Genome Wide Selection / Genomic Selection

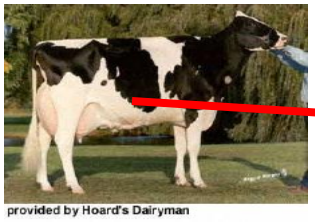
Lecture 23

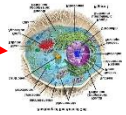
Introduction to Breeding and Genetics

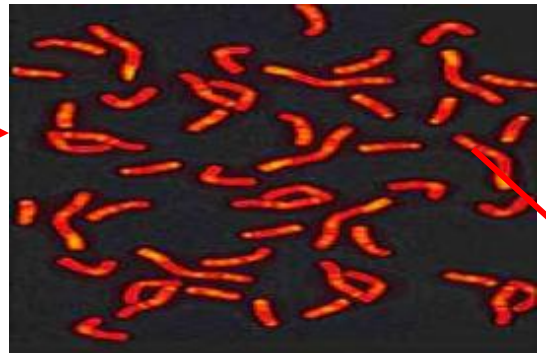
GENE 251/351

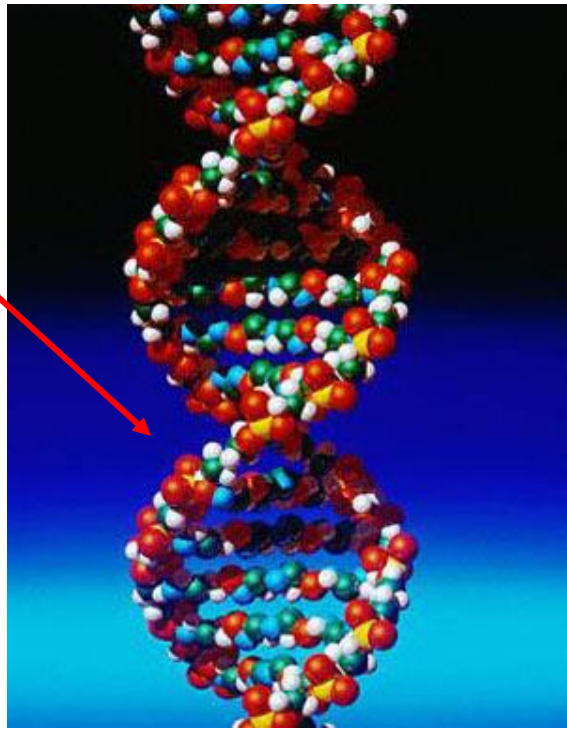
School of Environment and Rural Science (Genetics)

DNA: building blocks of life



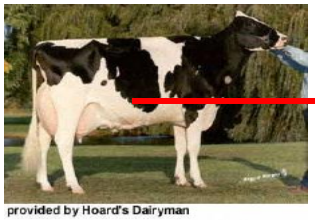


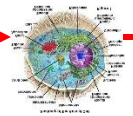


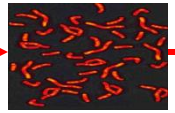


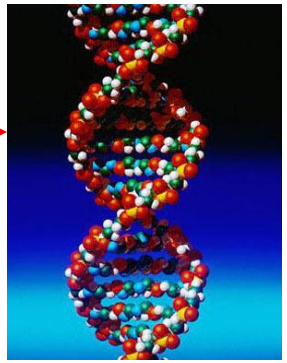
Each chromosome consists of large strings of DNA, all 30 of them together holding about 25,000 genes

