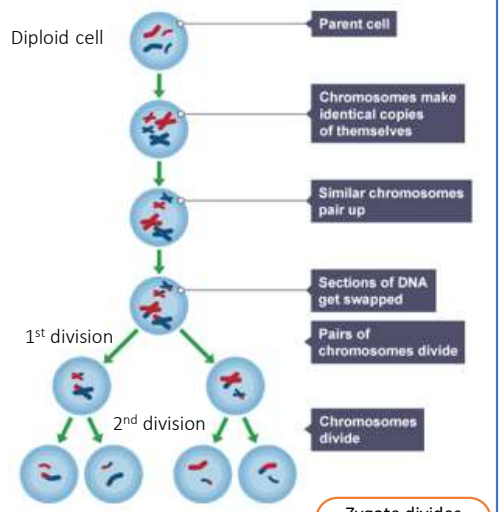
Inheritance

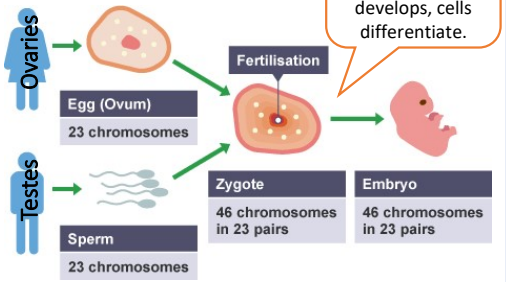
Keyword	Definition
Gamete	Sex cells with half the number of chromosomes, these cells are formed by meiosis. Sperm and egg cells in animals. Pollen and egg cells in flowering plants.
Fertilisation	The fusion of gametes to restore the full number of chromosomes.
Diploid cell	A cell that contains two (full) sets of chromosomes.
Haploid cell	A gamete that contains one set of chromosomes.
Chromosome	The structure made of DNA on which genes are found.
Gene	A small section of DNA on a chromosome. Each gene codes for a particular sequence of amino acids, to make a specific protein.
Allele	Different forms of the same gene.
Dominant	Allele is always expressed, even if only one copy is present.
Recessive	Allele is only expressed if two copies are present (therefore no dominant allele present).
Homozygous	A genotype in which the two alleles for the characteristic are identical.
Heterozygous	A genotype in which the two alleles for a particular characteristic are different.
Genotype	The alleles that an organism has for a particular characteristic, usually written as letters.
Phenotype	The visible characteristics of an organism which occur as a result of its genes.
Genome	The entire genetic material of an organism.
DNA	A polymer made up of two strands forming a double helix.

Ge 02. Meiosis

A



Fertilisation in humans:



Ge 03. Types of Reproduction

A

Sexual reproduction involves the joining (fusion) of male and female gametes. There is mixing of genetic information which leads to variety in the offspring.

Asexual reproduction involves only one parent and no fusion of gametes. There is no mixing of genetic information. This leads to genetically identical offspring (clones). Only mitosis is involved.

Advantages of sexual and asexual reproduction [Bio only]

Sexual	Asexual
Produces variation in the offspring.	Only one parent needed.
If the environment changes variation gives a survival advantage by natural selection.	Many identical offspring can be produced when conditions are favourable.
Natural selection can be speeded up by humans in selective breeding to increase food production.	Faster than sexual reproduction.
	More time and energy efficient as do not need to find a mate.

Some organisms reproduce by both methods depending on the circumstances:

- Malarial parasites reproduce asexually in the human host, but sexually in the mosquito.
- Many fungi reproduce asexually by spores but also reproduce sexually to give variation.
- Many plants produce seeds sexually, but also reproduce asexually by runners such as strawberry plants, or bulb division such as daffodils.

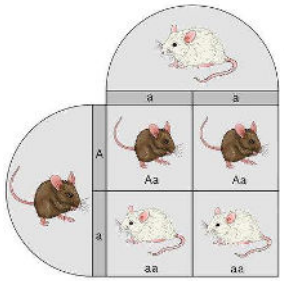
Ge 07&08. Genetic Inheritance

C

Most characteristics are a result of multiple genes interacting, rather than a single gene. Some characteristics are controlled by a single gene, such as: fur colour in mice; and red-green colour blindness in humans.

