

## Angora Color Genetics – by Marna Davis- classactangoras.com

This is my humble attempt to explain color genetic patterns in Angoras to the best of my ability.

**Phenotype**- what color an animal outwardly appears to be, this may not actually tell you its genotype- or genetic makeup

**Genotype**- the genetic makeup of an animal

**NRC**- Not Recognized color- not a showable color by the English Angora standards.

**Expression**- To show up as a phenotype (the color it LOOKS like)

?- Unknown- I use this to designate a gene that we can not determine other than the fact it must be equal to or less dominant than the gene that is listed. So if the listed gene is C then ? might represent  $c^{chd}$ ,  $c^{chl}$ ,  $c^h$ , or  $c$ - BUT if it was  $c^h$ , then ? could only represent  $c^h$  or  $c$ .

**Co-dominant**- These are genes that may affect each other and change the outward appearance. E series and C series are the ones you have to worry about the most here. For example a  $cchl$  makes the most correct color of sable- while  $cchlchl$  makes a sable turn to a seal. Es can be affected by the recessive e gene so that the steel coloration does not appear in the phenotype.

**Modifiers** – Special genes that have small quantitative effects on the level of expression of another gene- examples are rufus modifiers that intensify red/orange coloration or broken modifiers that express how much color is shown in a broken pattern. There is also a modifier that can cause stray white spots in coats- not related to the Vienna or broken gene.

### Order of dominance- most dominant to top

Keep in mind some of these may be co-dominant to some extent, that is one may influence the expression of the other.

A series Agouti (A) tan pattern ( $a^t$ ) or self (a)	B Series Black(B) or brown(b)	C series What color pigments are expressed or hidden	D series  dilute (washed out) or full color	E series extension- how far black pigments are extended up the shaft	Broken abbreviated en because of origin in English Spot	Wide band
A Agouti <i>(dominant)</i>	B Black <i>(Dominant)</i>	C Full Color <i>(Dominant)</i>	D Intense <i>(Dominant)</i>	Es Steel <i>(Dominant)</i>	En Broken <i>(Dominant)</i>	W
$a^t$ Tan pattern <i>(recessive)</i>	bb Chocolate <i>(recessive)</i>	$c^{chd}$ Dark Chinchilla	dd Diluted <i>(recessive)</i>	E Extension <i>(Dominant)</i>	enen Solid <i>(recessive)</i>	ww wideband coloration
aa Self <i>(recessive)</i>		$c^{chl}$ Light Chinchilla Shaded		ej Harlequin Japanese <i>(recessive)</i>		
		$c^h$ Himalayan		ee Non-extension <i>(recessive)</i>		
		cc Albino <i>(most recessive)</i>				

