

Produced in collaboration with
the Bracco Italiano Club UK



Coat Colours in Bracco Italiano

BREEDING AWAY FROM FAWN AND TAN MARKINGS

Standard Main Coat Colours



Orange



Chestnut

both can be with or without roan / white

Undesirable colours



Fawn



Chestnut and Tan

Dog Colours: Melanin

- ▶ Dogs come in many colours
- ▶ Colours in dogs and many mammals are created by a pigment called Melanin.
- ▶ Melanin gives each strand of hair its colour. It is also responsible for skin and eye colours.
- ▶ There are two main types of Melanin:

Dog Colours: Melanin

- 1. Eumelanin:** Black pigment
 - 2. Pheomelanin:** Red pigment
- ▶ A dog's coat colour is created by the Expression, Intensity and Distribution of these two pigments
 - ▶ Different genes control the expression, intensity and distribution of these two pigments.

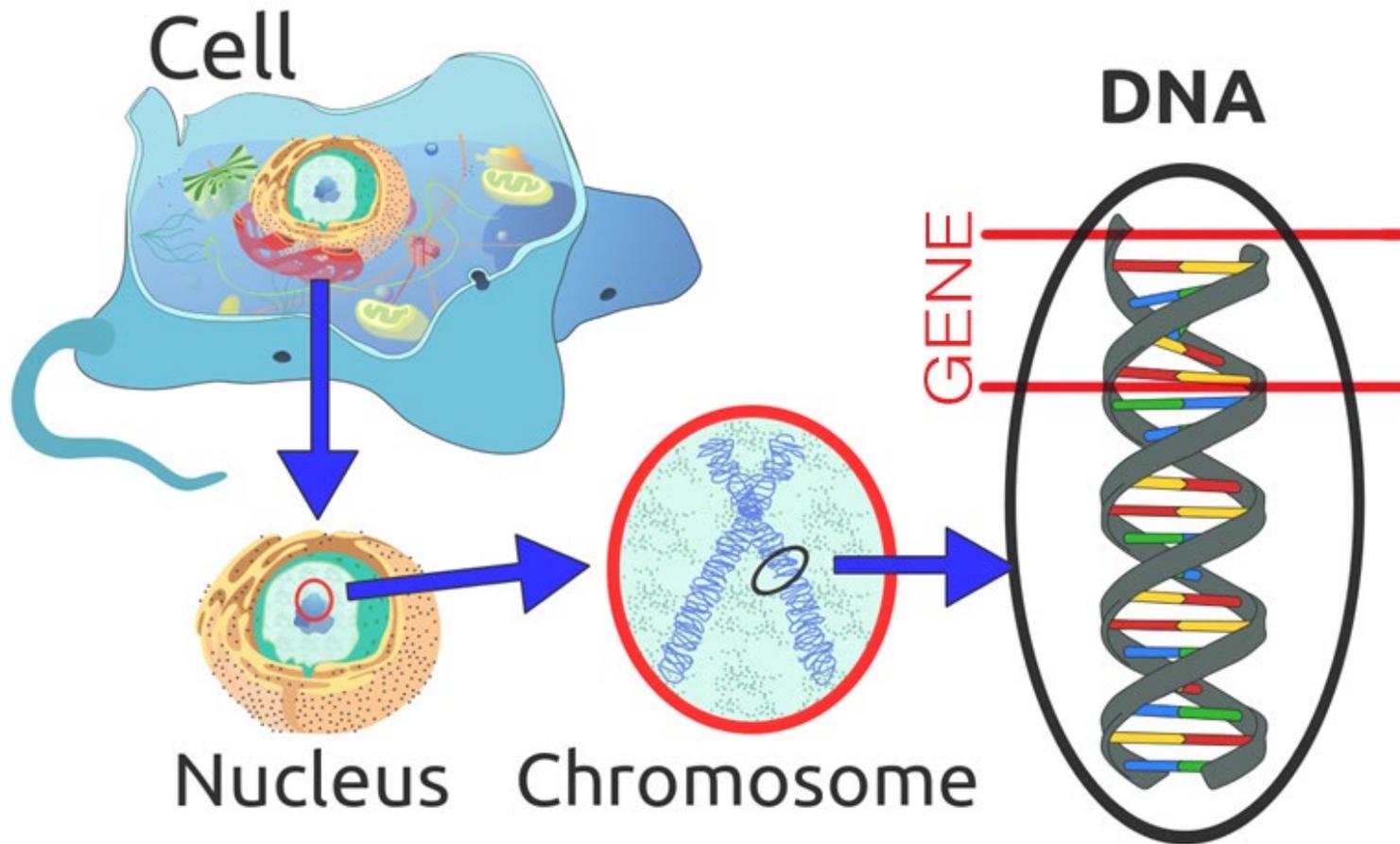
Genes

- ▶ Genes determine the dog's coat colour.
- ▶ Genes exist in every cell of the body and hold the information which controls the development and characteristics (traits) of the dog.
- ▶ Every dog passes this genetic information to its offspring.

