Study Notes: Module 5

Contents:

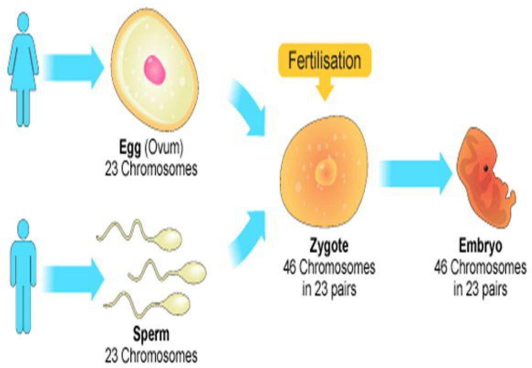
Inquiry Question 1:

How does reproduction ensure the continuity of a species?

DOT POINTS:

- *explain the mechanisms of reproduction that ensure the continuity of a species, by analysing sexual and asexual methods of reproduction in a variety of organisms, including but not limited to:*
    - *animals: advantages of external and internal fertilisation*
    - *plants: asexual and sexual reproduction*
    - *fungi: budding, spores*
    - *bacteria: binary fission*
    - *protists: binary fission, budding*

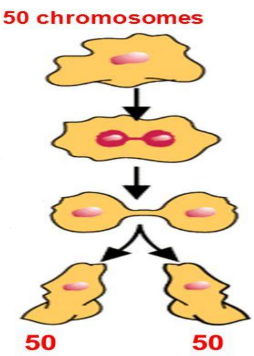
Sexual Reproduction



- Involves **two parents** and the **joining** of **male** and **female gametes** during fertilisation
- Offspring inherit a mixture of genes from both parents, so are different to each other and their parents.

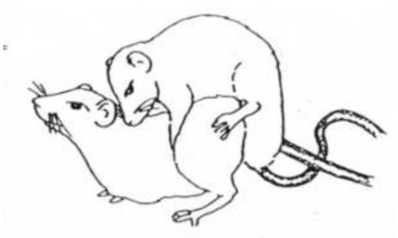
- Types of Sexual Reproduction:
    - **Cross-fertilisation**, also called **allogamy**
        - fusion of male and female gametes (sex cells) from different individuals of the same species
    - **Self-fertilisation**, also called **autogamy**
        - can fertilise itself. Individuals have fully functioning male and female reproductive system parts necessary to make both the male and female gamete for that individual. Do not need a partner to reproduce, but some may still be able to reproduce with a partner if the opportunity arises

Advantages	Disadvantages
• produces genetic variation • species can adapt to new environments due to variation → Survival advantage • disease is less likely to affect all the individuals	• time and energy are needed to find a mate • it is not possible for an isolated individual to reproduce

Asexual Reproduction

 	
	• Only one parent. The offspring are clones of the parent and each other.
	
	• Types of Asexual Reproduction:
	  ○ **Binary fission**
	    ■ a cell simply copies its DNA and then splits in two, giving a copy of its DNA to each "daughter cell,"
	  ○ **Budding**
	    ■ split off a small part of themselves to grow into a new organism.
	  ○ **Vegetative propagation**
	    ■ this process involves a plant growing a new shoot which is capable of becoming a whole new organism
	  ○ **Sporogenesis**
	    ■ production of reproductive cells, called spores, which can grow into a new organism
	  ○ **Fragmentation**
	    ■ a "parent" organism is split into multiple parts, each of which grows to become a complete, independent "offspring" organism
	  ○ **Parthenogenesis**
	    ■ an unfertilized egg begins to develop into a new organism, which by necessity possesses only genes from its mother

Advantages	Disadvantages
• population can increase rapidly when the conditions are favourable • only one parent is needed • it is more time and energy efficient as you don't need a mate • it is faster than sexual reproduction	• it does not lead to genetic variation in a population • the species may only be suited to one habitat • disease may affect all the individuals in a population

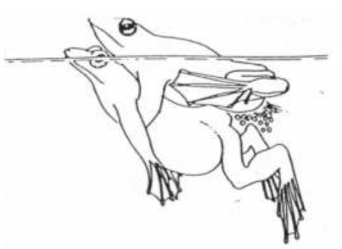
Internal Reproduction: Animals



- Internal fertilisation happens inside one of the organisms
- Involves the two organisms having to touch one another
- Occurs in land organisms as if it were to happen externally, the sex cells would die.
    - Mammals eg. humans
    -