Self colors	A series	B series	C series	D series	E series	Description
<b>Black</b>	a a	B ?	C ?	D ?	E ?	Eyes brown. Guard hair, face & normal furred areas jet black. Wool is dark slate which may fade toward skin.
<b>Blue</b>	a a	B ?	C ?	d d	E ?	Eyes blue/grey. Guard hair, face & normal furred areas dark blue. Wool is slightly lighter and may fade toward skin.
<b>Chocolate</b>	a a	b b	C ?	D ?	E ?	Eyes brown. Guard hair, face & normal furred areas rich dark chocolate. Wool is lighter chocolate which may fade to dove grey toward skin.
<b>Lilac</b>	a a	b b	C ?	d d	E ?	Eyes blue/grey. Guard hair, face & normal furred areas mousey taupe grey. Wool is slightly lighter and may fade toward skin.
<b>Tortoiseshell (black tort)</b>	a a	B ?	C ?	D ?	e e	Eyes brown. Mask, ears, feet and tail to be brownish black or dark smoke. Wool is dark fawn over back shading to smoky color on flanks haunches and belly. Allowed to have some dark ticking and lap spots. White belly or tail is a disqualification.
<b>Blue Tortoiseshell (tort)</b>	a a	B ?	C ?	d d	e e	Eyes blue/gray. Mask, ears, feet and tail to be blue. Wool is beige or almond color over back shading to blue on flanks haunches and belly. Allowed to have some blue ticking and lap spots. Body wool pure white or white belly or tail is a disqualification
<b>Chocolate Tortoiseshell(tort)</b>	a a	b b	C ?	D ?	e e	Eyes brown. Mask, ears, feet and tail to be milk chocolate in color. Wool is fawn over back shading to creamy chocolate on flanks haunches and belly. Allowed to have some chocolate ticking and lap spots. White belly or tail is a disqualification.
<b>Lilac Tortoiseshell(tort)</b>	a a	b b	C ?	d d	e e	Eyes blue/gray. Mask, ears, feet and tail to be lilac. Wool is is beige or almond color over back shading to lilac on flanks haunches and belly. Allowed to have some lilac ticking and lap spots. Body wool pure white or white belly or tail is a disqualification.
<b>Black self chin (NRC)</b>	a a	B ?	c <sup>chd</sup> ?	D ?	E ?	May look like a self (solid color) because the lack of the agouti gene A will keep the chinchilla gene from expressing. Sometimes these will be shown as the solids they appear to be and until odd babies pop up no one realizes they aren't a solid color.
<b>Blue self chin (NRC)</b>	a a	B ?	c <sup>chd</sup> ?	d d	E ?	
<b>Chocolate self chin (NRC)</b>	a a	b b	c <sup>chd</sup> ?	D ?	E ?	
<b>Lilac self chin (NRC)</b>	a a	b b	c <sup>chd</sup> ?	d d	E ?	
<b>Self steel (NRC)</b>	a a	? ?	C ? or c <sup>chd</sup> ?	D ?	E <sup>s</sup> E	May look like a self (solid color) because the lack of the agouti gene A will keep the steel gene from expressing. c <sup>chd</sup> will give silver ticking, while C will give tan ticking when expressed- but will not show due to self gene.

Self Colors	A series	B series	C series	D series	E series	
<b>Black pearl</b>	a a	B ?	c <sup>chd</sup> ?	D ?	e e	Brown eyes. Black face/legs/feet/tail shading rapidly to pearl or very light body wool, undercolor white. Colored toenails. Belly or body wool pure white is a Disqualification.
<b>Blue pearl</b>	a a	B ?	c <sup>chd</sup> ?	d d	e e	Blue/gray eyes. Blue face/legs/feet/tail shading rapidly to pearl or very light body wool, undercolor white. Colored toenails. Belly or body wool pure white is a Disqualification.
<b>Chocolate pearl</b>	a a	b b	c <sup>chd</sup> ?	D ?	e e	Brown eyes. Chocolate face/legs/feet/tail shading rapidly to pearl or very light body wool, undercolor white. Colored toenails. Belly or body wool pure white is a Disqualification.
<b>Lilac pearl</b>	a a	b b	c <sup>chd</sup> ?	d d	e e	Blue/gray eyes. Pinky dove gray face/legs/feet/tail shading rapidly to pearl or very light body wool, undercolor white. Colored toenails. Belly or body wool pure white is a Disqualification.
<b>Sable pearl</b>	a a	B ?	c <sup>chl</sup> ?	D ?	e e	Brown eyes. Sepia or sable face/legs/feet/tail shading rapidly to pearl or very light body wool, undercolor white. Colored toenails. Belly or body wool pure white is a Disqualification.
<b>Blue pearl</b>	a a	B ?	c <sup>chl</sup> ?	d d	e e	Description as above- notice c <sup>chl</sup> can create the same phenotype as c <sup>chd</sup> in some pearls
<b>Chocolate pearl</b>	a a	b b	c <sup>chl</sup> ?	D ?	e e	
<b>Lilac pearl</b>	a a	b b	c <sup>chl</sup> ?	d d	e e	
<b>Sable</b>	a a	B ?	c <sup>chl</sup> ?	D ?	E ?	Eyes brown. Guard hair, face and normal furred areas a very dark sepia brown. Wool is medium sepia brown shading to lighter sepia on flanks, chest, belly, and underside of tail.
<b>Smoke pearl</b>	a a	B ?	c <sup>chl</sup> ?	d d	E ?	Eyes blue/gray. Guard hair, face and normal furred areas a very dark smoky blue. Wool is medium smoky blue shading to lighter smoky blue on flanks, chest, belly, and underside of tail.
<b>Seal</b>	a a	b b	c <sup>chl</sup> c <sup>chl</sup>	D ?	E ?	Color is same as sable only so dark it is nearly black.
<b>Pointed White Black (Himi)</b>	a a	B ?	c <sup>h</sup> ?	D ?	E ?	Eyes- Pink iris Red pupil. Body wool pure clean white Marking color black on nose, ears, feet and tail. Toenails must be colored.
<b>Pointed White Blue (Himi)</b>	a a	B ?	c <sup>h</sup> ?	d d	E ?	Eyes- Pink iris Red pupil. Body wool pure clean white Marking color blue on nose, ears, feet and tail. Toenails must be colored.
<b>Pointed White Chocolate(Himi)</b>	a a	b b	c <sup>h</sup> ?	D ?	E ?	Eyes- Pink iris Red pupil. Body wool pure clean white Marking color chocolate on nose, ears, feet and tail. Toenails must be colored.
<b>Pointed White Lilac (Himi)</b>	aa	bb	c <sup>h</sup> ?	dd	E ?	Eyes- Pink iris Red pupil. Body wool pure clean white Marking color lilac on nose, ears, feet and tail. Toenails must be colored.

