Core focus
All learners
HT only
Triple science only

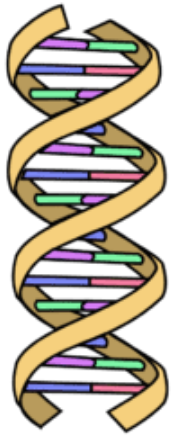
Reproduction (B13)

Big idea: characteristics are inherited

Key words	
Asexual reproduction	Involves one parent and the offspring are genetically identical. No fusion of gametes
Sexual reproduction	Involves the fusion (joining) of male and female gametes producing genetic variation in the offspring
Meiosis	Two stage process of cell division, that reduces the chromosome number in the daughter cells. Used to produce gametes.
Natural selection	Process by which evolution takes place. Organisms produce more offspring than the environment can support. Only those best suited will survive, passing on their characteristics to the next generation.
Genome	The entire genetic material of an organism

DNA

- Long polymer made of two strands
- Organised into chromosomes
- Different organisms have different amount od chromosome (e.g. humans have 46)
- A small section of DNA is called a gene



DNA

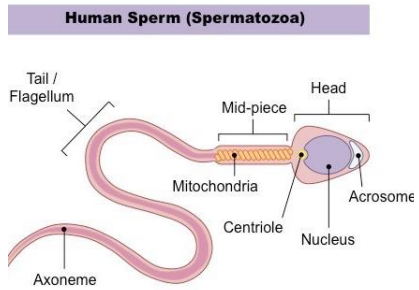
The Genome

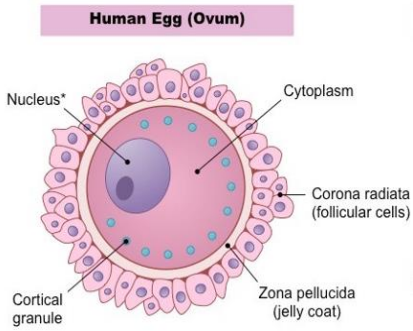
Knowing the genome can benefit scientist in the following areas:

- To search for genes to different types of diseases
- Understanding and treating inherited diseases
- Tracing human migration

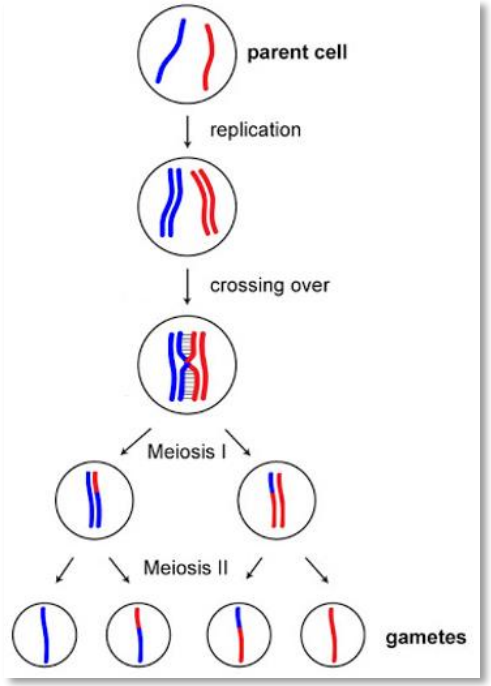
Gametes

Gametes are formed by meiosis. During meiosis the number of chromosomes a cell has is halved





Sexual reproduction	Asexual reproduction
Two parents	One parent
Fusion of gametes	No fusion of gametes
Genetic variation	Genetically identical



In Meiosis…

- The genetic material is copied before cell division
- The cell divides twice
- Four gametes are formed, each with a single set of chromosomes

- All gametes are genetically different from each other and their parent cell
- Sexual reproduction results in genetic variation because gametes from each parent fuse,
  - each containing half the genetic information from the mother and father

Alleles	Different forms of the same gene (e.g. eye colour)
Punnett square	A way of modelling a genetic cross and predicting the outcome using probability
Phenotype	The physical expression of a gene
Genotype	The genetic makeup of an individual for a particular characteristics
Heterozygote	An individual with different alleles for a characteristic (e.g. Bb)
Homozygote	An individual with the same alleles for a characteristic (e.g. BB or bb)
Dominant (allele)	The phenotype will be expressed even if only one of the alleles is inherited
Recessive (allele)	The phenotype will only be expressed in an offspring if both of the alleles for the characteristic are inherited

Sex determination

- Humans have 23 pairs of chromosomes, one pair being the sex chromosomes
- Human females have two X chromosomes (XX), human males have one X and one Y chromosome (XY).
- All egg cells will have one X chromosome
- Sperm cells will either have one X or one Y chromosome

		Father	
		X	Y
Mother	X	XX	XY
	X	XX	XY

- The chances of having a boy or a girl is 1:1

Inheritance in action

- Some characteristics are controlled by a single gene
  - This gene may have different alleles
- Punnett squares can be used to predict the probability of inheriting certain characteristics

Punnett square example

- Dimples are dominant (D) to no dimples (d).
- The genotype for a person with dimples can be DD or Dd, and the genotype for a person with no dimples is dd.