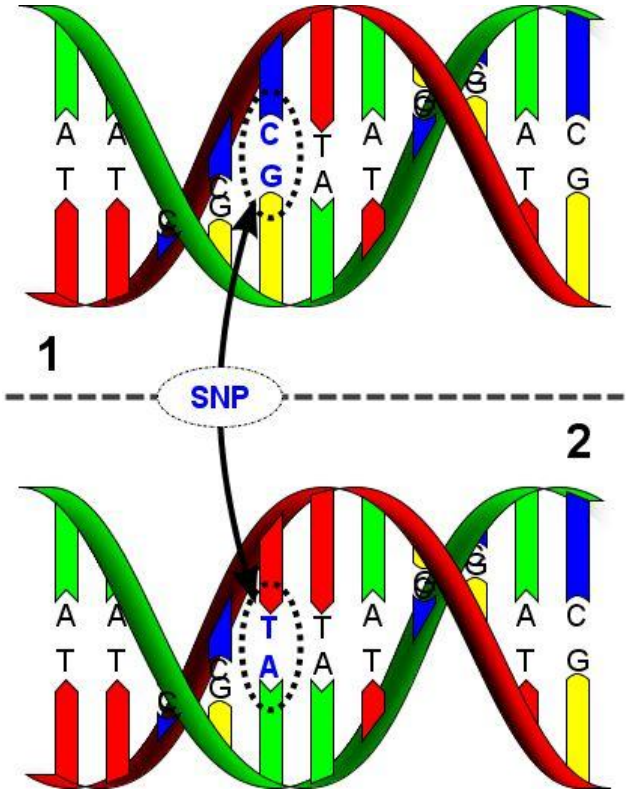
DNA: building blocks of life











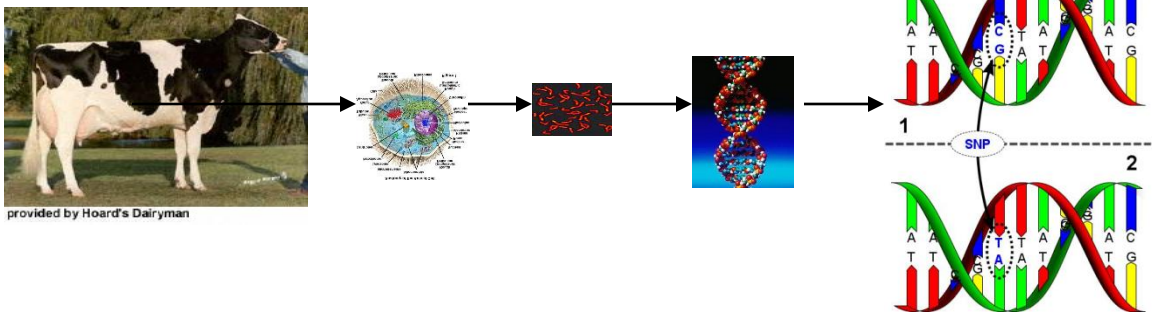
DNA code shows subtle differences between individuals:

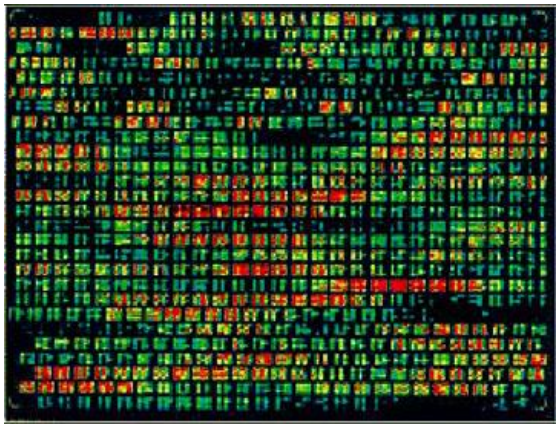
→The basis of genetic variation

These are genetic markers,

most common ones are called ‘SNPs’

The SNP chip



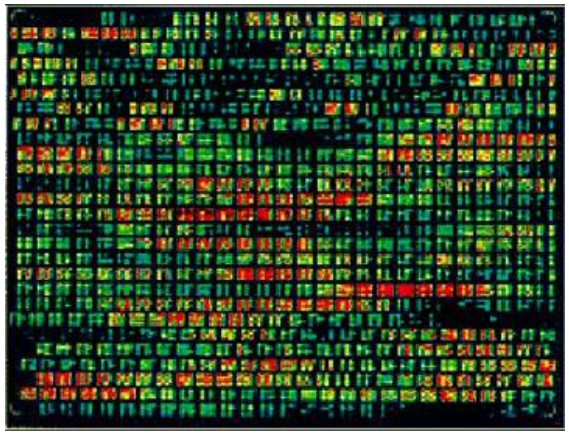


DNA chip or SNP chip shows tens of thousands of such differences in one test for one individual

