RABBIT GENETICS

The Basics

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Contents

A Locus

The A Locus is responsible for the APPEARANCE of the coat. Please understand that the A locus is not defining COLOUR, only the appearance or pattern of the coat

The A Locus
A- agouti. Agouti is recognised by a ringed pattern on the hair shaft. Chestnut and chinchilla are examples of agouti.

at- tan pattern. Tan pattern is recognised by the rabbit having one colour on top (black, blue, chocolate, lilac, sable, smoke pearl) and a different colour on the belly (white/silver, or rufus) Otter and silver marten (Fox) are examples of tan pattern

a-self. This is identified by a rabbit that is one solid colour (black, blue, chocolate and lilac, REW and BEW)

These alleles are listed in order of inheritance. All rabbits will have two alleles for each gene or loci location, I.E. A_ , at_ , aa. They inherit once copy from each parent.

An agouti rabbit can carry agouti, tan pattern, or self as the second gene, Tan pattern can carry tan pattern, or self as the second gene. A self rabbit can only carry self because it is the most recessive gene on this locus. So, self will always be aa, as will any other gene that is the most recessive on that locus

Something else to note. REW and BEW, while considered "self" actually are not. They carry all the genetics for colour, but it is masked due to the gene responsible for REW or BEW. If you test breed one of these rabbits, you can cipher out what colours they actually carry.

‘A' locus works on the appearance of the coat, particularly the banding. There are three traits:
A- Agouti which means wild type coat, has their distinct bands (base colour, shaft colour, tip colour) Agouti rabbits can carry 'at' or 'a' recessively.
at- Tan which is otters, martens, and tans. Classified by their bold chin strap, nape, belly, and eye ring markings. 'at' rabbits can carry 'a' recessively. They can also be 'atat'.
aa- Self. Self is a solid coloured rabbit with no banding in it's fur shaft. This is the most recessive of the A locus. If it's Self, it cannot carry any other A locus trait.
You can get Agouti rabbits from Tan or Self rabbits if bred to an Agouti. You cannot get Agouti from breeding a Tan to a Self as neither have the dominant A allele.

B Locus

The B locus defines the BASE COLOUR of the rabbit. All colours have one of two base colours, either black, or chocolate.

The B Locus
B-black (blue is the dilute of black)
b-chocolate (lilac is the dilute of chocolate)

B can either be BB or Bb, but b can only be bb, because it is the most recessive allele on this locus, so b will always be written as "bb". Chocolate is recessive to black and can never carry black, and also can never produce black based colours.
Black can carry chocolate as a recessive, and can produce both black, and chocolate colours.

Examples of BLACK based colours are: black agouti (aka chestnut), opal (dilute chestnut), Chinchilla, and squirrel (dilute chin)

Examples of CHOCOLATE based colours are: chocolate agouti (cinnamon), lynx (dilute chocolate agouti). There are also chocolate and lilac versions of chinchilla

Black/Blue – BB
Black/Blue Carrying choc/Lilac – Bb
choc/lilac – bb

Black can carry chocolate, it's written as Bb. A dominant gene can carry a gene equal to it, or more recessive as it's second gene. Blue is the dilute of black, and once we cover the D locus, you will see that a black rabbit can carry both chocolate, and dilute

Black/Blue can produce Choc/Lilac
Choc/Lilac cannot produce black/blue

C Locus

The C locus CONTROLS the expression of colour on the hair shaft. this locus is responsible for giving us chinchillas, among other colours.

C Locus
C-full colour expression
cchd- Chinchilla, this allele strips the yellow from the coat, leaving only black and white.
cchl-this is the shaded gene, it produces colours such as Siamese Sable and Smoke Pearl
ch-the Himalayan gene. Also called pointed white, or Californian.
c-ruby eyed white. Any rabbit with two copies of this gene will be a REW regardless of other alleles.

To make this easier to understand. Let me explain.

C is full colour expression, such as black, or chestnut
cchd- this gene turns a chestnut into a chinchilla, and an otter into a silver marten (Fox)
cchl- this gene turns a black rabbit into a Siamese Sable
ch-this gene turns a black rabbit into a white rabbit with coloured points
c-two copies of this gene will turn any rabbit into a REW. Carried recessively, it has no effect on colour.

Some of these genes will affect different colours in different ways, such as the chin gene. It turns chestnut into chinchilla, and harlequin into magpie. The shaded gene can also double up cchl/cchl, to produce seal, which is sometimes mistaken for chocolate, or black. The chinchilla gene has no effect on self coloured rabbits, other than it will occasionally produce a bluegray eye on a dense colour such as black (that should have a brown eye).

