

The use of genetics to improve canine and equine breeds



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Breeding and genetics

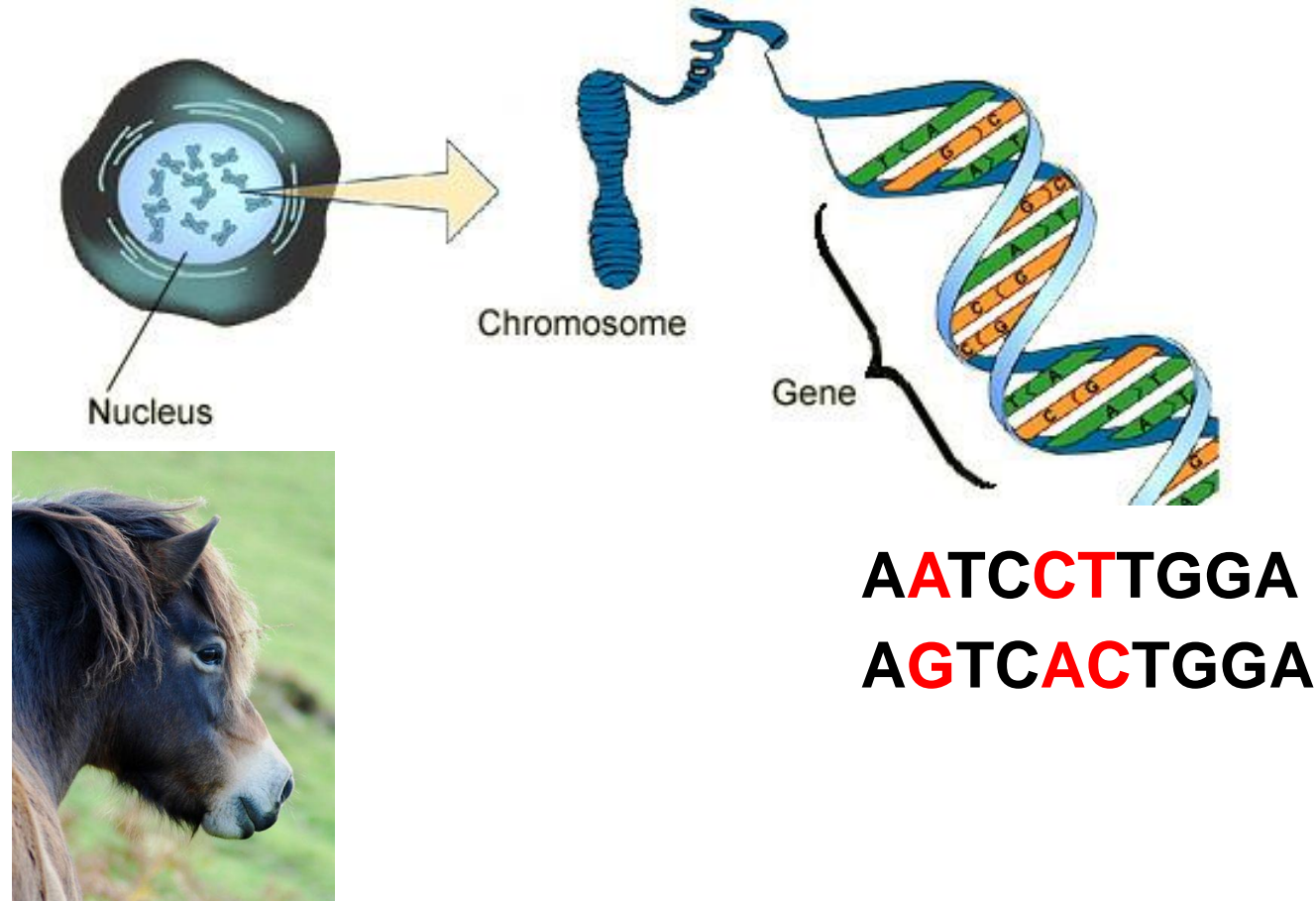


- Genetics tools – DNA tests, EBVs
- Breeding programmes
- Health

- Health?
- Performance?
- Genetic tools – EBVs, GBVs?