Likelihood of successful fertilisation of eggs (high/low)	High - Aquatic environment High - Terrestrial environment
Location of development of zygote	Inside an organism
Likelihood of fertilised egg surviving until birth (high/low)	High
Number of eggs produced by female (many/few)	Few
Environment in which this type of fertilisation typically occurs	Inside organisms
Examples of organisms that use this method of fertilisation	Giraffes

External Reproduction: Animals



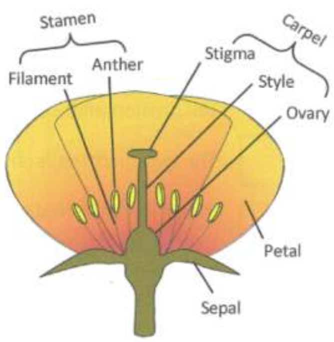
- External fertilisation occurs in an outside environment
- Has to occur in a body of water otherwise the male and female sex cells dry out.
- Are exposed to external elements and can contract diseases, be eaten or die out
    - Generally is only done by animals that can be in a body of water eg.
        - Fish such as salmon
        - Amphibians such as frogs

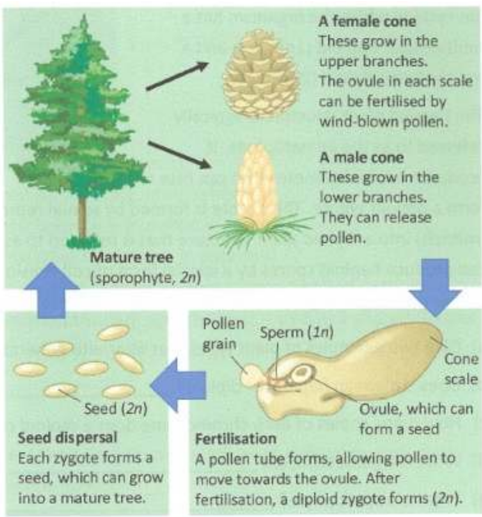
Likelihood of successful fertilisation of eggs (high/low)	High - Aquatic environment Low - Terrestrial environment
Location of development of zygote	In an environment
Likelihood of fertilised egg surviving until birth (high/low)	Low
Number of eggs produced by female (many/few)	Many
Environment in which this type of fertilisation typically occurs	Water
Examples of organisms that use this method of fertilisation	Frogs

Comparison of Internal and External Reproduction:

External Fertilisation	Internal Fertilisation
The union of two gametes – a sperm and an ovum	
Male gametes swim to female gametes	
No copulation	Copulation occurs (union of male and female with transfer of gametes)
The female gametes are expelled outside the female's body. Chemicals are released that attract the male gamete which is also shed outside the body.	Gametes fused inside the female body
The male gametes are shed into a large space; there is less chance of fertilisation	The male gametes are shed into a confined space; there is a greater chance of fertilisation
Many female gametes are produced	Few female gametes are produced; this saves body materials
Zygotes develop outside male and female parents	Zygote can be retained inside the female's body for protection until it is fully developed
Most common in fish, amphibians and algae	Most common in land plants, reptiles, birds and mammals

Plants: Sexual Reproduction





- Reproduction through the use of sexual organs that are within the plant.

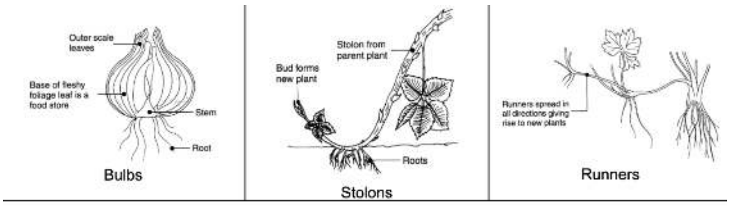
Angiosperms:

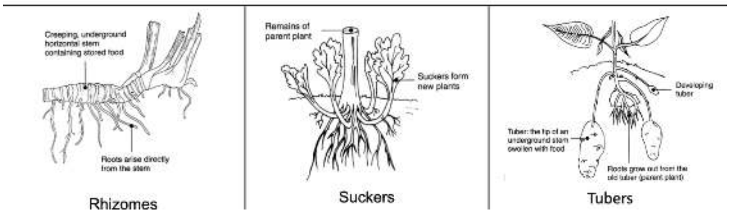
- Some flowers contain **both** male and female reproductive parts, while other flowers contain only male **or** only female parts.
- **Female Sexual Organs:**
  - Carpel:
    - Stigma
    - Style
    - Ovary
      - Turns into fruit
- **Male Sexual Organs:**
  - Stamen
    - Filament
    - Anther
      - Produce pollen
- Through the use of pollinators eg. bees, the pollen is transferred to each flower. The pollen is transferred to the female reproductive organs where the pollen attaches to the stigma and then transports the sperm cells inside to the ovary where fertilisation occurs

