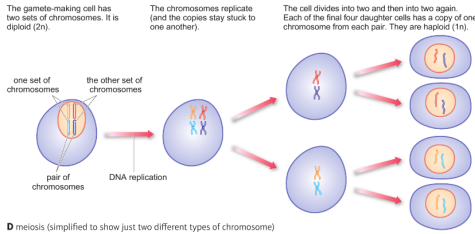


CB3 Genetics

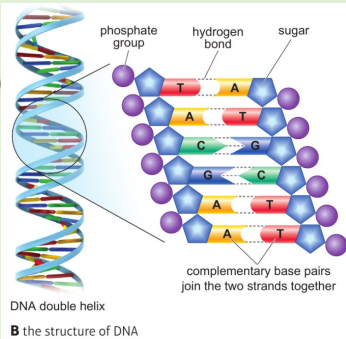
1. Meiosis

There are two types of cell division called mitosis and meiosis. Mitosis produces 2 genetically identical, diploid body cells for growth and repair. **Meiosis produces 4 haploid, genetically unidentical sex cells (gametes)**. These fuse to form a diploid zygote after fertilisation.



2. Structure of DNA Double helix

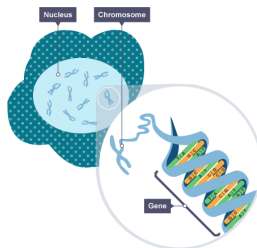
There are four bases in DNA: Adenine (A), Thymine (T), Cytosine (C) and Guanine (G). The image shows how the complementary base pairings (A with T and G with C). Each base pair is held together by weak hydrogen bonds.



3. DNA code

Chromosomes

The cell's **nucleus** contains **chromosomes**. These are long threads of DNA, which are made up of many **genes**.



Genes

A gene is a small section of DNA. Each gene codes for a particular sequence of amino acids which produces a specific protein. Genes are inherited down different generations.

4. Extracting DNA

Aim: Describe how to extract DNA from a fruit.

Method

1. Peel the skin from half a kiwi fruit and mash it up.
2. Mix a teaspoon of salt and small volume of washing up liquid and pineapple juice into the fruit.
3. Gently heat this mixture at about 60°C for five minutes.
4. Filter the mixture and retain only the filtrate (the filtered liquid).
5. Cool using an ice bath and gently pour chilled ethanol onto the top of the filtrate.

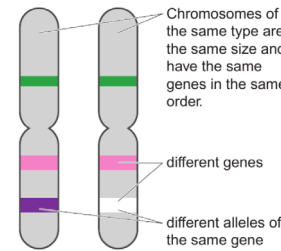
Why use...

- Salt:** Breaks the cell wall
- washing up liquid** Remove cell/nuclear membrane
- Pineapple juice** Enzymes to break apart proteins
- Chilled ethanol** To precipitate the DNA so we can see it

5. Alleles

We have two copies of each chromosome. Each gene on each chromosome is called an allele. A certain allele can be the same (**homozygous**) or different (**heterozygous**).

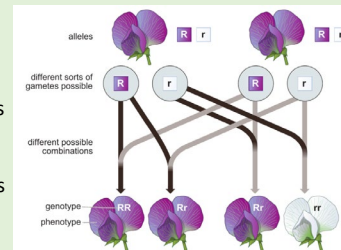
Each allele can also be dominant (this one will always be used) represented by a capital letter or recessive (will only be used if the other allele is also recessive) represented as a lower case letter.



B Each gene can exist in a number of different forms called alleles.

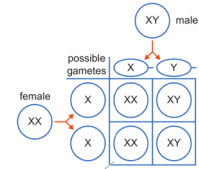
6. Haploid and diploid cells

Gametes are **haploid**, only carrying one set of the chromosome. When the **gametes** are made in meiosis, only one of the alleles is used. When the sperm and the egg come together in fertilisation, a **diploid zygote** is produced (now with both alleles - one from the father and one from the mother).



7. Inheritance (sex determination)

A Punnett square shows the possible outcomes for the sex of a baby.



The boxes show the possible combinations in the offspring.

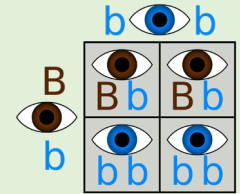
B Punnett square for human sex determination

Male (body) cells have an XY chromosome (an X allele and a Y allele). Female (body) cells have an XX chromosome (two X alleles).

The sperm then either has an X chromosome or a Y chromosome. The egg cell can only have an X chromosome. The completed punnett square shows that there are 2 possible outcomes: XX (girl) or XY (boy). So 50% chance of a baby being male or female.

8. Inheritance (characteristics)

A Punnett square can also be used to look at characteristics of a baby.



In this example the father has blue eyes **Phenotype** (what it looks like: Blue) **Genotype** (the alleles that code for it: bb) The mother has brown eyes **Phenotype** (brown) **genotype** (Bb).

