

LEARNING AREA: SCIENCE

# Thoroughbred Breeding and Genetics



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Thoroughbred breeding combines knowledge of genetics, selective breeding strategies, pedigree analysis, and modern genetic testing to enhance performance and health in racing horses. Understanding how genetic traits are inherited, the role of chromosomes, DNA, and genes helps breeders predict and plan for the traits in future generations of racehorses.



## How genetic traits are inherited in thoroughbreds

An organism's genetic traits are their features or characteristics that are inherited from their parents. In thoroughbred horses, genetic traits such as coat colour, speed, stamina, strength, and temperament are passed down from parent to offspring through **genes**, the fundamental units of heredity. These genes contain the specific instructions for each trait. Thoroughbreds inherit two copies of every gene, one from each parent, which together determine how these traits are expressed.

Horses have 32 pairs of **chromosomes**, which are made up of long strands of Deoxyribonucleic acid (DNA). DNA contains many genes. Some genes are **dominant**, meaning they will override the effects of **recessive** genes, which are only expressed when both copies are recessive. Together, the interaction between dominant and recessive genes shape the physical and behavioural characteristics of each thoroughbred.



## Cell division: Meiosis and mitosis

**Meiosis** is the process of cell division that produces sex cells (sperm and eggs), reducing the chromosome number by half so that when the sperm and egg combine during fertilisation, the offspring has the correct number of chromosomes. Each sex cell carries a unique set of genes, leading to genetic variation in offspring. This variation is the foundation of heredity and explains why foals may inherit traits from both the sire (father) and the dam (mother).

**Mitosis** is the process of cell division that ensures the fertilised egg grows into a foal with identical cells. Chromosomes contain DNA, which carries genes – the units of heredity that determine traits like coat colour and speed. Horses inherit two copies of each gene (alleles) – one from each parent.



## Selective breeding to enhance desirable traits

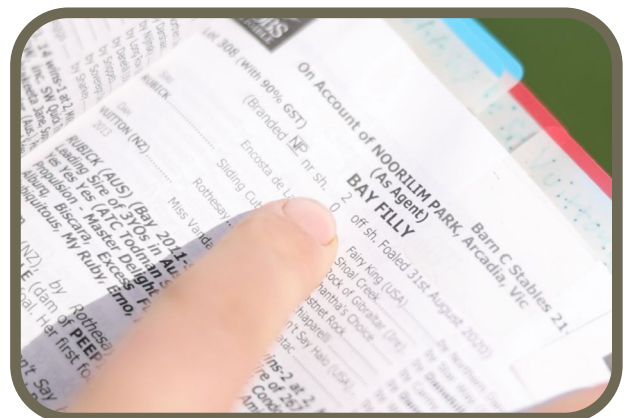
Selective breeding involves deliberately mating horses to enhance traits such as speed, stamina, temperament, muscle strength, and health which are controlled by a number of different genes. By understanding the genetic makeup of thoroughbreds, breeders can make informed decisions to select which horses to breed with each other to produce racehorses with favourable traits.

Many years of selection for desirable traits have produced thoroughbred horses that tend to have the speed and strength that makes them good sprinters.

All thoroughbred horses in Australia can only be conceived naturally by allowing a stallion to mate a mare. To be registered as a thoroughbred, a foal must be the product of a “live cover,” meaning a witnessed natural mating of a stallion and a mare. Though artificial insemination (AI) and embryo transfer are possible and common in other horse breeds, it is banned with thoroughbreds.

## Reading pedigrees

A pedigree shows a horse’s ancestry and helps predict the likelihood of inheriting certain traits. Breeders use pedigrees to identify strong lineages and avoid health issues by tracking inheritance patterns across many generations.



