BOERBOEL COLOUR GENETICS – ANGELA DE VILLIERS NOV 2016

CONTENTS

FOREWORD

I'd like to take a moment to thanks all the people that helped me, inspired me and nagged me to do this. Without all of you I wouldn't have made it.

I would like to make a disclaimer, I am not a geneticist nor am I coat colour expert, I am an instructional designer. I am used to taking information out of documents, websites and people's heads and creating training material. That's what I did with this document. I have a list of websites I used to help inform me on the different loci, genes, alleles, patterns and colours. Also talking to a lot of the people listed below made me re-examine and rework where I had missed something or got something wrong.

So this document is a part of all of the following Boerbeol people. A special thank you to those of you who gave me the right to use your pictures. Pictures paint a thousand words and this document would not be the same without them. I am so grateful to you all for willingly helping me and making this document awesome.

The document was reviewed by Michael Jarvis BSc (Hons) Genetics, University of Manchester.

Contributors to the document include in alphabetical order:

Amanda Viljoen	*Cabaret Boerboels*
Beverli Steenkamp	*Klien Sandfontien Boerboels*
Christina Ross	*Revelation Boerboels*
Debora Huebner Malcolm	*RockingChair Boerboels*
Douglas Thorburn	*Alba Boerboels*
Eddie Michaels	*Iwinosa Boerboels*
Jenny Wells	*Quo Vadis Boerboels*
Joseph Philips	*Golden State Boerboels*
Karen Oosthuizen	*Makulu Laani Boerboels*
Michael Jarvis	*Geneticist*
Katie Johnson	*Boerboel Lover and Owner*
Kristie Hecimovic	*Bluefern Mastiffs*
Sandra Brownlie	*Sandaharr Boerboels*
Steve Papworth	*Gatekeeper Boerboels AU*
Svetlana Akifyeva	*Mascot Millennium Boerboels*
Tish Norton	*East Coat Boerboels*
Tracey Bodington	*Bodington Boerboels*
Veronica Chao	*Boerboel Lover and Owner*
Yvonne Philips-Reineman	*Karasi Boerboels*

I have referenced the SAABBS breed standard in this document: http://sabbs.org/resources/documents/legal-documents/constitution

Many other organisations have different breed standards around the world, so please refer to your own organisation with regard to allowable colours and breeding recommendations.

BASIC GENETIC THEORY OR UNDERSTANDING THE BASICS OF GENETICS

Genetics is the study of genes, genetic variation, and heredity in living organisms. The father of genetics was Gregor Mendel. Mendel studied "trait inheritance," patterns in the way traits are handed down from parents to offspring, in the late 1800's. He observed that organisms (pea plants) inherit traits by way of discrete "units of inheritance." This is what we refer to as a gene. Genes are represented by one or more letters and are shown as a series of two letters combinations, one inherited from each parent. Each of these letters is referred to as an allele of the gene.

Genes can be referred to as dominant or recessive (there are many more varieties but for the purpose of keeping this simple we will stick with these two main types for now). Dominant will express its trait over recessive. For a recessive gene to express its trait you must have two alleles the same. Colour genetics in dogs can be complicated because many of the colour varieties we see are the work of combinations of genes and to date, many are still theoretical. Geneticists have and continue to define the genes and where possible develop tests. Today many of the colours in dogs and the genetically inherited diseases can be tested for at laboratories around the world.

COLOUR

Understanding the basis of dog coat colour genetics is simple, there are two types of pigment that create coat colour in dogs. Pigment is the thing that gives each strand of hair its colour, just like pigment in paint or dye. All coat colours and patterns in dogs are created by these two pigments, which are both forms of melanin, the same stuff that makes our skin darker or lighter depending on the amount of melanocytes (cells that produce melanin). The two pigments are:

EUMELANIN Black, but can be changed into other colours like blue, grey, chocolate (liver), Isabella, by modifying genes. When the colour is changed by a modifying gene there is no black hair on the dog. It is either black or it is a modified colour of blue, grey, chocolate (liver), Isabella. With the liver gene the nose and other leathers are all changed to brown so there is no black on the dog. That can be confusing as our Boerboels also come in brown colours.

PHAEOMELANIN Red, can mean anything from a rich deep red like an Irish Setter to brown, cream, apricot, yellow etc. Red is effected by intensity which causes all the different shades a bit like the intensity colour filter of a photo. If we think of the default colour of red being golden or tan, the Irish Setter red would be the most intense and the cream or pale yellow the least. Although we do have a red colour in our Boerboels all the different shades of red, brown, sable have phaeomelanin and in some cases work together with eumelanin to achieve the different effects.

WHITE White is not a colour it is actually the lack of colour and lacks both eumelanin and phaeomelanin.

COLOUR GENES

E OR EXTENSION LOCUS: dominance not fully known four alleles.

Em	Eg and Eh	E	e

1. **BLACK MASK** **Em/Em, Em/E, Em/e** One of the more common modifiers in the Boerboel. The mask can be partial, full and extreme where the black extends down the chest and even to the toes. Em is top dominant and only requires one Em allele to show a mask.
2. **GRIZZLE AND COCKER SABLE** **See Appendix**
3. **NORMAL EXTENSION** **E/E, E/e** Allows the expression of dominant black, brindle, sable, agouti, tan points and recessive black.
4. **RECESSIVE RED** **e/e** changes all eumelanin in the coat to phaeomelanin. **Found in Boerboels.** Recessive red dogs are always be solid red (with or without white), regardless of which alleles are present on the other loci, meaning recessive red hides black, brindle, sable/brown, chocolate\liver, merle and, black and tan. It is genetically impossible for a recessive red dog to have any black in its coat. The yellow Labrador is a recessive red dog. The colour can range from red to almost pale cream as it is effected by the intensity locus. In Boerboels recessive red often shows as a very pale cream but the problem is that a clear, unmasked sable/brown/red dog can look identical to a recessive red dog. In newborn puppies it often shoes as a pink/liver nose and toes. The only way to be sure is to genetically test the dog. This is not a desirable trait as it hides the true colour of the dog.