Agouti based colors	A series	B Series	C series	D series	E series	Wide band	Description
<b>Chestnut</b>	A ?	B ?	C ?	D ?	E ?		Eyes brown. Rich chestnut color, ticked with black tipped guard hairs. Hair shafts will have banding of tan and slate with blue-gray under color.
<b>Copper</b> <i>Genotype is chestnut with high rufus modifiers</i>	A ?	B ?	C ?	D ?	E ?		Eyes brown. Surface color of rufus red, ticked with black tipped guard hairs. Hair shafts will have banding of bright orange and slate with slate under color.
<b>Opal</b>	A ?	B ?	C ?	dd	E ?		Eyes blue gray. Surface color mainly blue ticked with blue tipped guard hairs. Hair shafts have banding of tan alternating with bands of blue and a light blue under color.
<b>Chocolate Agouti</b>	A ?	bb	C ?	D ?	E ?		Eyes Brown Rich chestnut color, ticked with chocolate tipped guard hairs. Hair shafts will have banding of tan and chocolate with dove-gray under color.
<b>Lynx</b>	A ?	bb	C ?	dd	E ?		Eyes blue gray. Surface color is light tan ticked with lilac tipped guard hairs. Hair shafts have banding of tan alternating with bands of blue and a light lilac under color. White undercolor is allowed.
<b>Note on Wideband colors- cleanest colors are often chocolate based.</b>							
<b>Fawn</b>	A ?	B? or bb	C ?	D ?	ee	ww	Eyes brown. Dorsal color is to be clear golden color. White eye circles, inside ears, nostrils, underside of jowls, belly and underside of tail. Lap spots allowed
<b>Red</b> <i>Note Red is the same as Fawn with high rufus modifiers</i>	A ?	B? or bb	C ?	D ?	ee	ww	Eyes brown. Dorsal color is to be deep reddish sorrel. May have white, cream or pale red eye circles, inside ears, nostrils, underside of jowls, belly and underside of tail. Lap spots allowed
<b>Cream</b>	A ?	B? or bb	C ?	dd	ee	ww	Eyes blue gray. Dorsal color is to be pinkish beige to almond. White eye circles, inside ears, nostrils, underside of jowls, belly and underside of tail. White under color allowed. Lap spots allowed
<b>Chinchilla</b>	A ?	B ?	c <sup>chd</sup> ?	D ?	E ?		Eyes can be brown, blue/grey or marbled. Surface color is a blend of medium slate and pearl, with black tipped guard hairs. The hair shafts should have bands of pearl and blue-grey with a blue-grey undercolor.
<b>Squirrel (blue chin)</b>	A ?	B ?	c <sup>chd</sup> ?	dd	E ?		Eyes blue/grey . Surface color is a blend of blue and pearl, with blue tipped guard hairs. The hair shafts should have bands of pearl and light blue with a light blue undercolor.
<b>Chocolate Chinchilla</b>	A ?	bb	c <sup>chd</sup> ?	D ?	E ?		Eyes can be brown, blue/grey or marbled. Surface color is a blend of chocolate and pearl, with chocolate tipped guard hairs. The hair shafts should have bands of pearl and light chocolate with a dove-gray undercolor.
<b>Lilac Chinchilla</b>	A ?	bb	c <sup>chd</sup> ?	dd	E ?		Eyes blue/grey . Surface color is a blend of lilac and pearl, with lilac tipped guard hairs. The hair shafts should have bands of pearl and light lilac with a light lilac undercolor.