Something else to note. "ch" the himalayan gene is colour sensitive, and reacts to cold. If the rabbit lays up against something cold, such as a frozen water bowl, the area of skin that is near that cold will produce a dark spot on the fur called "smut", this can appear anywhere on the body, and will disappear with the next moult. But smut is a disqualification on the show table, so care should be taken to ensure that if you have ch rabbits, they are not exposed to extreme cold.

C- your rabbits look like their normal selves
cchd-your chestnut is now a chinchilla, your black looks the same
cchl-your black rabbit is now a sable, your chestnut is now shaded agouti
ch-your black rabbit is now a himalayan, your agouti is now a colour that has no name, but is essentially a himalayan with agouti points
c-if your rabbits only have one copy "_c", they look normal. If they have two copies "cc" they are now both ruby eyed white

cchd strips yellow/orange from the coat, leaving only black, grey and white
cchl produces shaded

D Locus

The D locus determines whether the rabbit will be DENSE, or DILUTE. As an example, using black and blue. Black is the dense colour, blue is the dilute colour (blue is the dilute of black). Chocolate is dense, lilac is dilute. Chestnut is dense, opal is dilute, chinchilla is dense, squirrel is dilute, the list goes on and on. Almost all colours have both a dense and a dilute.

D Locus
D - Dense
d- Dilute Bass

D_ is dense
Dd is dense carrying dilute
dd is dilute

As with all of the most recessive genes, a dilute rabbit is shown as "dd".

Du Locus

Du, or the Dutch gene. This gene is an either/or gene. Either the rabbit has it, or it doesn't.

Du locus, in order of dominance

Du - dutch
du - not dutch

Du is dominant over du, so two dutch rabbits could presumably produce a non-dutch offspring. It's not likely to happen, simply because Dutch have been bred for so long that most other genes have been eliminated.

This gene has NOTHING to do with vienna marked rabbits that are the result of bew breeding and the vienna gene.

E Locus

The E locus controls the extension of colour on the hair shaft. It's the locus responsible for steel, harlequin, and non-extension colours such as tort

There are only four genes in the E Locus. But some of them are very important.

Es - steel
E - full extension ("normal" colour)
ej - harlequin
e - non-extension

Es (steel) . This gene removes the rings from an agouti, leaving only the midband colour, and the top ticking colour. It has no effect on self, and quite a weird effect on tan patterns

Steel is the most dominant gene on the E locus. It takes an agouti rabbit and not only removes the bands from the hair shaft, but also extends the undercolour further up the coat, past where the second band would have been. It will take the white belly colour and change it into the dark undercolour. In order for a rabbit to be Es, one parent must be steel.

Now, something interesting occurs when a rabbit has both parents as steel and it happens to inherit two copies of the steel gene, making him EsEs. When you get a double steel or super steel, the undercolour will still extend up the hair shaft, but the surface ticking can thin way out, or even vanish completely, leaving a rabbit that appears to be an oddly coloured self. The only indicator that you have EsEs is that both parents were steel, and the animal looks like a self, but the colour is off.

Self varieties can also inherit the Es gene. The only indicator that you have a self steel is there will be a light ticking along the cheeks, chest and along the sides near the belly. If you have a self rabbit that has one steel parent, look for the ticking in case you have a self steel.

E - this is full extension. This produces what we would expect to see, i.e. normal colouration

ej – Harlequin. The ej allele separates the black and orange colours of the hair shaft and puts them into solid patches of individual colour. This gene only works correctly on agouti based animals. If you have an animal where the colours are separated, but the individual coloured hairs are mingled together, rather than being in solid patches, that is called "brindled" Harlequin can be carried as a recessive, since it is recessive to both Es and E.

e - non-extension This gene restricts the extension of black pigment in the hair shaft. It leaves the yellow or orange pigment (sometimes appears tan or cream). This gene turns a black rabbit into a tortoiseshell. It turns a siamese sable into a sable point. And it can turn a black agouti rabbit into an orange one.

Non-e is the most recessive gene on the E locus, and can be carried as a hidden recessive on Es, E, and ej. In order for a rabbit to BE non-extension, it must have two copies of the "e" gene, i.e. "ee".

Things to remember: Fawn is the dilute of orange. Tort comes in four colours (black, blue, chocolate, and lilac), so the non-extension gene will act on any of the four self colours. Harli comes in both dense and dilute.

On this locus, we have an incomplete dominance between ej and e, in such that sometimes a rabbit that is ej/e will be a harlequin that has tort traits such as shading. No other genes have this issue on the E locus, only ej and e.