Mother = Homozygous recessive

Father = Heterozygous



Brown fur allele is dominant (A).
White fur allele is recessive (a).

Offspring: Genotype – 50% Aa, 50% aa.
Phenotype – 50% brown fur, 50% white fur.

Ge 09. Inherited Disorders

- **Polydactyly** (having extra fingers or toes) is caused by a **dominant** allele.
- **Cystic fibrosis** (a disorder of cell membranes) is caused by a **recessive** allele.

Ge 08. Sex Determination

C

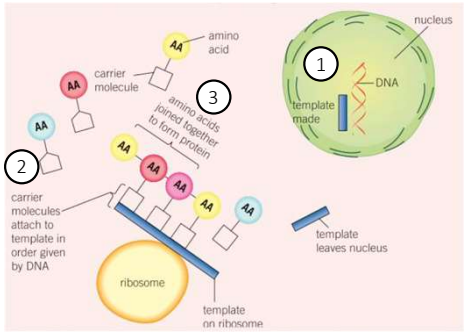
22 chromosomes pairs control characteristics only, but one of the pairs carries the genes that determine sex. In females the sex chromosomes are the same (XX). In males the chromosomes are different (XY).

(HT) Ge 06. Protein Synthesis [Bio only]

B

4 When the protein chain is complete it folds up to form a unique shape.

Mutations occur continuously. Most do not alter the protein, or only alter it slightly so that its appearance or function is not changed.



Required Practical:

None

Mathematical Skills:

- *Understand the concept of probability in predicting the results of a single gene cross.*
- *Use direct proportion and simple ratios to express outcome of a genetic cross.*
- *Complete a Punnett square diagram and extract and interpret information from genetic crosses and family trees.*
- *(HT only) Construct genetic cross by Punnett square diagram and use it to predictions using the theory of probability.*

Ge 05. The Human Genome

B

The whole human genome has now been studied and this will have great importance for medicine in the future.

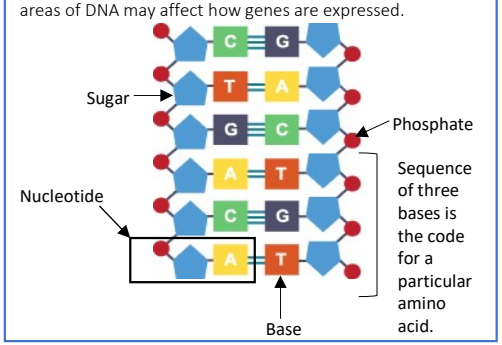
Understanding the human genome has been important for:

- the search for genes linked to different types of disease
- understanding and treatment of inherited disorders
- the use in tracing human migration patterns from the past.

Ge 06. DNA structure [Bio only]

B

The DNA polymer is made up of repeating nucleotide units. Not all parts of DNA code for proteins. Non-coding parts of DNA can switch genes on and off, so variations in these areas of DNA may affect how genes are expressed.



Relevant Modules:

- Cells
- Cell division
- Organisation

Useful YouTube links:

Ge 07&08. Genetic Inheritance

Ge 02. Meiosis

Ge 06. Protein Synthesis [Bio only]

Variation and Evolution

Keyword	Definition
Variation	Differences in the characteristics of individuals in a population.
Phenotype	The visible characteristics of an organism which occur as a result of its genes.
Evolution	A change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of a new species.
Selective breeding	The process by which humans breed plants and animals for particular genetic characteristics.
Genetic engineering	A process which involves modifying the genome of an organism by introducing a gene from another organism to give a desired characteristic.
Extinction	When there are no remaining individuals of a species still alive. Can be caused by new predators, new diseases, new successful competitors.

Ge 01. Variation

D

Variation may be due to differences in:
- the genes they have inherited (e.g. eye colour)
- the conditions in which they have developed (e.g. accents)
- a combination of genes and the environment (e.g. height).

Variants arise from mutations that occur continuously. However, most have no effect on the phenotype; some influence phenotype; very few determine phenotype.

Ge 19. Evidence for Evolution

F

The theory of evolution by natural selection is now widely accepted. Evidence for Darwin's theory is now available as it has been shown that characteristics are passed on to offspring in genes.

There is further evidence in:
1. The fossil record
2. The knowledge of how resistance to antibiotics evolves in bacteria.

