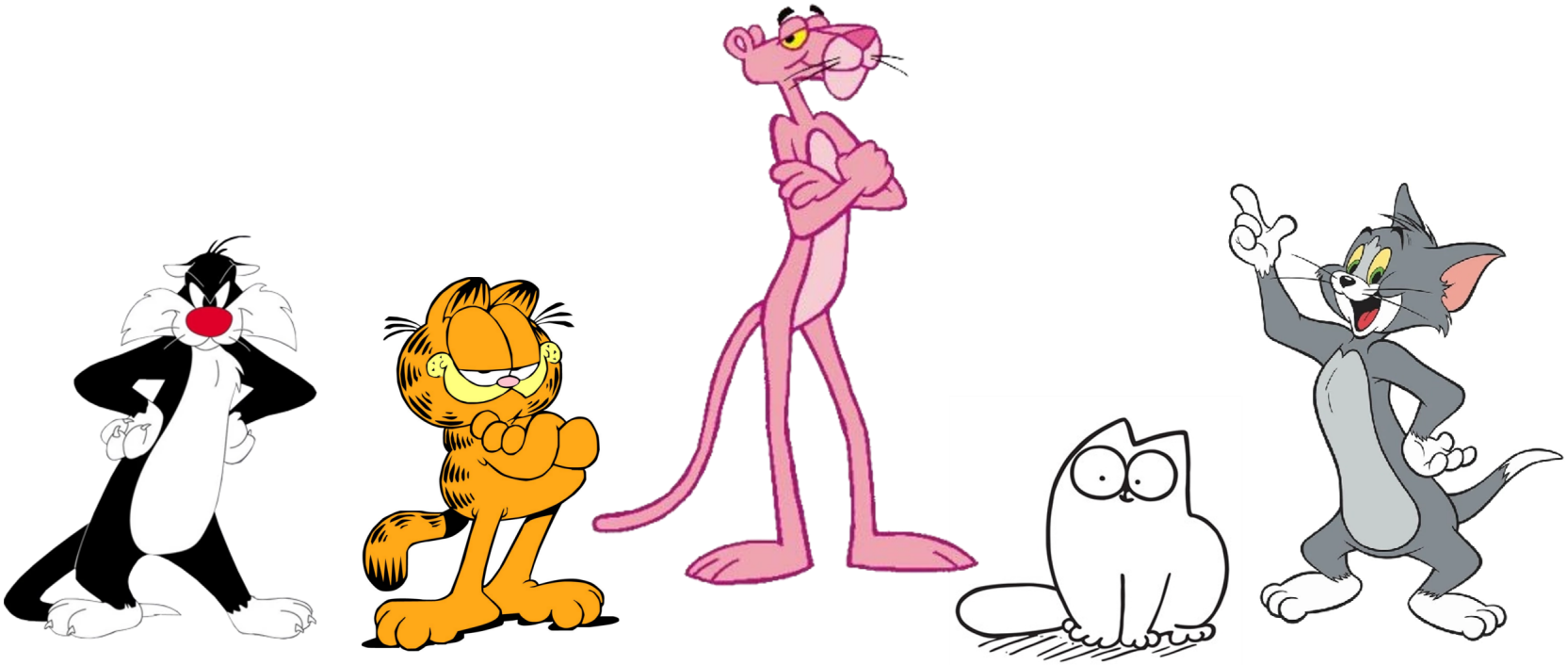
Cat Coat – Color, Pattern and Genetics

Sonja Prohaska

Computational EvoDevo
University of Leipzig

SS 18

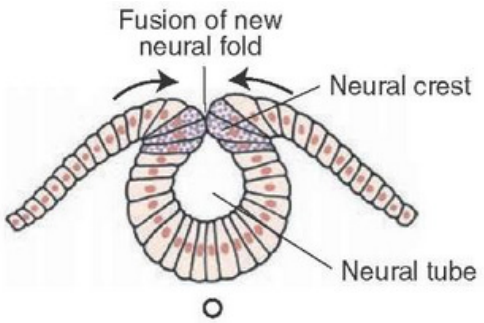
Cat Coat Color, Pattern and Genetics

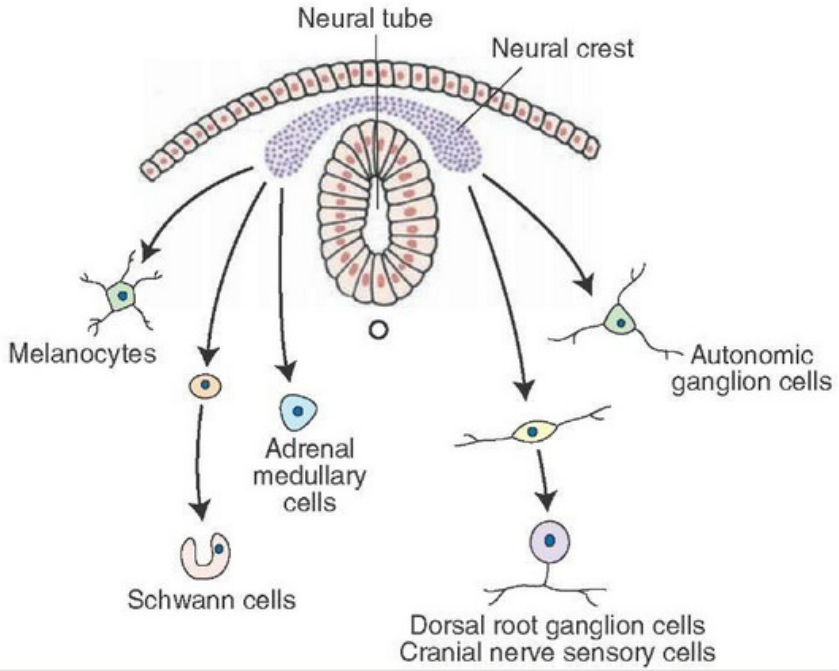


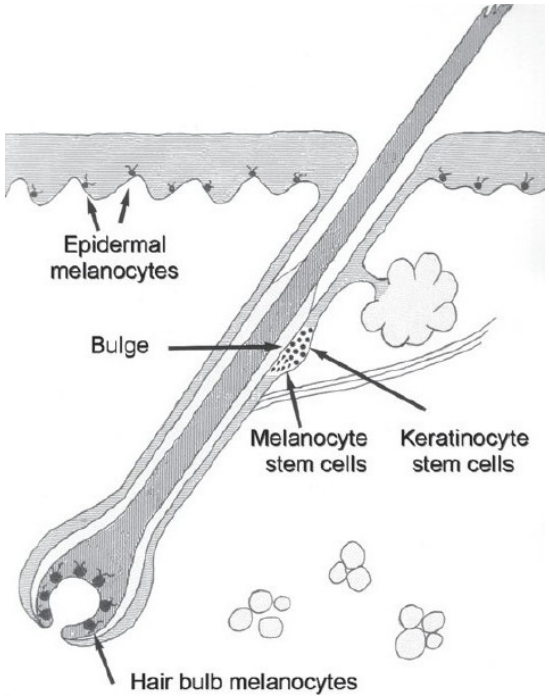
How Hair Gets Color

- melanoblasts derive from neural crest
- dorso-ventral migration (back to belly)
- differentiation into melanocytes
- melanocytes move into epidermis and to the basis of hair folicle
- production of melanin
- formation of melanosomes

How Hair Gets Color – melanocytes







Melanine, the pigment, is produced by melanocytes and stored in melanosomes.

Excursion into Genetics

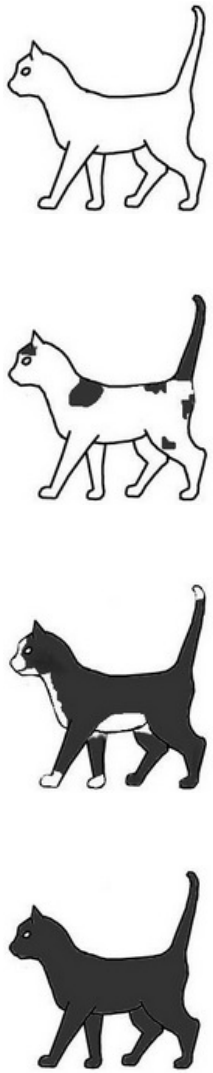
- locus vs. gene
- allele
- diploidy
- homozygote – heterozygote
- dominant – recessive
- autosome – sex chromosome
- female X,(inactive)X – male X,Y
- epistatic – hypostatic
- pleiotrophic effect