Gymnosperms:

- Use cones to reproduce
- Female cones grow in the **upper** branches, have an **ovule** in each scale and can be fertilised by the wind-blown pollen from the male cones which grow in the **lower** branches.
- Pollen from the male cone is blown, a pollen tube forms, allowing pollen to move towards the ovule. After fertilisation a diploid zygote forms.

Plants: Asexual Reproduction



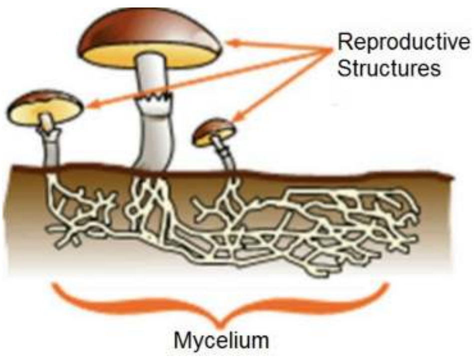
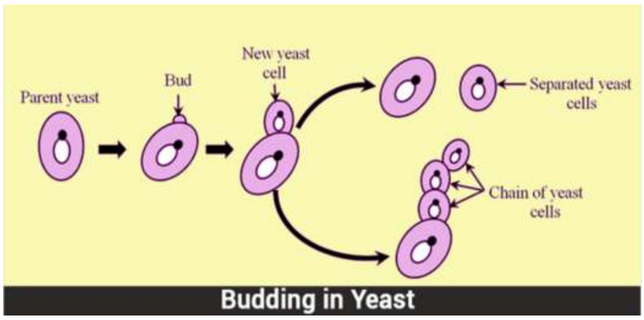
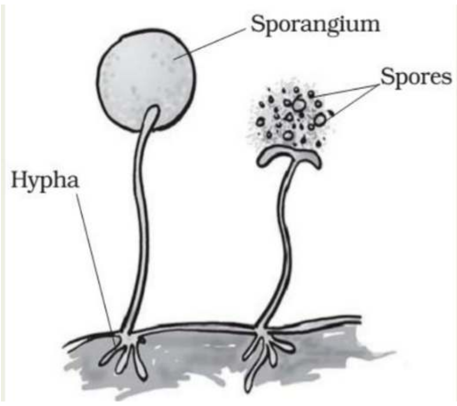


- are able to reproduce asexually by vegetative propagation
  - parts of the parent plant detach and will grow into new individuals
    - only one parent and specialised plant tissues in the parent plant can grow into offspring which are clones of the parent

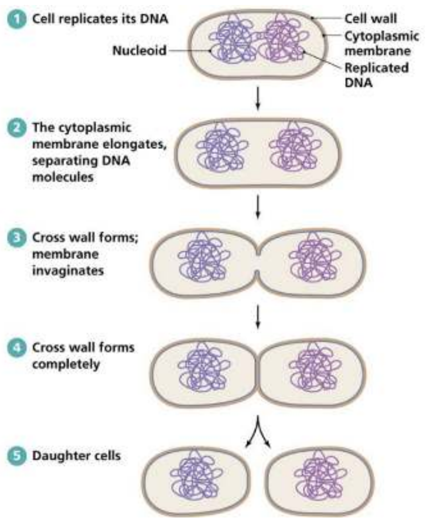
Advantage	Disadvantage
• less time and energy is needed to produce new individuals • the need for pollinators and pollination, fertilisation, the production of seeds and seed dispersal is removed	• lack of genetic diversity

Some ways to produce new plants asexually include:

- Cuttings
  - When shoots are cut from a plant and planted in moist soil, a new plant will form
- Runners
  - These are long thin stems, which grow along the ground from the parent plant. Roots and bud appear at the end of the runner (nodes) and a new plant is produced
- Tubers
  - thickened stems below the surface that store food called ligno-tubers. This is protected from fire and re-grows after a fire
- Bulbs
  - These are underground disc-like stem bearing close-set leaves containing stored food.
- Rhizomes
  - These are underground stems that give rise to new roots and shoots at the nodes
- Suckers

