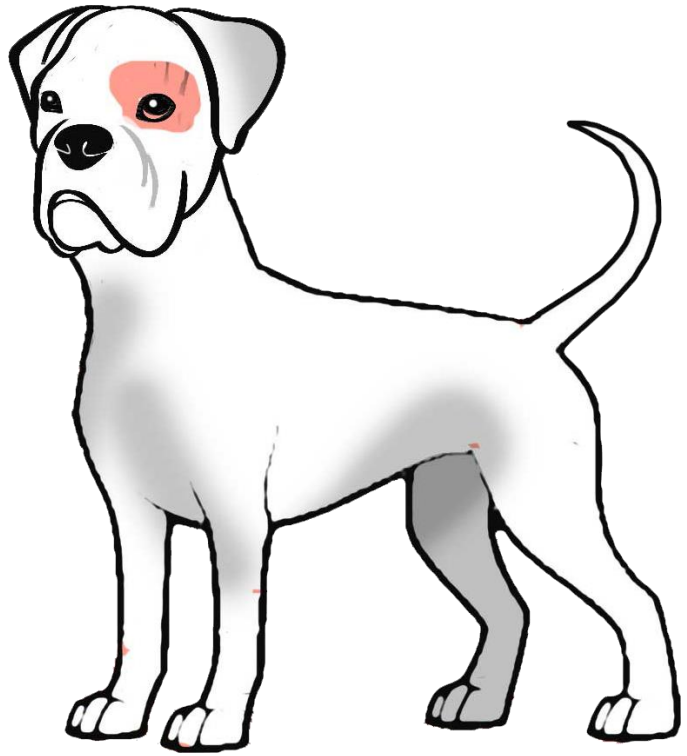


The second variation of white markings is a boxer with nice white markings, or flashy.

This is a fawn or brindle boxer with white markings covering up to 1/3 of the body surface. The white markings are in the same places, only larger, and some have a white spot in the neck or a full collar

This boxer has one of each of the possible gene variations, one for white markings, and one for no white markings Ss_w

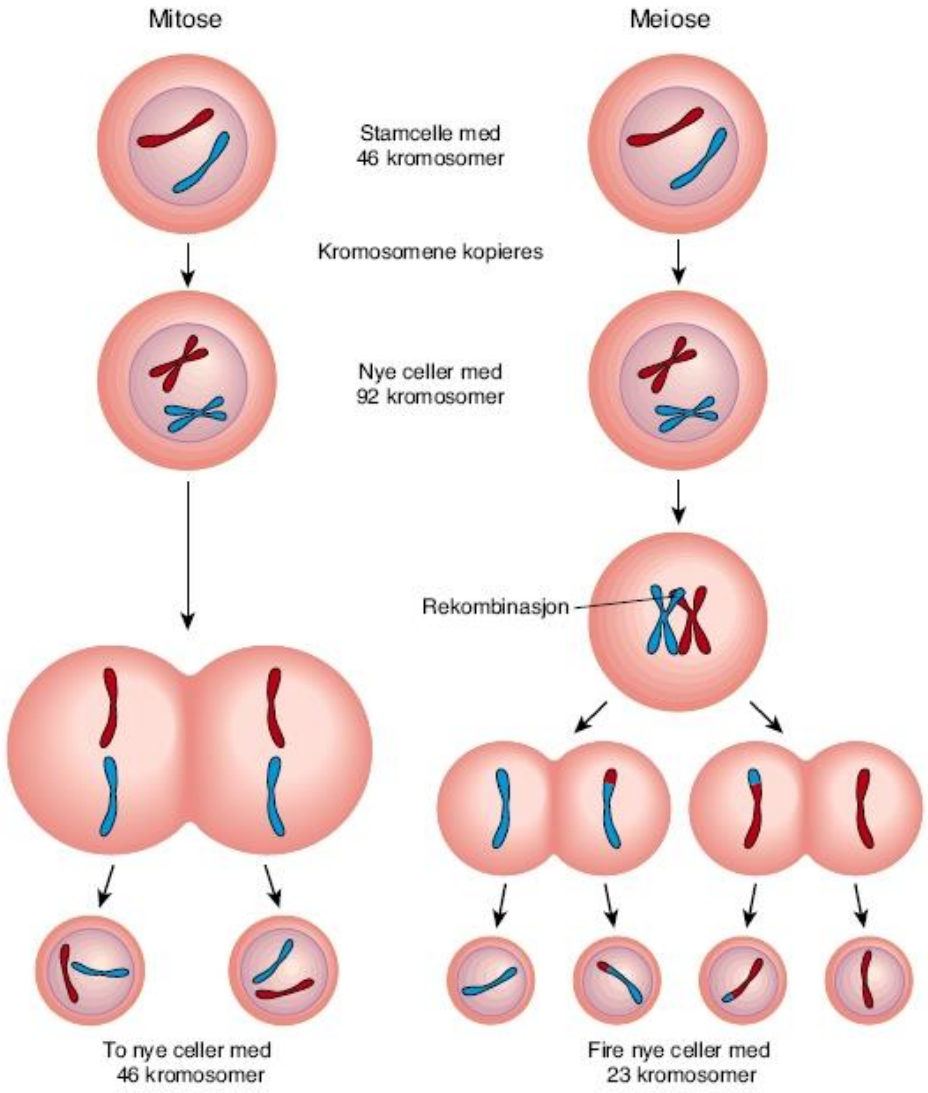




The third variation of white markings is the variation we often call the white boxer

This is a fawn or brindle boxer with white markings covering most of the body. The ground colour may be visible in small areas on the ears, around the eyes in the face, on the sholder or the tail base.

This boxer has two of the gene variant for wite markings - $s^{w}s^{w}$



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In cell biology, mitosis is a part of the cell cycle when replicated chromosomes are separated into two new nuclei. This happens when cells replicate in the body to grow skin, organs and so on.

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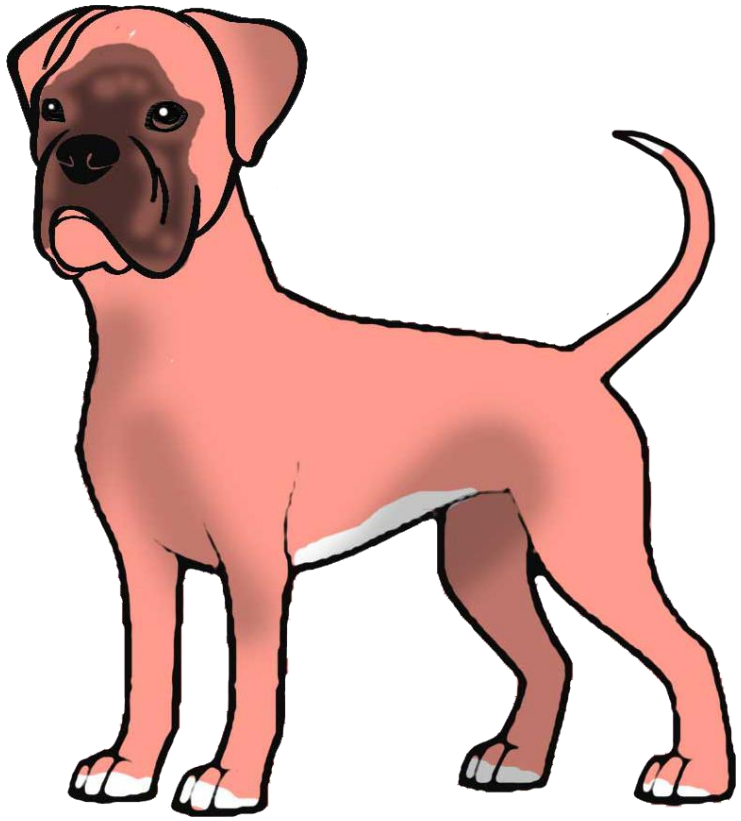
A female without white markings, will only produce eggcells without the gene for white markings