The **W** "White" Locus

- "dominant white" (W-locus)
- dorso-ventral migration of melanoblasts
- allels: **W, w^s, w$^+$**
- piebald spotted phenotypes
- W,_ – (dominant) white

  w^s,w^s – more than 50% white

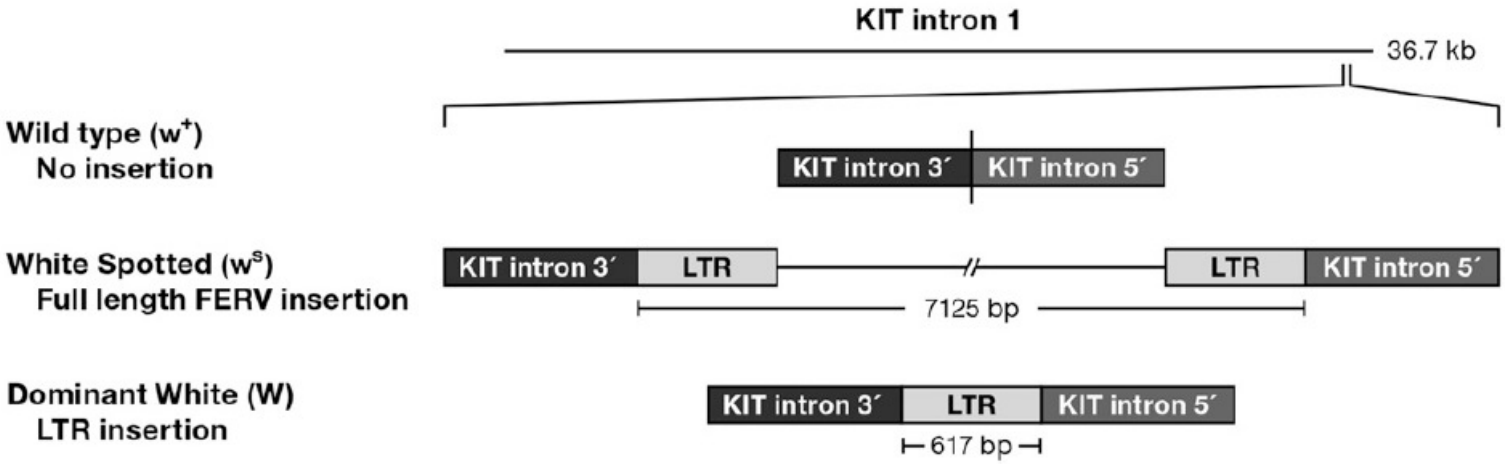
  w^s,w$^+$ – less than 50% white
- w$^+$,w$^+$ – completely pigmented



Dysfunction in dorso-ventral melanoblast migration is the source of white spotts and patches.

Molecular Basis of "white" Alleles

- gene **kit**: tyrosine-protein kinase and transmembrane receptor
- ligand: stem cell factor (MGF)
- relevant for skin and eye color, hearing ability
- temporal and tissue-specific expression
- retrovirus FERV (feline endogenous retrovirus)
- w^s – retrovirus insertion in intron 1 of kit
- W – only LTR of retrovirus in intron 1 of kit



Piebald-Spotted Phenotypes in Rats (H locus)