Chromosomes, genes, DNA



Genome (all chromosomes) contains around 20,000 genes

Genomic tools

- Canine genome sequenced 2005
- Equine genome sequenced 2007

Sequencing

AATCCTTGGGA
AGTCACTGGA



3 million + variants

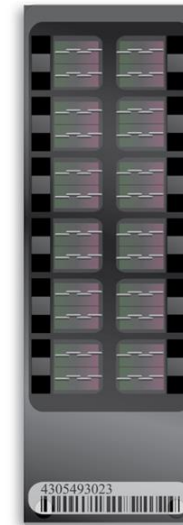


Genotyping

AATCCTTGGGA
AGTCACTGGA



670,000 variants



Genetic traits

- **Single gene trait**
 - Affected/carrier/normal
 - Genotype predicts whether affected or not (diagnostic)
- **Complex trait**
 - Multiple genes interacting with environment
 - Genotype predicts risk but is NOT diagnostic

Equine single gene DNA tests

- Hyperkalemic periodic paralysis disease (HYPP)
 - Polysaccharide storage myopathy (PSSM1)
 - Malignant hyperthermia (MH))
 - Hereditary equine regional dermal asthenia (HERDA)
 - Glycogen branching enzyme deficiency (GBED)
- Quarter Horse
- Junctional epidermolysis bullosa (JEB1, JEB2)
 - Congenital stationary night blindness
 - Lethal white overo
 - Lavender foal syndrome
 - Severe combined immunodeficiency (SCID)
 - Cerebellar Abiotrophy (CA)
 - Warmblood fragile foal syndrome
 - Foal immunodeficiency syndrome
 - Hoof wall separation disease
 - Hydrocephalus
 - Coat colour
 - Gait testing
- American Saddlebred
Belgian Draught
Appaloosa
Arab
Warmblood
Fell
Dales
Connemara
Friesian

Single gene diseases

Fell and Dales Ponies: Foal Immunodeficiency Syndrome
Fox-Clipsham *et al* (2011)



Connemara Pony: Hoof Wall Separation Disease
Finno *et al* (2015)