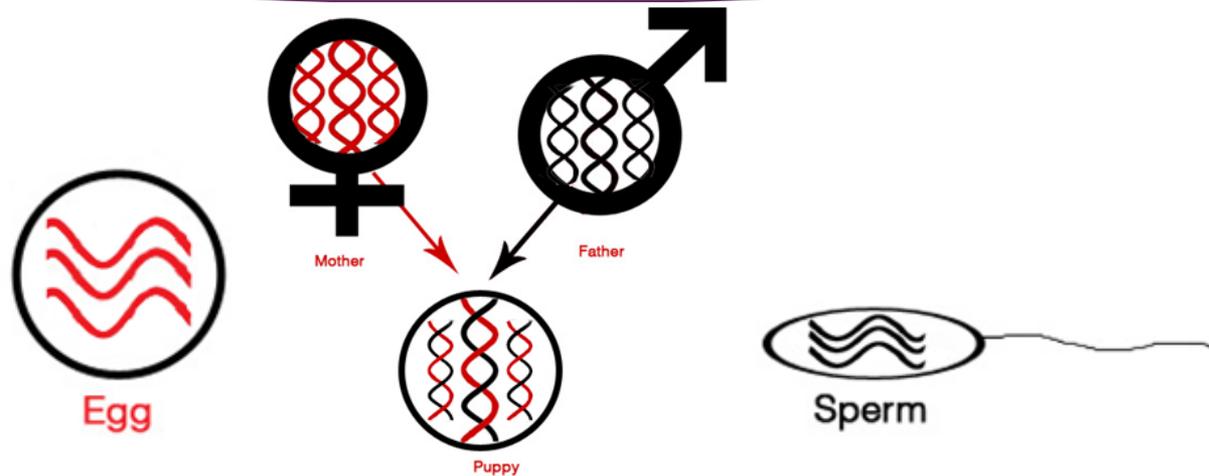
Where are these genes?

- ▶ Inside the cell's nucleus there are structures called Chromosomes, a chromosome is made of a thread of DNA, which consists of two strands of small chemical structures joined together known as the bases.
- ▶ A gene is a region of DNA that is responsible for a particular inherited trait / characteristic.

Genes

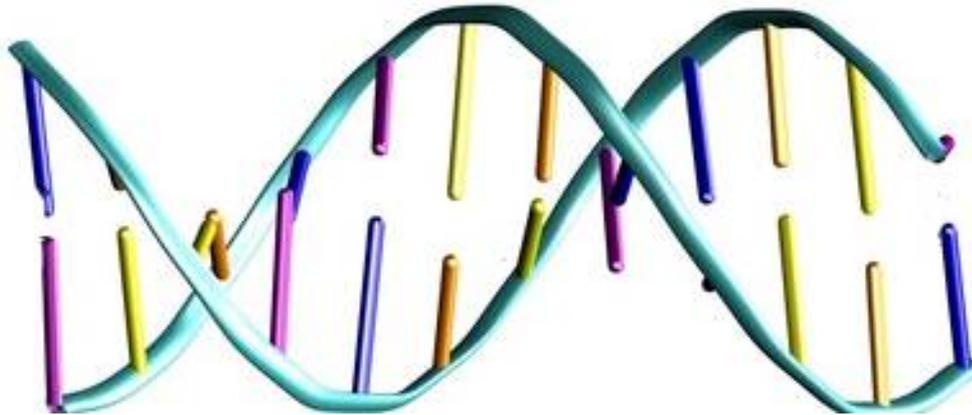


Genes



- ▶ Chromosomes, in a body cell, are arranged in pairs, one from the mother and one from the father.
- ▶ Eggs and sperms are different from body cells in that each contains only one copy of each chromosome.
- ▶ When the egg unites with the sperm the fertilised egg contains one copy of the father's chromosomes and one copy of the mother's chromosomes.
- ▶ The fertilised egg contains the genetic data of the new puppy.