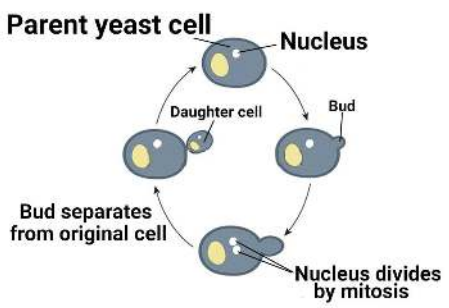
	○ These are new shoots that arise from roots or underground stems, often after fires. ● Stolons ○ Where a weak stem touches the ground its tip swells and it develops roots.
Fungi: Budding & Spores   	● Fungi both reproduce sexually and asexually, with the most common asexual methods being budding & spores ● **Budding** ○ a bud develops on the surface of either the yeast cell or the hypha. ○ Nucleus of the parent cell then divides; one of the daughter nuclei migrates into the bud, and the other remains in the parent cell. ○ parent cell is capable of producing many buds over its surface by continuous synthesis of cytoplasm and repeated nuclear divisions. ○ After a bud develops to a certain point and even before it is severed from the parent cell, it is itself capable of budding by the same process. ■ a chain of cells may be produced. ○ the individual buds pinch off the parent cell and become individual yeast cells. ● **Spores** ○ reproduce by releasing large numbers of microscopic spores. ○ Spores are haploid single cells – reproductive cells and are often contained within a structure known as a sporangium which will disintegrate dispersing the spores by wind or water into the environment. ○ When a spore lands in a suitable environment it will germinate (start to grow) forming a new fungus.

Bacteria: Binary Fission



- Bacteria are unicellular, microscopic prokaryotes that usually reproduce asexually
- Reproduce via binary fission
  - The bacterium, which is a single cell, divides into two identical daughter cells.
  - Binary fission begins when the DNA of the bacterium divides into two (replicates).
  - The bacterial cell then elongates and splits into two daughter cells each with identical DNA to the parent cell. Each daughter cell is a clone of the parent cell.

Protists: Budding & Binary Fission



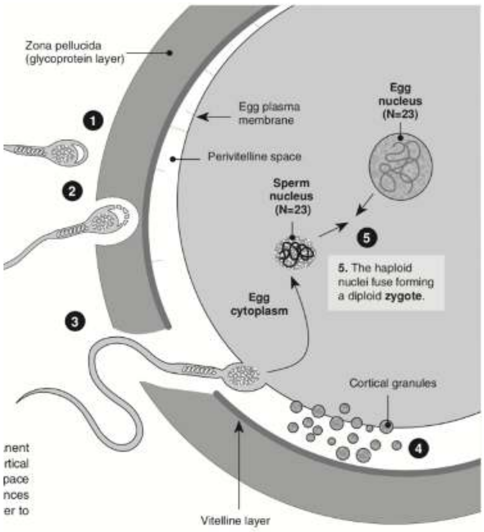
- Eukaryotes that live in aquatic water or moist environments.
- Can be unicellular or multicellular as well as autotrophic or heterotrophic and can reproduce asexually or sexually.
- Asexual reproduction is the primary method of reproduction for protists.
- Most common forms of reproduction are binary fission followed by budding
  - **Binary Fission**
    - It is the division of the parent body into two equal daughter individuals.
      - Examples: Amoeba, Euglena and Paramecium.
  - **Budding**
    - A small outgrowth develops from the parent body which separates and develops into a new individual.
      - Example: Arcella (a sarcodine)

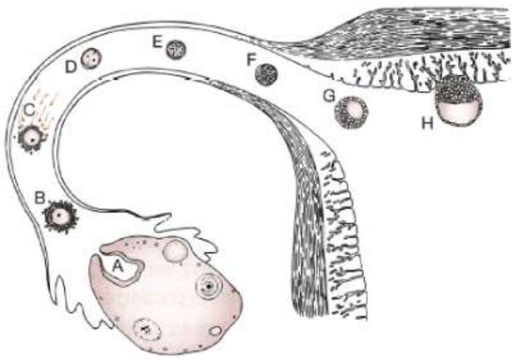
DOT POINTS:

- *analyse the features of fertilisation, implantation and hormonal control of pregnancy and birth in mammals*
- *evaluate the impact of scientific knowledge on the manipulation of plant and animal reproduction in agriculture*

Fertilisation and Implantation

- occurs when a sperm penetrates an egg
- After fertilisation the zygote will divide by mitosis in a process called cleavage that converts the zygote to a small mass of cells.