Female withouth white markings

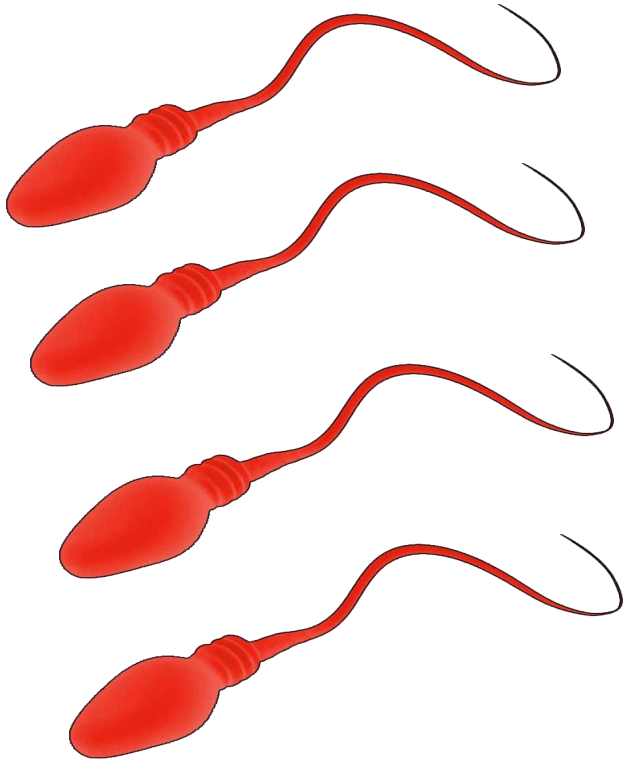
Produces eggcells without the gene variant for white markings.

A male without white markings, will only produce spermcells without the gene for white markings

Male without white markings



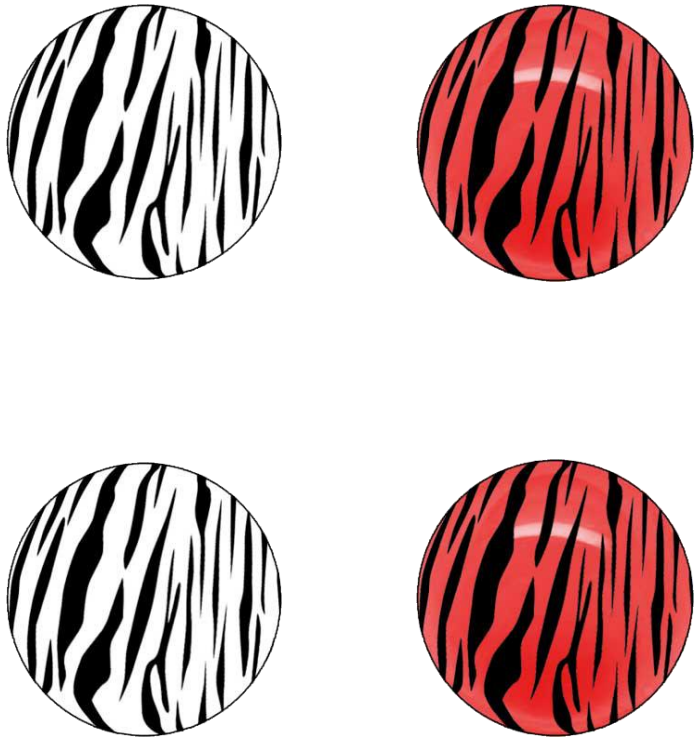
Produces spermcells without the gene for white markings



A female with white markings, will produce50% eggcells **without** the gene for white markings and 50% eggcells **with** the gene for white markings.

