

Meiosis halves the number of chromosomes

Gametes are made in reproductive organs (in animals ovaries and testes)

Cells divide by meiosis to form gametes

Copies of the genetic information are made.
The cell divides twice to form four gametes each with single set of chromosomes.
All gametes are genetically different from each other.



Sexual reproduction involves the fusion of male and female gametes.
Asexual reproduction involves only one parent and no fusion of gametes.

Sperm and egg in animals.
Pollen and egg cells in flowering plants.
e.g. cloning of females only in an aphid population.

Produced by meiosis. There is mixing of genetic information which leads to a variety in the offspring.
Only mitosis is involved. There is no mixing of genetic information. This leads to genetically identical clones.

Advantages and disadvantages of sexual and asexual reproduction (Biology only)

Gametes join at fertilisation to restore the number of chromosomes

The new cell divides by mitosis. The number of cells increase. As the embryo develops cells differentiate.

When the protein chain is complete it folds to form a unique shape. This allows proteins to do their job as enzymes, hormones or new structures such as collagen.

Meiosis

Meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed

Some change the shape and affect the function of proteins e.g. and enzyme active site will change or a structural protein loses its strength

Most do not alter the protein so that its appearance or function is not changed.

(HT) Making new proteins (protein synthesis)

Composed of chains of amino acids. A sequence of 3 bases codes for a particular amino acid.

Reproduction advantages/disadvantages

Sexual	Asexual
Needs two parents.	Only one parent needed (quicker).
Produces variation in the offspring.	Identical offspring (no variation).
If the environment changes variation gives a survival advantage by natural selection.	Vulnerable to rapidly changing conditions due to lack of variation.
Negative mutations are not always inherited.	Negative mutation can affect all offspring.
Natural selection can be speeded up using selective breeding to increase food production.	Food/medicine production can be extremely quick.

DNA and the genome

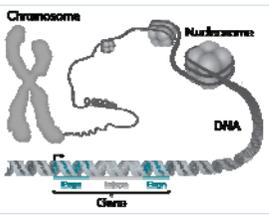
Sexual and asexual reproduction

AQA GCSE INHERITANCE, VARIATION AND EVOLUTION Part 1

Genetic material in the nucleus is composed of a chemical called DNA.

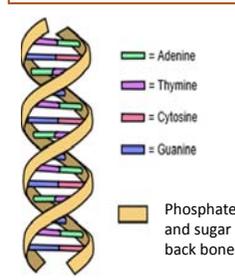


DNA structure
Polymer made up of two strands forming a double helix.
Contained in structures called chromosomes. A gene is a small section of DNA on a chromosome. Each gene codes for a sequence of amino acids to make a specific protein.



The genome is the entire genetic material of an organism.

DNA structure (Biology only)



(HT only) Not all parts code for proteins. Non-coding parts can switch genes on and off. Mutations may affect how genes are expressed.

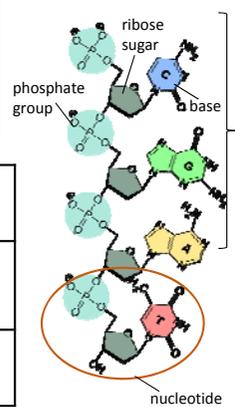
Mutations occur continuously (HT only)

Protein synthesis (HT only)

In DNA the complementary strands C, A, T, G always link in the same way. C always linked to G on the opposite strand and A to T.

DNA is polymer made from four different nucleotides. Each nucleotide consists of a common sugar, phosphate group and one of 4 different bases A, C, G & T

Repeating nucleotide units.



DNA in the nucleus unravels.
↓
Enzymes make a copy of the DNA strand called mRNA.
↓
mRNA moves from the nucleus to ribosome in the cytoplasm.
↓
Ribosomes translate each 3 bases into amino acids according to mRNA template
↓
Ribosomes link amino acids brought by carrier proteins.
↓
A long chain of amino acids form. Their specific order forms a specific protein.

A sequence of 3 bases is the code for a particular amino acid. The order of bases controls the order in which each amino acid is assembled to produce a specific protein.

Some organisms use both methods depending on the circumstances	Malarial parasites		Asexually in the human host but sexually in a mosquito.
	Fungi		Asexually by spores, sexually to give variation.
	Plants		Produce seeds sexually, asexually by runners in strawberry plants, bulbs division in daffodils.