Genes



- ▶ Genes are regions of DNA on the chromosomes, and since chromosomes are arranged in pairs, every gene has two parts, one paternal and one maternal.
- ▶ An allele is one of the two parts of the gene; it can be maternal or paternal.
- ▶ The two alleles of the gene can be identical holding the same information, or can be different and so each holds different information.

Useful Terms

What is a Locus?

A locus is location on the chromosome where the gene is located. It is like an address.

Genotype vs Phenotype

Genotype is the actual genetic information related to a gene, whether it is expressed or not.

Examples: Genotype e / e for E-Locus (orange)

Genotype ay / ay for A-Locus (fawn)

Phenotype is the actual observed colour

Examples: Chestnut dog, Orange dog, Fawn dog, Long haired dog

Homozygous vs Heterozygous

Homozygous is when the gene has two identical alleles

Examples. N / N (both the same)

e / e (both alleles the same)

Heterozygous is when the gene has two different alleles

Example N / e (two different alleles)

Useful Terms

What is a recessive allele?

- ▶ A recessive allele of a particular trait will only express the trait if the gene has two copies of this allele. It is usually denoted by a lowercase letter (example 'e')

What is a dominant allele?

- ▶ A dominant allele of a particular trait will express the trait even if the dog has one copy of this allele. It is usually denoted by an uppercase letter (example 'N')

Example

The E Locus which is responsible for the orange coat colour has two alleles, each of them can be on of the following variants:

- ▶ The 'e' allele which is responsible for expressing the orange coat colour, 'e' is recessive and therefore the dog must have two copies of the 'e' allele to express the orange trait.
- ▶ The 'N' allele for No Orange is dominant to 'e' . If the dog has one or two copies of 'N' it will not be orange.

Coat Colours in Dogs

- ▶ There are many genes involved in dog coat colours. These genes interact with each other. A dog may express certain coat colours but hide other coat colours, hidden colours may be expressed in next generations.
- ▶ Genes which are important for one breed may not be the same for another breed. This is because in some breeds, some genes are always homozygous or have no importance for a particular breed.
- ▶ For example. the white spotting gene is not important for the Labrador breed because Labradors have no white spotting.
- ▶ Bracco Italiano always have white spotting so testing this gene has little importance because a Bracco Italiano should always have white spotting.
- ▶ The coat areas which are not white are called the Pigmented areas, which are the subject of our study.

Genes important for the Bracco Italiano Breed

There are seven important genes, which play an important role in determining the coat colour of Bracco Italiano, these are:

- ▶ **The E Locus:** responsible for the Orange coat colour. it controls the presence or absence of Orange.
- ▶ **The K Locus:** in Bracco Italiano this gene is responsible for switching the A Locus on or off (We will explain how later)
- ▶ **The A Locus:** responsible for the Agouti Patterns: Fawn, banded hair, and Chestnut-and-tan.
- ▶ **The B Locus:** responsible for the chestnut (brown) coat colour. In Bracco Italiano the genotype of B-Locus is always b/b and so there is little benefit in testing for the B-Locus.
- ▶ **The S Locus:** responsible for the white spotting. In Bracco Italiano the genotype of S-Locus is always S/S and so there is little benefit in testing for the S-Locus.
- ▶ **The T Locus (Roan / Ticking):** Ticking refers to flecks or spots of colour on white areas. It can occur on any white area on a dog. Currently there is no test for Roan.
- ▶ **The I Locus (red intensity):** this gene controls the intensity of the Pheomelanin (red) pigment (orange and fawn). Dogs with two copies of the mutation (i/i) will have lighter shade of orange / fawn.

The E Locus

- ▶ In Bracco Italiano, the E locus controls the presence or absence of the orange coat colour.
- ▶ The E locus has two alleles, each allele can be either:
- ▶ N = no orange, or
- ▶ e = orange.
- ▶ The orange allele (e) is recessive to the no orange allele (N).
- ▶ A Bracco Italiano dog can have one of the following genotypes at E locus:
- ▶ **e / e**: the coat colour will be orange in the pigmented areas. All the other genes will have no effect on the coat colours and will be hidden.
- ▶ **N / N**: The dog will not be orange. Coat colour in the pigmented areas is determined by the other genes.
- ▶ **N / e**: the dog will not be orange because N is dominant and 'e' is recessive. Coat colour in the pigmented areas is determined by the other genes.