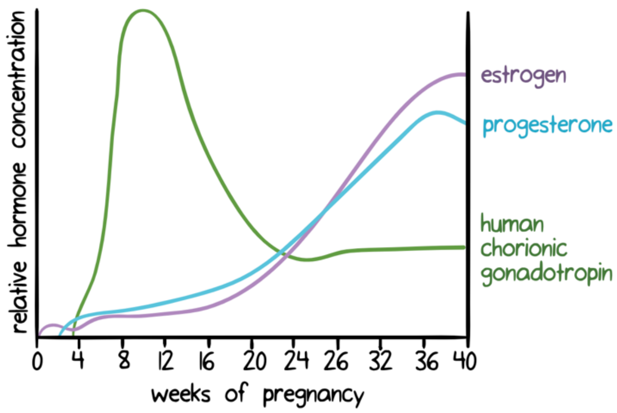


- After five days the embryonic mass of cells is called a blastocyst.
    - The blastocyst consists of a ball of cells around an inner cavity and implants in the endometrium of the uterine wall.

Generalised Steps of Fertilisation and Implantation

1. The male and female copulate (have sexual intercourse) – this involves the male penis being inserted into the female vagina.
2. A muscular contraction (ejaculation causes semen from the male to move into the female vagina. Semen contains large numbers of sperm, plus nutrients and fluids.
3. The sperm cells travel through the female reproductive tract – passing through the cervix, into the uterus and into an oviduct (fallopian tube).
4. A single sperm cell fertilises each available egg (ova), resulting in one or more zygotes (fertilised ova). Different species release different numbers of eggs.
5. As a zygote travels down the oviduct to the uterus, it begins to grow through cell division (mitosis). It begins to develop into an embryo.
6. The embryo implants in the endometrial wall of the uterus to continue developing, nourished by the mother's body via the placenta. It grows into a foetus, then a baby.

Hormonal Control



- Hormones act as the body's chemical messengers sending information and feeding back responses between different tissues and organs

1st Trimester:

- The embryonic hormone HCG rises rapidly
    - Human chorionic gonadotropin (HCG) is a hormone produced by some of the cells in the blastocyst/embryo when it implants in the endometrium
- HCG maintains the corpus luteum
    - a hormone-secreting structure that develops in an ovary after an ovum has been discharged
        - Allows it to continue producing oestrogen and progesterone
            - are essential for maintaining the

uterus lining to support embryonic development

- Due to high levels, HCG can be detected in the urine which makes it useful for pregnancy tests

2nd Trimester:

- high levels of oestrogen and progesterone are vital to continue maintaining the pregnancy
- Production of HCG declines and the corpus luteum deteriorates
- Placenta takes over role of producing oestrogen and progesterone

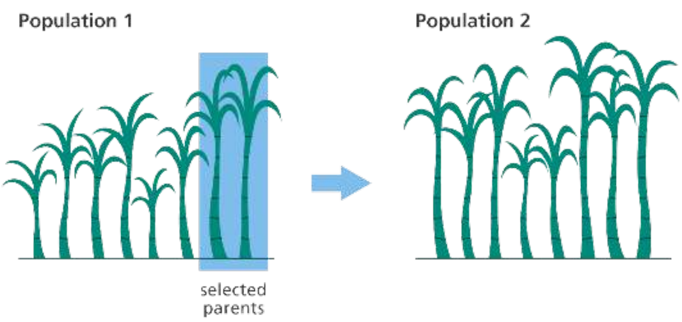
3rd Trimester:

- increased oestrogen is released
- oestrogen induces receptors to form on the uterus wall that can bind with the hormone oxytocin
  - Oxytocin is critical to triggering and maintain labour
- Oxytocin causes muscular contractions of the uterus, which push the baby towards the cervix and vaginal opening
- Once the baby is born, oxytocin promotes lactation by moving the milk into the breast

DOT POINTS:

- *evaluate the impact of scientific knowledge on the manipulation of plant and animal reproduction in agriculture*