The whole human genome has now been studied.
It is of great importance for future medical developments
Searching for genes linked to different types of disease.
Understanding and treatment of inherited disorders.
Tracing migration patterns from the past.

Embryo screening: small piece of developing placenta removed to check for presence of faulty genes

Gene therapy: replacing the faulty allele in somatic cells with a normal allele

Very rarely a mutation will lead to a new phenotype which if is suited to environmental change can lead to rapid change in the species.

Embryo screening /gene therapy issues	Economic	Costly and not 100% reliable.
	Social	Not available to everyone (due to cost).
	Ethical	Should only 'healthy' embryos be implanted following screening.

Embryo screening and gene therapy may alleviate suffering

Some disorders are inherited. They are caused by the inheritance of certain alleles

Polydactyly	Cystic fibrosis
Caused by inheriting a dominant allele.	Caused by inheriting a recessive allele (both parents have to at least carry it).
Causes a person/animal to have extra toes or fingers.	A disorder of the cell membrane. Patients cannot control the viscosity of their mucus.

Ordinary human body cells contain 23 pairs of chromosomes

One pair of chromosomes carry the genes that determine sex

	Female	Male
	XX	XY
Gametes	X	Y
X	XX	XY
X	XX	XY

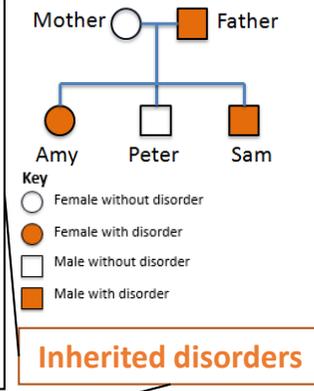
The probability of a male of female child is 50%. The ratio is 1:1

Variation: difference in the characteristics of individuals in a population may be due to

- Genetic causes (inheritance)**
- Environmental causes (condition they have developed in)**
- A combination of genes and environment**

There is usually extensive genetic variation within the population of a species e.g. hair colour, skin colour, height that can also be affected by environment e.g. nutrition, sunlight.

Using a family tree: If the father was homozygous dominant then all of the offspring would have the disorder. He must be heterozygous



Inherited disorders

All genetic variation arises in mutation, most have no effect on phenotype, some influence but very few determine phenotype.

Variation

The genome and its interaction with the environment influence the development of phenotypes

AQA GCSE INHERITANCE, VARIATION AND EVOLUTION PART 2

Define terms linked to genetics

Gamete	Sex cells produced in meiosis.
Chromosome	A long chain of DNA found in the nucleus.
Gene	Small section of DNA that codes for a particular protein.
Allele	Alternate forms of the same gene.
Dominant	A type of allele – always expressed if only one copy present and when paired with a recessive allele.
Recessive	A type of allele – only expressed when paired with another recessive allele.
Homozygous	Pair of the same alleles, dominant or recessive.
Heterozygous	Two different alleles are present 1 dominant and 1 recessive.
Genotype	Alleles that are present for a particular feature e.g. Bb or bb
Phenotype	Physical expression of an allele combination e.g. black fur, blonde hair, blue eyes.

Some characteristics are controlled by a single gene e.g. fur colour, colour blindness.

The alleles present, or genotype operate at a molecular level to develop characteristics that can be expressed as a phenotype.

Most characteristics are as a result of multiple genes interacting.

Genetic inheritance

The concept of probability in predicting results of a single gene cross.

Dominant and recessive allele combinations

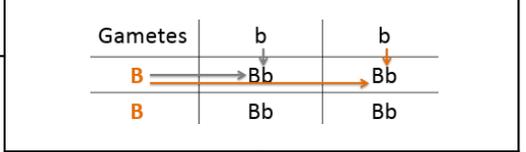
Dominant	Recessive
Represented by a capital letter e.g. B.	Represented by a lower case letter e.g. b.

3 possible combinations:
Homozygous dominant BB
Heterozygous dominant Bb
Homozygous recessive bb

Sex determination

Using a punnet square (using mouse fur colour as an example)

Parent phenotype	Black fur	White fur
Parent genotype	BB	bb
What gametes are present	In each egg B B	In each sperm b b



The probability of black fur offspring phenotype is 100%. All offspring genotypes are heterozygous (Bb).

Crossing two heterozygous mice (Bb)

Gametes	B	b
B	BB	Bb
b	Bb	bb

The probability of black fur is 75% and white fur 25%. The ratio of black to white mice is 3:1

Over time this results in the formation of new species.