Remember:

- ▶ Orange Bracco are always “e / e” so there is no need to test the E Locus.
- ▶ Non Orange Bracco can be either “N / N” or “N / e”.

COAT COLOUR INHERITANCE IN
Bracco Italiano

E LOCUS: ORANGE

Responsible for the presence or absence
of the Orange Coat Colour

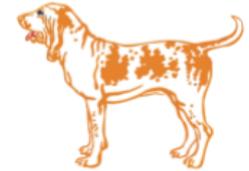
Each of the E Locus alleles
can be either:

e = Orange

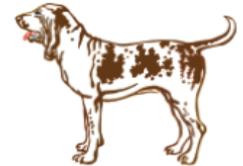
N = No Orange

N is dominant, e is recessive

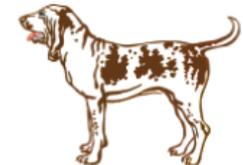
e / e = orange



N / e = no orange
Carrying orange

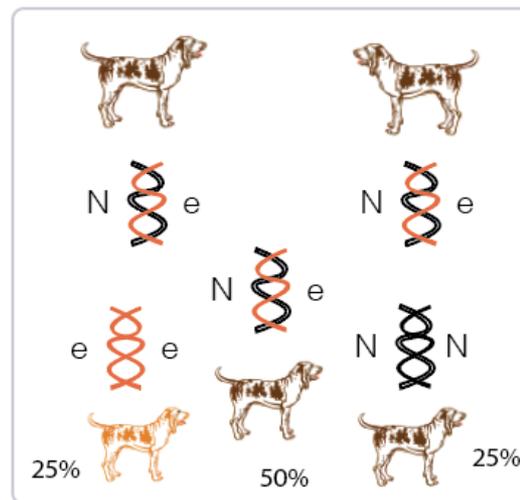
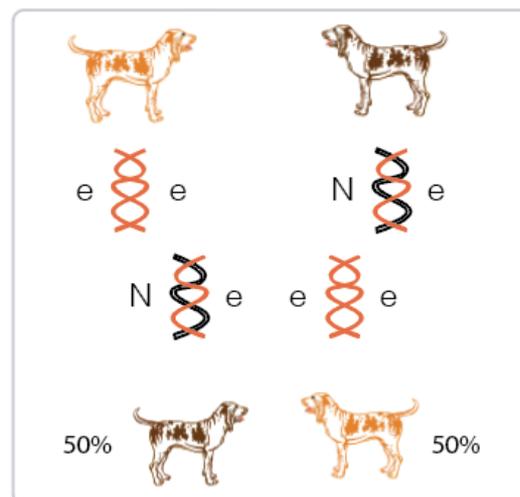
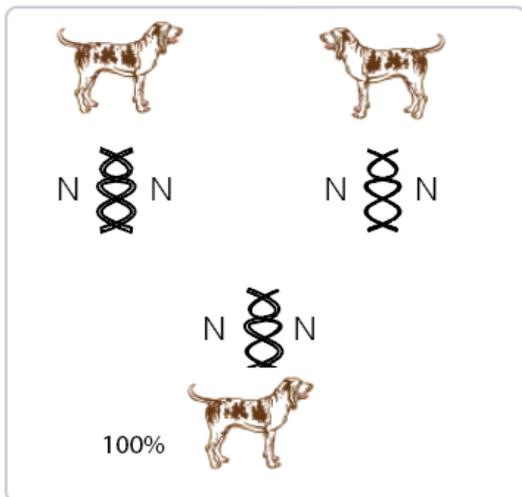
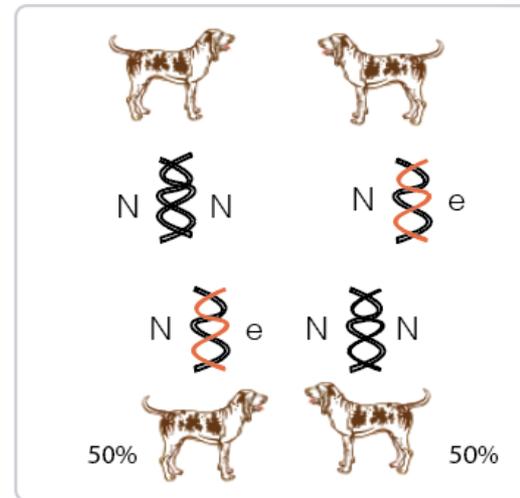
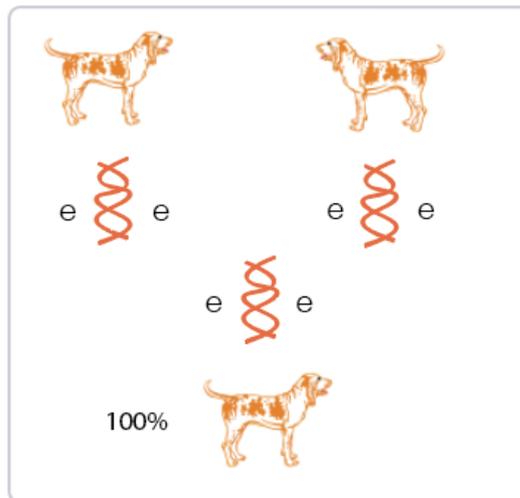
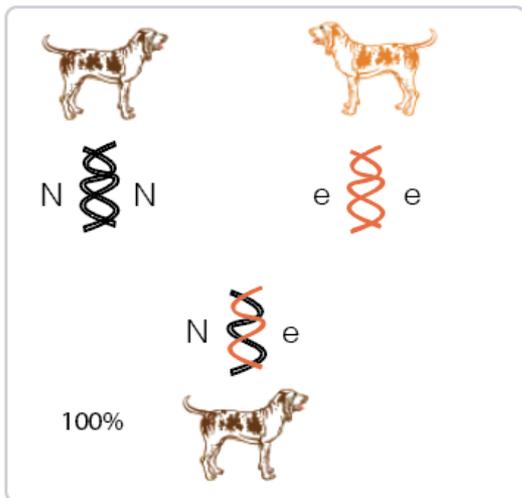