Required Practical:

None

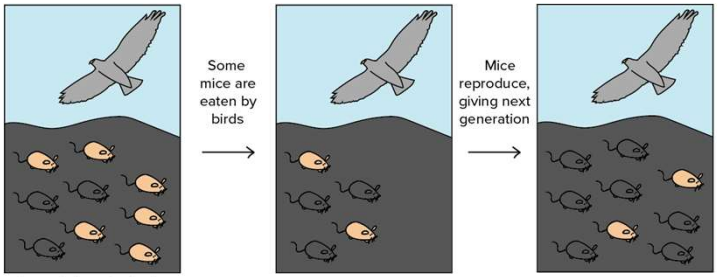
Mathematical Skills:

- ***Extract and interpret information from charts, graphs and tables (such as evolutionary trees).***

Ge 10. Evolution by Natural Selection

D

All species of living things have evolved from simple life forms that first developed more than three billion years ago.



A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and have offspring.

Because black mice had a higher chance of having offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.

If two populations of one species become so different in phenotype that they can no longer interbreed to produce fertile offspring, they have formed two new species.

Ge 16. Classification

G

Carl Linnaeus' system:
Kingdom, Phylum, Class, Order, Family, Genus, Species.

Species named by binomial system (*Genus species*, e.g. *Panthera leo*).

New models of classification proposed because:
(1) evidence of internal structures became more developed due to improvements in microscopes
(2) the understanding of biochemical processes progressed.

'Three- domain system' developed by Carl Woese:
- archaea (primitive bacteria usually extremophiles)
- bacteria (true bacteria)
- eukaryotes (plants, animals etc)

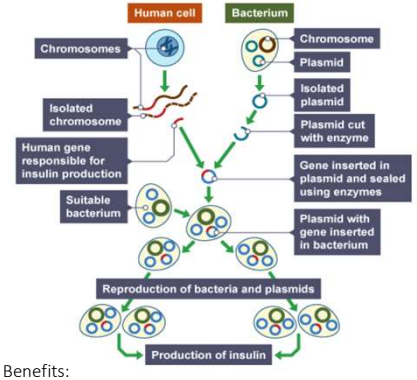
Ge 14&15. Genetic Engineering

E

Plant crops have been genetically engineered (GM crops) to be resistant to diseases or to produce bigger better fruits.

Bacterial cells have been genetically engineered to produce useful substances such as human insulin to treat diabetes.

(HT only) Process of Genetic Engineering:



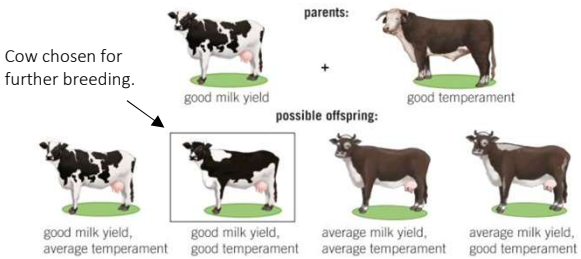
Benefits:
- GM crops include ones that are resistant to insect attack or to herbicides.
- GM crops generally show increased yields.
- Modern medical research is exploring the possibility of genetic modification to overcome some inherited disorders.

Concerns:
- The effect of GM crops on populations of wild flowers and insects.
- Some people feel the effects of eating GM crops on human health have not been fully explored.

Ge 12. Selective Breeding

D

1. Choose parents with the desired characteristic and breed together.
2. From the offspring those with the desired characteristic are bred together.
3. This continues **over many generations** until all the offspring show the desired characteristic.



The characteristic can be chosen for usefulness or appearance:
- Disease resistance in food crops.
- Animals which produce more meat or milk.
- Domestic dogs with a gentle nature.
- Large or unusual flowers.

Selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects.

Ge 20. Fossils

F

Fossils are the 'remains' of organisms from millions of years ago, which are found in rocks.

Fossils may be formed:
(1) from parts of organisms that have not decayed because conditions needed for decay are absent
(2) when parts of the organism are replaced by minerals as they decay
(3) as preserved traces of organisms, such as footprints, burrows and rootlet traces.

Many early forms of life were soft-bodied and left few traces behind. This is why scientists cannot be certain about how life began on Earth.