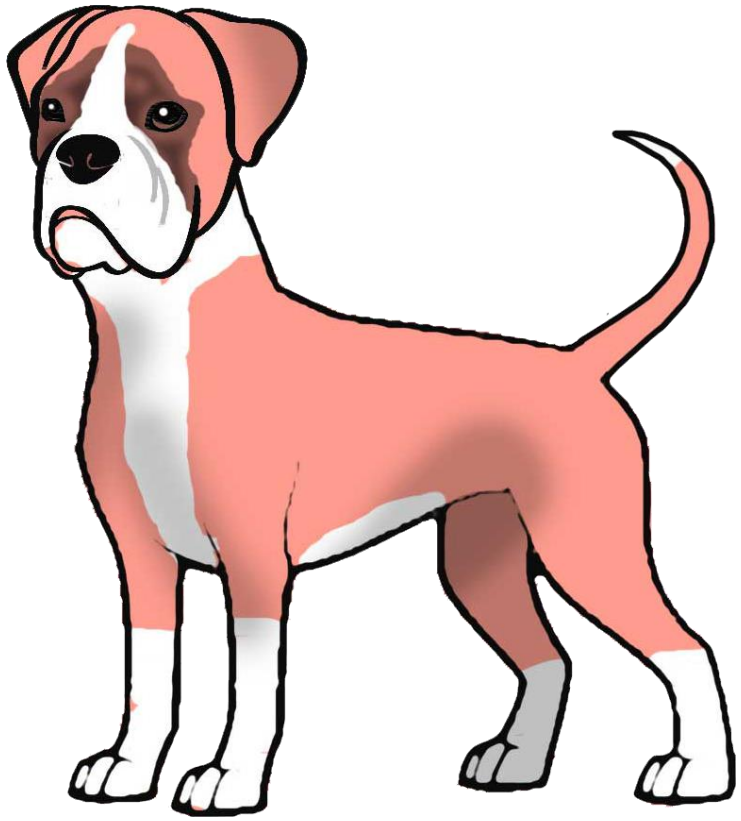
Female with white markings

Produces eggcells with both gene variations

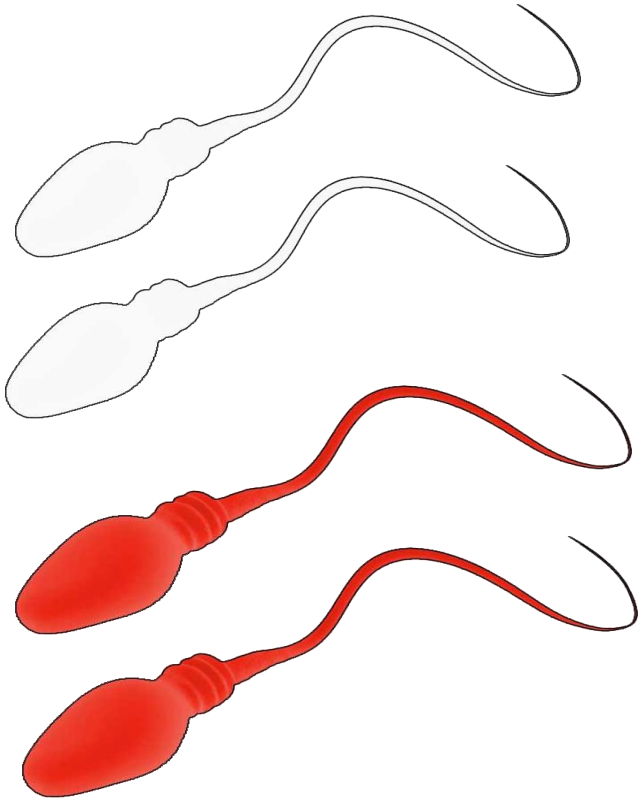


A male with white markings, will produce50% spermcells without the gene for white markings and 50% spermcells with the gene for white markings.

A male with white markings

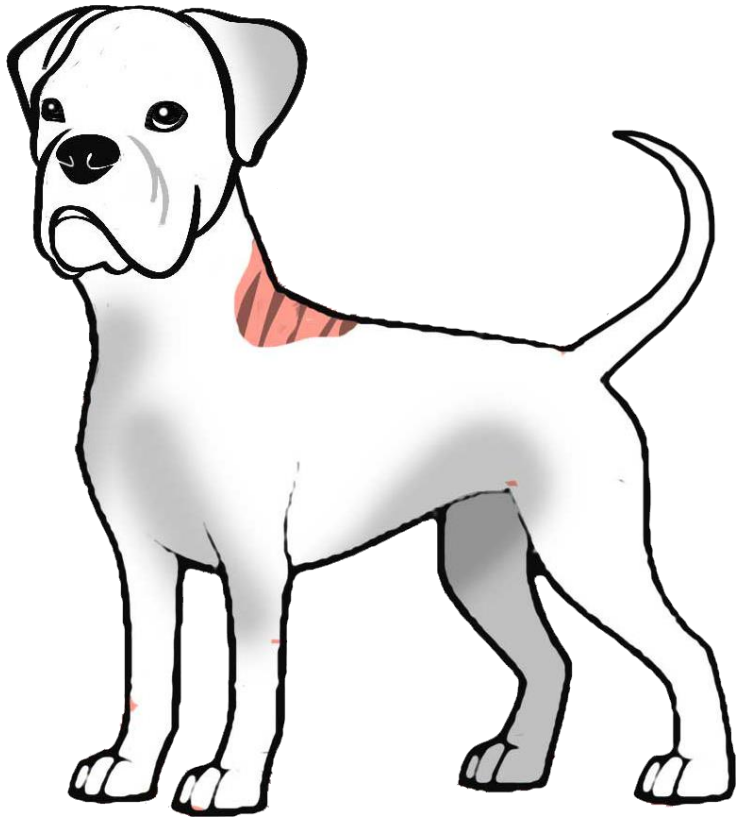


These are his sperm, with 50% of each of the gene variants

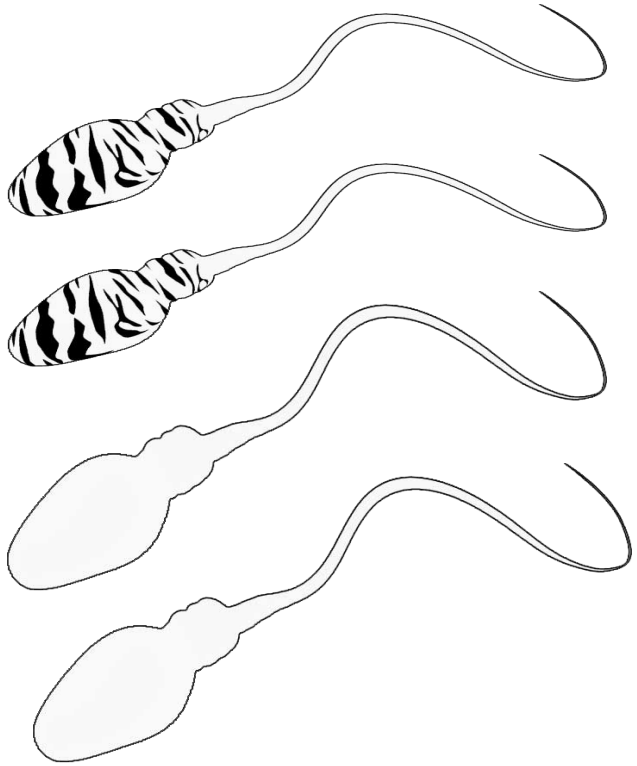


A boxer male with white markings covering more than 1/3 of the ground colour will only produce spermcells with the gene for white markings.