N / N = no orange



COAT COLOUR INHERITANCE IN
Bracco Italiano

E-LOCUS: ORANGE - Breeding



The B Locus: chestnut (brown)

- ▶ The B Locus is responsible for the Chestnut coat colours.
- ▶ In Bracco Italiano, Chestnut refers to varying degrees of brown .
- ▶ In Bracco Italiano, the B-locus is always homozygous for the 'b' allele (genotype b/b)
- ▶ When the B Locus is expressed the dog's colour will be chestnut.
- ▶ The B Locus is expressed in non-orange Bracco Italiano dogs when the agouti gene is switched off:

This means that the B Locus is expressed in the hair of the dog when both of the followings is true:

- ❖ the E Locus is N / N or N / e: the dog is not orange, and
 - ❖ the agouti gene (A Locus) is switched off: the dog is not fawn and has tan-marking.
-
- ▶ The K Locus is responsible for switching the Agouti on or off
 - ▶ The K Locus has two alleles: KB and ky. KB is dominant to ky.
 - ▶ If the K Locus is KB / KB or KB / ky: the agouti is switched off and the dogs coat colour is
 - ▶ determined by the B Locus (Chestnut).
 - ▶ If the K Locus is ky / ky: the agouti is switched on and the dog will be either fawn or chestnut-and-tan.

Next: more about the K Locus

The K Locus

- ▶ The K locus comes into play ONLY in non-orange dogs, in orange dogs it has no effect on the coat colour.
- ▶ The K Locus decides whether the Agouti patterns (fawn / chestnut-and-tan) will be expressed or not.
- ▶ If it decides that the Agouti is not expressed, dog coat colour in the pigmented areas will be uniform and determined by the B Locus (Chestnut b/b). If it decides that the Agouti is expressed, the dog coat colour will be either fawn or chestnut-and-tan.
- ▶ The K-Locus also decides if the brindle (K^{BR}) pattern is expressed, however, at the moment there is no test for the brindle.

How?

- ▶ The K locus has three alleles, each allele can be either K^B , K^{BR} or ky . K^{BR} is for brindle but at the moment we cannot test for brindle
- ▶ K^B enables uniform distribution of the eumelanin pigment (Chestnut b/b) in the pigmented areas by switching off the Agouti gene.
- ▶ ky enables the Agouti patterns to be expressed (fawn / chestnut-and-tan).
- ▶ It is thought that when the K^{BR} is expressed, the dog's colour would be determined by the A-Locus (Fawn or chestnut-and-tan), however, the red pigment (fawn / tan) would be brindled with chestnut hair stripes.
- ▶ K^B is dominant, while ky is recessive. It is thought that K^{BR} is recessive to K^B but dominant to ky

The K Locus genotypes

The K Locus can have the following genotypes:

- ▶ **KB / KB**: the dog will be unicolour (Chestnut b/b) in the pigmented areas.
- ▶ **KB / ky**: because KB is dominant, the dog will be unicolour (Chestnut b/b) in the pigmented areas.
- ▶ **ky / ky**: the Agouti pattern will be expressed, to find out whether the dog is fawn or chestnut-and-tan, we need to test the A Locus.