Ge 11. Resistant Bacteria

F

Bacteria can evolve rapidly because they reproduce at a fast rate. Mutations of bacterial pathogens produce new strains (e.g. MRSA, which is resistant to antibiotics). The development of new antibiotics is costly and slow. It is unlikely to keep up with the emergence of new resistant strains.

1. Some strains might be resistant to antibiotics (red).
2. And so are not killed by antibiotics.
3. They survive and reproduce, so the population of the resistant strain rises.

To reduce the rate of development of antibiotic resistant strains:
- doctors should not prescribe antibiotics inappropriately, such as for treating non-serious or viral infections
- patients should complete their course of antibiotics so all bacteria are killed and none survive to mutate and form resistant strains
- the agricultural use of antibiotics should be restricted.

Relevant Modules:

AQA
- Infection and response
- Ecology
- Inheritance

Useful YouTube links:

Ge 12. Selective Breeding

Ge 14&15. Genetic Engineering

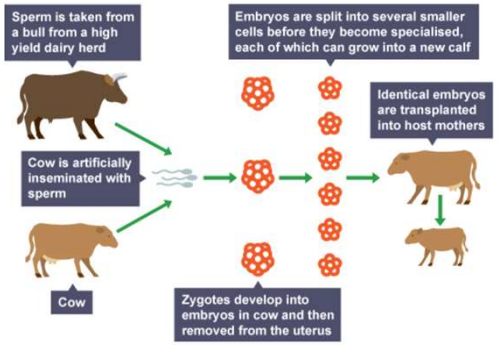
Ge 11. Resistant Bacteria

Inheritance, Variation and Evolution [Bio only]

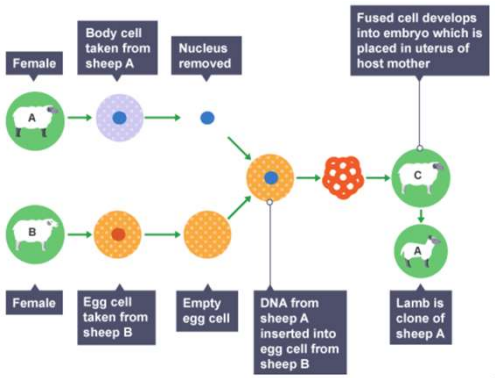
Keyword	Definition
Variation	Differences in the characteristics of individuals in a population.
Phenotype	The visible characteristics of an organism which occur as a result of its genes.
Evolution	A change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of a new species.
Dominant	Allele is always expressed, even if only one copy is present.
Recessive	Allele is only expressed if two copies are present (therefore no dominant allele present).
Allele	Different forms of the same gene.
Gene	A small section of DNA on a chromosome. Each gene codes for a particular sequence of amino acids, to make a specific protein.

Ge 13. Cloning in animals [Bio only] H

Embryo transplants:

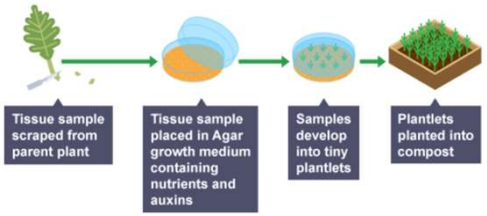


Adult cell cloning:



Ge 13. Cloning in plants [Bio only] H

Tissue culture: using small groups of cells from part of a plant to grow identical new plants. This is important for preserving rare plant species or commercially in nurseries.



Cuttings: an older, but simple, method used by gardeners to produce many identical new plants from a parent plant.