Male with two of the gene variant for white markings

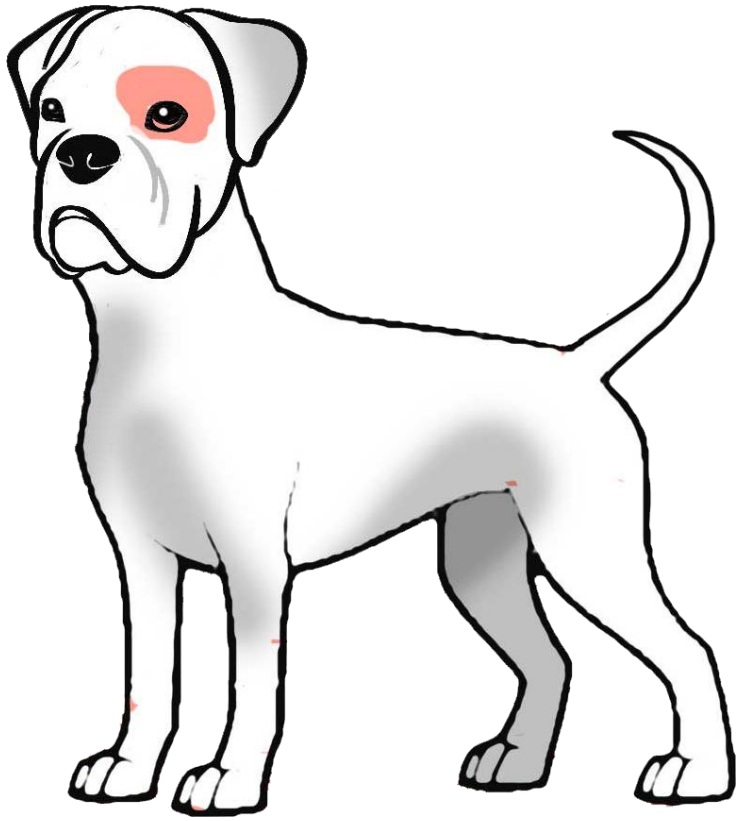


All his spermcells will have this variation of the gene

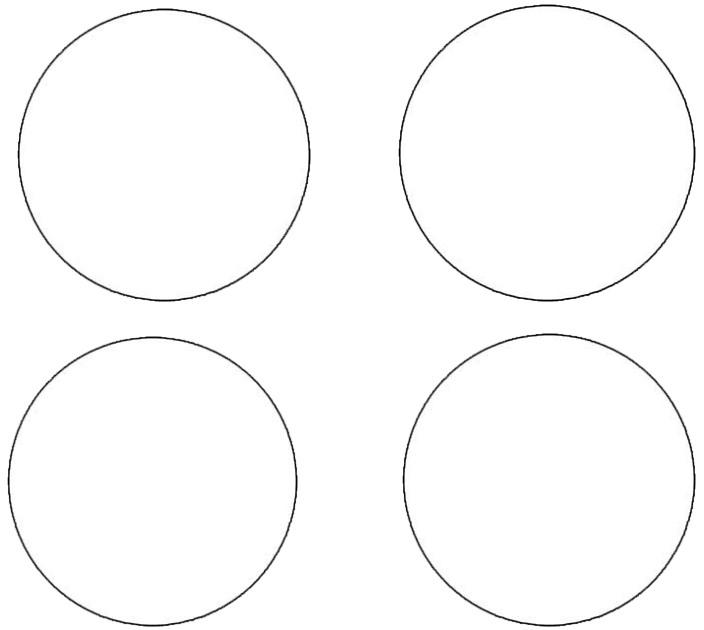


A boxer female with white markings covering more than 1/3 of the ground colour will only produce eggcells with the gene for white markings.

Female with two of the gene variant for white markings

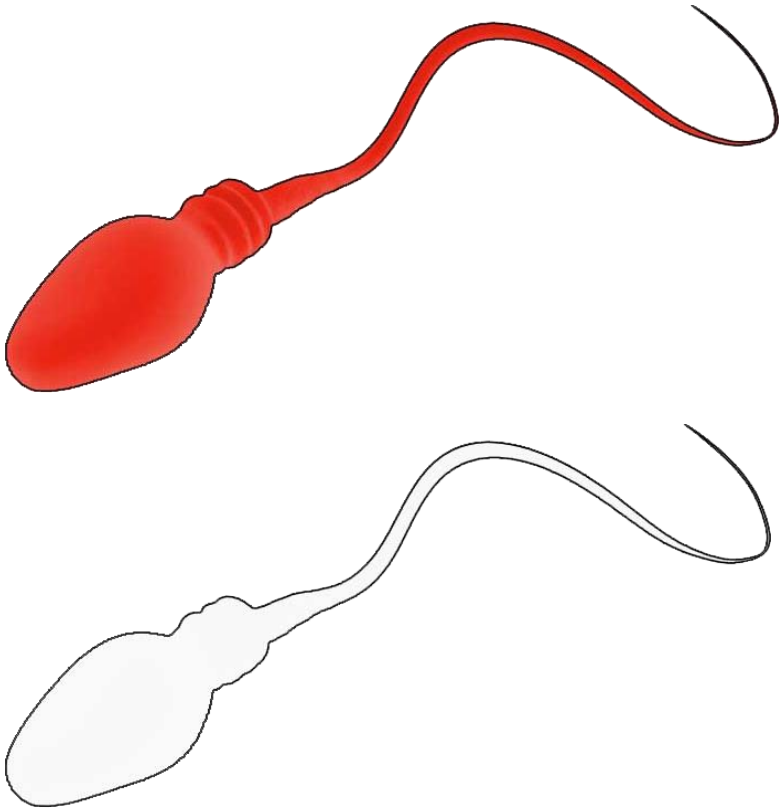


All her eggcells will have this variation of the gene

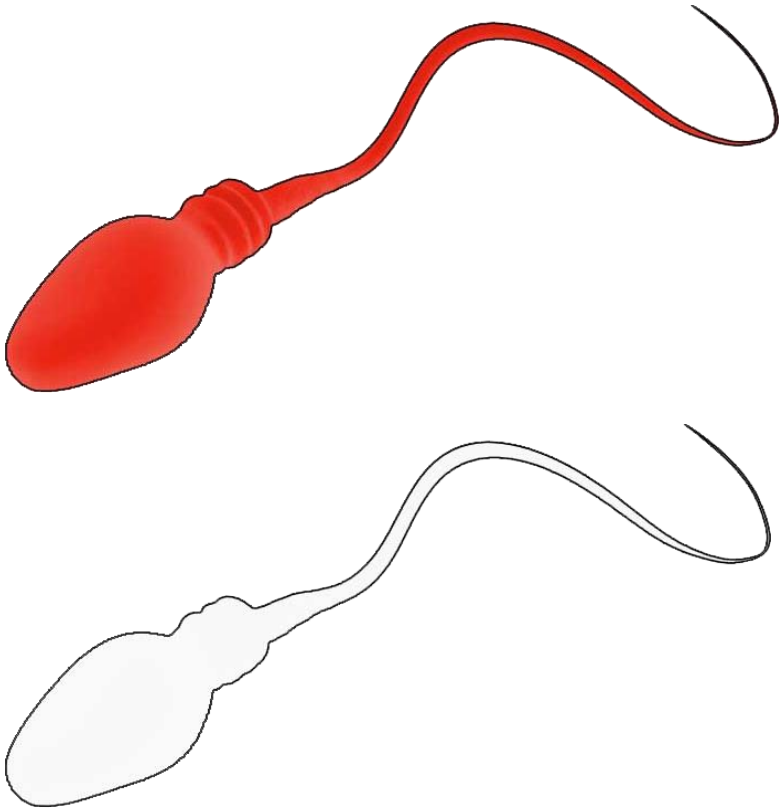


We are now going to make some boxer puppies!

