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Genome Editing in Animal Breeding

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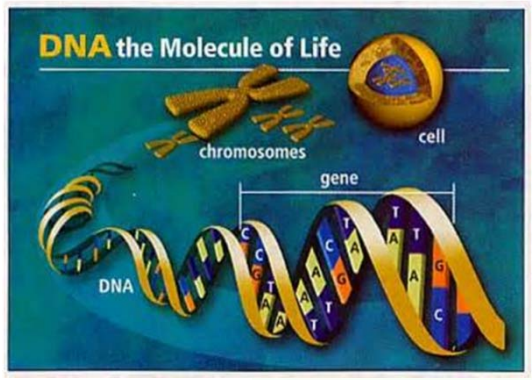
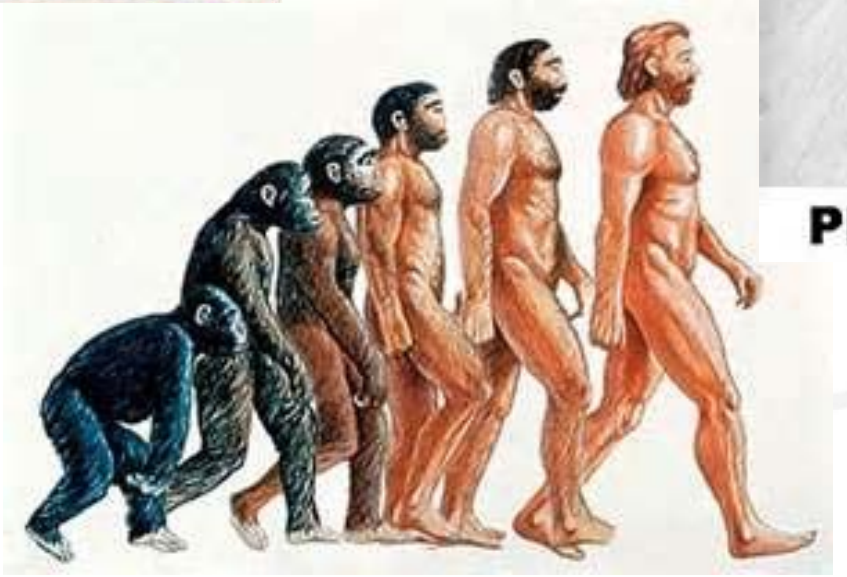
Inherited Genetic Change



PROOF OF EVOLUTION !



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Inherited Genetic Change

Livestock Breeding Continuum

- "beginning of farming" in Mesolithic –Neolithic (9000 BC)

- Initially bred for:
  - temperament
  - social structure
  - ability to breed in captivity
- Genetics >> MAS
- New Breeding Technologies
  - including GS and editing

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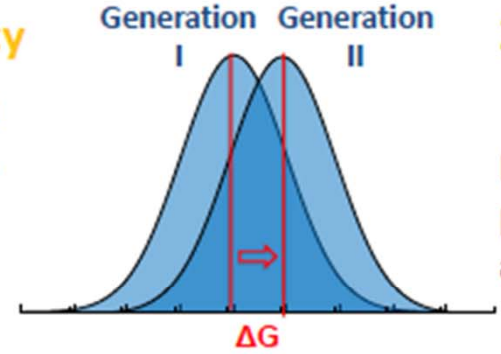
How do you drive genetic improvement?

1. Selection intensity

How fine is your filter in choosing which animals to breed?



2. Index standard deviation

How varied is your population (how far apart are the 'tails')?

RATE OF GENETIC IMPROVEMENT

$$\Delta G = \frac{\text{SEL INTENSITY} * \text{INDEX STD} * \text{ACCURACY}}{\text{GENERATION INTERVAL}}$$

4. Generation interval

How long does it take to breed the next generation?

3. Accuracy

How accurate are you in selecting the best animals in your herd?