As the mother's genotype is Bb we call this **heterozygous**. The fathers genotype bb is **homozygous recessive**. If the dominant (B) allele is used, then the baby will have brown eyes. If both recessive (b) allele is used, then the baby will have blue eyes.

9. Variation

Some of the variation between individuals of the same species is the result of variation in their genes. **Genetic variation** is caused by the different alleles inherited during sexual reproduction. Different alleles are produced by mutations, some of which cause changes in the phenotype. However, many characteristics also show **environmental variation**, because they are affected by their surroundings. For example, how well a plant grows is affected by how much light, water and nutrients it gets.



CB4 Natural Selection

1. The Theory of Natural Selection

Charles Darwin studied populations of species and made the following observations:

1. there is **variation** in organisms of same species.
2. parents pass on characteristics to **offspring**.
3. organisms have to **compete** for resources and avoid being eaten.

From his observations he devised the Theory of Natural Selection: the idea that populations change over time. Below are the main stages of the theory, with reference to *antibiotic resistance in bacteria*.

GENETIC VARIATION – within the population, some have a mutation which gives them antibiotic resistance.

ENVIRONMENT – the bacteria are exposed to antibiotics.

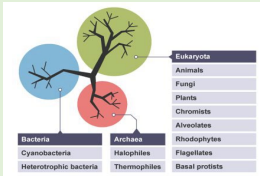
NATURAL SELECTION – those with the resistance survive and reproduce.

INHERITANCE – the gene for antibiotic resistance is passed on to the bacteria's offspring when they reproduce.

EVOLUTION – over many generations, all individuals in the population have antibiotic resistance.

3. Classification

Organisms are grouped based on their features. Carl Linnaeus developed the five-kingdom system. The genus and species form the scientific name of the species.



Classification systems have continued to be developed by other scientists, such as Carl Woese, who developed the three-domain system. This is based on evidence from genetic analysis, which groups archaea and eukaryota as more similar, based on sections of unused genes.

5. Selective Breeding

Selective breeding is when **humans artificially select** the plant or animals that are going to breed, depending on the **genes**.

We choose characteristics that are useful or attractive:

- Cows which produce lots of milk
- Plants that don't get many diseases
- Dogs which are friendly

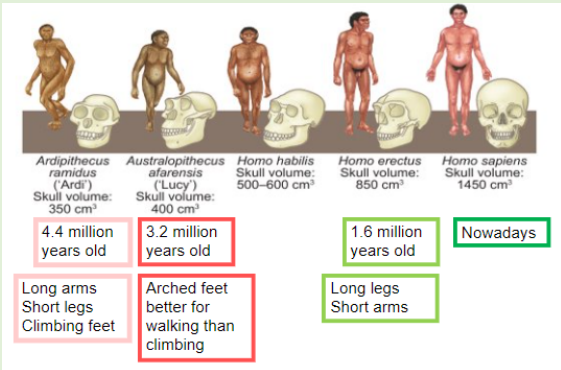


Process of Selective Breeding

1. choose parents with the desired characteristic from a mixed population e.g. the cow with the biggest muscle mass
2. They are bred together
3. From the offspring those with the desired characteristic are bred together.
4. This continues over many generations until all the offspring show the desired characteristic.

2. Evidence of Human Evolution

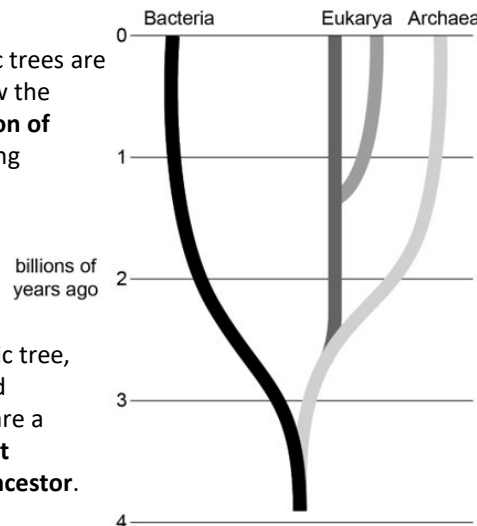
Scientists believe humans have changed over time.



Other evidence for human evolution is **stone tools**. They were used for activities such as hunting. The depth of rock they were found in tells us when they were used. Rocks that were found in younger rock are more specialised, suggesting a higher level of intelligence.

4. Phylogenetic Trees

Phylogenetic trees are used to show the **diversification of species** during **evolution**.



From this phylogenetic tree, eukarya and archaea share a **more recent common ancestor**.

6. Genetic Engineering

Artificial transfer of a gene responsible for a desired characteristic from one organism into another organism, so that it also has the desired characteristic.

Examples of genetic engineering:

- Golden Rice – rice that contains **beta-carotene**
- Bacteria containing the **human insulin gene**.

The stages of genetically engineering:

1. Cut gene using restriction enzymes
2. Cut plasmid vector with restriction enzymes
3. Complementary sticky ends left
4. Join DNA using ligase