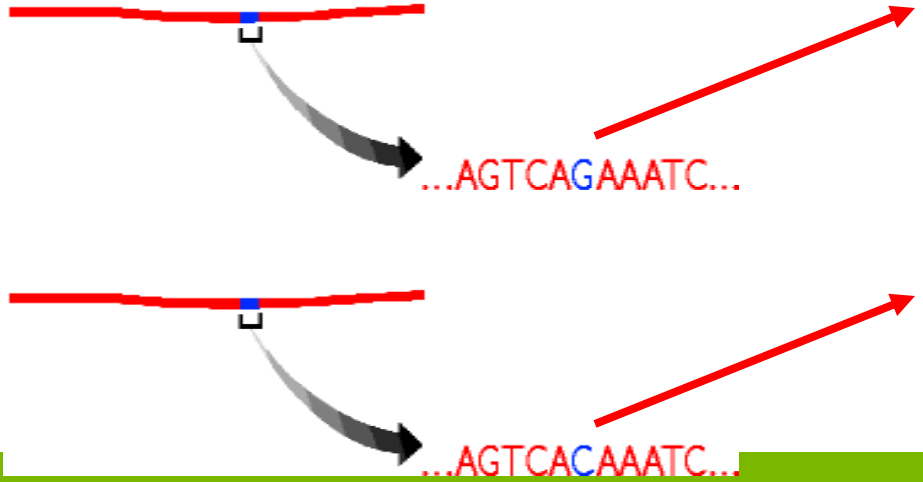
This can be used to predict
- breeding value
- human disease
- phenotypes in forensics

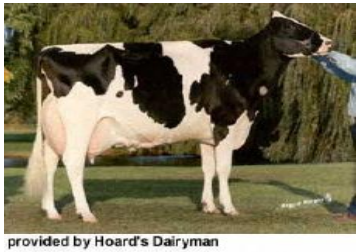
nr of SNPs on chip	
humans	>1 million
cattle	800k
sheep	50k

SNP chip



60,000 test for DNA differences, possibly predicting difference in characteristics (or BV)

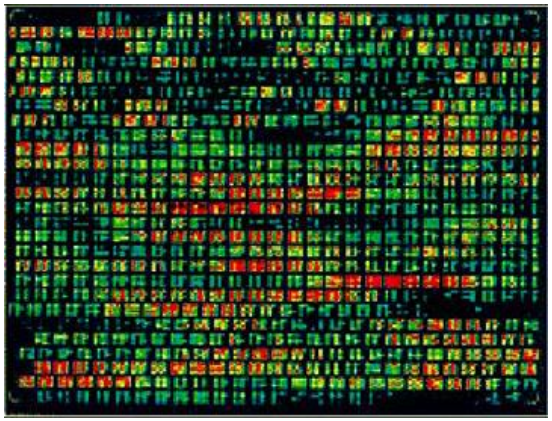




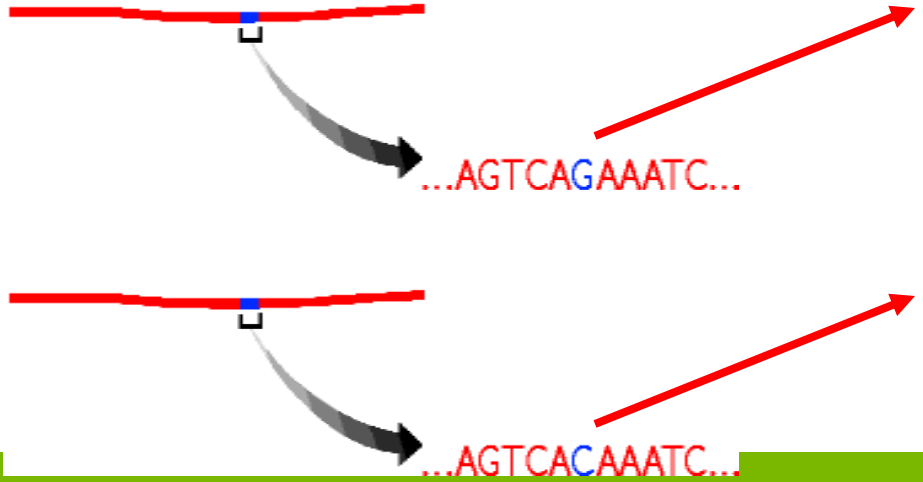
provided by Hoard's Dairyman

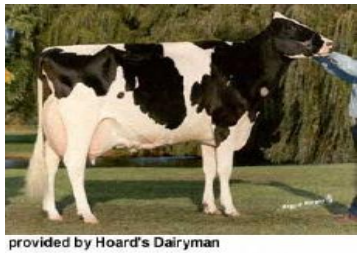
Either in coat colour……

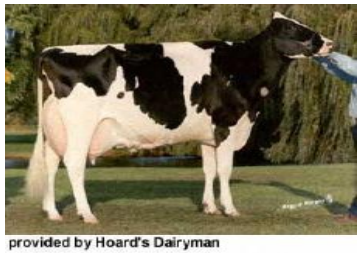
SNP chip

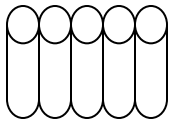


60,000 test for DNA differences, possibly predicting difference in characteristics (or BV)