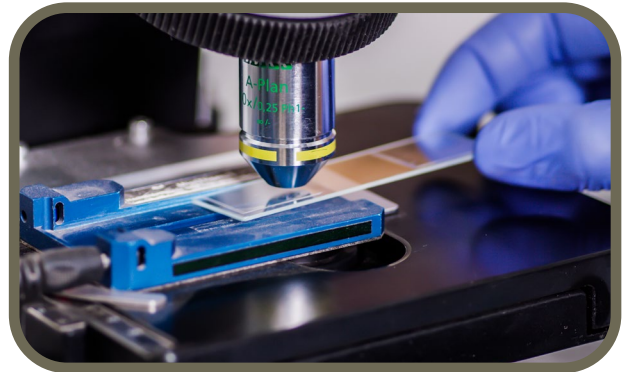
Scan the QR code or click on the link to learn the basics of understanding how to read a horse’s pedigree.

### Introduction to Reading Pedigrees

<https://www.tbalearning.com/course/introduction-to-reading-pedigrees-module>

## Genetic testing in thoroughbreds

Genetic testing is a biotechnology that helps breeders make more informed decisions by identifying specific genes related to performance traits. Genetic testing can identify genes for speed, stamina, and even temperament. For example, certain mutations in the myostatin gene are associated with sprinting ability. By testing for these genes, breeders can select horses more likely to excel in specific racing conditions.



Genetic testing also identifies carriers of recessive genes for health disorders. Horses that carry these genes may appear healthy but could pass on the disorder to their offspring. Testing helps breeders avoid mating two carriers, reducing the risk of producing affected foals.

Genetic testing can also detect genetic mutations responsible for certain coat colours and/or patterns. This can be helpful if breeding a particular colour or pattern is desired.

## Constructing Punnett squares to predict traits

A Punnett square is a tool used to predict how dominant and recessive alleles combine in offspring. It helps breeders understand the probability of certain traits, like coat colour or even genetic disorders, appearing in foals.

Example: Genetic trait: Coat colour (chestnut alleles)

Chestnut colour is controlled by the recessive allele (e). A horse with two chestnut alleles (ee) will have a chestnut coat.

A horse with one chestnut allele and one black allele (Ee) will have a black or bay coat, as the black allele is dominant. A horse with two black alleles (EE) will have a black or bay coat.

Example Punnett square

EE x ee

	e	e
E	Ee	Ee
E	Ee	Ee

All (100%) of the foals from this cross will inherit a black or bay coat (Ee). All offspring have a 0% chance of inheriting a chestnut coat (ee).

## Thoroughbred breeding and genetics

a) A famous Australian thoroughbred horse, Winx, is known for her dark bay coat (likely Ee genotype). If Winx were bred with a chestnut-coloured stallion (ee), what is the probability of the foal being chestnut? Use a Punnett square to predict the outcome.

b) What is selective breeding, and why is it important in the breeding of thoroughbred horses?

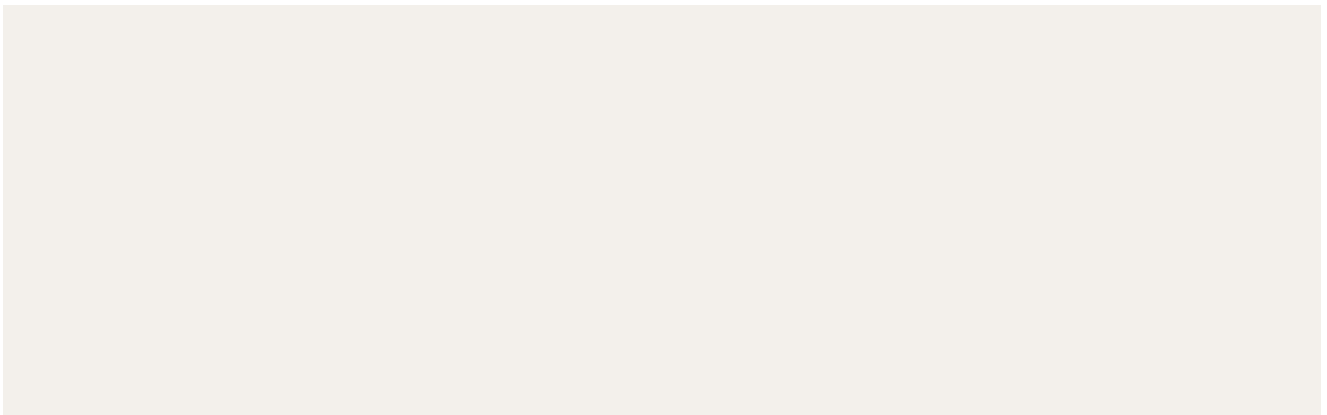
c) What is the purpose of a pedigree in thoroughbred breeding, and how does it help breeders?