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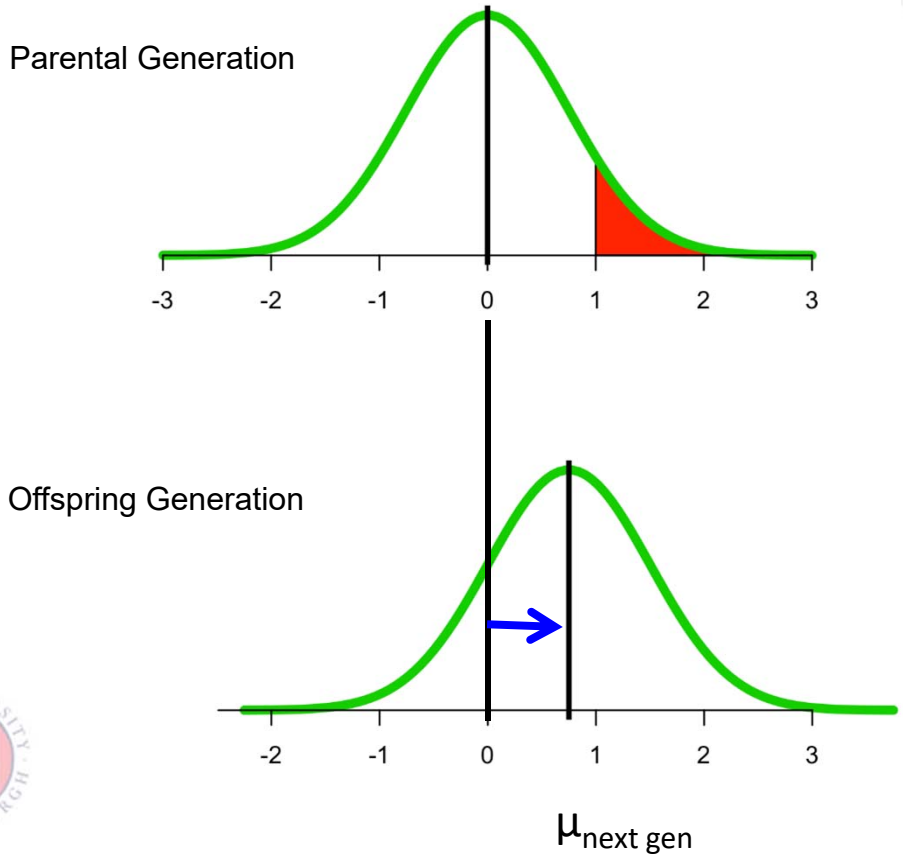
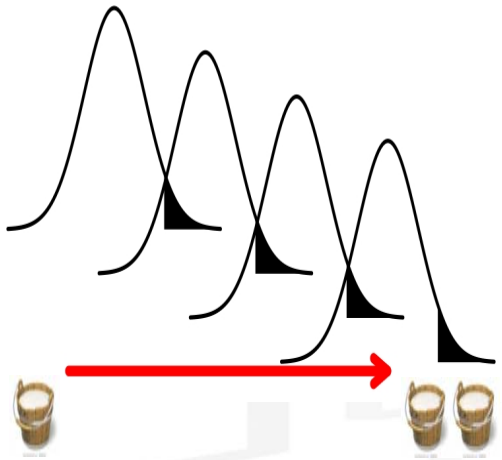
Response to Selection

Difference between the mean of 2 generations



Gain over generations



Genetic Variation

Genetic Variation

Spontaneous (luck)