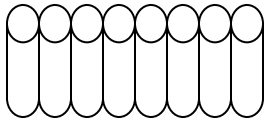




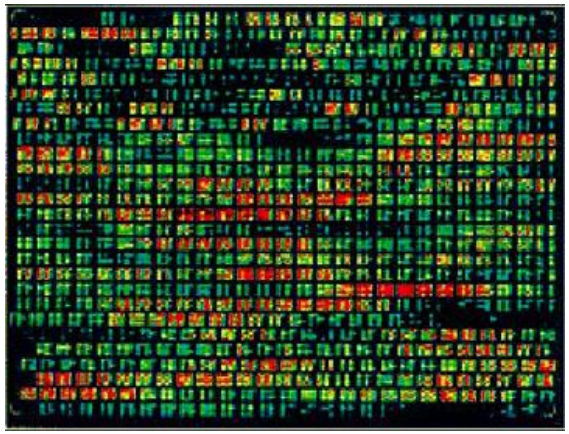




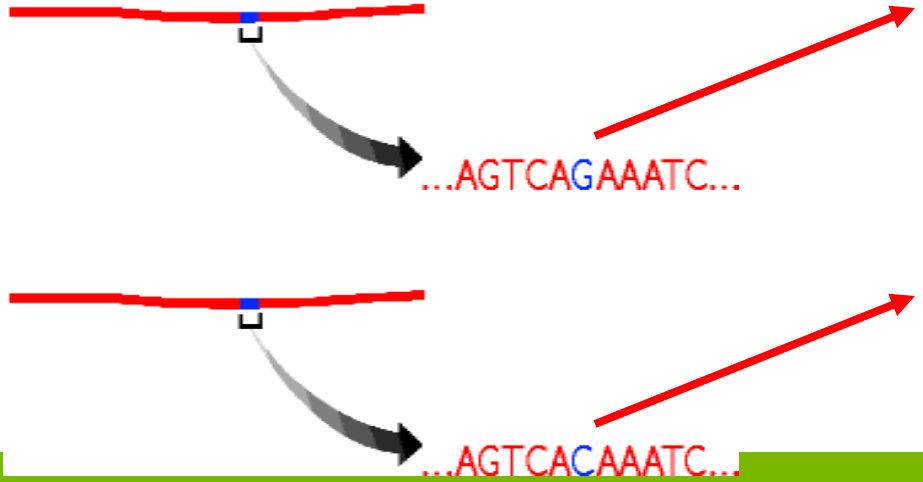
or in milk production

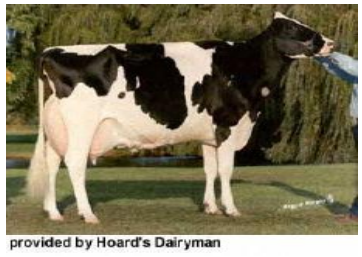


SNP chip

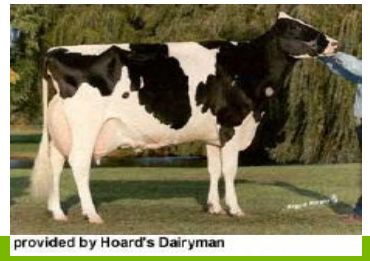


60,000 test for DNA differences, possibly predicting difference in characteristics (or BV)