Inherited disorders

- **Polydactyly :**
  - genetic condition in which a baby is born with an extra finger or toe.
  - Caused by a dominant allele (P). Only one allele is needed to inherit the disorder (Pp)
  - Children who are homozygous recessive do not develop the disorder (pp)
- **Cystic fibrosis:**
  - caused by a recessive allele (cc)
  - Affects cell membranes, causing over production of mucus
  - A child must inherit one recessive gene from each parent to develop cystic fibrosis
  - The disorder can be passed on from parents who are carriers (Cc).

		Father (homozygous dominant)	
		D	D
Mother (homozygous recessive)	d	Dd	Dd
	d	Dd	Dd

- All possible offspring have dimples, as they are heterozygous

		Father (heterozygous)	
		D	d
Mother (homozygous recessive)	d	Dd	Dd
	d	Dd	dd

- 50% chance of offspring having dimples.
- 50% chance of offspring not having dimples

Screening genetic disorders

- Embryo screening involves tests to diagnose genetic disorders before the baby is born.
- Samples can be taken from the fluid around the developing baby (amniocentesis) or from the placenta (chorionic villus sampling).
- The results enable parents to make a choice.
  - Some parents may terminate the pregnancy
  - Other parents may decide it is not ethical to terminate the pregnancy
- Concerns of embryo screening:
  - Risk of miscarriage
  - Information may not be reliable
  - Decision about terminating a pregnancy are hard. People have ethical and religious arguments against terminating
  - Screening is expensive, but caring for a child with a disability is also expensive
  - There are ethical issues involved with destroying living embryos

Pros and cons of types of reproduction

	Asexual	Sexual
Advantages	➢ One parent needed ➢ More time and energy efficient ➢ Faster than sexual ➢ Many offspring can be produced when conditions are favourable	➢ Produces variation in offspring ➢ If environment changes, variation gives a survival advantage by natural selection ➢ Natural selection can be accelerated by humans
Disadvantages	➢ Offspring are clones = little variation ➢ If environment changes, all offspring are affected	➢ Two gametes needed (two parents) ➢ Takes more time and energy ➢ Slower than asexual

Examples

- Some organisms reproduce using both methods:
- Malarial parasites reproduce asexually in the human host, but sexually in the mosquito
- Many fungi reproduce asexually by spores, but also sexually to give variation
- Many plants produce seeds sexually, but also asexually by runners (e.g. strawberries) or bulb division (e.g. daffodils)

DNA structure

DNA structure:

- DNA is made up of alternating sugar and phosphate sections
- One of four bases are attached to each sugar
  - A, C, G or T
- Each unit containing a sugar, phosphate and base is called a **nucleotide**
- A sequence of three bases codes for a specific amino acid
- The order of bases determines the order of amino acids
  - And thus the protein made
- A **mutation** is a change in the order of bases
  - This causes the wrong protein to be made

Protein synthesis

DNA bases a complementary (C is always linked to G , A is always linked to T). Remember *GCAT!*

Protein synthesis:

1. a gene produces a template for a particular protein
2. The template leaves the nucleus through the pore in the membrane
3. The template attaches to a ribosome in the cytoplasm
4. Carrier molecules in the cytoplasm each carry a specific amino acid
5. Carrier molecules attach to the template in the correct order defined by the template
6. The amino acids they bring join to form a protein chain
7. The complete protein detaches and folds into a specific shape
8. The carrier molecules return the the cytoplasm and pick up more amino acids

Gene expression and mutation

- When a gene codes for a protein that is synthesised, it is said to be **expressed**.
- Most of the DNA does not code for proteins
  - Non-coding parts are involved in switching genes on and off
  - Variations in non-coding areas may affect how genes are expressed
- New forms of genes result from changes in existing genes. These are called **mutations**.
- They occur continuously, but most do not alter the protein shape
- A few mutations result in an altered protein that folds into a different shape.
  - In this case the active site could change, or a structural protein could have less strength
- Mutations in non-coding regions of DNA may affect which genes are switched on or off
- Some mutations can be beneficial