or

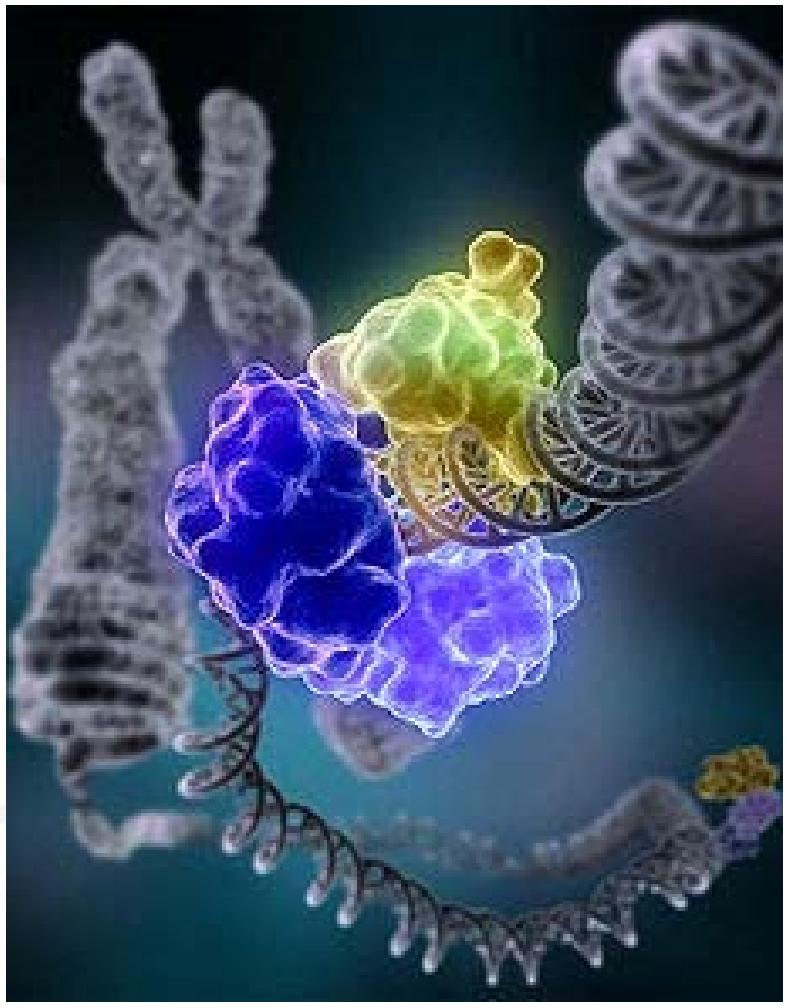
Genome Editing (precise)

Genome Editors

NHEJ

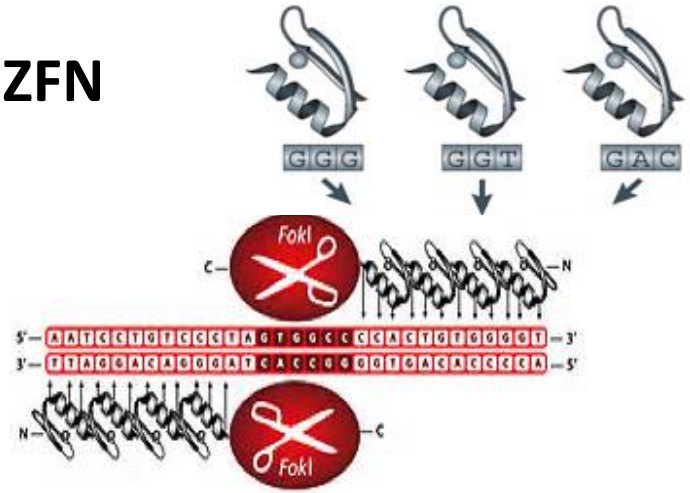
HDR

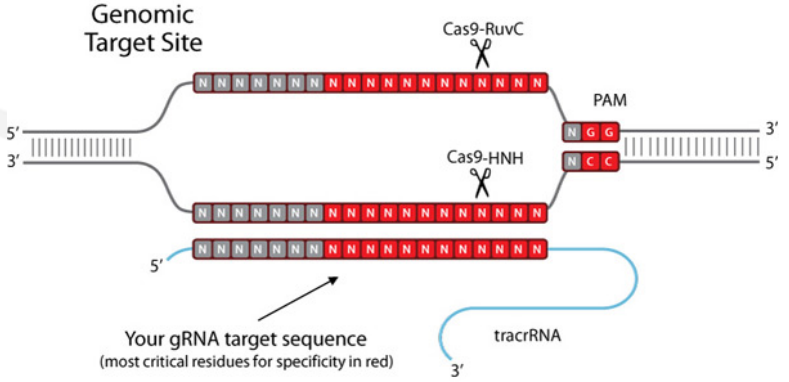
rely on DNA repair



Engineer specificity into these editing tools:

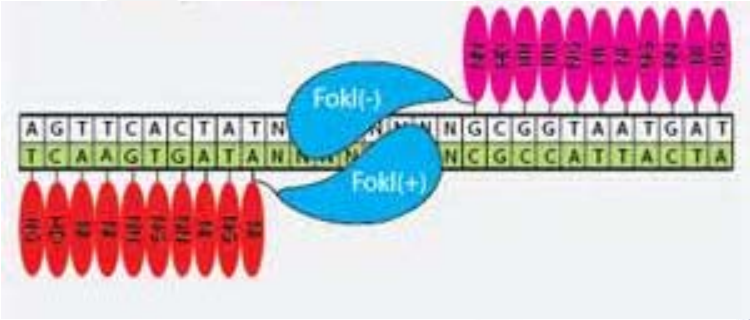
ZFN

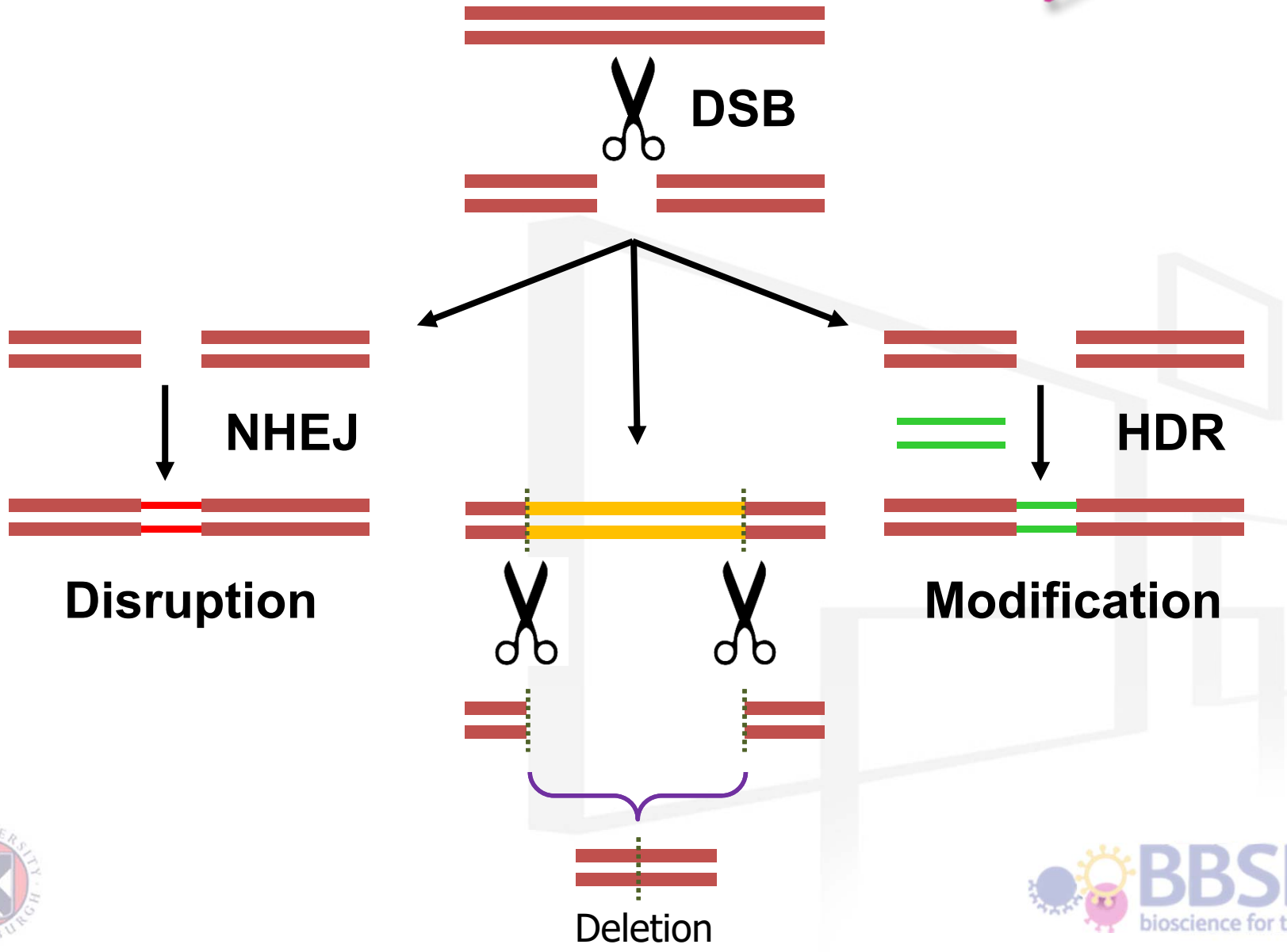




CRISPR/Cas9

TALEN




DSB
NHEJ
HDR
Disruption
Modification
Deletion

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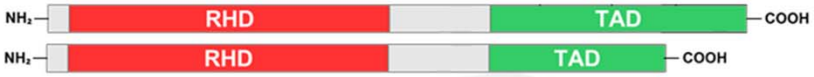
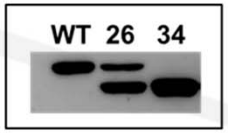
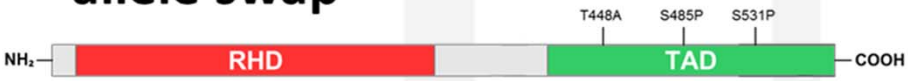
frameshift (premature stop)





deletion

allele swap



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recombinetics

Genus

SANGAMO Sangamo BioSciences