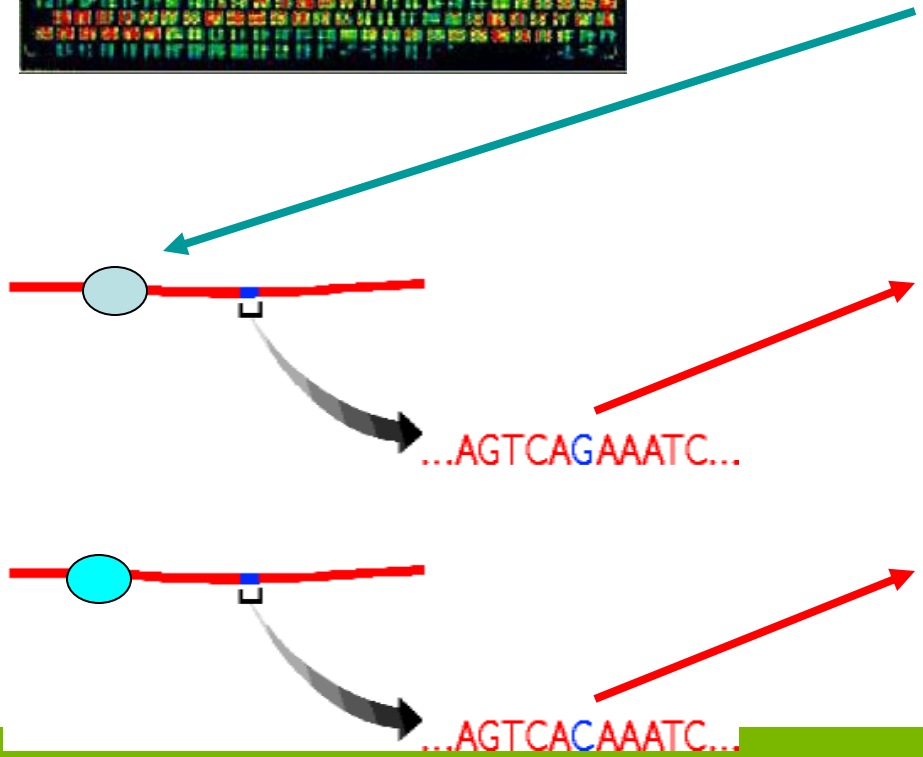


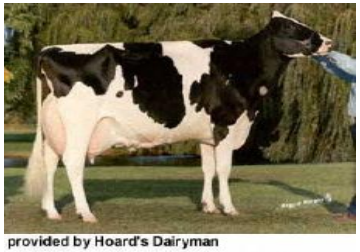
or in fertility

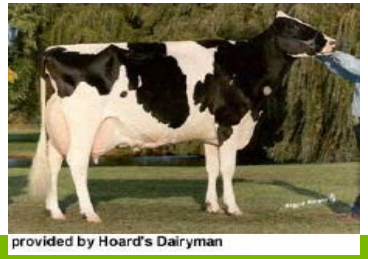


SNP chip

Would also pick up differences in genes close to the SNP marker



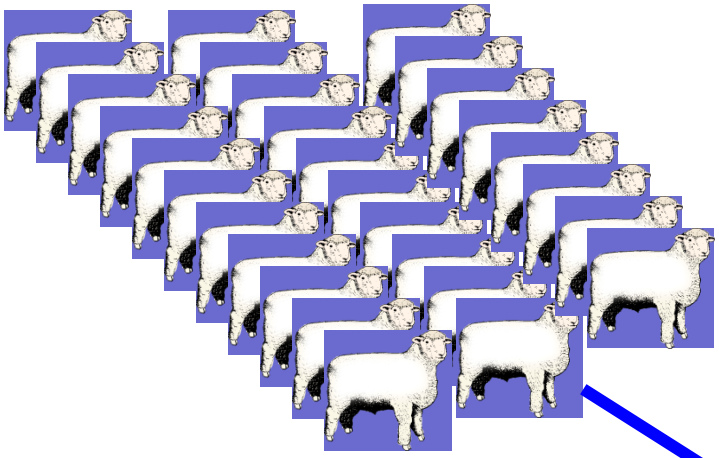




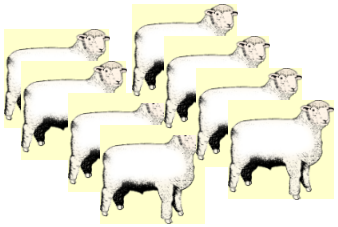
Use of SNP chip in genomic selection

- Single markers (& genes) will predict very small differences
- Variation in most traits determined by very many genes
- The fact that we have so many markers (and so close together), gives us much more power to predict differences
- Interest is in predicting differences in breeding value
  - based on sharing of chromosome segments not so much in actually finding the genes

Genomic Prediction: basic idea

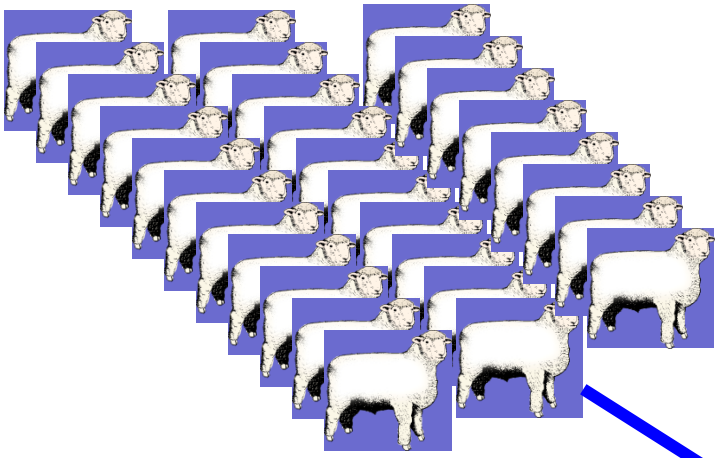


1) Somebody (else) measures lots of sheep, and their DNA
→ Reference population



2) A breeder tests DNA on young rams

Genomic Prediction: basic idea



Reference population

young rams

3) Computer centre can predict breeding value for young rams
based on genomic relationship, combines it with other info