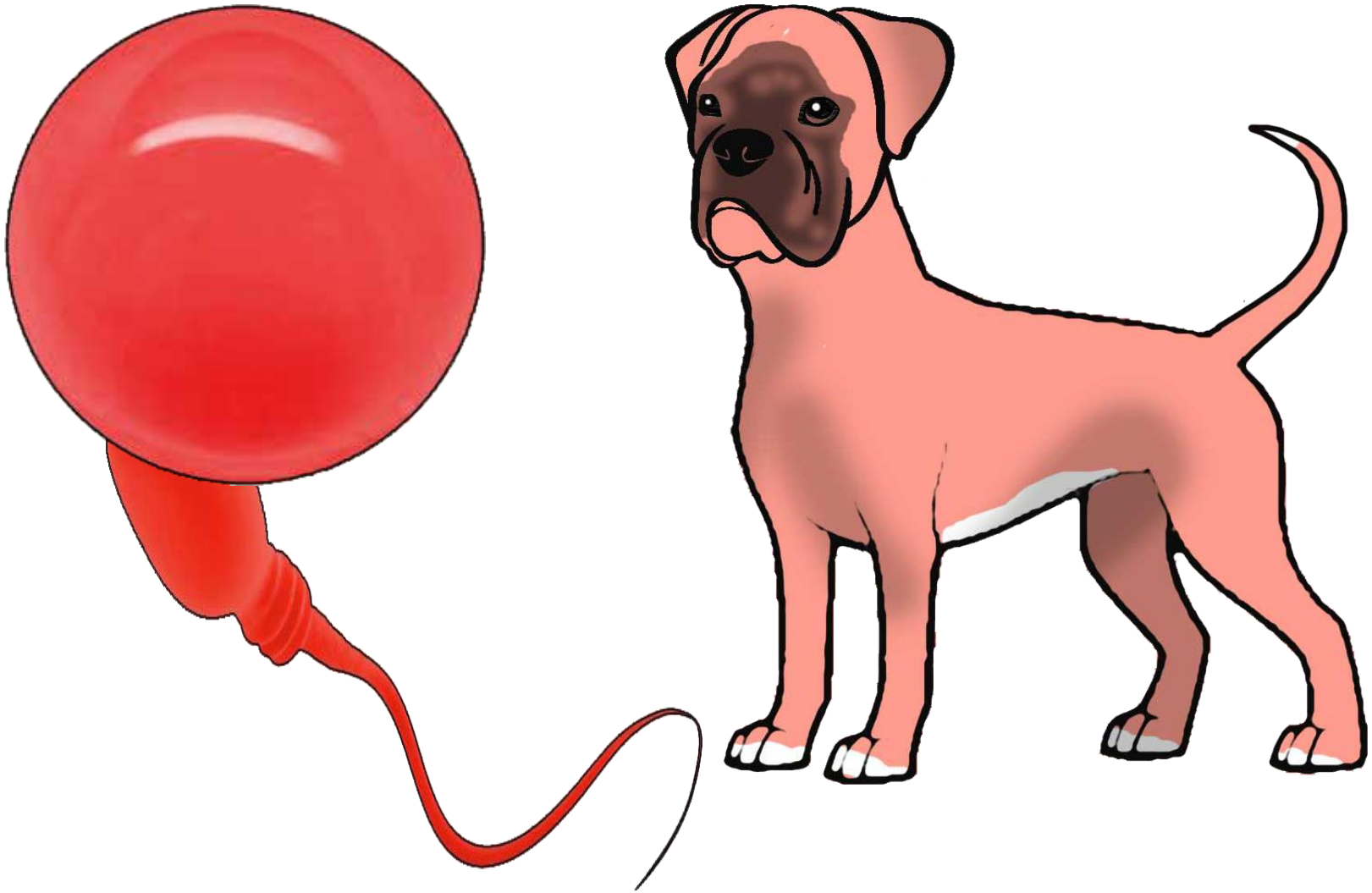
If we only look at the genes for white markings – we will have two different germ cells to choose from, one with and one without the gene for white markings



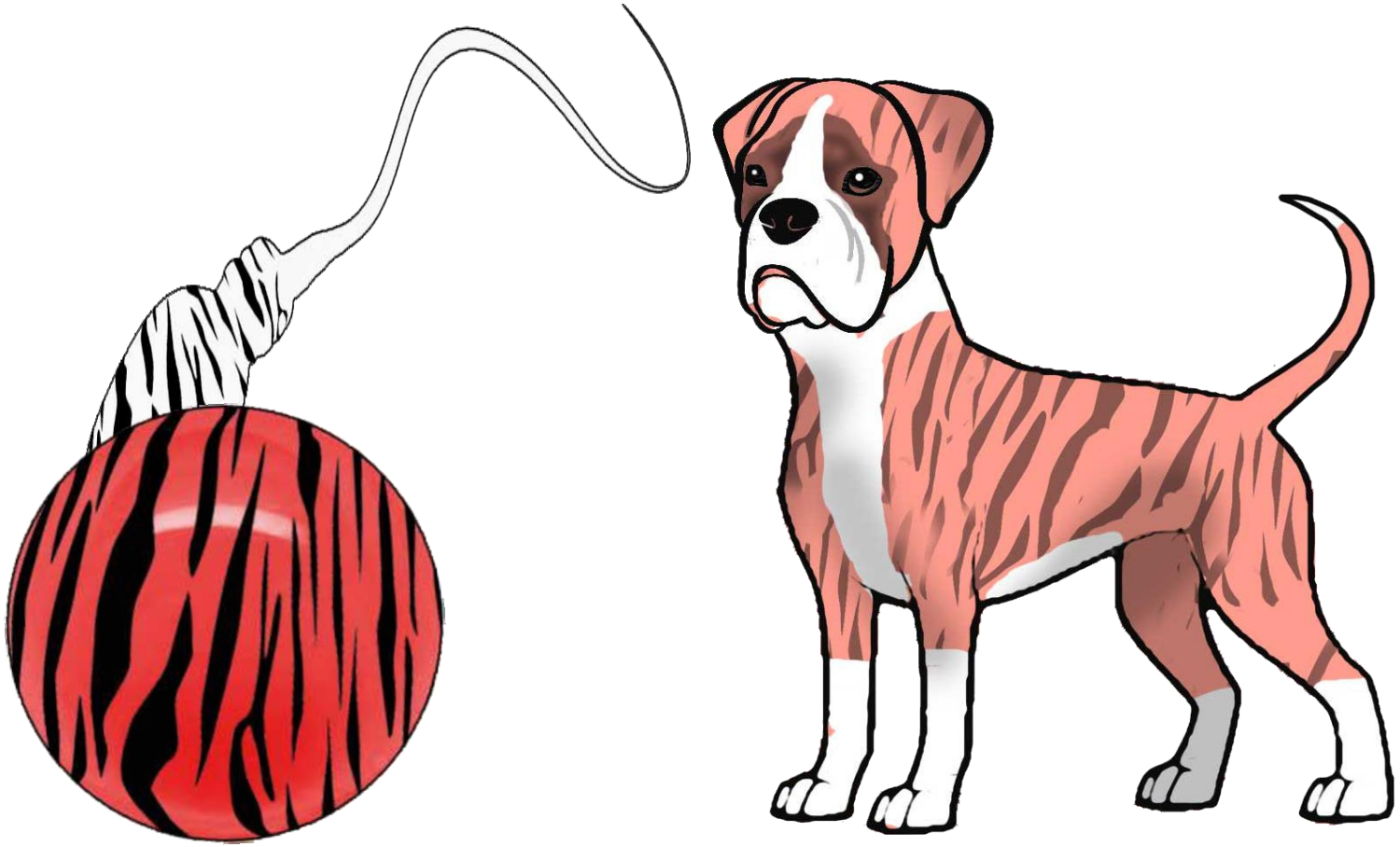
Together they can make thre different variations of white markings on the puppies