Brindle

- ▶ Brindle is caused by an allele that is located on the K-Locus known as K^{BR} .
- ▶ Brindle is not yet well-understood and there is no test for it at the moment.
- ▶ It is thought that when the K^{BR} is expressed, the dog's colour would be determined by the A-Locus (Fawn or Tan-marking), however, the red pigment (fawn / tan) would be brindled with chestnut hair stripes.
- ▶ Since a test is not available for brindle, it will not be possible, at least at the moment, to breed away from brindle.
- ▶ There are a number of ongoing research project into brindle but no commercial test is yet available.



K LOCUS: The Switching gene

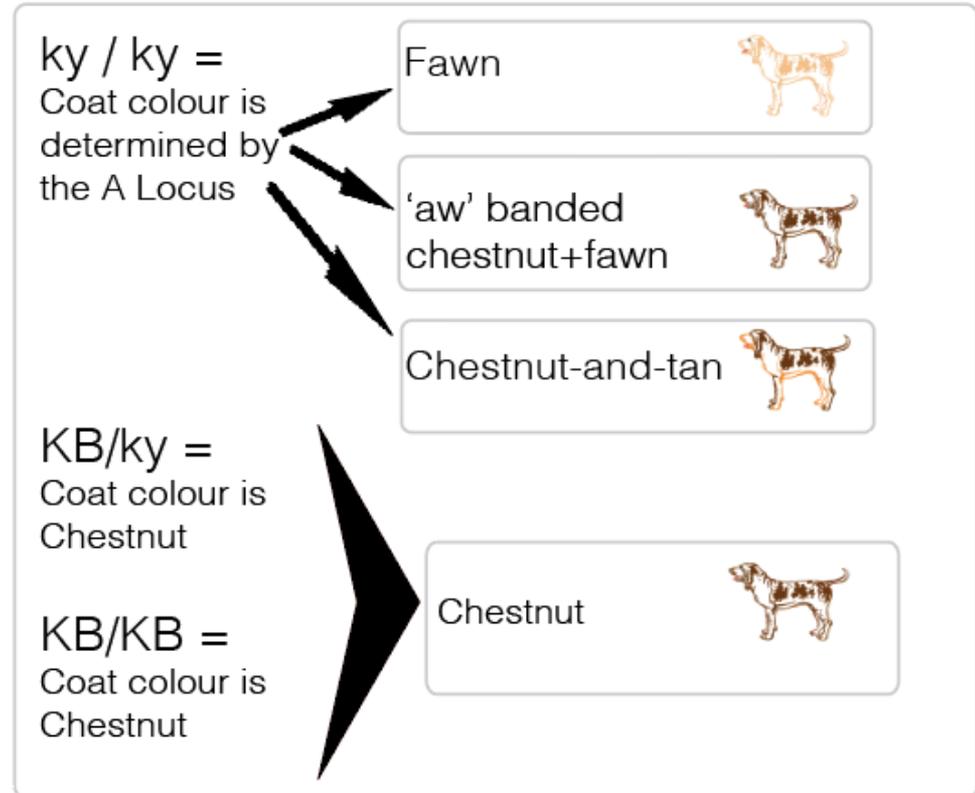
In non-orange dogs, the K Locus is responsible for deciding if the Agouti patterns are expressed (fawn / chestnut-and-tan) or not (coat colour in the pigmented areas is uniform (Chestnut b/b).

Each of the K Locus alleles can be either:

ky = Coat colour determined by the A Locus (Fawn / Chestnut-and-tan)

KB = Coat colour uniform and determined by the B Locus (Chestnut b/b)

KB is dominant
ky is recessive



The A Locus patterns

- ▶ The A Locus is responsible for the Agouti patterns: fawn, wolf grey, tan-marking and recessive uniform colour.
- ▶ The A Locus has four alleles:

Ay- Fawn, this coat colour is not desirable in Bracco Italiano.