Reproductive Techniques used in Agriculture



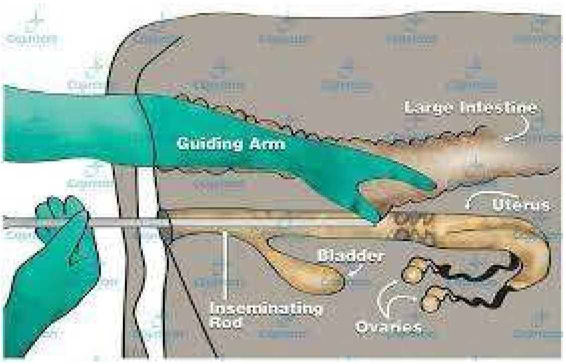
- Reproductive techniques can be used to manipulate the reproduction of plants and animals

Animals

Selective Breeding

- Involves humans choosing the parents with specific characteristics/traits to breed together in the hopes of passing that trait down

Advantages	Disadvantages
• Desirable trait can be passed down	• Similar genetics • Same strengths/weaknesses • Infectious diseases can spread more likely genetically • Inbreeding ○ Suffer from genetic conditions



Artificial Insemination

- A fertility treatment method used to deliver sperm directly to the cervix or utures in the hopes of getting pregnant.
- Involves placing semen directly into the uterus.
  - Used in both stud and commercial herds

Advantages	Disadvantages
• Provides access to the best genetics, supporting animal health and the safety of people who work on farms.	• Requires well-trained operations and special equipment. • Requires more time than natural services. • Necessitates the knowledge of the structure and function of reproduction on the part of operator. • Improper cleaning of instruments and in sanitary conditions may lead to lower fertility

Plants

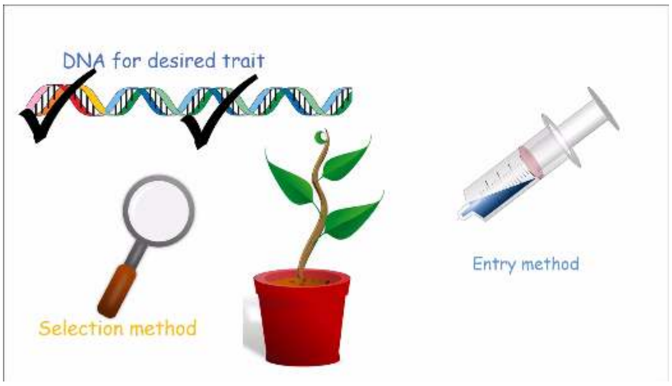
Artificial Pollination

- A technique that can be used to pollinate plants when natural or open pollination is either undesirable or insufficient.
- Generally done via a mechanical method by which pollen is carried or plant sperm from one flower to another flower.

Advantages	Disadvantages
• Can increase the fruit size and seed numbers • Can convert flowers to export fruits. • Doesn't depend on any chance factors • Generate a large variety of hybrid plants	• It is inefficient and costly • Does not produce as many crops as natural pollination • Produces less biodiversity

Genetic Engineering

- Genetic modification of plants involves adding a specific stretch of DNA into the plant's genome, giving it new or different characteristics.
  - This could include changing the way the plant grows, or making it resistant to a particular disease.
- Modern technology now allows scientists to use genetic engineering to take just a beneficial gene, like insect resistance or



drought tolerance, and transfer it into a plant.

Advantages	Disadvantages
• Increased crop yields • Reduced costs for food or drug production • Reduced need for pesticides • Enhanced nutrient composition and food quality • Resistance to pests and disease, greater food security, and medical benefits to the world's growing population.	• Allergic reactions or increased antibiotic resistance. • Change in Herbicide Use Patterns. • Squandering of Valuable Pest Susceptibility Genes. • Poisoned Wildlife. • Creation of New or Worse Viruses. • Cross Contamination.

Inquiry Question 2:

How important is it for genetic material to be replicated exactly?