The theory of evolution by natural selection.
Species of all living things have evolved from simple life forms that first developed 3 billion years ago.

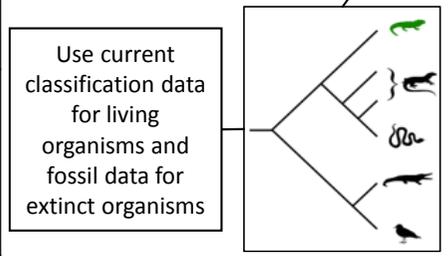
Through natural selection of variants (genotypes) that give rise to phenotypes best suited to their environment or environmental change e.g. stronger, faster. This allows for variants to pass on their genotype to the next generation.

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.



Classification of living organisms

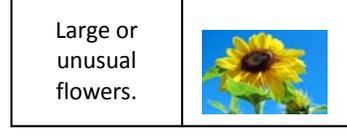
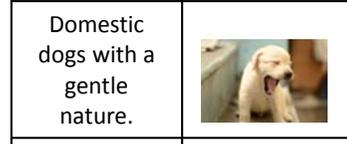
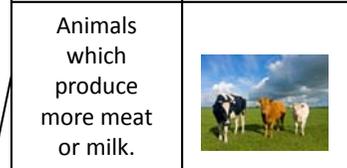
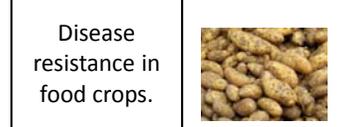
Evolutionary trees are a method used by scientists to show how organisms are related



Use current classification data for living organisms and fossil data for extinct organisms

Choosing characteristics

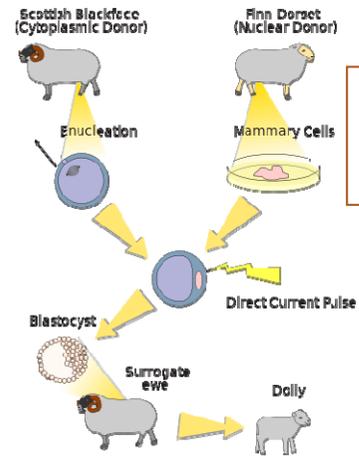
Desired characteristics are chosen for usefulness or appearance



Selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects e.g. British Bulldogs have breathing difficulties.

A change in the inherited characteristics of a population over time through the process of natural selection.

Evolution



Cloning (Biology only)

AQA GCSE INHERITANCE VARIATION AND EVOLUTION PART 3

The process by which humans breed plants/animals for particular genetic characteristics

Selective breeding

Genetic engineering

Humans have been doing this for thousands of years since they first bred food from crops and domesticated animals.

Selective breeding

Choosing parents with the desired characteristics from a mixed population

Chosen parents are bred together.

From the offspring those with desired characteristics are bred together.

Repeat over several generations until all the offspring show the desired characteristics.

Concern: effect of GMO on human health not fully explored

Concern: effect of GMO on wild populations of flowers and insects.

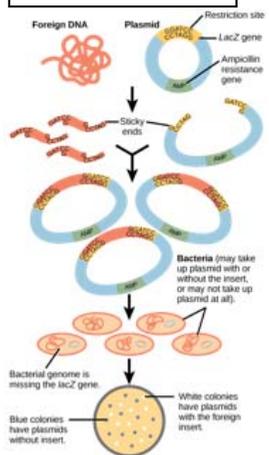


Cloning techniques in plants/animals

Tissue culture	Small groups of cells to grow new plants. Important for preservation of rare plants and commercially in nurseries.
Cuttings	Part of a plant is cut off and grown into full plant.
Embryo transplants	Splitting apart cells from animals embryo before they become specialised. New clone embryos are inserted into womb of adult female.

Concern: some people have ethical objections to adult cell cloning e.g. welfare of the animals.

Modern medical is exploring the possibility of GM to overcome inherited disorders e.g. cystic fibrosis



Genetic engineering process (HT only)

1. Enzymes are used to isolate the required gene.
2. Gene is inserted into a vector – bacterial plasmid or virus.
3. Vector inserts genes into the required cells.
4. Genes are transferred to plants/animals/microbes at an early stage of development so they develop the required characteristics.

Genes from the chromosomes of humans or other organisms can be 'cut out' and transferred to the cells of other organisms.