Ge 18. Speciation [Bio only] I

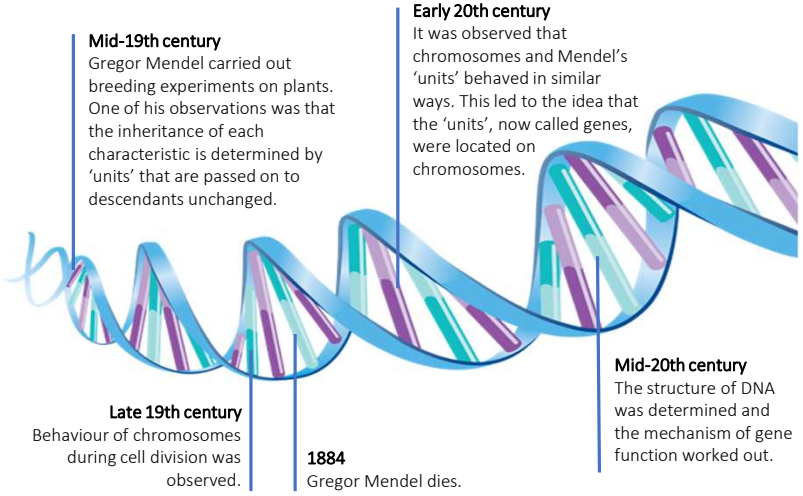
Alfred Russel Wallace independently proposed the theory of evolution by natural selection. He published joint writings with Darwin in 1858 which prompted Darwin to publish *On the Origin of Species* the following year. Wallace is best known for his work on warning colouration in animals and his theory of speciation.

Wallace did much pioneering work on speciation but more evidence over time has led to our current understanding:

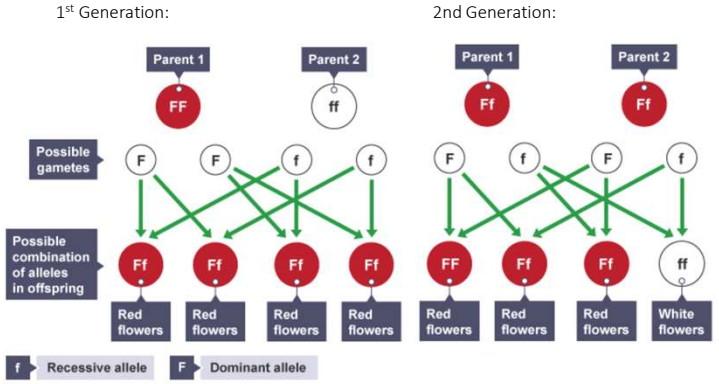
1. Isolation: where two populations of a species become geographically separated.
2. Genetic variation between the populations.
3. Different natural selection takes place in each population.
4. Speciation: where the populations become so different that successful interbreeding is not possible (no fertile offspring).

Ge 04. The History of Genetics [Bio only]

This scientific work by many scientists led to the gene theory being developed, including the work of Mendel:



Gregor Mendel studied the inheritance of different characteristics in pea plants. He found that when he bred red-flowered plants with white-flowered plants, all the offspring produced red flowers. If he bred these plants with each other, most of the offspring had red flowers, but some had white. This was because the allele for red flowers is **dominant**, and the allele for white flowers is **recessive**.



Required Practical:

None

Mathematical Skills:

- ***Extract and interpret information from charts, graphs and tables (such as evolutionary trees).***

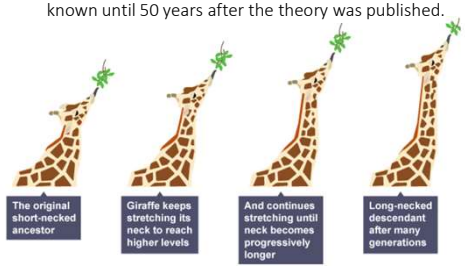
Ge 17. Theory of Evolution [Bio only] I

Charles Darwin proposed the theory of evolution by natural selection:

- Individual organisms within a particular species show a wide range of variation for a characteristic.
- Individuals with characteristics most suited to the environment are more likely to survive to breed successfully.
- The characteristics that have enabled these individuals to survive are then passed on to the next generation.

Darwin published his ideas in *On the Origin of Species* (1859). There was much controversy surrounding these revolutionary new ideas and it was only gradually accepted because:

1. the theory challenged the idea that God made all the animals and plants that live on Earth
2. there was insufficient evidence at the time the theory was published to convince many scientists
3. the mechanism of inheritance and variation was not known until 50 years after the theory was published.



Other theories, including that of Jean-Baptiste Lamarck, are based mainly on the idea that changes that occur in an organism during its lifetime can be inherited. We now know that in the vast majority of cases this type of inheritance cannot occur.

Relevant Modules:

- Ecology
- Inheritance

Useful YouTube links:

Ge 13. Cloning

Ge 04. History of Genetics

Ge 18. Speciation