

## Color Inheritance in Cattle

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## Color

- First breeding efforts
- Economic Value
- Adaptive Value
- Brand recognition
- Study of inheritance

## Observational Determination

- Good, big phenotype
- T.A. Olson, Ph.D. dissertation
- J.O. Sanders
- Observed inheritance and designation of loci
- Heading into the molecular era (causative)

## Color Inheritance

- Base color
- Gray
- Dilution
- Brindling
- Spotting

## Genetic Action

- Qualitative--Controlled by a single gene (or very few)--known
- Quantitative- Controlled by a large number of genes--unknown

## Some Terminology

- Genome--complete genetic material within a cell—two 6' strands of DNA composed of nucleotides A, T, G, C
- One strand inherited from each parent
- Locus—physical location within a genome
- Gene—DNA that codes a protein or other product.

## More Terminology

- **Allele**—alternative form of a gene
  - For a given gene there is 1 allele on each strand of DNA
- **Genotype** is a pair of alleles
- **Homozygous** genotype has 2 copies of the same allele: EE or ee
- **Heterozygous** genotype has 1 each of 2 alleles: Ee

## Pigmentation

- **Presence/absence of melanin in skin and hair**
- **Early embryogeny**
  - Gene expression is sensitive to orientation of the embryo (there is an up and down orientation to the embryo)
  - Melanocytes carry pigment from neural crest to the extremities of the body

## Base Color

- “**Extension**” (of black pigment) locus
- **Dominant gene action: one allele is dominant to (covers or masks the expression of) the other**
- E
- e
- E<sup>+</sup> the “wild type” allele

## Black vs. Red

- EE, EE<sup>+</sup>, Ee = BLACK
- ee = RED
- E<sup>+</sup>E<sup>+</sup>, E<sup>+</sup>e other modifiers take over—non-black
- **MC1R Melanocortin 1 Receptor (BTA18)**



### Coat Color

- Dr. Lauren Hanna, NDSU
- $EE^+$  --all should be black
- Modifier present on BTA 6
- Spotting locus nearby
- “Simple” inheritance probably is not

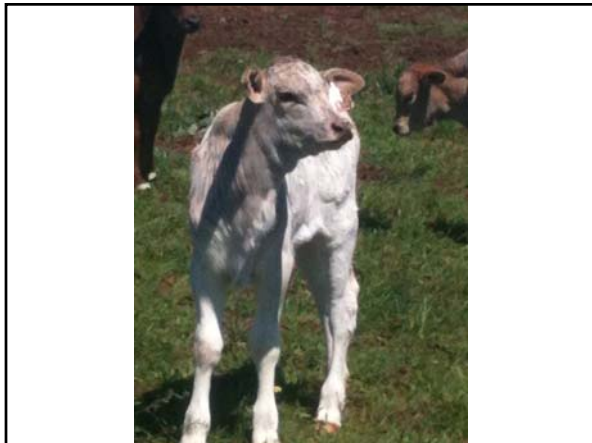


### Gray

- Red base color  $ee$  or  $E^+ E^+$  or  $E^+ e$
- Two alleles:  $G$  and  $g$
- Gray animals:  $gg$







## Gray

- BTA 6 near gene responsible for spotting
- In the same area as the gene/locus modifying black in crossbred cattle

## Dilution

- Charolais
- Simmental
- Tuli
- 2 alleles, almost an additive effect
- Presence of each dilution allele augments the effect: DD, Dd, dd



### Dilution

- Intermediate phenotypes
- Smokey E-, Dd
- Straw ee, Dd
- *PMEL* BTA 5
- Skin color may be more related to base color

### Brindling

- Red background (but yes, black brindle)
- A second locus appears to be responsible for Black NFT; B, b alleles
- E<sup>+</sup>E<sup>+</sup> or E<sup>+</sup>e, B-
- *Agouti*- BTA 13

### Black Nose, Feet, Tail, Ear tips

- Speculate 2 alleles: A, a
- E<sup>+</sup>E<sup>+</sup> or E<sup>+</sup>e, B-, A-
- Results in brindle
- E<sup>+</sup>E<sup>+</sup> or E<sup>+</sup>e, B-, aa
- Born red turn dark
- Restriction of black pigment—shiny black nose, feet tail, ear tips: aa







**Spotting Alleles—KIT BTA 6**

- Solid S
- Hereford S<sup>H</sup>
- Paint Side S<sup>P</sup>
- Speckling S<sup>G</sup>
- Simmental S<sup>S</sup>
- Recessive spotting—Holstein s
- Codominance v. Dominance

## Roaning

- Shorthorn specific
- 2 alleles R and r
- Rr: solid
- Rr: roaning
- RR: white

## Color Inheritance

- Simple (well . . .)