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Gene-edited pigs are protected from porcine reproductive and respiratory syndrome virus

Kristin M Whitworth, Raymond R R Rowland, Catherine L Ewen, Benjamin R Trible, Maureen A Kerrigan, Ada G Cino-Ozuna, Melissa S Samuel, Jonathan E Lightner, David G McLaren, Alan J Mileham, Kevin D Wells & Randall S Prather

Affiliations | Corresponding author

Nature Biotechnology **34**, 20–22 (2016) | doi:10.1038/nbt.3434

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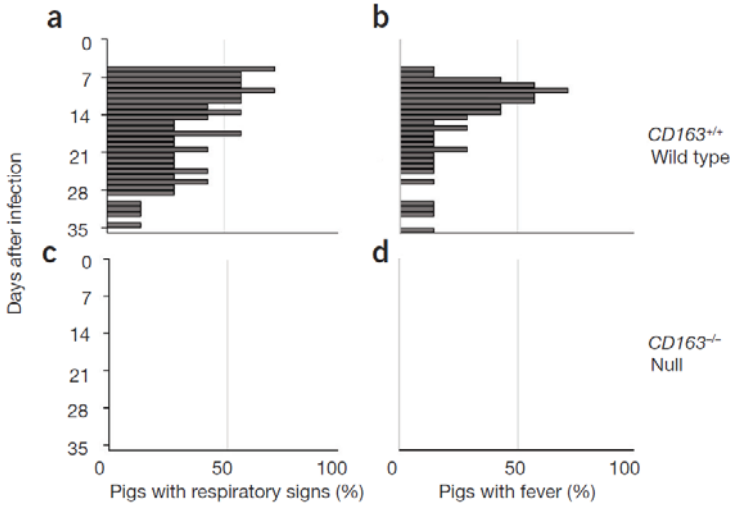
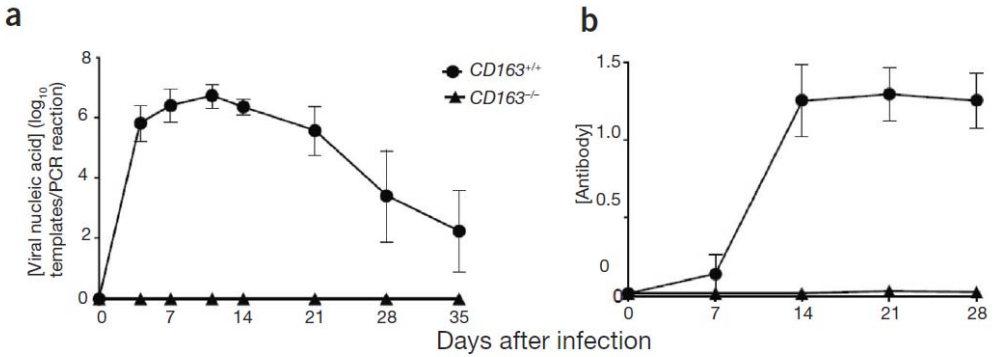