BLACK MASK

© Angela de Villiers
Skystorm Boerboels

NORMAL EXTENSION

© Jenny Wells
Quo Vadis Boerboels

RECESSIVE RED

© Karen Oosthuizen
Makulu Laani Boerboels

EXTREME MASK

© Christina Ross
Revelation Boerboels

K LOCUS DOMINANT BLACK: Three alleles.

K	kbr	k

1. **BLACK** **K/K, K/kbr, K/k** is dominant black. A dog with both dominant alleles will have only black puppies irrespective of the colour of the other dog (colour modifiers excluded).
2. **BRINDLE** **kbr/kbr, kbr/k** dominant over sable/brown. A brindle dog with kbr/kbr when bred to a sable/brown dog will have all brindle puppies (colour modifiers excluded).
3. **NON BLACK** **k/k** allows the colour of the A locus to be expressed.

BLACK

© Beverli Steenkamp
Klien Sandfontien Boerboels

BRINDLE

© Beverli Steenkamp
Klien Sandfontien Boerboels

NON BLACK

© Angela de Villiers
Skystorm Boerboels

Ultra or Reverse Brindle occurs when it appears that the brindle dog has brown/red/sable stripes on a black body. This is not in fact true and the black stripes are just wider than normal. The base colour of the dog is still the lighter colour and not black. Some ultra brindles are almost fully black and appear black but are in fact brindle and will produce brindle puppies. Ultra-brindle puppies that appear black when born, develop stripes later on.

ULTRA-BRINDLE

© Svetlana Akifyeva
Mascot Millenium Boerboels

© Svetlana Akifyeva
Mascot Millenium Boerboels

© Svetlana Akifyeva
Mascot Millenium Boerboels

Seal in Black dogs - Seal is currently a complete mystery, it makes the dogs coat appear brownish or bronzed. The shades can vary from a bronze sheen to a shade almost as light as chocolate. The nose remains black.

SEAL

© Tracey Bodington
Bodington Boerboels

AGOUTI OR A LOCUS: Four alleles.

Ay	aw	at	a

1. **SABLE/BROWN** **Ay/Ay, Ay/aw, Ay/at, Ay/a** dominant over all other alleles on this locus. In Boerboels the most common combination is Ay/Ay but Ay/aw, Ay/a do occur. Ay/at is unusual and very rare.
2. **AGOUTI OR WOLF GREY** **aw/aw, aw/at, aw/a** dominant over tan points and recessive black, very rare in Boerboels.
3. **TAN POINTS** **at/at or at/a** also known as black and tan and is dominant over recessive black. Recently found in the Boerboel, but very rare.
4. **RECESSIVE BLACK** **a/a** recessive to the rest of the Agouti loci and quite rare, generally only found in hunting dogs. Not found in the Boerboel.

SABLE/FAWN

© Angela de Villiers
Skystorm Boerboels

AGOUTI OR WOLF GREY

© Unknown
If this is your picture please let me know.

TAN POINTS

© Amanda Viljoen
Cabaret Boerboels

RECESSIVE BLACK

© MyGermanShephard.org

COLOUR MODIFICATIONS

S OR WHITE SPOTTING LOCUS: currently two alleles are proved to exist but the hypothesis is that there are four alleles.

S	s	si	sp	sw

1. **MINIMAL WHITE** **S/S** minimal white spotting.
2. **WHITE SPOTTING** **s/s, S/s** white spotting, again very common in the Boerboel and can be seen in varying degrees from white toes and tail tip to full chest area, feet and tail tip.
3. **ISRISH SPOTTING** **si/si, si/sp, si/sw** theoretical only, white on the legs, the tip of the tail, the chest, neck and muzzle. Many dogs with this pattern have a full white neck ring and a blaze. There is some thought that there is a true irish mark that we see in the likes of boxers. This may exist in Boerboels as some only ever produce irish marked and not piebald.
4. **PIEBALD** **sp/sp, sp/sw** theoretical only, more common than people realise and is quite prolific in the Boerboel. Because it is recessive it can travel through the generations for long periods before suddenly popping up in a litter where both parents carry the allele. Piebald has been part of the breed long before the foundation of the breed standard and was included in the first breed standard. A good example of a piebald founding dog is Ysterberg Vegter 1. Pseudo irish spotting can occur with piebald and the dogs look like they are irish marked but are in fact carrying piebald. Breeding two Piebald dogs can cause a greater amount of white to appear in the offspring and is therefore not recommended.
5. **EXTREME WHITE** **sw/sw** theoretical only, this creates a predominantly white dog with some but generally little colour patterns, usually around the head.

