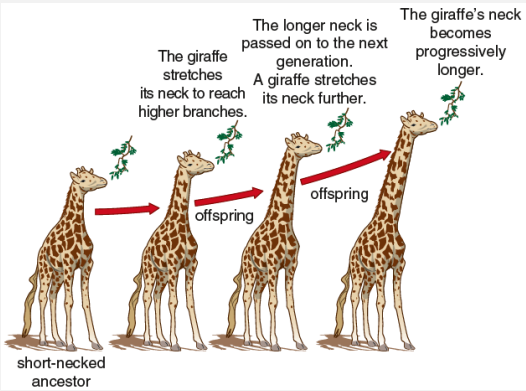
Individuals of every **organism** that have been produced by sexual reproduction are different. With the exception of identical twins, we all have different genomes. Our **genome** gives us a unique set of **characteristics**.

Our genetics	Environment	Combination
blood group	hair colour and length	height
eye colour	language	skin colour
natural colour of hair	scars	weight
shape of earlobe	tattoos	sporting achievements

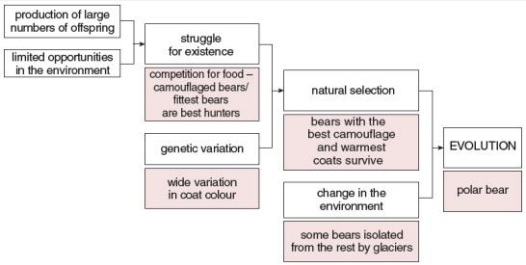
Variation is essential to survival. There's usually a large amount of genetic variation within a population. This is essential to survival. Variation is crucial to **evolution**.

These advantages might make an organism better able to catch food, resist disease or attract a mate.

Organisms best suited to the conditions will **survive and breed**. If the desirable **characteristics** are genetic, they will be passed on to their offspring.



These inherited characteristics are the result of genes and alleles.
This is called **natural selection**.



Differences will emerge in the **characteristics** – the **phenotypes** – of the two populations. Eventually, two new species are produced. The organisms can be regarded as a new species when they are no longer able to successfully breed with each other, or interbreed to **produce fertile offspring**.

Hybrids, if they do happen, are infertile. The key to our definition of a species is that *successful* **Interbreeding – that produces fertile offspring** – is not possible between two different species.

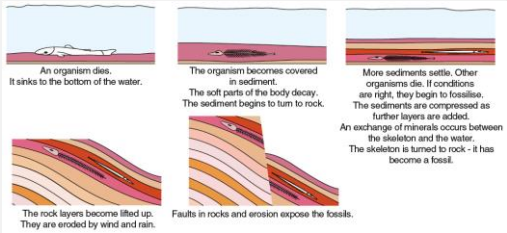
Competition among the birds for these food supplies would have produced a struggle for existence. Slight **variations** in beak shape enabled some birds to exploit slightly different food supplies, for example, small seeds, nuts and insects.

Wallace had researched **warning colouration**, the purpose of which is to deter predators. Warning colours are usually bright and conspicuous and in certain patterns.

Predators learn to avoid animals with warning colouration and patterns. They learn that the animals taste bad, or will cause injury. Wallace realised that warning colouration must be favoured by natural selection.

Plants trick animals using **mimicry**. Sometimes animals, too, have evolved to mimic other organisms. Unrelated species will have similar colours and patterns.

If an **organism** dies in water, or is washed into water, conditions may be right for it to be fossilised.
Most **fossils** are formed as a dead animal or plant becomes buried in mud, silt or sand. Oxygen must be excluded. Otherwise, microorganisms would feed on the body and it would quickly decay.

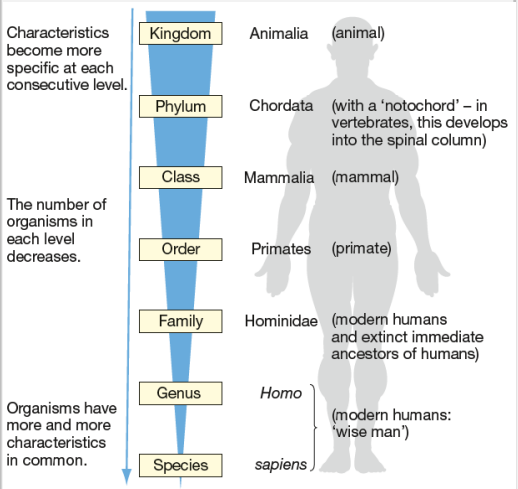


Fossilisation is when an dead organism becomes replaced by minerals. Fossils may also be produced if the organisms dies encased in **amber**, in a **glacier** or in other conditions that decomposers cannot survive (**extreme pH**). We can use fossils to create a timeline of evolution, creatures with harder, more chitinous bodies are more likely to leave a fossil.