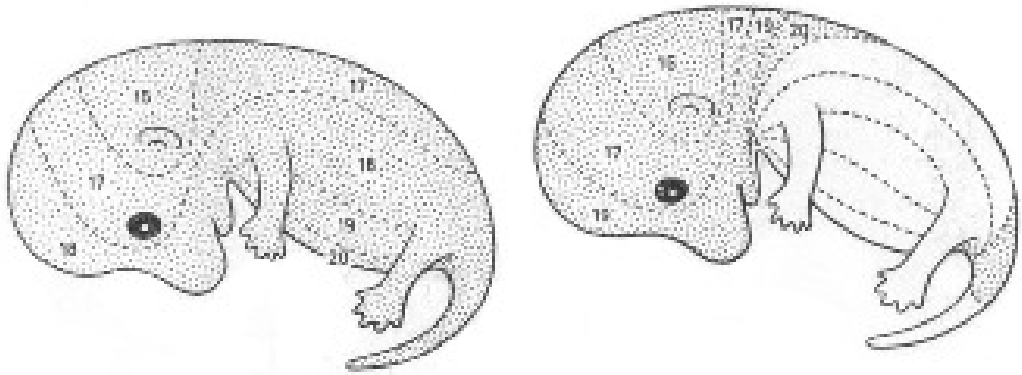
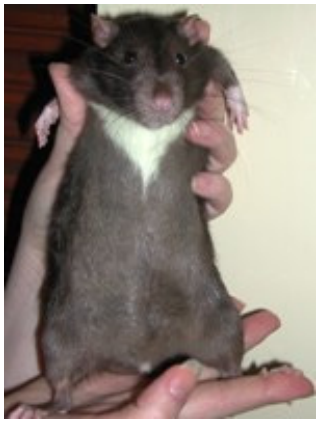


Figure 24 Normal and hooded rat foetuses, showing the days on which melanoblasts reach the epidermis. It can be seen that there is a delay in migration of these cells in the hooded rat, and in the regions destined to become white they fail to reach the epidermis at all. (After WENDT-WAGENER, 1961.)

(Searle 1968)



"irish"

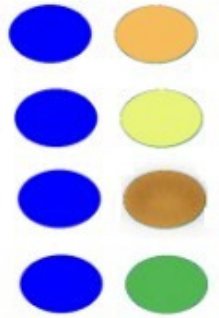
"berkshire"

"hooded"

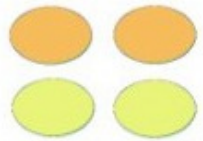
“Dominant white” Phenotype and Eye Color

Hair, skin and eye color depend on the function of **kit**.

Blue eyed white
50-80% deaf

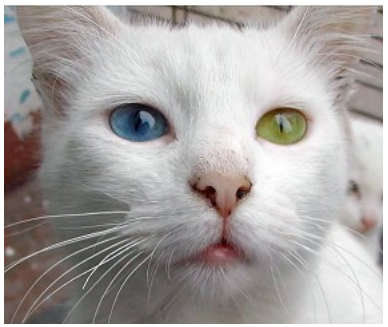


Odd-eyed white
30-40% deaf



Orange-eyed white
(Yellow and hazel
count as orange)
10-20% deaf

“blue-eyed”



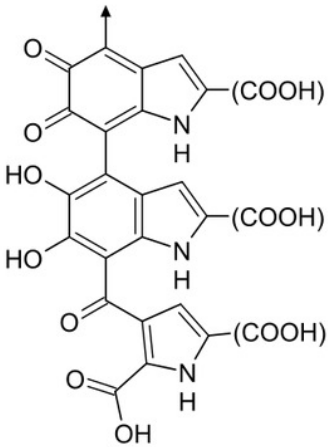
“odd-eyed”

“orange-eyed”

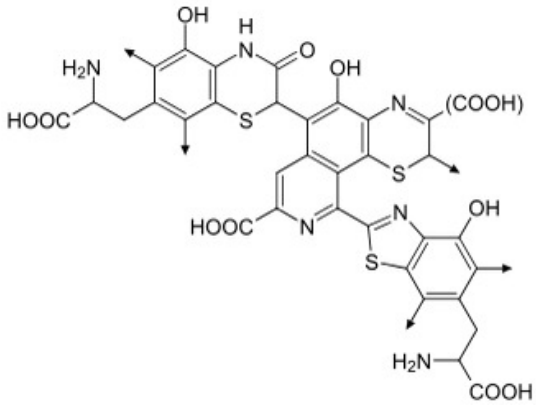
Dominant White cats with odd-eye color are usually deaf on the ear near to the blue eye.