MINIMAL WHITE SPOTTING

© Svetlana Akifyeva
Mascot Millenium Boerboels

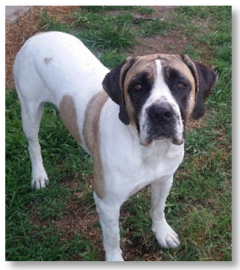
WHITE SPOTTING

© Angela de Villiers
Skystorm Boerboels

IRISH MARKED

© Jenny Wells
Quo Vadis Boerboels

PIEBALD

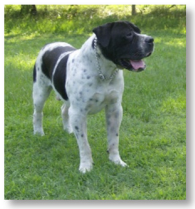


© Angela de Villiers
Skystorm Boerboels

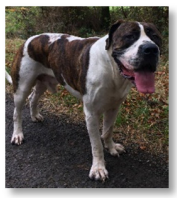
EXTREME WHITE

© Steve Papworth
Gatekeeper Boerboels AU

PIEBALD COLOURS



© Christina Ross
Revelation Boerboels



© Douglas Thorburn
Alba Boerboels

© Angela de Villiers
Skystorm Boerboels

© Sandra Brownlie
Sandaharr Boerboels

I OR INTENSITY LOCUS: hypothesized only and not fully understood. Modifies red to yellow, lemon, cream and apricot. It is responsible for the range of red/brown colouring in both brindle and sable/brown Boerboels.

DIFFERENT SHADES OR INTENSITIES SEEN IN THE BOERBOEL

© Jenny Wells
Quo Vadis Boerboels

© Beverli Steenkamp
Klein Sandfontein Boerboels

© Beverli Steenkamp
Klein Sandfontein Boerboels

© Steve Papworth
Gatekeeper Boerboels AU

© Jenny Wells
Quo Vadis Boerboels

B LOCUS OR LIVER/CHOCHOLATE: Liver colour or sometimes called liver nose in Boerboels and chocolate in Labradors, modifies all the black on the dog to a chocolate brown colour, this brown has no relation to the base pigment red caused by Phaeomelanin, a dog must have black in its coat to display the liver/chocolate colour. There are two alleles.

B	b

1. **NON CARRIER** — **B/B** normal does not carry liver.
2. **CARRIER** — **B/b** carries one copy of the liver allele and can pass that to offspring.
3. **AFFECTED** — **b/b** will be chocolate coloured and pass one of each allele to its offspring.

Liver is quite common in Boerboels but is not a desirable trait as it hides the true colour of a dog. A black, brindle or sable/brown dog will appear to be brown with a brown nose and lips, there will be no black on the dog. Someone who does not understand dog coat colour genetics could make the mistake of breeding a liver dog hiding black or brindle to a sable/brown dog and a brindle or black puppy could be produced. Two brown or sable/brown dogs could never produce a brindle or black puppy (unless there was recessive black in the breed).

A dog with black in its coat caused by any other modification such as tan points or recessive black will still display the liver/chocolate colour in those areas. A dog with a mask will have a darker liver/chocolate mask as in the second picture below that shows two liver and two standard coloured pups with masks.

LIVER/CHOCOLATE AND LIVER BRINDLE

© Yvonne Philips-Reineman
Karasi Boerboels

© Tish Norton
East Coat Boerboels

© Veronica Chao

© Katie Johnson

T LOCUS – TICKING: Ticking is flecks or spots of colour on white areas. It can only occur if the dog has the white spotting gene and there is white on the dog. There are two alleles.

T	t

The exact interaction of the ticking alleles is not completely known but we can hypothesize that.

1. **TICKED** **T/T** normal will have heavy ticking.
2. **AFFECTED** **T/t** some ticking will be visible.
3. **NOT TICKED** **t/t** No ticking.

TICKED/AFFECTED

© Christina Ross
Revelation Boerboels

NOT TICKED

© Jenny Wells
Quo Vadis Boerboels

G LOCUS – PROGRESSIVE GREYING: The greying gene affects eumelanin (black and liver, it does not affect the nose or eye colour. It works progressively, a dog with greying is born with solid colour and gets lighter as it gets older. The gene for greying has not yet been found. There are two hypothesised alleles.

G	g

1. **GREYING** **G/G, G/g** Greying is expressed.
2. **NON GREYING** **g/g** No greying.

Greying may be found in Boerboels, some Boerboels start greying on their masked muzzles and this can extend to all the black in the coat within a few years. Greying usually starts when young at one to two years old. We may find that greying becomes more prominent in the black Boerbel if the gene is present.

PROGRESSIVE GREYING

© Kerry Blue Terrier Foundation

COLOUR DILUTION

D LOCUS OR DILUTE: The dilution modifier gene affects all the black hair and skin and can lighten the red hair as well. There are two alleles.

D	d

1. **NON CARRIER** **D/D** normal does not carry dilute.
2. **CARRIER** **D/d** carries one copy of the dilute allele and can pass that to offspring.
3. **AFFECTED** **d/d** all black will be diluted and pass one of each allele to its offspring. Notably the nose leather is usually diluted as well and looks grey.

Dilute Brown

© Tracey Bodington
Bodington Boerboels

Dilute Black (Blue)

© Tracey Bodington
Bodington Boerboels

Dilute Irish

© Kristie Hecimovic
Bluefern Mastiffs

Dilute Brindle

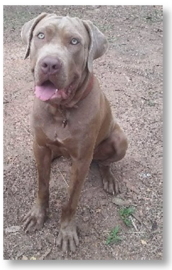
© Kristie Hecimovic
Bluefern Mastiffs

In Boerboels the dilute gene has been present since the beginning of the breed. In non-black dogs it is often referred to as **Powder** rather than **Dilute**, in black dogs it is often referred to as **Blue**. This has caused a confusion in the Boerboel community where people believe that the blue colour or dilute gene comes from the introduction of the black coat colour. This is not true and in fact is more likely the opposite, the blue is caused by the dilute gene which has always been present.

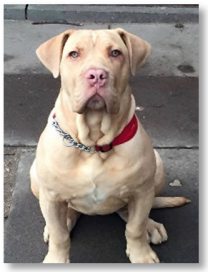
When a dog witch affected by the Liver gene also is affected by the Dilute gene, you get a lilac also known as Isabella dog, such as a Weimaraner. Lilac or Isabella is a pale greyish brown. An isabella dog has the genotype **b/b-d/d** (both liver and dilute). It is unusual in Boerboels but can occur. The two pictures on the right are of the same Boerboel dog as a pup and adult the two on the left show the shade difference in two Bandogs from the same litter. Note the very light coloured eyes and pink on the nose.