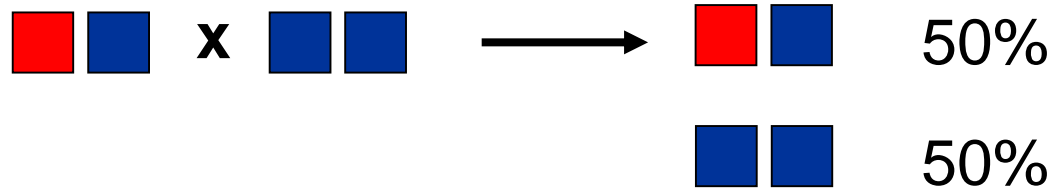


DNA testing

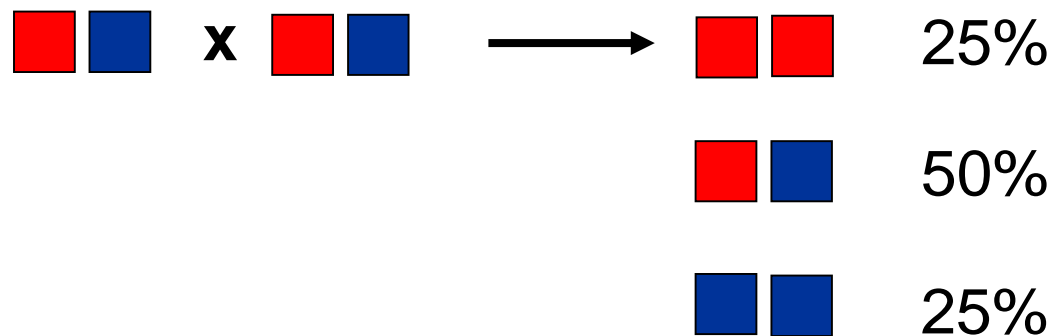
Normal x Normal



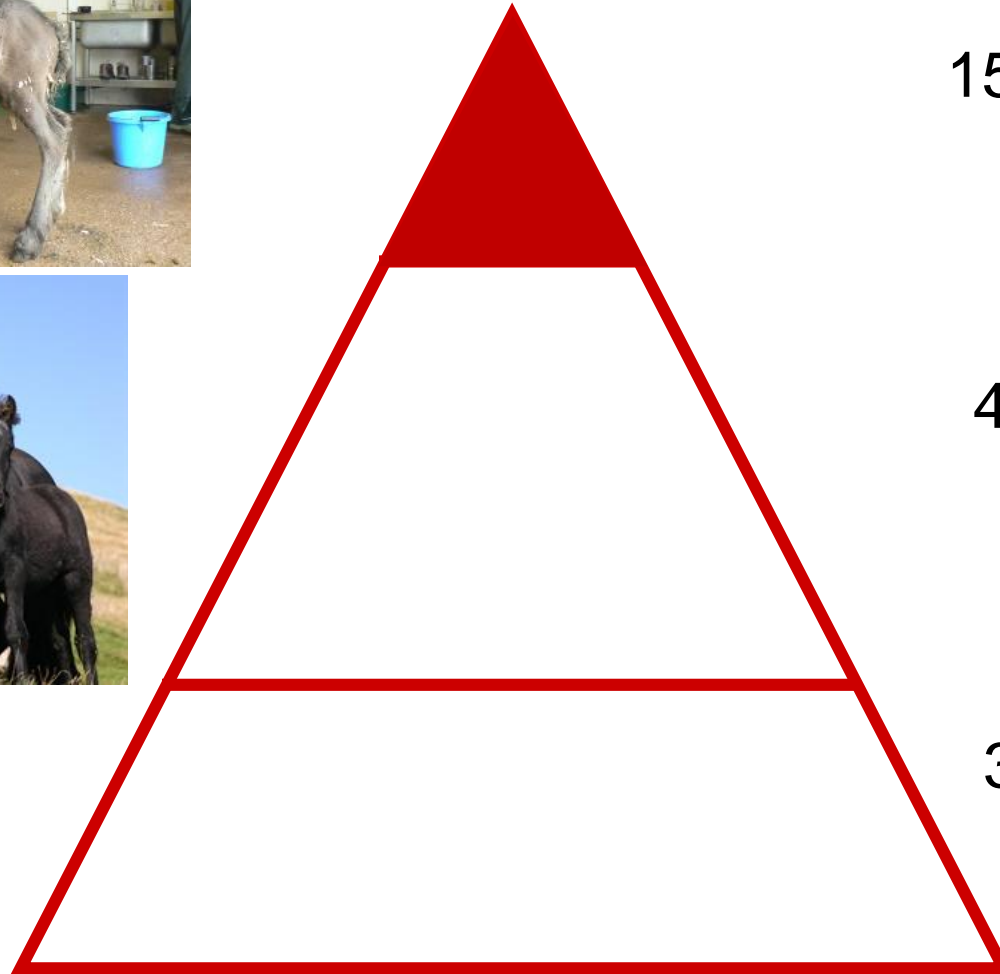
Carrier x Normal



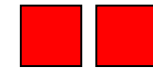
Carrier x Carrier



Carrier frequency



15% affected



47% carrier



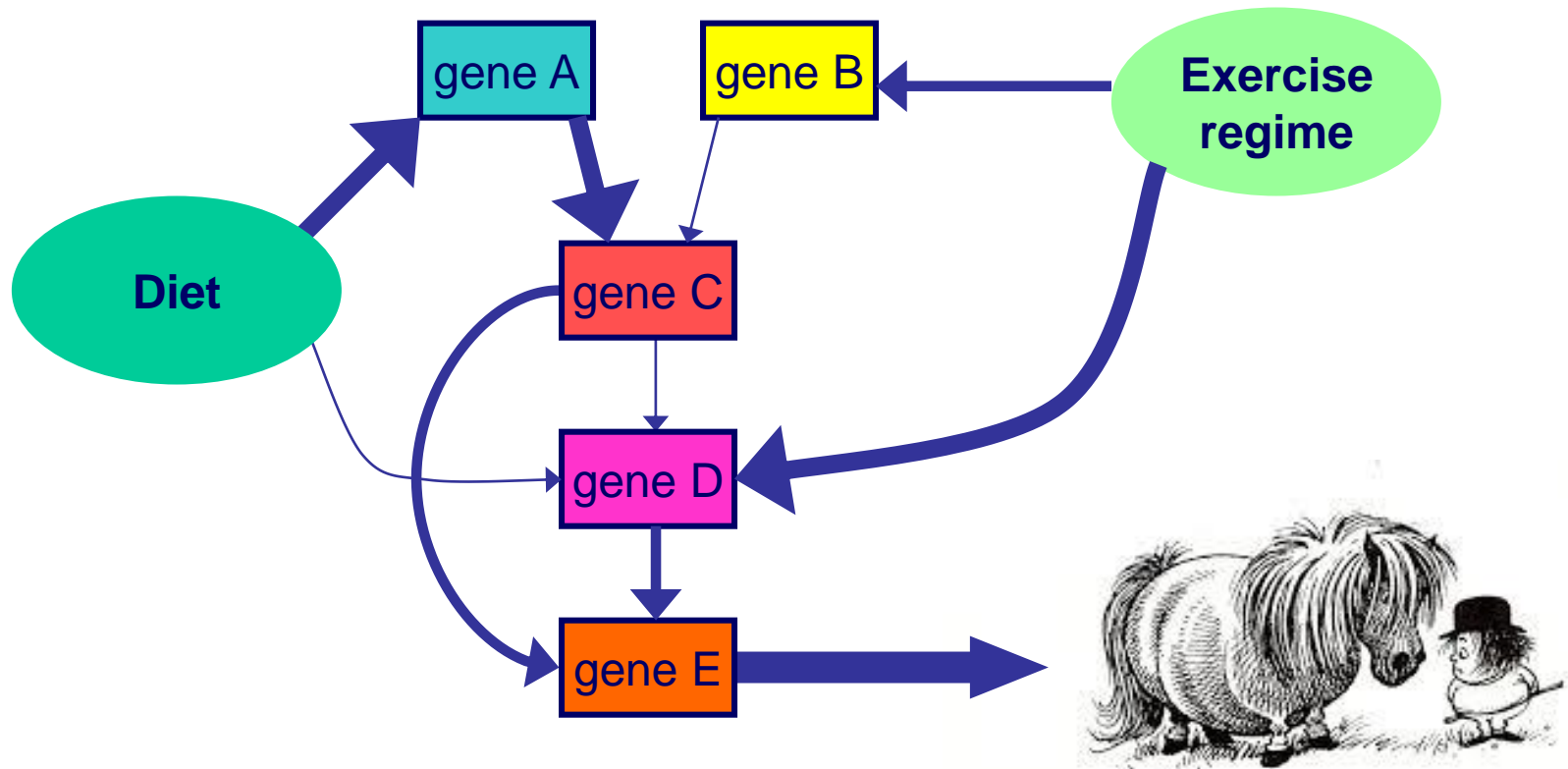
38% normal



Breed health

- Consider the entire breed
- Need to reduce carrier frequency carefully
- Genotype offspring
- Select replacement breeding stock from normal animals
- Monitor population structure to minimise inbreeding

Complex traits



INSUFFICIENT EXERCISE, HOWEVER, CAN LEAD TO EXCESSIVE FAT ...

Performance

- Racing time
- Winnings
- Optimum distance
- Precocity
- Elite performance
- Height