Can predict breeding value of young animals for 'any trait' measured in reference

Genomic Selection: Benefit

Overall:

More accurate prediction of genetic merit for breeding objective

Specific:

Traits that are usually difficult to improve

- difficult or expensive to measure
- can not be measured early
- low heritability

e.g.

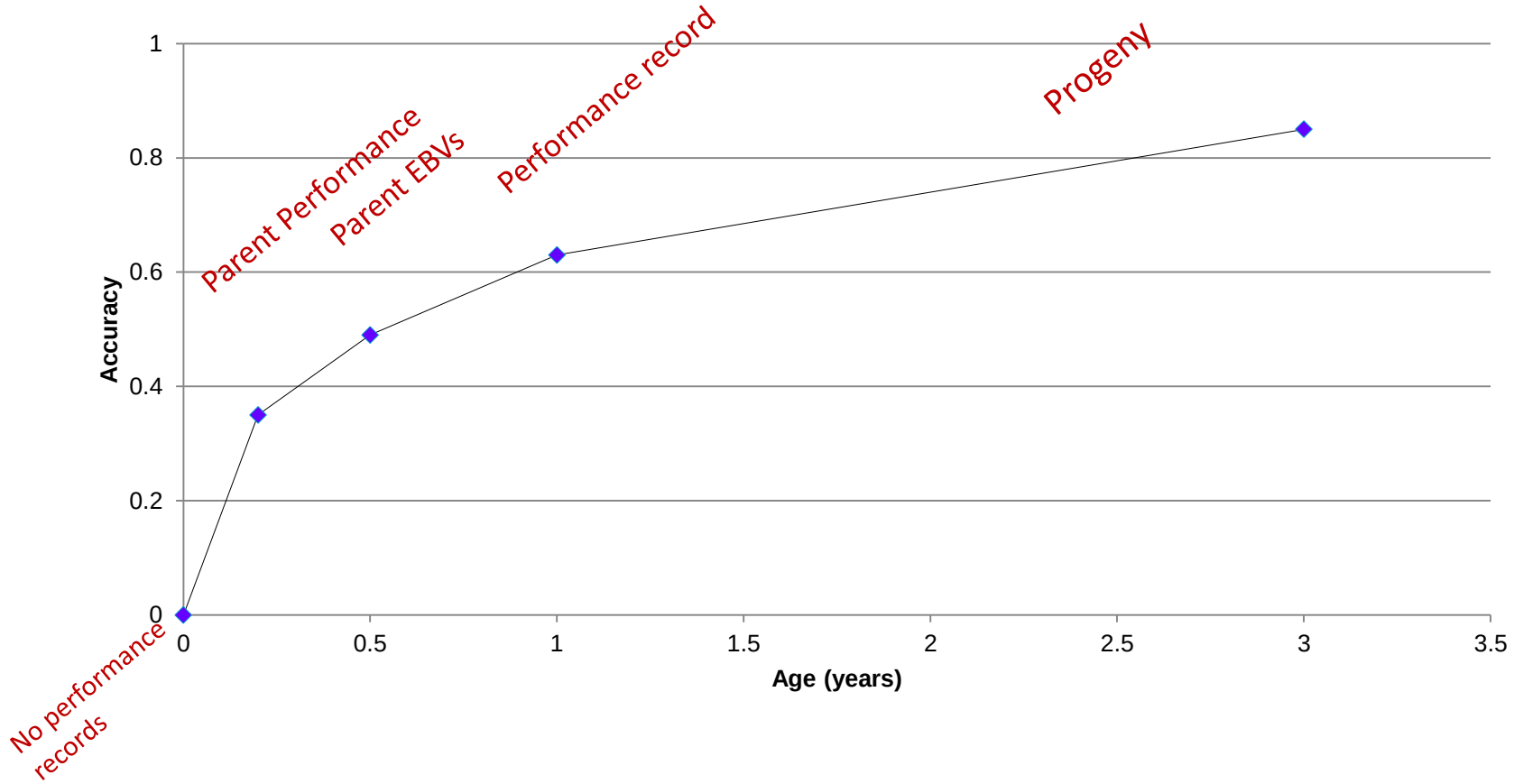
- Carcass traits
- Lifetime time wool production
- Reproductive rate
- Parasite resistance

