5.9 Natural and artificial selection

Natural selection and the evolution of the modern dairy cow and modern bread wheat

Natural selection

Natural selection is the driving force of **evolution**. Variation, adaptation, selection and speciation all contribute towards evolution. Natural selection does not involve any man-made effects on nature, but instead refers only to the **selection pressures** which naturally exist, including lack of space and availability of food, water, minerals or nutrients.

Natural selection allows certain members of species (and certain species altogether) to gain advantages in the wild to outcompete its competitors and survive those selection pressures. Any advantageous alleles or characteristics are passed on to offspring, so that the members of the species without those advantages are less likely to survive.

Artificial selection: the modern dairy cow

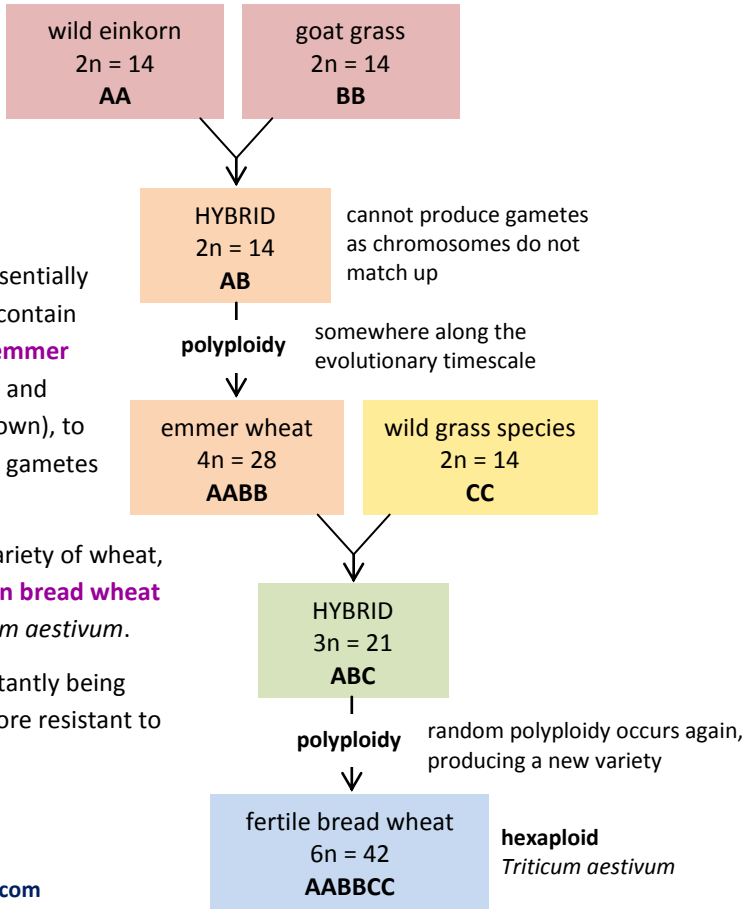
Cattle have been domesticated for several thousand years. Humans have selected animals for docility, meat and milk production, and to survive in the environment. There are now several breeds. Some have thick coats and can live in the Scottish Highlands, and some can survive in arid areas. The main breeds of dairy cattle, with high milk yields, are Holstein-Friesian, Brown Swiss, Guernsey, Ayrshire, Jersey and Milky Shorthorn

The original wild cattle which were first domesticated are thought to have looked like modern Chillingham White cattle. By repeatedly selecting cows with high milk yields and allowing them to breed over many generations, humans have artificially selected improved breeds with higher milk production. Today, breeders still practise artificial selection. In this way, a few elite cows can produce more offspring than they would naturally

- Each cow's milk yield is measured and recorded
- The progeny of bulls is tested to find which bulls have produced daughters with the highest milk yields
- Only a few good-quality bulls need be kept as the semen from one bull can artificially inseminate many cows
- Some elite cows are given hormones to produce many eggs
- The eggs are fertilised **in vitro** (in a test tube) and the embryos are implanted into surrogate mothers
- These embryos could also be cloned and divided into many more identical embryos

Artificial selection: modern bread wheat

The flow diagram shows how modern wheat, *Triticum aestivum*, has evolved by selection, beginning with a cross hybrid of **wild einkorn** and a wild goat grass. Although this will have been introduced many times, the hybrid cannot produce gametes, as its chromosomes do not match up (one **A** from the einkorn and one **B** from the goat grass).



At some point, the hybrid will undergo **polyploidy**, that is essentially the doubling of the diploid nucleus, so that the nucleus can contain more than one diploid set of chromosomes. This produced **emmer wheat**, a species of **AABB** which is able to produce gametes, and reproduce with another wild species of grass (which is unknown), to produce once more an infertile new hybrid of 3n **ABC**. Again gametes cannot be produced, as chromosomes do not match up.

Once more, a random polyploidy occurs, producing a new variety of wheat, which now has 6n of the original wild einkorn. This is **modern bread wheat** with the genes **AABBCC** (now known as a **hexaploid**), *Triticum aestivum*.

Subsequently, characteristics of the modern wheat are constantly being improved, due to *artificial selection*. This helps to make it more resistant to disease and improve crop yields, both benefits to farmers.