**d) The pedigree for Winx can be summarised below. A sire is the male parent and a dam is the female parent.**

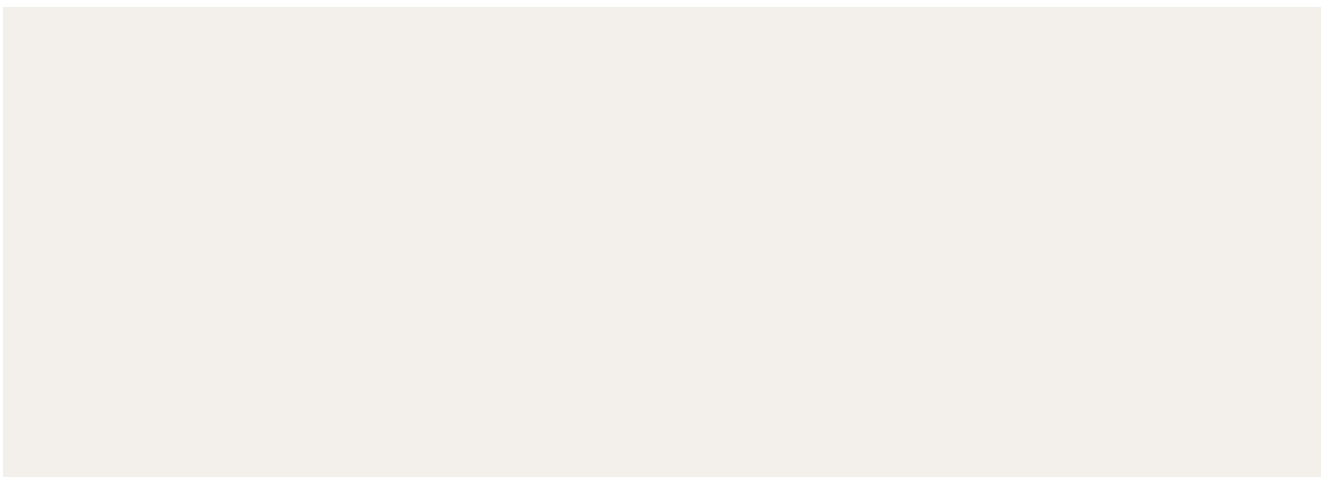
Winx (b. 2011)

- Sire: Street Cry (IRE) (b. 1998)
  - Grandsire: Machiavellian (b. 1987)
  - Granddam: Helen Street (b. 1982)
- Dam: Vegas Showgirl (NZ) (b. 2002)
  - Grandsire: Al Akbar (b. 1990)
  - Granddam: Vegas Magic (b. 1993)

**i) What is a Grandsire and a Granddam in relation to Winx?**



**i) Draw a pedigree diagram for Winx. Remember that males are represented by squares and females are represented by circles. Breeding is indicated by a horizontal line, and a vertical line indicates offspring.**



## Learning Area | Australian Curriculum Content:

### Science

Explain the role of meiosis and mitosis and the function of chromosomes, DNA and genes in heredity and predict patterns of Mendelian inheritance (AC9S10U01)

### ATTRIBUTION, CREDIT & SHARING

This resource was produced by Primary Industries Education Foundation Australia (PIEFA) in collaboration with Thoroughbred Breeders Australia. Primary Industries Education Foundation Australia's resources support and facilitate effective teaching and learning about Australia's food and fibre industries. We are grateful for the support of our industry and member organisations for assisting in our research efforts and providing industry-specific information and imagery to benefit the development and accuracy of this educational resource.

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