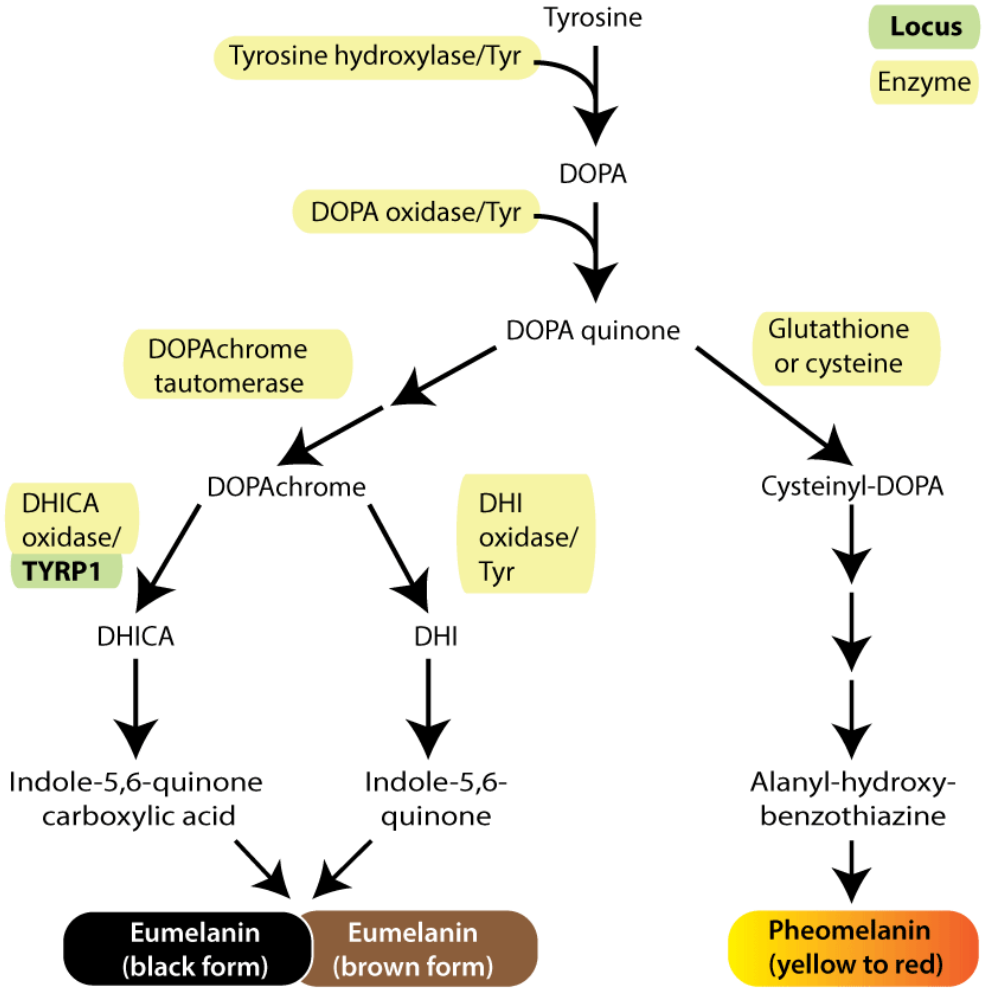
How Hair Gets Color – Pigment Chemistry

Eumelanin



Pheomelanin





The **B** "black" Locus

- gene: typr1
- eumelanin production
- alleles: **B**, **b**, $\mathbf{b}^{l}$
- B,_ – black
- b,b – brown, "chocolate"
- b^{l},b^{l} – light brown, "cinnamon"

Solid black cats might get a brownish tinge to their fur if the diet is deficient in tyrosine.

the **O** "orange" Locus

- pheomelanin production
- alleles: **O**, **o**
- O is located on the X chromosome

  $\rightarrow$ sex-linked
- **males are XY**

  XO,Y – orange (no "black")

  Xo,Y – no orange ("black")
- **females are XX**
- one X is inactivated
- X inactivation differs from cell to cell

  XO,XO – orange (no "black")

  Xo,Xo – no orange ("black")

  XO,Xo – orange - black mixed

“Glückskatzen” und Co.