Genetic Improvement – General Observations

- It is about how well we select breeding animals….
  - Breeding objective
  - Accuracy of selection, EBV
  - Selection intensity
- ..and about using them as soon as possible
  - Generation interval

Accuracy of predicting a breeding value

- increases as an animal gets older

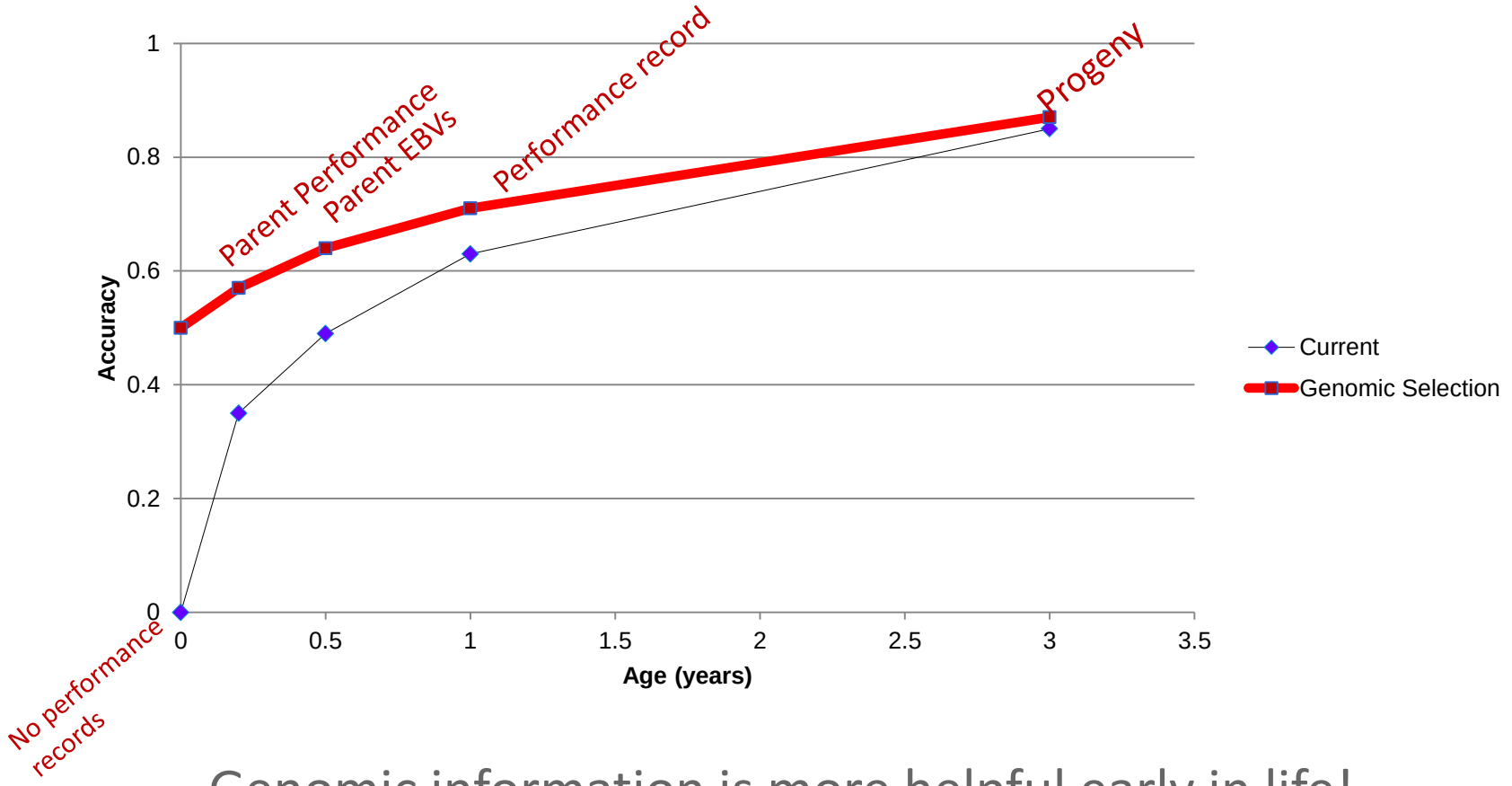


Assumed heritability = 25%

Need to balance accuracy and generation interval!