SHADES OF ISABELLA

© Kristie Hecimovic
Bluefern Mastiffs



© Kristie Hecimovic
Bluefern Mastiffs



© Sandra Brownlie
Sandaharr Boerboels

© Sandra Brownlie
Sandaharr Boerboels

OTHER TRAITS AND FURNISHINGS

L LOCUS – LONG HAIR GENE: The Long Hair gene is a recessive gene. It governs the length of the dog's coat. Although one of the genes can now be tested for, it is not known what other alleles or genes may interact to cause the different lengths. There are two alleles that can be tested for.

L	l

1. **SHORT HAIRED COAT** **L/L, L/l**
2. **LONG COAT** **l/l**

LONG HAIR IN A BOERBOEL

© Kristie Hecimovic
Bluefern Mastiffs

The genetic profile of the Boerboel pictured above, which shows a longer or fluffy coat as well as tail and hind leg feathers, is:

TRAIT(S):
LONG HAIR GENE (PHENOTYPE) **(CARRIER/HETEROZYGOUS - ONE COPY DETECTED)**
A-LOCUS AGOUTI **($a^y a^y$ BROWN/SABLE - NO FACTOR/PURE)**
B (TYRP1 LOCUS) BROWN/CHOCOLATE **(NORMAL – BB FULL COLOR DOES NOT CARRY BROWN)**
DILUTE MLPH GENE (BLUE/GREY) **(dd GREY, GRAY BLUE, OR SILVER - COLOUR IS DILUTED)**
K-LOCUS (DOM BLACK/WILD TYPE) **(k/k - DOES NOT CARRY DOM BLACK COLOUR DETER OUTI)**
E-LOCUS (EXTENSION - YELLOW/RED/CREAM/APRICOT **(NORMAL EE - DOMINANT BLACK)**

Tested by Orivet Genetic Pet Care in Australia.

Although the test only shows one copy of the long haired genes, as other alleles and genes may be involved, this Boerboel clearly shows a longer than normal coat. There seems to be a great variety in Boerboel coats including thick undercoat, no undercoat, short flat hair, wavy hair on the spine, slightly longer hair and rougher hair. There are obviously many factors at play.

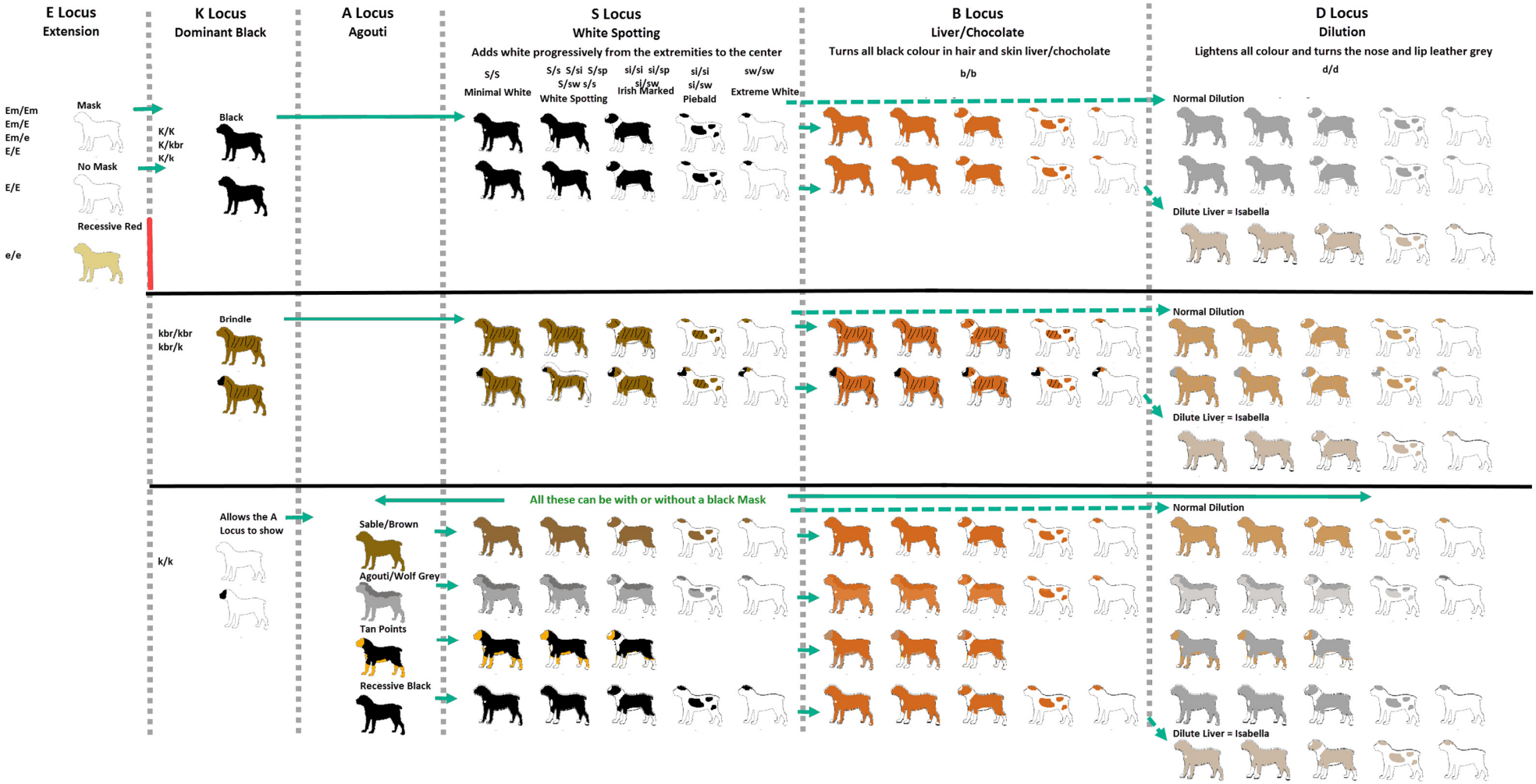
COLOURS ACROSS THE SPECTRUM

Here's a good example of how all the colours can change through this process:

COLOURS ACROSS THE SPECTRUM
Isabella/liver/dilute/tan point

© dobermann-vom-pinienberg.com

A QUICK REFERENCE CHART OF THE MAIN INTERACTIONS



© Angela de Villiers

WORKING OUT WHAT YOU MIGHT GET FROM A BREEDING OF TWO DOGS.

Although the colour genetics seems simple enough, it can get quite complicated to work out what you might get from breeding two dogs together. If you know the genotype of the dogs from doing genetic tests, you can use punnet squares to work out the possible results. If you don't know the genotype, anything can happen.

GENOTYPE is what the genes say. Only available by testing the dog.

PHENOTYPE is how the dog looks and is visible.

So if we have a brindle dog with kbr/k, one brindle allele and one non-black allele and Ay/Ay on the A locus and we pair it with a sable/brown dog k/k and Ay/Ay on the A locus. We can immediately work out that all the pups will have Ay/Ay on the A locus. As there is no other A locus allele in play.

But how will the brindle be affected?

We can use punnet squares, a punnet square is a diagram that is used to predict an outcome of a particular breeding.

The blank punnet square for a simple breeding calculation is shown above. The parent's alleles go into the yellow shaded boxes and then the genes are matched one from each parent into the clear boxes.

	kbr	**k**
k		
k		

	kbr	**k**
k	k/Kbr	k/k
k	Kbr/k	k/k

So there is a chance that **50% of the litter will be brindle.**

But colours come in lots of different options not just the two alleles. For example if we look at the dilute gene which is recessive, with the brindle gene sequence from above. We have one parent that is brindle kbr/k, and carries the recessive dilute gene D/d. Another parent that is sable/brown, k/k, and carries the recessive dilute gene D/d.

If we just did the dilute gene for these two dogs it would look like this.

	D	**d**
D	D/D	D/d
d	d/D	d/d

25% non-carriers, 25% dilute and 50% carriers.

So now we do a larger Punnet square combining the two genes. Instead of putting one parent at the top and one at the side, we put the results from the K locus and the D locus in those boxes. There are four results from each of those, so the Punnet square needs to be 4 x 4 (giving 16 results):

	k/kbr	k/kbr	k/k	k/k
D/D	k/kbr D/D	k/kbr D/D	k/k D/D	k/k D/D
D/d	k/kbr D/d	k/kbr D/d	k/k D/d	k/k D/d
d/D	k/kbr d/D	k/kbr d/D	k/k d/D	k/k d/D
d/d	k/kbr d/d	k/kbr d/d	k/k d/d	k/k d/d

The first two columns, 8 squares will be brindle, so 50% of the litter could be brindle, the second two columns are brown, so 50% of the litter could be brown. The first three rows are non-dilute, 12 squares, of which 8 squares carry the dilute allele, so 75% of the litter could be non-dilute with 50% carrying one dilute allele. The bottom row in red are all dilute, so 25% of the litter could be dilute.

All the brown squares will be brindle so 6 out of 16 of which 4 carry the dilute allele. The blue squares will be brown and 4 carry the dilute allele. All the red squares will fully dilute, two brindle and two brown.

So the chances are:

- 12.5 % Brindle no dilute allele
- 25 % Brindle carrying dilute
- 12.5 % Dilute brindle
- 12.5 % Brown no dilute allele
- 25 % Brown carrying dilute
- 12.5 % Dilute brown

Let's look at a real example. Unfortunately I don't have a Boerboel example but I am grateful to Kristie Hecimovic from Bluefern Mastiff's for letting me use this Bandog example.

FATHER PHENOTYPE DILUTE BLACK

TRAIT(S):

A-LOCUS AGOUTI **(ay/ay PURE FAWN or SABLE only PRODUCE ay OFFSPRING)**
B (TYRP1 LOCUS) BROWN/CHOCOLATE **(CARRIER Bb - CARRIER OF BROWN / FULL COLOUR)**
DILUTE MLPH GENE (BLUE/GREY) **(dd GREY, GRAY BLUE, OR SILVER - COLOUR IS DILUTED)**
K-LOCUS (DOM BLACK/WILD TYPE) **(CARRIER - K/k ONE COPY DOM BLACK and ONE COPY NON BLACK)**
EM-LOCUS MELANISTIC BLACK MASK ALLELE **(E^m e -ONE MASK ALLELE & ONE RECESSIVE RED ALLELE)**

Genotype Ay/Ay B/b d/d K/k Em/e dilute black carries a non-black allele, one liver allele and one mask and one recessive red allele.

Mother: Phenotype Dilute Black

TRAIT(S):

A-LOCUS AGOUTI **(AFFECTED - A^yA^y)**
B (TYRP1 LOCUS) BROWN/CHOCOLATE **(CARRIER - Bb)**
DILUTE COAT COLOUR MLPH GENE (BLUE/GREY) **(AFFECTED - dd GREY, GRAY BLUE, OR SILVER)**
K-LOCUS (DOMINANT BLACK/WILD TYPE) **(CARRIER - KK, Kk^{br}, Kk)**
EM-LOCUS MELANISTIC BLACK MASK ALLELE **(AFFECTED - E^m MASKING, DOMINANT)**

Genotype Ay/Ay B/b d/d K/k Em/Em dilute black carries a non-black allele, one liver allele and two mask alleles.