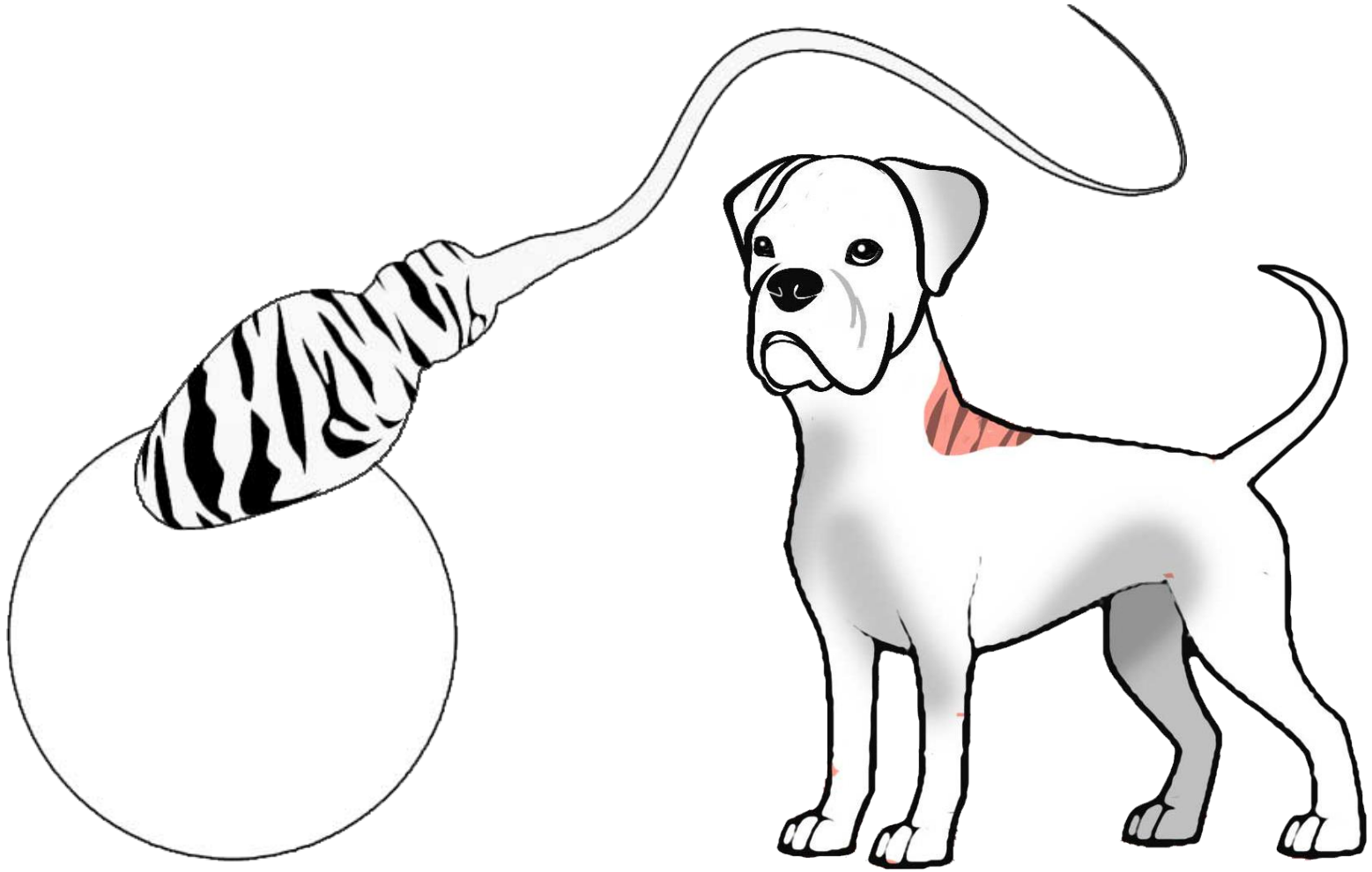
Egg and sperm without the gene for white markings can only produce (fawn or brindle) puppies without white markings.



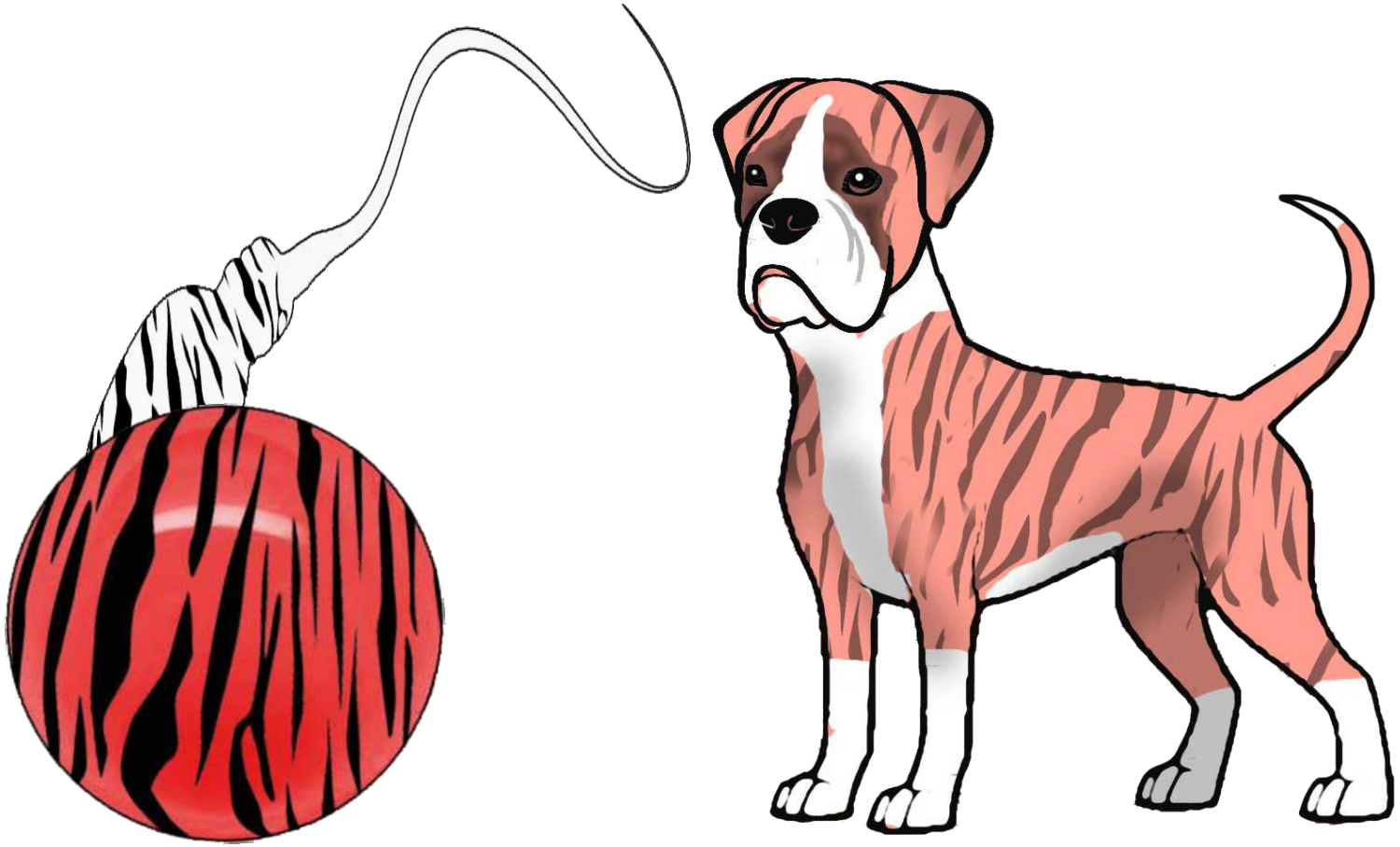
An eggcell without the gene variant for white markings and an eggcell with the gene variant for white markings will only produce (fawn or brindle) puppies with white markings