<b>Note on steels- <math>c^{chd}</math> will give you silver tipped steels and C will give you tan tipped steels</b>							
<b>Steel</b>	A ?	B ?	C ? or $c^{chd}$ ?	D ?	EsE or EsEs	Eyes are brown. Color is dark charcoal or steel grey ticked with tan or silver. Belly and underside of tail can be lighter and do not have to be ticked.	
<b>Blue Steel</b>	A ?	B ?	C ? or $c^{chd}$ ?	dd	EsE or EsEs	Eyes are blue/gray. Color is blue ticked with tan or silver. Belly and underside of tail can be lighter and do not have to be ticked.	
<b>Chocolate Steel</b>	A ?	bb	C ? or $c^{chd}$ ?	D ?	EsE or EsEs	Eyes are brown. Color chocolate with tan or silver. Belly and underside of tail can be lighter and do not have to be ticked.	
<b>Lilac Steel</b>	A ?	bb	C ? or $c^{chd}$ ?	dd	EsE or EsEs	Eyes are blue/gray. Color is lilac ticked with tan or silver. Belly and underside of tail can be lighter and do not have to be ticked.	
<b>Self Steel (NRC) (agouti based)</b>	A ?	??	C ? or $c^{chd}$ ?	??	Ese	Any of the steel colors MAY appear to be a self (solid) color rabbit IF the rabbit carries the non extension gene $\epsilon$ in addition to the Steel gene (Es)	
<b>Ruby Eyed White REW</b>	??	??	cc	??	??	??	White with red eyes. This can hide ANYTHING in any of the genes except the c series INCLUDING broken. The ONLY thing this color must have to express are the cc- which means that a REW cannot carry Himi ( $c^h$ ), shaded ( $c^{chl}$ ), or chinchilla ( $c^{chd}$ )
<b>Ermine(NRC)</b>	A ?	??	$c^{chd}$ ? or $c^{chl}$ ?	??	ee	Ermines can be in any base color- they are MOSTLY white with eye color that is NOT REW (can be mostly anything else) They often have stray ticking, tiny bits of point color, smut or ear lacings.	
<b>Agouti Pointed White (NRC)</b>	A ?	??	$c^h$ ?	??	E?	Red eyes- traces of coloring on ear, nose, tail and feet often with white bottom to tail and a very washed out or lacings of white in the ears and feet.	

<b>Broken Pattern Rabbits (NRC in English Angora)</b>							
<b>Broken pattern can be a combination of any other genetics with the En gene.</b>							
	A	B	C	D	E	En English Spot	
<b>Solid color or self</b>	??	??	??	??	??	enen	
<b>Broken</b>	??	??	??	??	??	Enen	Broken MUST have nose marking, eye circles and ears in color, with no less than 10% color and no more than 50% color on body.
<b>Charlie (double dominant)</b>	??	??	??	??	??	EnEN	
<p><b>Modifiers to the En gene has much to do with how much or how little white appears on a broken rabbit.</b></p> <p><b>All rabbits that appear to be Charlies are not double dominant</b></p> <p><b>AND all rabbits that appear to be dutch marked are NOT carrying the Vienna(BEW, VM, VC) gene.</b></p> <p><b>ARBA generally accepted limits on broken are more than 10% color and less than 50%.</b></p>							