Just looking at them you might think you will only get dilute black pups.

- So both parents are Ay/Ay and all the puppies will be Ay/Ay. No need to work that out.
- Both the father and mother carry one liver/chocolate allele B/b.
- Both parents are dilute so all puppies will be dilute d/d.
- The father and mother are either brindle or black the test is not conclusive. Carrier KK, Kkbr, Kk. We know from Phenotype that they are black so K/k.
- The father carries one mask allele and one recessive red allele Em/e
- The mother is full mask Em/Em all puppies will have masks as the e is recessive and only one mask allele is needed for the mask to show.

So what colours will these puppies be? Let's start with the K Locus:

	K	**k**
K	K/K	K/k
k	k/K	k/k

- 25% Dominant Black two copies of the K allele
- 50% K/k Dominant black one copy of the K allele
- 25% Sable/brown two copies of the recessive k allele.

B Locus

	B	**b**
B	B/B	B/b
b	b/B	b/b

- 25% No liver/chocolate i.e. dominant black
- 50% B/b Dominant black one copy of the B allele
- 25% Liver/chocolate two copies of the b recessive allele.

	K/K	**K/k**	**k/K**	**k/k**
B/B	**K/K B/B**	**K/k B/B**	**k/K B/B**	**k/k B/B**
B/b	**K/K B/b**	**K/k B/b**	**k/K B/b**	**k/k B/b**
b/B	**K/K b/B**	**K/k b/B**	**k/K b/B**	**k/k b/B**
b/b	**K/K b/b**	**K/k b/b**	**k/K b/b**	**k/k b/b**

So it looks like the pups will be:

- 9/16 Black – grey squares carrying at least one dominant K allele and one B allele
- 3/16 Brown – Blue squares k/k and at least one B allele
- 4/16 Liver/chocolate – Red squares carrying two recessive b alleles

However remember that all these puppies will be dilute and dilute + brown/liver is isabella.

So we will have No liver/chocolate puppies, they will all be Isabella.

- 9/16 Dilute Black 56%
- 3/16 Dilute Brown 19%
- 4/16 Isabella 25%

© Kristie Hecimovic
Bluefern Mastiffs

COLOUR BREEDING RULES

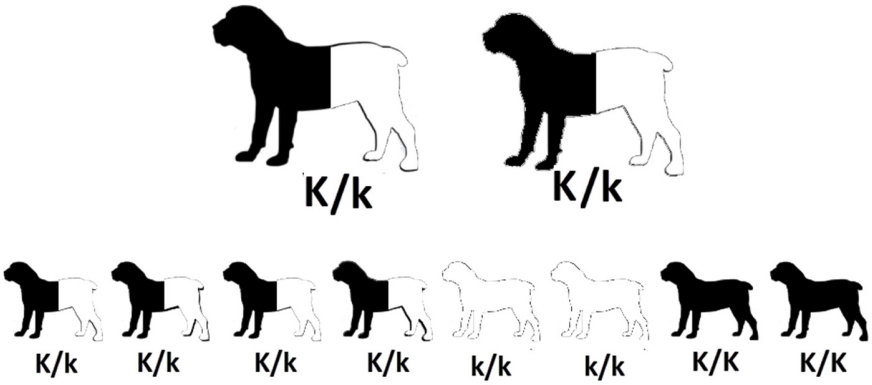
These colour breeding rules are based on the current 2016 SABBS standard and are aimed at breeding desirable coloured dogs and minimising inbreeding. Note: for the purpose of these rules black is included although it is currently suspended, as it still forms part of the SABBS breed standard.

DOMINANT COLOURS, BLACK AND BRINDLE.

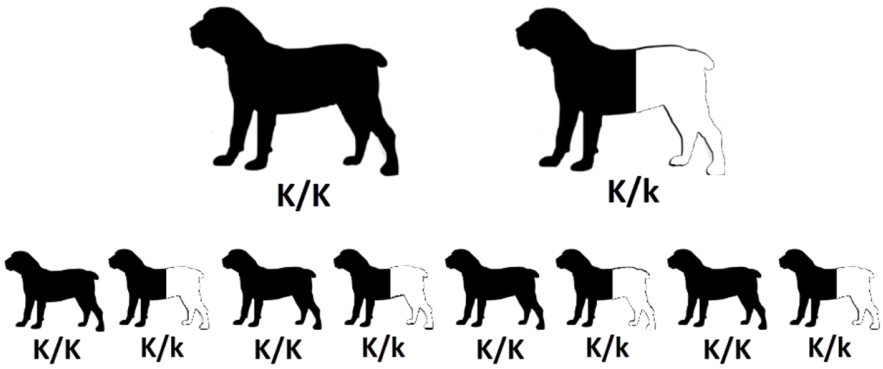
In Boerboels black is a dominant colour, recessive black has not been found in a Boerboel. So for a puppy to be black it must have at least one black parent.

The black Boerboel is descended from only three dogs. Two of the three we believe, were sisters and would share the same DNA. Therefore it is recommended that a black Boerboel not be bred to another black Boerboel or the offspring of a black Boerboel for two reasons.

1. When you breed dominant black carrier to dominant black carrier 25% of the litter are likely to be homozygous (have two of the same alleles) for dominant black. So they would be K/K. When bred to any other colour (ignoring the effects of liver and recessive red) all the puppies will be black.