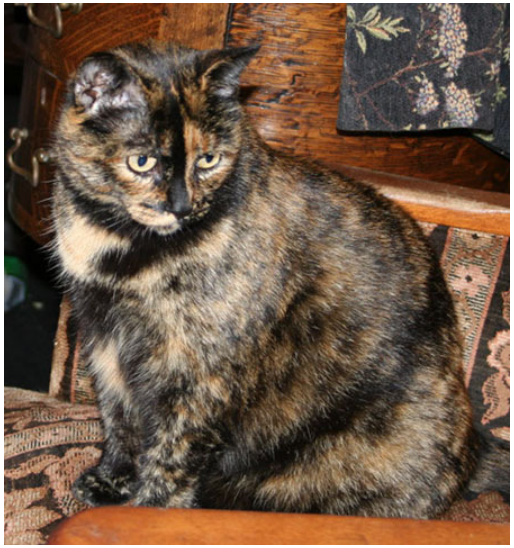
Tortoiseshell (“Tortie”))

- a XO,Xo female cat
- solid color, no spotting
- orange where Xo inactive
- black where XO is inactive

Calico

- an XO,Xo female cat

  and piebald-spotted
- shows patches of orange
- and patches of black
- where she is not white
- “Glückskatze”



The **D** "dilution" Locus

- pigment density
- alleles: **D**, **d**
- D,_ – full density
- d,d – diluted
- dilution turns