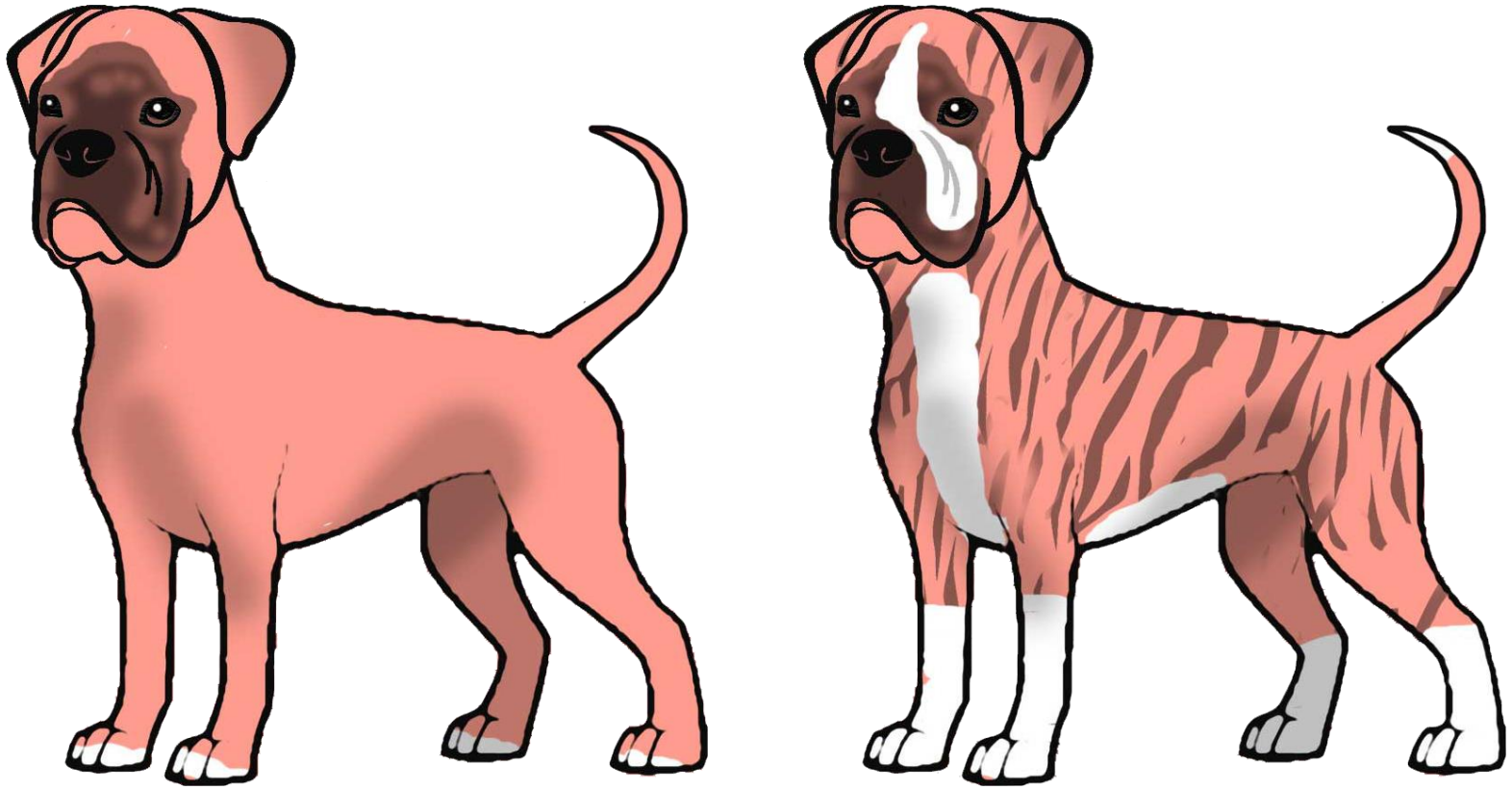
A boxer with a double set of the gene variant for white markings, has been given this gene variant from both its parents. It is a (fawn or brindle) boxer with white markings covering most of the ground colour



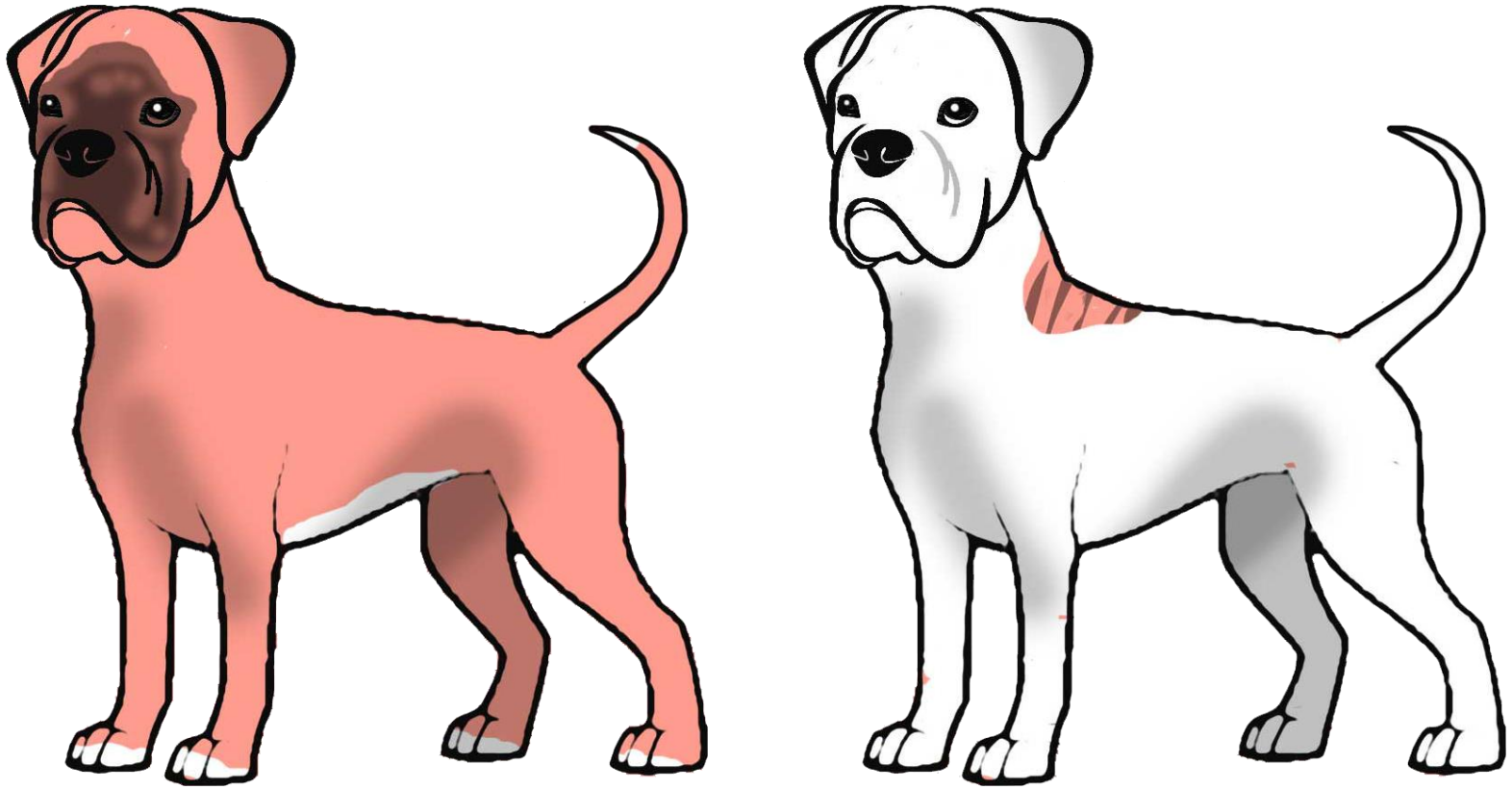
We know that this flashy boxer is created from one cell with the gene variant for white markings, and one cell without the gene variant for white markings