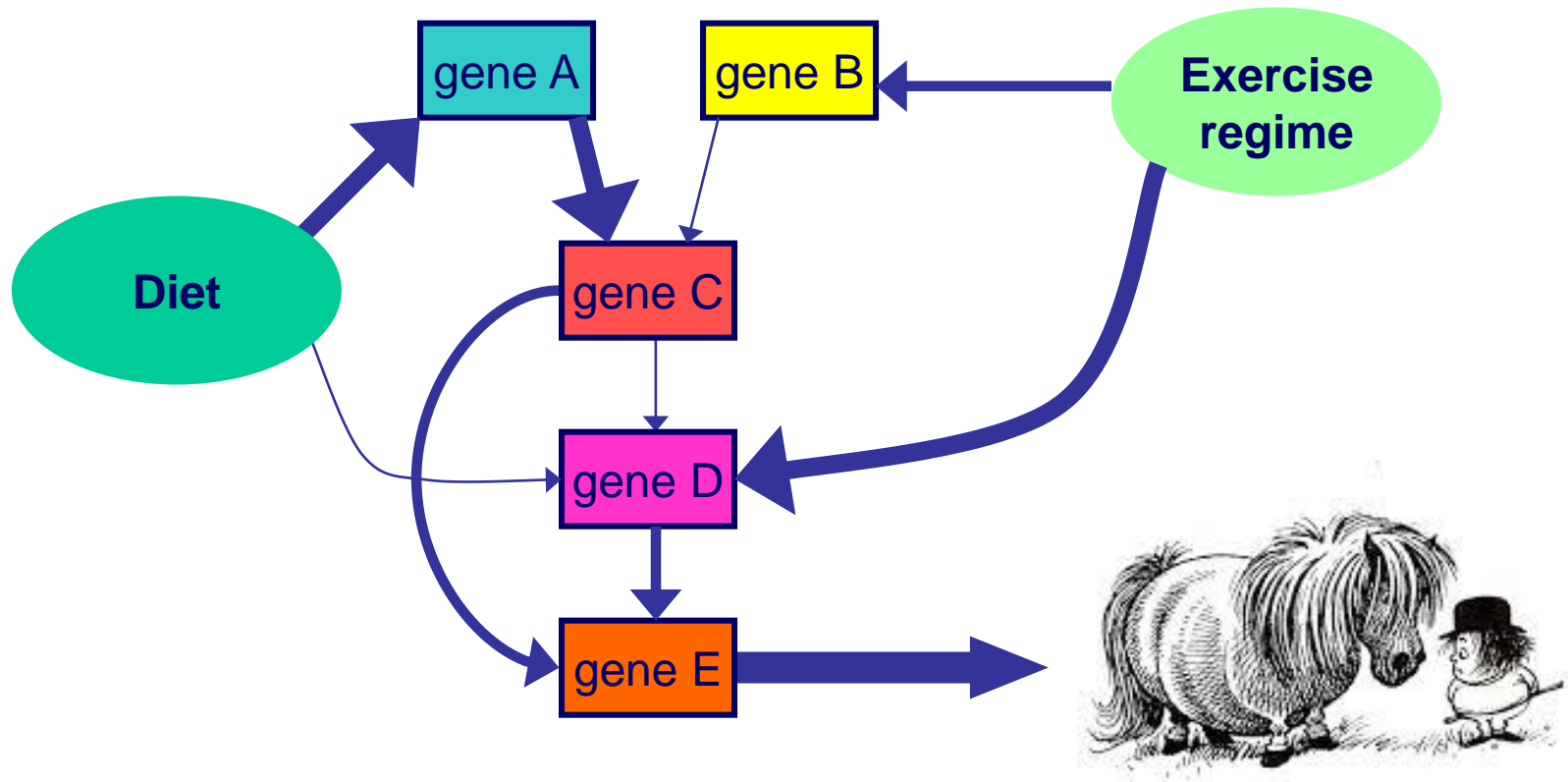


- Tendon injury
- RER 'Tying up'
- Fracture risk
- Osteochondrosis
- Airway disease
- RLN 'Roaring'
- EIPH 'Bleeding'
- Durability