Aw- Wolf Grey: this pattern is characterised by strands of fur that are banded.

The banded hair is usually restricted to certain parts of the coat, which are, roughly, the upper parts (back, head, top of legs etc).

In Bracco, banded hair strands have bands of fawn alternating with bands of chestnut. Only one Bracco Italiano tested as aw/aw at the A-Locus.

at - Chestnut-and-tan: this coat colour is not desirable in Bracco Italiano.

a - Recessive unicolour: this allele leads to unicolour (chestnut), however, so far we haven't tested any Bracco Italiano to carry this allele.

Order of dominance: AY > aw > at > a

The A Locus genotypes

In Bracco Italiano, the A Locus can have the following genotypes:

- ▶ **Ay / Ay**: the dog will be Fawn in the pigmented areas (provided the Agouti is switched on by the K locus)
- ▶ **Ay / at**: Since Ay (Fawn) is dominant to at (Tricoloured), the dog will be fawn in the pigmented areas (provided the Agouti is switched on by the K locus)
- ▶ **Ay / aw**: Since Ay (Fawn) is dominant to aw (wolf grey), the dog will be fawn in the pigmented areas (provided the Agouti is switched on by the K locus)
- ▶ **aw / aw**: Hair strands have bands of fawn alternating with bands of chestnut. (if the Agouti is switched on by the K locus)
- ▶ **aw / at**: Since aw is dominant to at, aw is expressed and hair strands will have bands of fawn alternating with bands of chestnut. (provided the Agouti is switched on by the K locus)
- ▶ **at / at**: If the Agouti is switched on (by the K Locus) the dog will be chestnut-and-tan.

A LOCUS: The Agouti gene

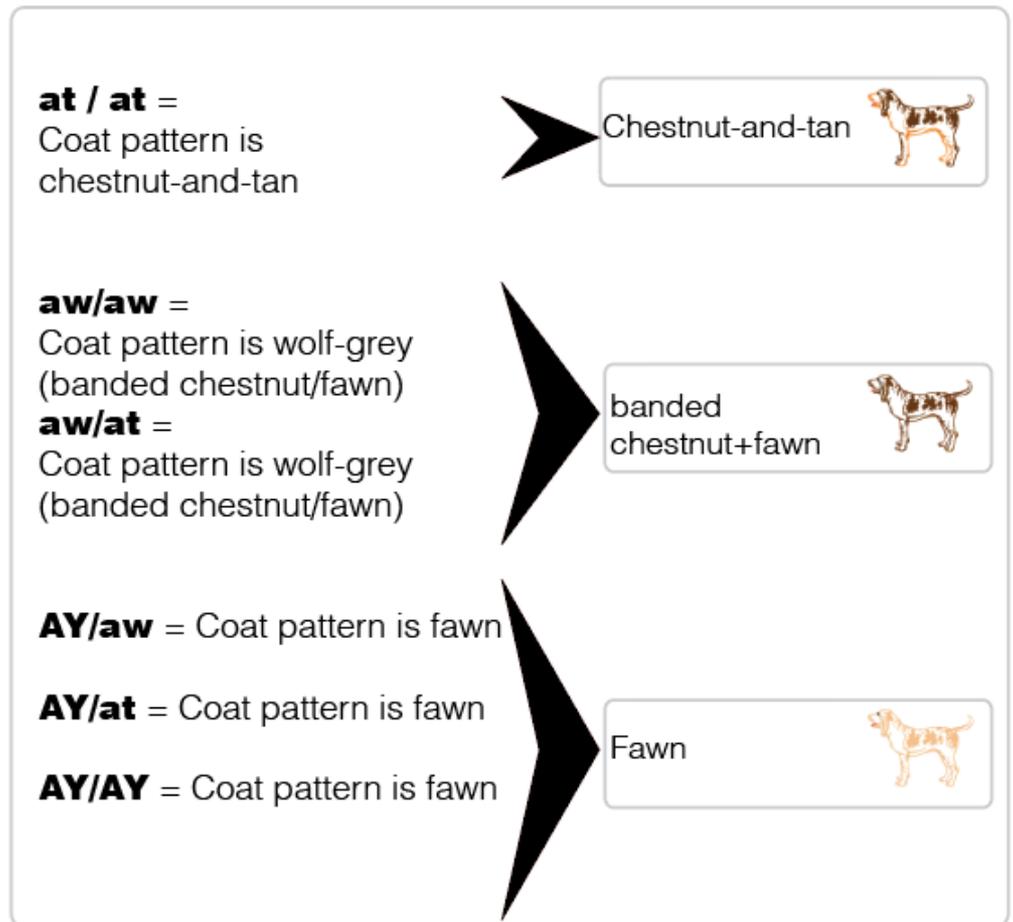
The A Locus is responsible for the Agouti patterns, this includes Fawn, Wolf Grey, tan-marking and recessive uniform colour.