The Earth's environment is constantly changing. When the environment changes, organisms either adapt to these changes, or they become extinct. A species is considered to be extinct when there are no remaining individuals of that species still living – ***EXTINCTION!***

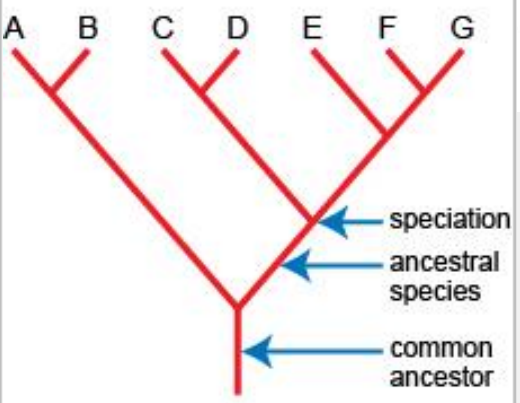
Classifying Organisms

Linnaeus named species using the **binomial system**. Each organism has two names – a generic name and species name.



An **evolutionary tree** shows how scientists think organisms evolved as they diverged from common ancestors.

New versions exist due to better microscopes

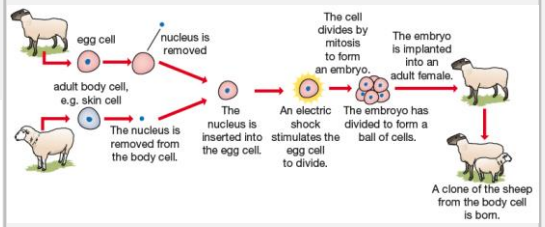


Selective Breeding

Animals in a population show **genetic variation**. Humans would have selected those with the characteristics required – the ones that produced the most meat or milk, for instance – and allowed them to breed. From the **offspring** of those animals, the humans would then have selected those animals producing the largest yields and bred those. This was repeated over many generations.

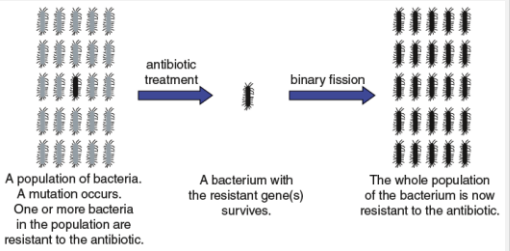
Studies show that **inbreeding** puts dogs at risk of birth defects and genetically inherited health problems, and makes them prone to disease. Unnaturally small or large dogs are particularly prone to problems.

Adult cell cloning is when the embryo produced is actually implanted into a female.



Cloning is also important in animals. It enables the animal breeder to produce many animals that have identical characteristics. This can be important commercially, perhaps related to producing high milk volumes or quality beef. Cloning in animals is done by **embryo transplants.**

Bacteria and other microorganisms are becoming **resistant** to the drugs that have been designed to kill them. The **mutation** of genes in pathogenic bacteria produces new strains of the bacteria. Some of these strains may be resistant to an **antibiotic** used on a patient. So the bacteria will not be killed.



Antibiotics are often prescribed, inappropriately, for minor viral infections such as colds or respiratory infections. Doctors are also often persuaded by patients to prescribe them.

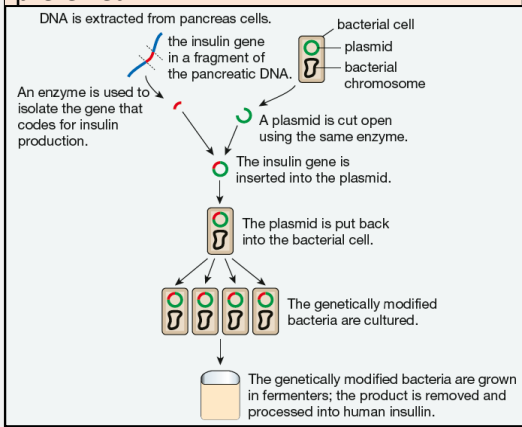
Many people, when prescribed **antibiotics**, do not complete the course. But completing the prescribed course is **essential** – all bacteria must be killed. Any left will be more resistant to **antibiotics**.

New Plant Varieties

In modern agriculture, new crop varieties are bred for disease resistance. Increased yields and improved quality of food crops are also the main goals of plant breeders. Other beneficial characteristics are that crops:

- **Grow and mature quickly**
- **have a distinctive taste, aroma or colour, for Example, in strawberries**
- **Have long shelf-life, store well or can be frozen.**

With genetic engineering it became possible to genetically engineer the bacterium, *Escherichia coli*, and the fungus, yeast, to produce 'human' insulin. This is *identical* to the insulin produced by the human body. Yeast produces a more complete version of the insulin molecule. Less processing is required, so this method is often preferred.



Enzymes are used to remove the required gene, or genes, from the organism that carries the gene(s).

Gene Therapies

Introducing genes from other organisms into humans would be unethical. But modern medicine has been investigating **gene therapy** in humans to overcome inherited disorders.