So, Es will take an agouti rabbit, and make it a steel
E will leave an agouti rabbit to appear as expected
ej will take an agouti rabbit and turn into a harlequin
ee will take an agouti rabbit and make it an orange, take a sable rabbit and turn it into a sable point, and take a black rabbit and turn it into a black tort.

En Locus

The En locus controls broken patterning, or the lack of it.

EnEn - charlie
Enen - broken
enen - solid.

True charlies can only come from a broken to broken breeding. If you breed a broken to a solid and get a rabbit that looks like a charlie, that is called a false charlie, because genetically the rabbit is Enen, where as a true charlie is EnEn and can only come from broken x broken.

Charlies are identified by a distinct lack of colour. What little colour their is, is normally found on the nose, around the eyes, or on the ears. True charlies can only come from the breeding of broken x broken.

Enen produces broken rabbits with more colour, up to rabbits that are completely coloured other than white boots (booted). Enen can be what is called "false charlie". They appear to be a charlie, but since they are out of a broken x solid breeding, they cannot be a true charlie "ENEN"

enen is solid, aka not a broken pattern of colour mixed with white.

P Locus

Also known as the pink gene
P - no effect
p- lutino effect

Lutino is a recessive gene which deletes the black pigment and only lets the yellow/orange pigment appear ,so you can have all the colour possible ! Black, black otter,blue,lilac,agouti etc

Lutino gene as a colour stripping gene. Like the chinchilla gene, which strips the orange/yellow pigments from the fur leaving behind the black and grey, the lutino gene does the opposite, and strips the fur of all black/grey, leaving behind the orange and yellow pigments.

Si Locus

Known as the Silvering Gene. This gene is only seen in a very few breeds. Primarily the Argent breeds, Champagne de Argent, Argent Brun, Creme de Argent.

These rabbits are born a solid, dark colour. Their silvering appears over time as they mature. This gene causes white tipped hairs to be deposited throughout the coat, resulting in a coat that appears to have a silver overlay.

The Si Gene
SI - no effect
si - silvered

Most silvered rabbits are born black or very dark, and develop their silvering as they mature

V Locus

This is the gene that is responsible for blue eyed white rabbits, and vienna marked rabbits. When a rabbit is blue eyed white, it is actually a coloured rabbit, wearing white fur. If a rabbit has two copies of the Vienna gene "vv", then it will be a coloured rabbit wearing white fur. The vienna gene will over-ride the colour genetics, to produce a white rabbit with blue eyes.

V locus, or "Vienna" gene

VV - normal coloured rabbit, no vienna gene
Vv - "vienna marked" or "vienna carrier"
vv - BEW

If a rabbit is Vv, they will exhibit markings that can resemble a dutch marked rabbit, even though the dutch gene has nothing to do with the vienna gene. Vienna marked or vienna carrier rabbits can also display only a white blaze, or a white spot somewhere. If a rabbit is the result of the cross between a BEW and a non-bew rabbit, then it is Vv. Vv rabbits can have eyes of any colour, they do not necessarily have to be blue. Occasionally, a Vv rabbit will be produced that has no white/dutch markings at all. This animal is still Vv, and the breeder must be VERY careful to ensure that this animal is never allowed outside of the BEW program, because visually no one can tell that this rabbit is Vv.

W Locus

This gene is known as the Wideband Gene. It will double the width of the intermediary band on agouti coats, and it will also turn the white belly, under the jaw, inside the ears and behind the ears into a rich, red rufus. The wideband gene is responsible for the high rufus colouration in the Flemish Giant Sandy, and Castor in Rex and Mini rex. The Tan rabbit is a perfect example of the actions of the wideband gene, with their rich, rufus bellies and other rufus markings. The Belgian Hare is also an excellent example of the actions of the wide band gene on the agouti coat.

There are only two alleles under the W locus:

W - normal band with, no increased rufus
w - wide band, increased rufus.

There are other factors that can increase rufus even more, but they are poorly understood, and as of yet, not categorized.

Useful Links

http://www.rabbitz.net/colour/Colours.html
http://www.thenaturetrail.com/rabbit-genetics/rabbit-colour-genotypes-chart/
http://www.thenaturetrail.com/rabbit-genetics/
http://www.debsrabbittree.com/home/information-on-the-vienna-gene

Angora Links

http://www.bumblebeeacres.com/EnglishAngoraRainbowofColours.htm
http://www.classactangoras.com/uploads/4/7/9/9/4799673/colourgeneticchartangoras.pdf
http://www.oceansideangoras.com/angora-colours.htm
http://www.angorahouse.com/angora%20rabbit%20genetics.htm