

Artificial selection: the definition, the method and 25 examples

ARTIFICIAL SELECTION (selective breeding): humans choose which individuals reproduce, so the traits they want become more common over generations. It works because individuals vary and much variation is inherited. Darwin named it (1859) and used breeders' pigeons as evidence that selection can reshape a species.

The method

- [] 1 Decide the trait (milk yield, size, sweetness, tameness, speed, disease resistance)
- [] 2 Breed only from the parents that show it most strongly
- [] 3 Select the offspring that show it most strongly and breed only from them
- [] 4 Repeat for many generations; cross varieties to combine traits

Organism	Bred from	Trait selected
dogs (every breed)	the grey wolf, c. 15,000 years ago	tameness, then size, coat, behaviour
broccoli, cabbage, cauliflower, kale, kohlrabi, sprouts	one wild mustard, Brassica oleracea	flower buds, leaves, stem, side buds
maize (corn)	teosinte, a grass with 5-12 hard kernels	kernel number, size, softness
wheat	wild einkorn and emmer	non-shattering, larger seeds, dwarf stems (1960s)
rice	wild Asian rice	yield, grain size (IR8, 1966)
bananas	seedy wild bananas	seedless sweet fruit; the Cavendish is a clone
seedless grapes, watermelons	seeded ancestors	seedlessness (triploid watermelons)
strawberries	small wild species	size, sweetness (a cross, 1750s)
apples	Central Asian wild apples	size, sweetness, storage; every named apple is grafted
tomatoes	a pea-sized Andean wild tomato	size, flesh, colour
carrots	a thin bitter root	orange colour (Netherlands, 1600s), sweetness
sugar beet	a 4% sugar beet	sugar content, now about 20%
dairy cows (Holstein)	aurochs via early cattle	milk: about 10,000 litres a year
Belgian Blue cattle	European cattle	a double-muscle mutation; calves need caesareans
broiler chickens	the red junglefowl	growth: market weight in six weeks
laying hens	the same junglefowl	eggs: 300 a year against 10-15
thoroughbred horses	Arabian and English horses, 1700s	speed; three founding stallions
Merino sheep	the wild mouflon	fine wool that never stops growing
pigs	wild boar	growth, lean meat, litter size
silkworms	a wild moth, China	silk yield; adults cannot fly
Belyaev's silver foxes	farmed foxes, Siberia, 1959	tameness only; floppy ears and wagging tails in 40 generations
fancy goldfish	the Prussian carp	colour, double tails, bubble eyes
lab mice and rats	wild house mice	uniformity, docility
roses, tulips, orchids	wild species	colour, form, scent
honeybees	wild Apis mellifera	gentleness, honey yield, disease resistance

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The problems, the comparison table, and practice

The problems

- [] Inbreeding: the best individuals are relatives; harmful recessive genes double up (hip dysplasia in German shepherds, heart disease in Cavalier spaniels, breathing disorders in pugs, deafness in Dalmatians)
- [] Loss of genetic diversity: one disease can wipe out a uniform crop (the Irish potato famine, 1845–49, one variety; the Gros Michel banana lost to Panama disease in the 1950s; the Cavendish clone threatened now)
- [] Traits that harm the organism: udders too large, chickens whose legs cannot carry them, Belgian Blues that cannot calve unaided, silkworms that cannot fly
- [] Slow and limited: only existing variation can be selected; gains stop until mutation or a cross brings new variation

Artificial selection, natural selection, genetic modification

	Artificial selection	Natural selection	Genetic modification
who selects	humans	the environment (predators, climate, food, disease, mates)	humans, directly on the DNA
what is favoured	traits humans want	traits that help survival and reproduction	the inserted or edited gene
speed	generations to centuries	thousands to millions of years (faster under strong pressure)	one generation
source of variation	existing variation, plus crosses	mutation and existing variation	genes from any species, or edits (CRISPR)
examples	dog breeds, crops, livestock	peppered moths, finch beaks, antibiotic resistance	Bt cotton, golden rice, insulin bacteria
result	domesticated varieties, often unfit for the wild	adaptation to the environment	a specific new trait

Practice

1. Define artificial selection in one sentence.
2. The four steps for a faster racehorse.
3. Six vegetables from one wild mustard.
4. The wild ancestor of maize, and what was selected?
5. Why are pedigree dogs prone to inherited disease?
6. Why is the Cavendish banana at risk from one disease?
7. Two differences between artificial and natural selection.
8. Belyaev's foxes: artificial or natural? What was selected?
9. How does GM differ from selective breeding in speed and in the source of the trait?
10. Why did Darwin open his book with pigeon breeding?

Answers

- 1) humans choosing which organisms reproduce so wanted traits become common
- 2) decide on speed; breed from the fastest; select the fastest offspring; repeat
- 3) broccoli, cabbage, cauliflower, kale, kohlrabi, Brussels sprouts
- 4) teosinte; kernel number, size, softness
- 5) inbreeding doubles up harmful recessives
- 6) it is a clone with no variation
- 7) humans v environment; traits for use v traits for survival
- 8) artificial; tameness
- 9) one generation v many; genes from any species v existing variation
- 10) to show selection alone can transform a species