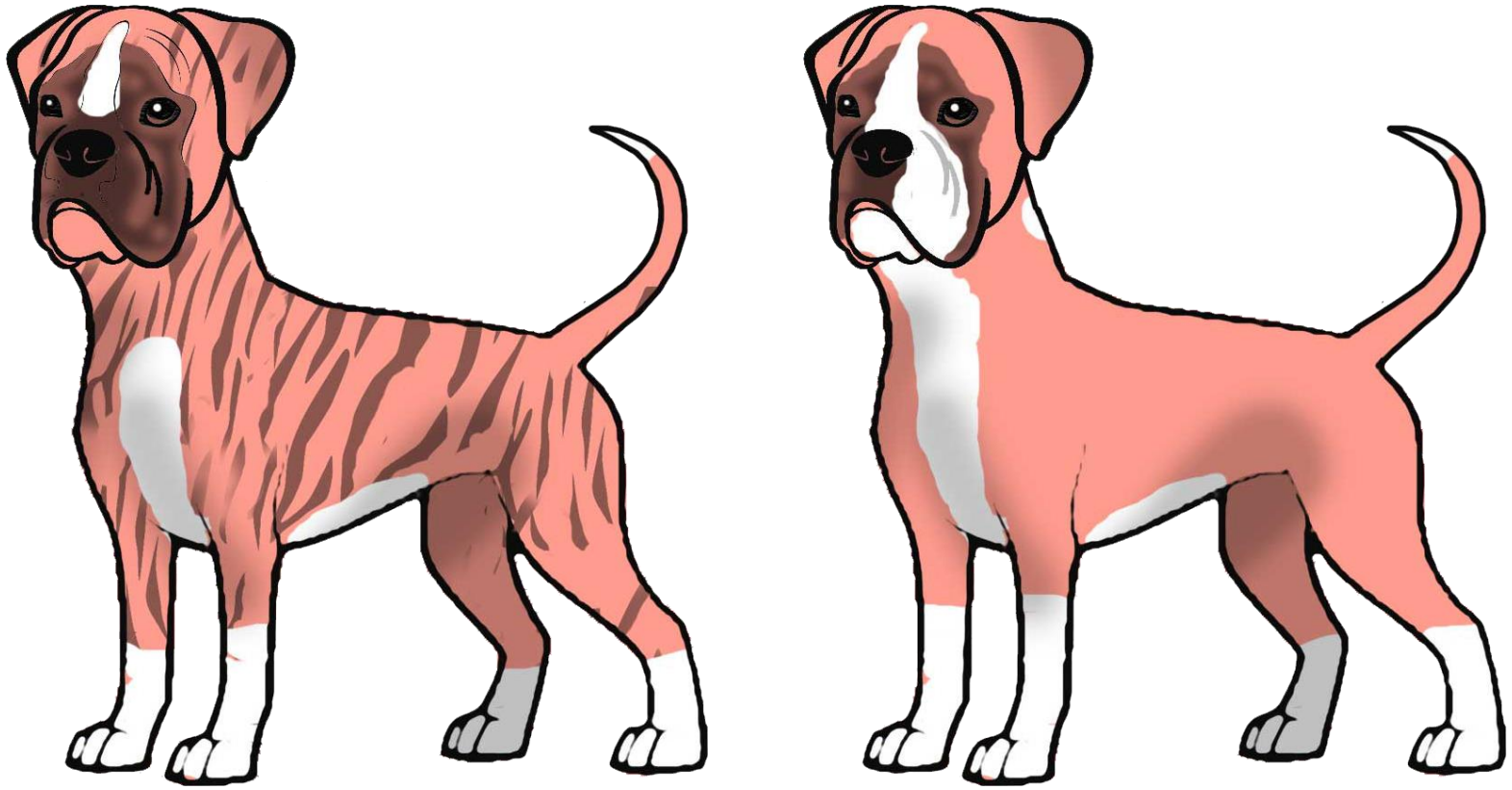
The parents can be these two



The parents can also be these two



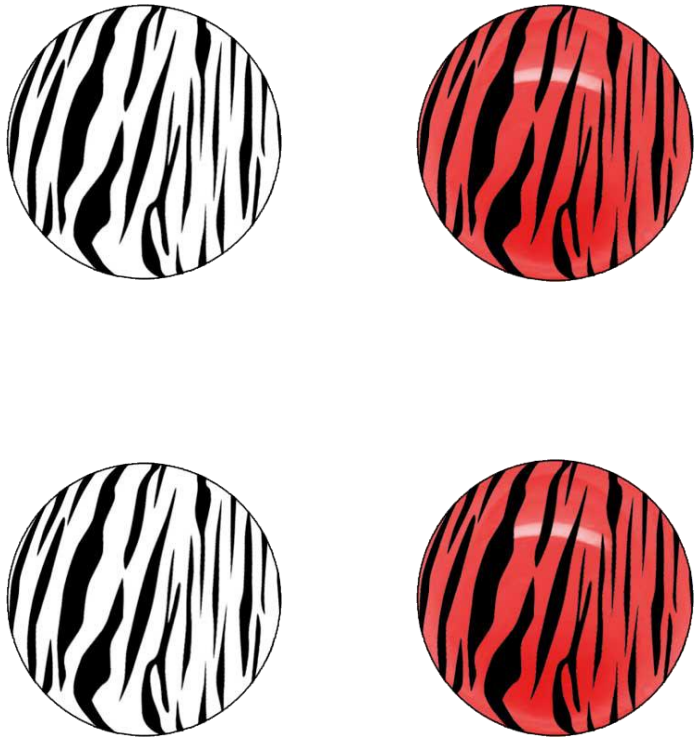
Or these two may be the parents



A male or female with white markings, is in reality a white parent to 50% of it's offspring. The white eggcells from a flashy female is no different from the eggcell from a female with two genes for white markings

Female with white markings

Produce 50% eggcells with the gene for white markings, and 50% eggcells without the gene for white markings



This means that we have actually used white boxer for breeding for a 100 years.