The A Locus is only expressed if the K locus is ky/ky

Each of the A Locus alleles can be either:

AY = fawn
aw = wolf grey
at = chestnut-and-tan
a = recessive chestnut
(not found in Bracco yet)

Order of dominance:
AY > aw > at > a



COAT COLOUR INHERITANCE IN BRACCO ITALIANO

E Locus

e/e



Orange and white

N/e
N/N



No orange check other genes



K Locus

KB/KB
KB/ky



B Locus



Chestnut and White

ky/ky



A Locus

AY/AY, AY/aw, AY/at



Fawn and White

aw/aw, aw/at



banded hair strands
(Chestnut + fawn)

at/at



Chestnut-and-tan

Phenotype to Genotype:

Orange and White

E Locus: always e / e
All other genes are hidden



Chestnut and White:

E locus: Either: N / N or N / e
K Locus: Either KB / KB or KB / ky
A Locus is hidden



Fawn and White:

E locus: Either: N / N or N / e
K Locus: always ky / ky
A Locus: Either AY/AY or AY / at



Wolf grey (banded chestnut+fawn):

E locus: Either: N / N or N / e
K Locus: always ky / ky
A Locus: always aw / aw or aw / at



Tricolour:

E locus: Either: N / N or N / e
K Locus: always ky / ky
A Locus: always at / at



Real Example (1)

Dog Name: Copper

Phenotype: **Chestnut-and-tan**

Genotypes:

E Locus: N / e

No Orange

K Locus: ky / ky

Agouti is expressed

A Locus: at / at

Chestnut-and-Tan



Real Example (2)

Dog Name: Dog A

Phenotype: **Fawn**

Genotypes:

E Locus: N / e

No Orange

K Locus: (ky / ky)

Agouti is expressed

A Locus: Ay / Ay

Fawn



Note: dog tested and verified by Laboklin – Owner does not wish the dog to be named.

Real Example (3)

Dog Name: Venzia

Phenotype: **Orange**

Genotypes:

E Locus: e / e

orange



Real Example (4)

Dog Name: Kora

Phenotype: **Chestnut**

Genotypes:

E Locus: N / N

no orange

K Locus: KB / KB

Agouti is NOT expressed
colour determined by
B Locus (Chestnut)



Fawn and Tricolour

- ▶ Fawn and Chestnut-and-tan are undesirable coat colours in the Bracco Italiano breed.
- ▶ Breeders would like to use genetic testing in order to avoid breeding fawn or Chestnut-and-tan dogs.

The Aim:

To reduce the occurrence of the
Fawn and Chestnut-and-tan coat colours in Bracco Italiano
without compromising the gene pool.

K Locus is the key

- ▶ Like most breeds, Bracco Italiano dogs will always carry the 'AY', 'aw' and the 'at' alleles whether these alleles are expressed or not.
- ▶ It is possible to prevent the expression of the fawn and Chestnut-and-tan colours by ensuring that the agouti gene is not expressed.
- ▶ To ensure that the agouti gene is not expressed the dog must have at least one copy of the KB allele at the K Locus.
- ▶ Regardless of the colour of the dog, test for the K Locus and ensure that the puppy will inherit at least one copy of the KB allele from either parent.
- ▶ If a dog has at least one copy of the ky, it must be bred with a dog that has KB / KB.
- ▶ It is possible to avoid breeding ky completely, however this approach is **not recommended** at all because it will limit the gene pool.

LABOKLIN

- ▶ All coat colour tests are available at LABOKLIN, a DNA sample is required for the tests, this can be either blood in EDTA tube (1-2 ml) or buccal swabs. Blood must be collected by a vet whereas Buccal swabs maybe used by dog owners. Sample collection materials are available from LABOKLIN free of charge.
- ▶ For further information contact: Dr Mansour Makki, LABOKLIN UK, 125 Northenden Road, Sale, Manchester M33 3HF. Tel: 0161 2803066 email: makki@laboklin.co.uk website: www.laboklin.co.uk.