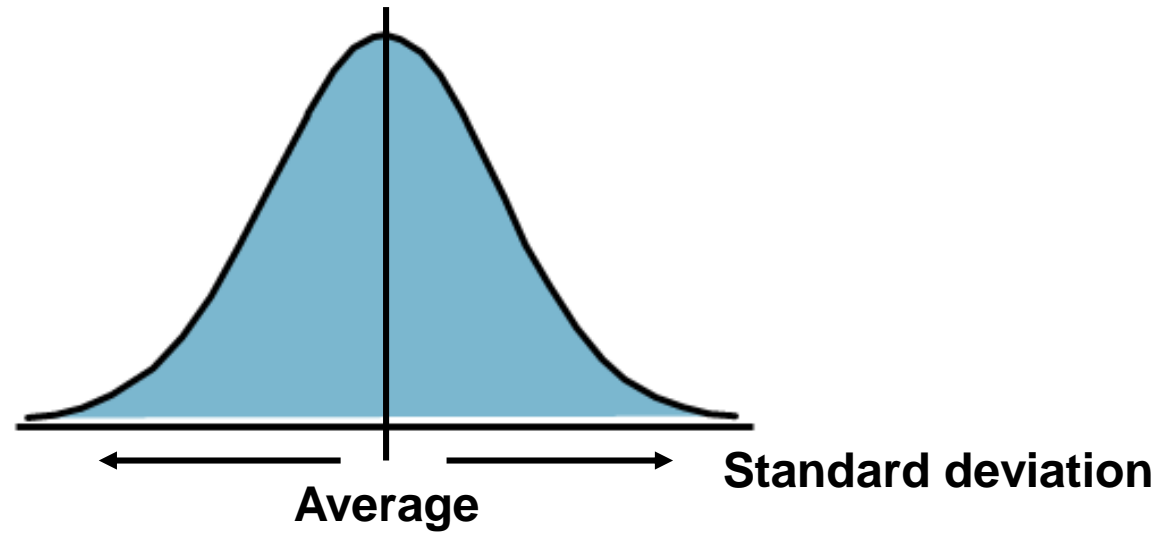
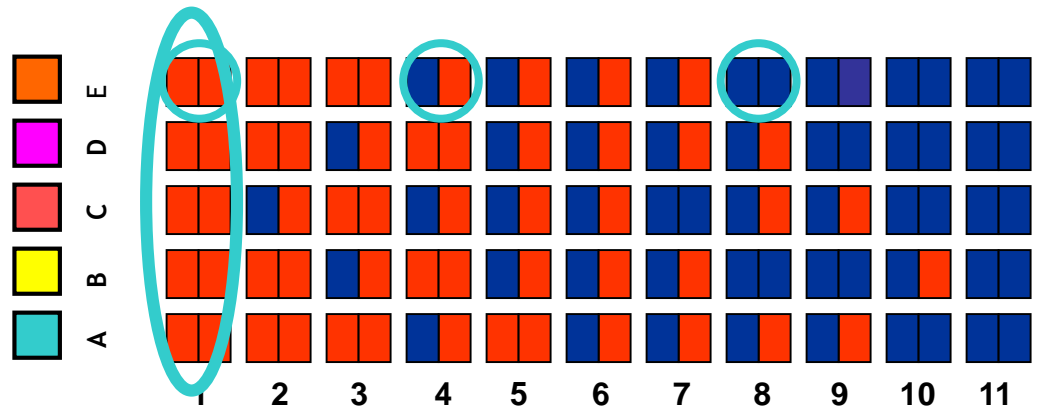
Health

Complex diseases

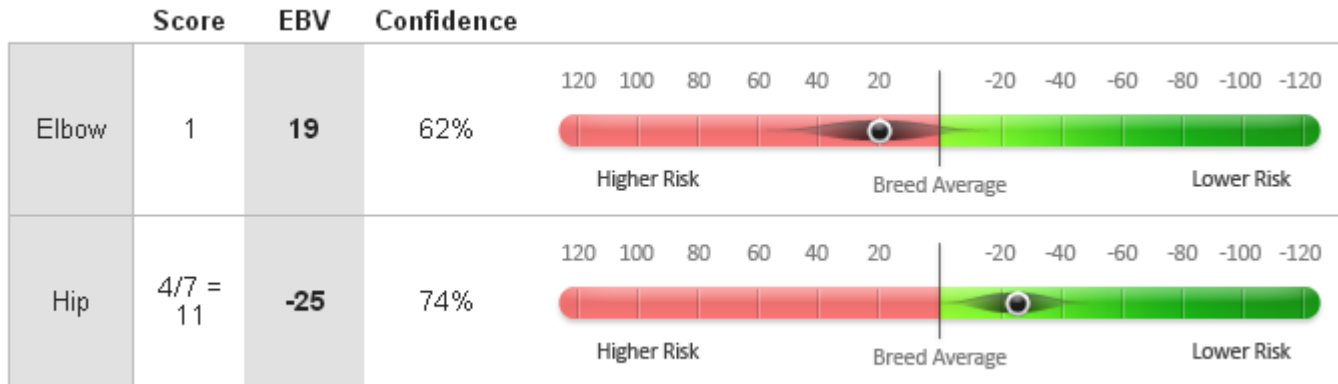


INSUFFICIENT EXERCISE, HOWEVER, CAN LEAD TO EXCESSIVE FAT ...

