Cat Genetics

Hair Length
In cats, hair length is controlled by the \textit{FMGS} gene, that has two alleles, \textit{L} and \textit{l}. The \textit{L} allele results in short hair and is dominant to the \textit{l} allele. Homozygous \textit{ll} cats have long hair.

\begin{itemize}
  \item \text{LL or Ll = short hair}
  \item \text{ll = long hair}
\end{itemize}

Coal Color Deposition

The deposition of coat color is controlled by the \textit{MLPH} gene, that has two alleles, \textit{D} and \textit{d}. The \textit{D} allele results in complete deposition of color into the fur, and is dominant to the \textit{d} allele. Homozygous \textit{dd} cats are unable to deposit as much color into each hair and appears faded, or “dilute”.

\begin{itemize}
  \item \text{DD or Dd = dark coloration}
  \item \text{Dd = dilute}
\end{itemize}
Agouti

The **agouti** gene is responsible for determining whether a hair is banded, or a single color. In cats, all striped cats contain the **A** allele, and is dominant to the **a** allele. Homozygous **aa** cats are non-striped.

![Agouti Cats]

**AA or Aa = striped**

**aa = non-striped**

Coat Color

The sex-linked **orange** gene (also called the **red** gene) is found on the X chromosome. The **O** allele results in orange color in the fur, whereas the **B** allele results in non-orange (usually black) fur. Since males only have one X chromosome, they will only have one allele of this gene. Females will either be **OO** (orange), **BB** (non-orange) or **OB** (showing both orange and non-orange patches). Calico cats, also called tortoiseshell, are almost always female.

![Coat Color Cats]

**Orange female:** $X^O X^O$

**Orange male:** $X^O Y$

**Black female:** $X^B X^B$

**Black male:** $X^B Y$

**Calico:** $X^O X^B$ (always female)

rarely a calico male: $X^O X^B Y$ (a mutant!)
Piebald

The piebald spotting gene, with $S^+$ and $S^-$ alleles, shows incomplete dominance for melanocyte migration. The $S^+$ allele allows colored melanocyte to migrate, leading to a colored coat. The $S^-$ allele prevents melanocyte migration, leading to a white coat color. Cats with the $S^+ S^+$ genotype have no white spots. Cats with an $S^- S^-$ genotype are predominantly white (though they can still have areas of color in their coats). Cats with a $S^+ S^-$ genotype have areas of white and colored coat, where the white areas cover ~50% of the total coat.

No white: $S^- S^+$

~50% white: $S^+ S^-$

>50% white: $S^- S^-$

White

The white masking gene is involved in the replication and migration of pigment-producing cells during embryonic development. The $W$ allele prevents normal replication and migration such that cats with $WW$ or $Ww$ fail to produce pigmented cells, and the cats are all white. Only a cat that is homozygous recessive, $ww$, will express normal pigmentation. Some (but not all) cats with the $W$ allele of this gene are deaf and/or have depigmentation of the iris of one or both eyes, resulting in blue eye color. White cats are also more likely to get skin cancer. The $W$ allele is pleiotropic (leads to more than one phenotype) and epistatic (masks the effect of other genes). This is a good reminder that dominant traits are not necessarily the most abundant!

WW or Ww
Classic vs. Mackerel Striping
Striped cats (genotype \( A_\_ \)) will present their stripes in different patterns. The mackerel pattern is characterized by narrow strips that are parallel to one another. This is determined by the dominant \( T^M \) allele at the “Tabby” gene. The classic pattern has distinctive and well separated stripes which are often in a swirled or “bulls eye” appearance. This is caused by the recessive \( T^b \) allele. The effect of these alleles at the Tabby locus can only be observed in cats that carry the dominant Agouti allele for striping.

AA or Aa and \( T^M T^M \) or \( T^M T^b \)

AA or Aa  and \( T^b T^b \)

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