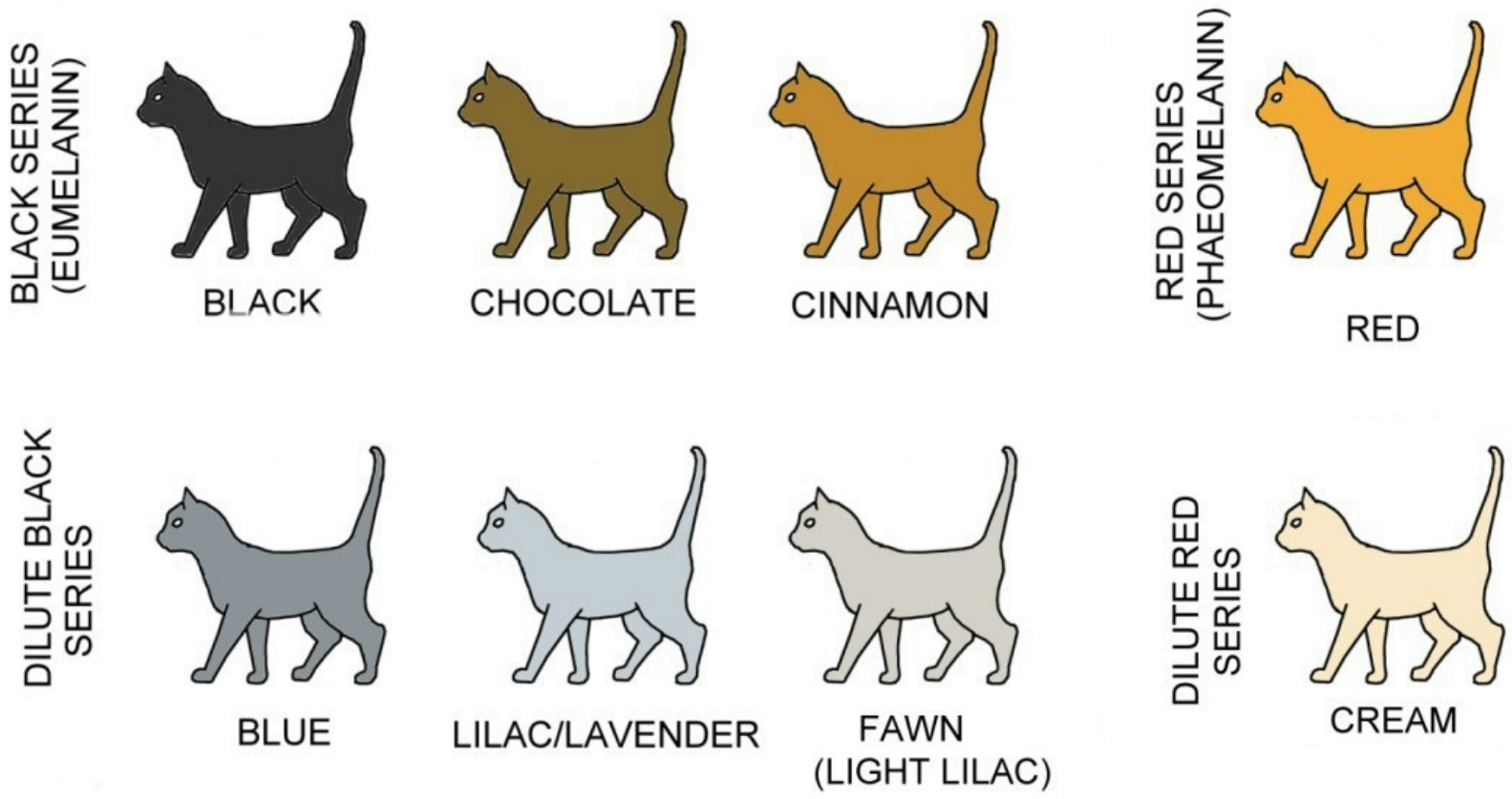
  black $\rightarrow$ blue

  chocolate $\rightarrow$ lilac

  cinnamon $\rightarrow$ fawn

  orange $\rightarrow$ cream

Summary of Solid Colors



adapted from `https://spotted-tabby-cat.deviantart.com/`

The **C** "color" Locus

- codes the tyrosinase gene

  first step in melanin synthesis
- allels: $\mathbf{C}$, $\mathbf{c}^b$, $\mathbf{c}^s$, $\mathbf{c}$
- temerature-sensitive variants
- C is completely dominant
- $\mathrm{C} > \mathrm{c}^b = \mathrm{c}^s > \mathrm{c}$
- C – full color
- c^s,c^s – Siamese/Pointed
- c^b,c^s – Tonkinese/Mink
- c^b,c^b – Burmese/Seal
- c,c – albino white

Complete dysfunction of tyrosinase on both alleles results in no pigment at all. An **albino** white cat has pale blue or pinkish eyes.

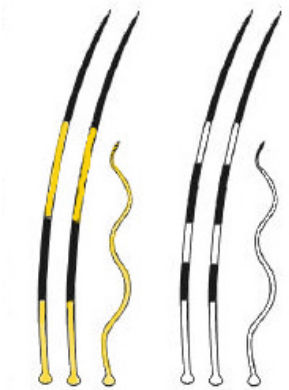
The **A** "agouti" Locus

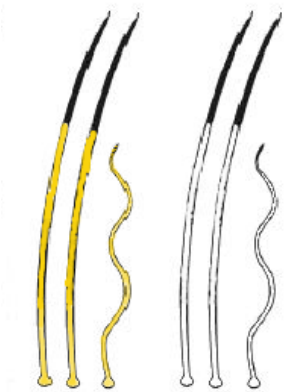
- transient inhibition of pigment production during hair growth
- causes bands of lighter color along the hair
- allele: **A**, **a**
- A,_ – agouti bands
- a,a – no agouti bands
- undercoat has color of bands
- different banding patterns are most likely a polygenetic trait
  - smoked, shaded, tipped, tabby (most common)

Agouti hair banding is required to make patterns visible.

The **I** "inhibition" Locus

- Melanin inhibition
- seen in agouti banding of tabbies
- allele: **I**, **i**
- bands of lighter color
- I,_ – white bands
- i,i – yellow bands
- undercoat has color of bands





tabby banding: brown & grey tabbies

shaded banding: golden & silver tabbies

The **Ta** "tabby" Locus

- hair of ticked and solid color
- causing formation of patterns
- alleles: $\mathbf{Ta}^{M}$, $\mathbf{ta}^{b}$
- Ta^{M},_ – mackerel (getigert)
- ta^{b},ta^{b} – bloched (gestromt)

  also known as "classic tabby"

The **Ti** "ticked" Locus

- pattern like "random noise"
- alleles: $\mathbf{Ti}^{a}$, $\mathbf{Ti}^{+}$
- Ti^{a},Ti^{a} – homozygote Abyssinian (ticked allover)
- Ti^{a},Ti^{+} heterozygote Abyssinian (stripes on face, legs and tail)
- Ti^{+},Ti^{+} – non-Abyssinian
- Ti is epistatic to Ta

For Comparison and Practice

golden blotched tabby

brown mackerel tabby

brown abyssinian (tabby)

silver blotched tabby

grey mackerel tabby

grey abyssinian (tabby)

Modifier of Tabby

- tagpep and Edr3 involved
- mackerel $\rightarrow$ dotted
- bloched $\rightarrow$ spotted,rosetted

cheetah (dotted) & king cheetah (blotched)

References

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