Color	A series	B series	C series	D series	E series	Vienna Gene	Description
Normal eye color	??	??	??	??	??	VV	
Vienna carrier(VC)	??	??	??	??	??	Vv	A Vienna carrier rabbit that does not “show” that it carries the gene by any white spotting or blue eyes. The only way you know for SURE is if they have a BEW parent, or they have produced BEW offspring.
Vienna Mark (VM)	??	??	??	??	??	Vv	May or may not have blue eyes, often “dutch” marked or lightly white spotted. All dutch marked bunnies are NOT VM, some are broken with modifiers for heavy markings. The only way you know for SURE is if they have a BEW parent, or they have produced BEW offspring.
Blue Eyed White	??	??	??	??	??	vv	Bright clear blue eyes (no mottling or marbling) and pure white coat
REW	??	??	cc	??	??	??	Red eyes, and pure white coat. The rew gene pairing (cc) will cover up anything including BEW(vv) it’s like throwing a huge white blanket over your rabbits coat color.

Color	A series	B series	C series	D series	E series	En Broken	Description
Harlequin Japanese(NRC) orange and black (well marked)	A?	B?	C?	D?	e <sub>j</sub> e or e <sub>j</sub> e <sub>j</sub>	en en	
Harlequin Magpie(NRC) (well marked)	A?	B?	c <sup>chd</sup> ?	D?	e <sub>j</sub> e or e <sub>j</sub> e <sub>j</sub>	en en	
Harlequin Japanese (NRC) orange and black (the self gene aa affects the expression of the Japanese gene e <sub>j</sub> making it less defined)	aa	B?	C?	D?	e <sub>j</sub> e or e <sub>j</sub> e <sub>j</sub>	en en	
Tri color (NRC) orange and black (well marked)	A?	B?	C?	D?	e <sub>j</sub> e or e <sub>j</sub> e <sub>j</sub>	En en	
Chocolate Harlequin (NRC)	A?	bb	C?	D?	e <sub>j</sub> ?		

## **A Word to the Wise on Colors**

There are so many colors that are showable, you don't really have to worry about breeding color right? Not necessarily so my friends. There are some colors that you should be wary of crossing together, and others that when you cross them will give you a surprise now and again. It is always my luck the very best baby of a litter is one that will never be showable because of color which is in the long run very few points in the Angora world.

Here are a few things that can possibly throw a color monkey wrench in you breeding program.

### **Wide band colors and non extension**

Orange, fawn, and cream to Torts or Pearls

Wideband(ww) combined with non extension (ee) can give you white bellies (ever had a tort with a white tummy pop up? There is that recessive wideband gene)

Wide band is recessive so it can hide and create problems down the road.

### **Steels**

Steels need Agouti AND Full extension to express themselves best.

Steel Gene is dominant- but not completely.

Breeding selfs (aa) and non extensions (ee) can give you self steels that appear to be solid colors. Then when someone looks on a pedigree later and sees an agouti popping up out of two blacks they think something is amiss with your records. In reality its probably that Steel gene messing with you as A?B?C?D?Ese can manifest itself as a black.

### **Shaded and Agoutis and Non-extension**

First off TORT is NOT SHADED. It is however, non-extension.

Agouti to non extension could give you reds, fawns and creams- but if they are not wideband they will be smutty looking. It may also give you Agouti colors that have lousy banding.

Shaded (cchl) and Agouti gives you the unshowable Shaded Agoutis, and shaded is recessive enough it hides....

Please try to keep them out of your Agouti lines.

### **A Bit about Brokens**

There are a few things you have to know about brokens.

The first is that you must have a broken to get a broken- REW can hide broken but most other colors can not carry the broken gene unseen. This is because broken is a Dominant gene, if the rabbit carries it, it will manifest itself. There are a few cases of false brokens which are usually BEW (Vienna gene) or the Dutch gene manifesting itself. Those are recessive and CAN hide in a solid.

Secondly is there are these pesky things called modifiers. These affect how the broken gene shows up. A broken rabbit must have at least 10 percent color and not more than 50 percent color (90-50% being white).

Modifiers to the broken gene can cause the phenotype to show up looking like something dutch marked(which can be mistakenly called VM or VC) OR it can make a regular broken look like a what is considered a Charlie (a white rabbit with just a tiny bit of color- named so after Charlie Chaplin's mustache) when it is actually NEITHER of those things. The rabbit may have the normal Ene gene pattern for a broken but modifiers can affect it in such a way it is now marked in an accepted pattern by the ARBA.