Clinical signs: respiratory fever



PRRSV RNA antibody

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When to use genome editing technology in breeding systems:

- to import variation … that is currently difficult to introgress

- **introgress alleles from different species (e.g. RELA)**
- **utilising 'backyard genetics' (e.g. polled)**
  - **- from outwith breeding population**
  - **- "capturing" rare breed alleles**
- **introduce novel variation (e.g. CD163)**

- **increasing fixation rate for low frequency variation**
  - **>> multiplex**

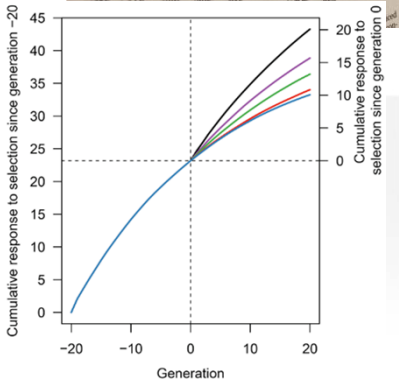

New edits to animal genes cut down on roug

COWS, FROM PAGE 1

bioethicists say, raises questions that are both unique to animals and may bear on the looming prospect of fiddling with our own.

"'We're going to see a stream of edited animals coming through because it's so easy,'" said Bruce Whitelaw, a professor of animal biotechnology at the Roslin Institute at the University of Edinburgh. "'It's going to change the societal question to 'If we could do it, would we want it?' to 'Next year we will have it; will we allow it?'"

Animal breeders have for centuries scoured species for desirable traits and combined them the old-fashioned way, by selective mating. But that process can decades to achieve a particular that are both resistant to a lot of milk. And



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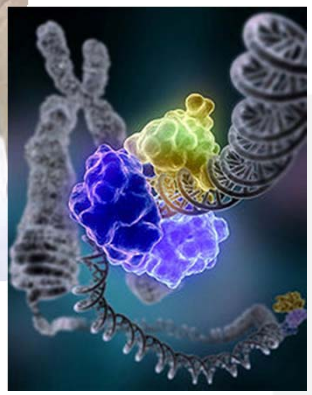

- **Disease resilience**
- **Gender skewing**
- **Improved welfare**
- **Adaption to stress**

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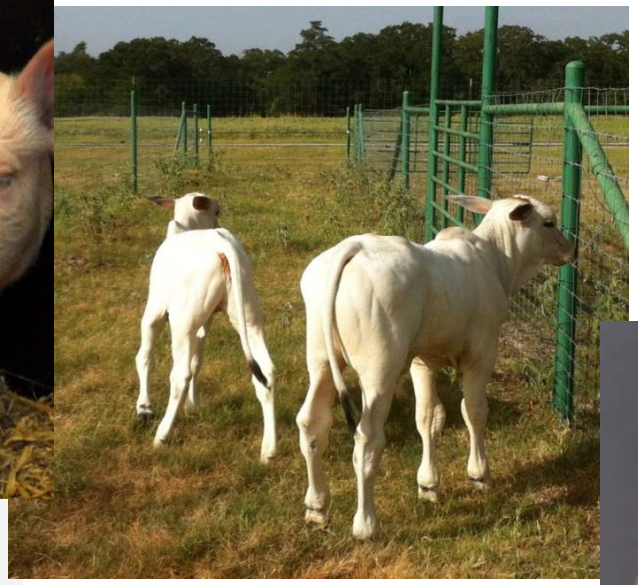

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