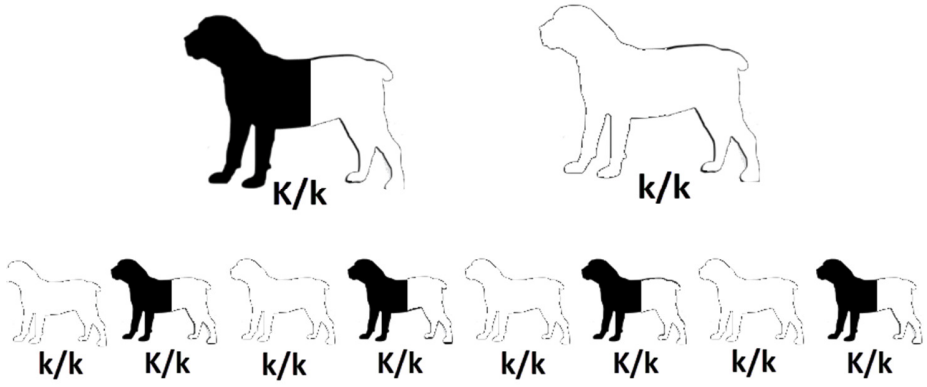


When you breed a homozygous black Boerboel to a black carrier the whole litter will be black and 50% will be homozygous.



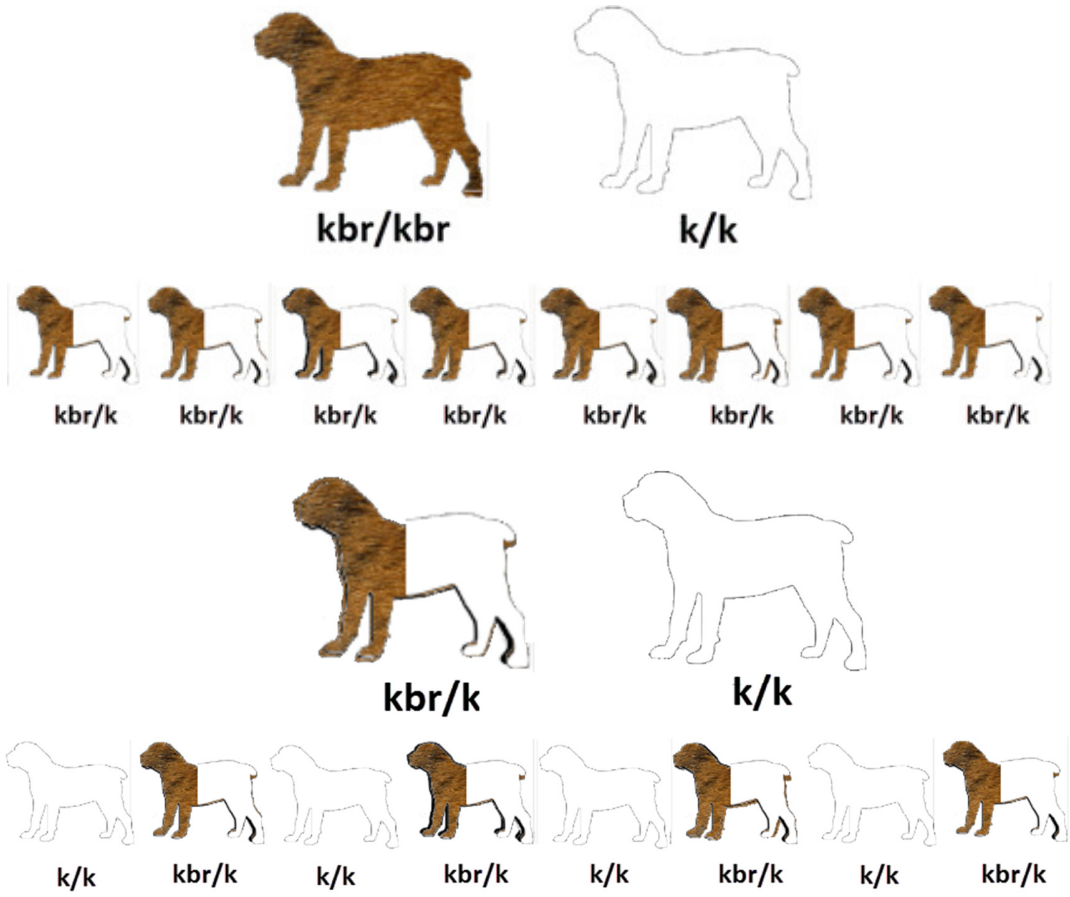
2. In addition, breeding black to black or another dog from black lines increases the coefficient of inbreeding and increases the chance of genetic faults and diseases. https://en.wikipedia.org/wiki/Coefficient_of_relationship.

The best option is to always breed black to a dog from non-black lines. That will keep the colour diversity and reduce the inbreeding coefficient.



Brindle is the second dominant allele to black and although not as much of an issue for inbreeding as black, if you want to get a diversity of colours it is best to also breed brindle to non-brindle.

Like with black, if you have a homozygous (have two of the same alleles) brindle, if you breed it to a sable/brown dog all the puppies will be brindle but carry the fawn allele.