Genetically modified crops (GMO)	<i>Crops that have genes from other organisms</i>	To become more resistant to insect attack or herbicides.
		To increase the yield of the crop.

Adult cell cloning

1. Nucleus is removed from an unfertilised egg.
2. Nucleus from body cell is inserted into egg cell.
3. An electric shock stimulates the egg to divide into an embryo
4. Embryo cells are genetically identical to adult cells.
5. When embryo has developed into ball of cells it is inserted into host womb.



Charles Darwin

Theory of evolution by natural selection.

Individual organisms within a particular species show a wide range of variation for a characteristic.

Individual most suited to the environment are more likely to breed successfully.

Characteristics enable individuals to survive are then passed on to the next generation.

Developed since its proposal from information gathered by other scientists.

Did much pioneering work on speciation but more evidence over time has led to our current understanding.

Allows biologists to understand the diversity of species on the planet.

Evidence from around the world, experimentation, geology, fossils, discussion with other scientists (Alfred Wallace) lead to:

Charles Darwin 'On the Origin of the Species' (1859)

Published the theory of evolution by natural selection

Slowly accepted; challenged creation theory (God), insufficient evidence at time, mechanism of inheritance not yet known.

Theory of evolution (Biology only)

Speciation (Biology only)



Alfred Wallace

Independently proposed the theory of evolution by natural selection

Published joint writings with Darwin in 1858.

Worked worldwide gathering evidence.

Best known for work on warning colouration in animals and his theory of speciation.

Speciation

Due to isolation of a population of a species e.g. species are split across far apart islands.

Environmental conditions differ for populations e.g. types of food available, habitat.



Individuals in each population most suited to their environments are more likely to breed successfully.

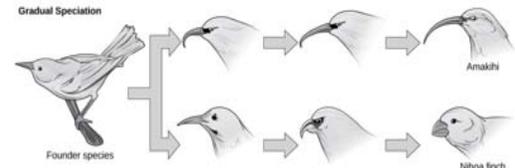


Over long periods of time each population will have greater differences in their genotype.



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.

AQA GCSE INHERITANCE VARIATION AND EVOLUTION PART 4



Other theories e.g. Lamarckism are based on the idea that changes occur in an organism during its lifetime which can be inherited. We now know that in the vast majority of cases this cannot occur.

The full human classification

Classification of living organisms

Carl Linnaeus classified living things	Kingdom	Animalia
	Phylum	Chordata
	Class	Mammalia
	Order	Primates
	Family	Hominidae
	Genus	Homo
	Species	sapiens

Due to improvements in microscopes, and the understanding of biochemical processes, new models of classification were proposed.

Carl Woese

3 domain based on chemical analysis.

Archaea (primitive bacteria), true bacteria, eukaryota.

Organisms are named by the binomial system of genus and species. Humans are *Homo sapiens*

Evidence for evolution

The understanding of genetics (biology only)

Gregor Mendel

In the mid 19th century carried out breeding experiments on plants

Inheritance of each characteristic is determined by units that are passed on to descendants unchanged.

Fossils and antibiotic resistance in bacteria provide evidence for evolution.

Antibiotic resistant bacteria

Mutations produce antibiotic resistant strains which can spread

Resistant strains are not killed.

Strain survives and reproduces.

People have no immunity to strain and treatment is ineffective.

Extinction

When no members of a species survive

Due to extreme geological events, disease, climate change, habitat destruction, hunting by humans.



Fossils tell scientists how much or how little different organisms have changed over time.

Fossils

'remains' of ancient organisms which are found in rocks

Parts of organism that have not decayed as necessary conditions are absent.

Parts of the organism replaced by minerals as they decay.

Preserved traces of organisms such as footprints, burrows and rootlet traces.

Early forms of life were soft bodied and few traces are left behind and have been destroyed by geological activity, cannot be certain about how life began.

Led to gene theory being developed but not until long after Mendel died.

Further understanding of genetics

Improving technology allowed new observations.

Late 19th century: behaviour of chromosomes in cell division.

Early 20th century: chromosomes and Mendel's 'units' behave in similar ways. 'units' now called genes must be located on chromosomes.

Mid 20th century: structure of DNA determined. Mechanism of gene function worked out.

Evolution is widely accepted. Evidence is now available as it has been shown that characteristics are passed on to offspring in genes.

Slide 4

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I just added a few capital letters and full stops

Amanda Fleck, 01/10/2017