Genetic risk



Estimated Breeding Values (EBVs)



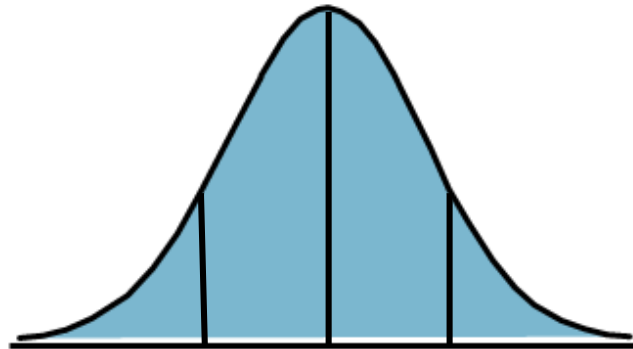
EBVs and GBVs for health

EBVs

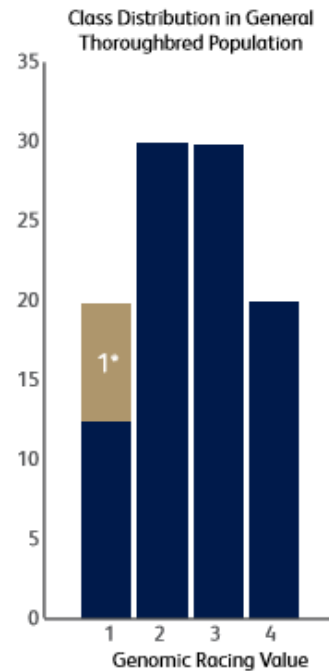
- Clinical data on population
- Pedigree
- Continuous data collection
- Available for all animals

Genomic BVs

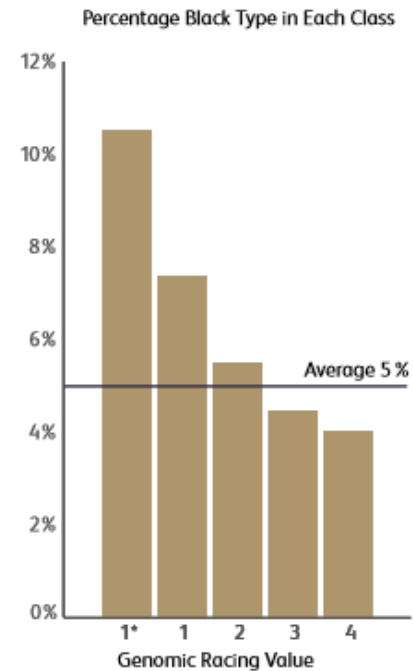
- Single cohort of animals with well-defined clinical data
- DNA sampled and genotyped
- Only available for genotyped animals



A score of 1* highlights Class 1 horses that are at the very top of the range.



Almost 40% of the Class 1 horses are Class 1*. Class 2 and 3 are the most common classes in the general Thoroughbred population



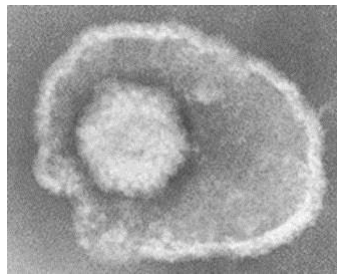
Class 1* horses are over two times more likely to achieve black type than Class 4 horses

Thoroughbred breeding

- Review industry structure to understand the impact of genetics
- Identify valid industry-wide selection objectives
- Develop reliable genetic evaluation tools
- Develop an appropriate education programme

Research

- Exercise induced pulmonary haemorrhage (EIPH)
- Equine herpes virus (EHV1)
- Hoof growth and development



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