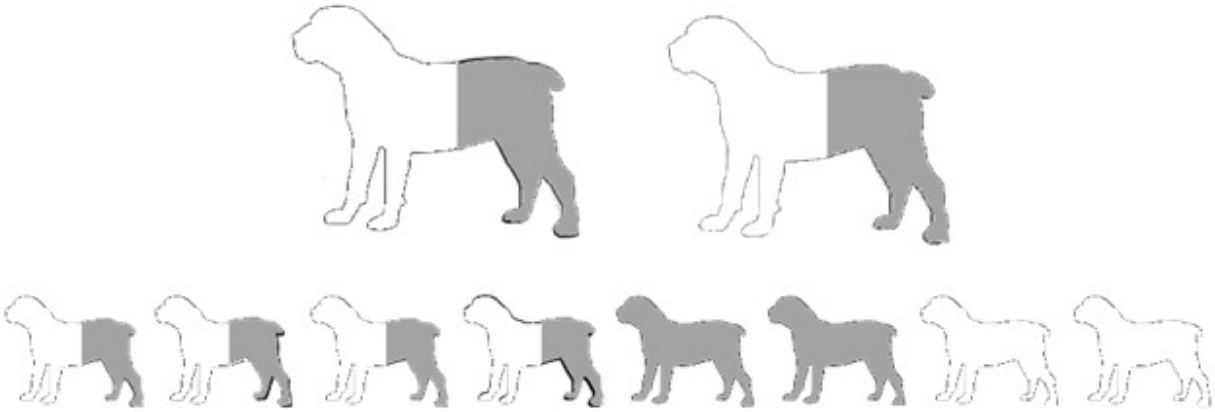


BREEDING RECESSIVE COLOURS

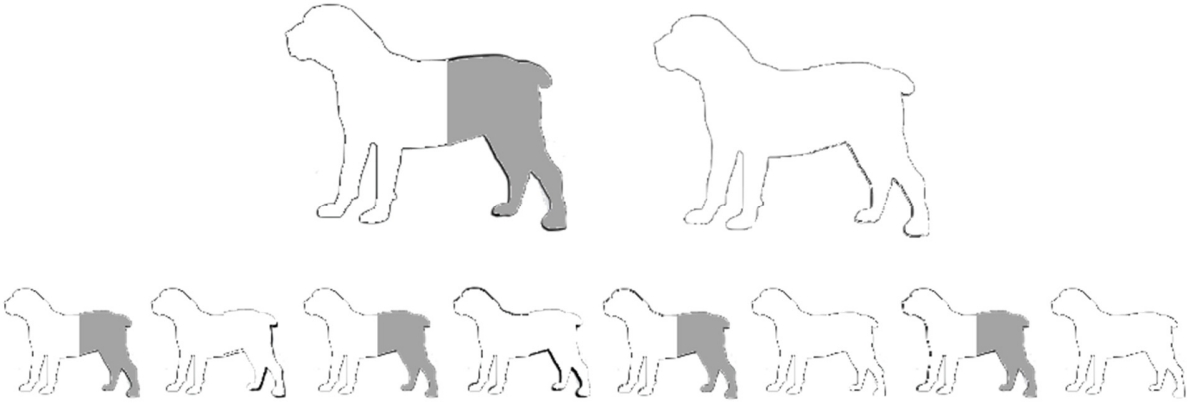
At this time dilute, piebald (more than 33% white) and liver/chocolate, isabella (dilute liver) and tan points are all excluded from the breed standard. In addition recessive red should be excluded as it hides all other colours.

When breeding dogs with recessive genes, best practice is to test for the genes before breeding. If you breed two carriers together you will have the chance of 25% homozygous offspring that display the recessive gene and 50% of offspring carrying the gene. It is better to breed a carrier to a clear dog to minimise the recessive gene.

TWO CARRIERS:



ONE CARRIER TO A NON-CARRIER:



If you wish to remove the recessive gene from your breeding program you can test the puppies and select a clear (non-carrier) to keep as a future breeding dog. Having 50% non-carries increases you choice of pup(s) to keep.

It should be noted that in addition it is not recommended to breed piebald to piebald or irish marked to piebald as it produces extreme white.

© Steve Papworth
Gatekeeper Boerboels AU

APPENDIX

COLOURS/PATTERNS NOT FOUND IN THE BOERBOEL

E OR EXTENSION LOCUS:

Em	Eg and Eh	E	e

1. **GRIZZLE AND COCKER SABLE** **Eg/Eg, Eg/E, Eg/e** Grizzle is specific to Salukis, Afghan Hounds and Borzoi. Cocker Sable **Eh/Eh, Eh/E, Eh/e** was discovered in Cocker Spaniels and modifies tan point. These are not found in the Boerboel.

M LOCUS – MERLE: Merle creates patches of colour randomly on a dog's coat. Merle affects only eumelanin and causes fading or dilution of some areas. There are 2 alleles.

M	m

1. **DOUBLE MERLE** **M/M** Merle is dominant and only requires one M allele to present. Dogs with both dominant alleles are known as double merles and typically have large patches of white with some merle patches.
2. **MERLE** M/m **M/m** is the normal gene for merle dogs. Merle is not found in Boerboels.
3. **NON MERLE** **m/m** No merle patches in the coat.

MERLE SHEEPDOG

© Ellen Levy Finch
owned by Kathie Leggett

H LOCUS – HARLEQUIN: Harlequin only shows when the merle gene is present. It causes the area between the dark patches on a merle to turn white. There are two alleles.

H	h

For Harlequin to display the merle must also be present, therefore all harlequin dogs are also merle.

3. **HARLEQUIN** **H/H, h/h** When combined with merle, harlequin is expressed. Harlequin is not found in Boerboels
4. **NON HARLEQUIN** **h/h** No harlequin.

HARLEQUIN

USEFUL SITES AND INFORMATION:

http://sabbs.org/

http://doggenetics.co.uk/index.htm

https://www.mydogdna.com/crm/index.html#en/breeds/522dc470119db41645000003/Boerboel/conformation

http://orivet.com.au/canine-coat-colours/

http://www.animalabs.com/dog-coat-color/

http://www.vetgen.com/canine-coat-color.html