Accuracy of predicting a breeding value

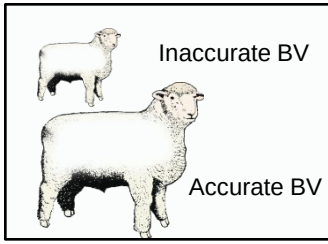
- increases as an animal gets older

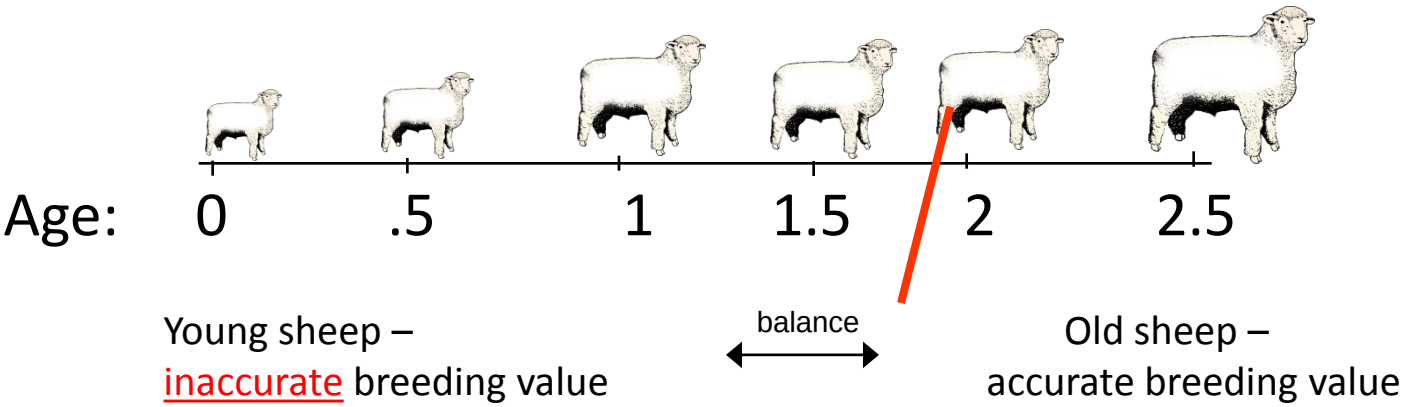


Genomic information is more helpful early in life!

Assumed heritability = 25%; Accuracy of genomic test = 50%

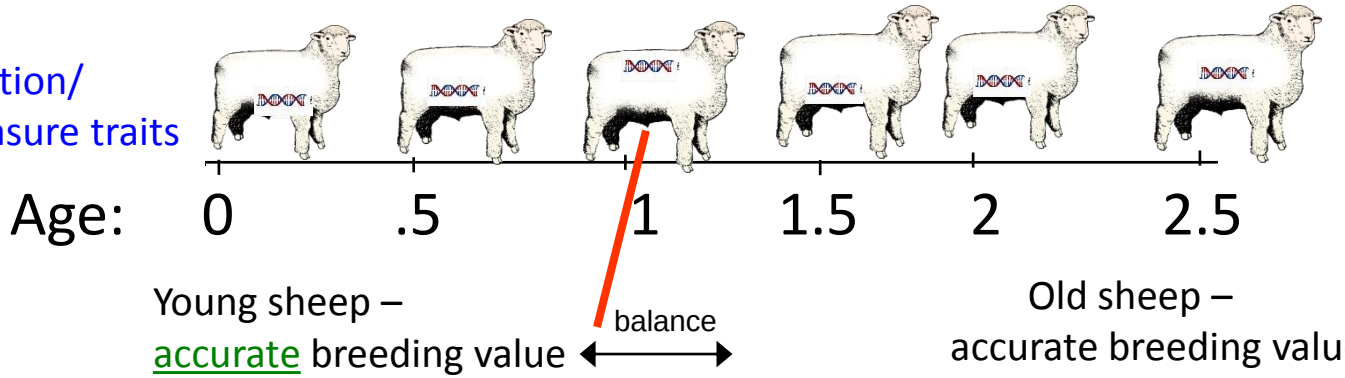
Traditional Selection





Genomic Selection

Earlier selection/
Hard to measure traits



Summary

- DNA test
  - provides information about breeding value, early, and reasonably accurate
  - Allows earlier selection and for hard to measure traits
  - Can increase rates of genetic gain (~100% in dairy, ~25% in sheep)
  - Requires always a reference population