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DOT POINTS:

- *model the processes involved in cell replication, including but not limited to:*
  - *mitosis and meiosis*
  - *DNA replication using the Watson and Crick DNA model, including nucleotide composition, pairing and bonding*
- *assess the effect of the cell replication processes on the continuity of species*

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Mitosis

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- a type of cell division that results in two daughter cells each having the same number and kind of chromosomes as the parent nucleus, typical of ordinary tissue growth.
- There are 6 main phases within mitosis
  - Interphase
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
  - Cytokinesis

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Mitosis: Interphase

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- **Interphase**
  - 'Resting stage', cell growths and DNA replicates during this stage
    - **G1:** Cells growth
    - **M/S:** DNA duplicated
    - **G2:** Cells continue to grow
  - each chromosome becomes replicated.
  - A cell that starts with four chromosomes would end up with four pairs of chromosomes at this stage. One with 46 chromosomes (a human cell) would end up with 92

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Mitosis: Prophase

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- **Prophase**
  - DNA will supercoil and form the 'x' shape chromosomes
  - Nucleus membrane degenerates
  - Chromosomes become shorter and thicker
  - Each chromosome and its replica are held together by a structure called the **centromere**.
  - The centromere (parts of a chromosome where the two chromatids join) go to poles and spindles start to form
  - This stage ends with the breakdown of the nuclear membrane

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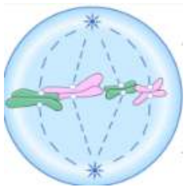
Mitosis: Metaphase (Middle)



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- **Metaphase**
  - Centrosomes extend spindles (filaments involved in moving + segregating chromosomes in cell division) and attach these to centromere
  - Chromosomes, thus, line up at the equator of the cell.

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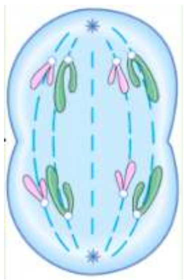
Mitosis: Anaphase (Away)



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- **Anaphase**
  - Spindles will contract, and they will pull apart the chromosomes
  - Sister chromatids (half of a chromosome) go to opposite poles of the cell.

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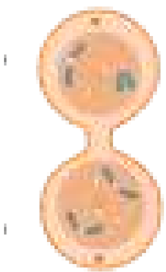
Mitosis: Telophase



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- **Telophase**
  - The chromosomes uncoil to become slender threads.
  - A new cell membrane forms at the equator.
  - The cytoplasm divides and two new daughter cells now exist, where there was originally only one parent cell.
  - The original ‘parent’ cell had four chromosomes.
  - Each daughter cell ends up with four chromosomes which are identical to the original four present in the parent cell.
  - Chromatids at each pole
  - Nucleus reforms
  - centrosomes and spindles degenerate
  - Cleavage → starting to break into 2 cells

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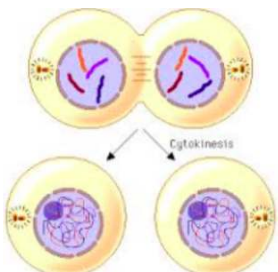
Mitosis: Cytokinesis



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- **Cytokinesis**
  - 2 identical daughter cells form

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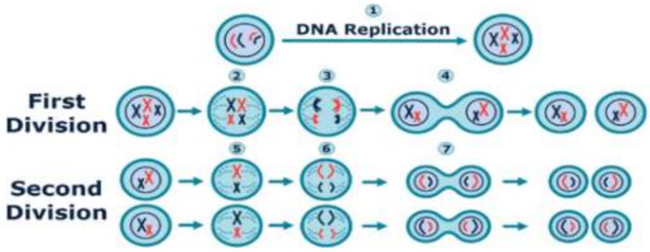
Meiosis



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- a type of cell division that results in four daughter cells each with half the number of chromosomes of the parent cell, as in the production of gametes and plant spores.
- Sex cells (gametes) are produced
- Produces **for non-identical daughter cells,** each with only half the number of chromosomes **(23 ONLY instead of 23 pairings)**
- Includes two separate sets of division
  - First set
  - Second Set

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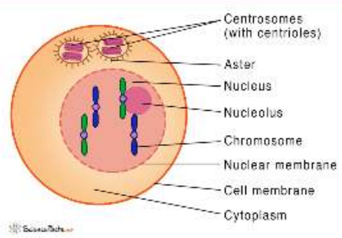
Meiosis: Interphase



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- The DNA in the cell is copied resulting in two identical full sets of chromosomes.

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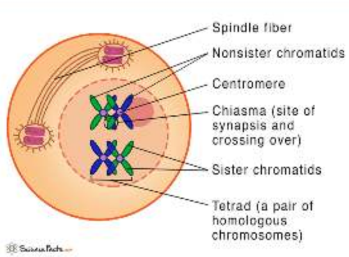
Meiosis: Prophase 1



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- **Prophase 1**
  - DNA condenses into chromosomes
  - Homologous chromosomes pair up
  - At the END of PROPHASE I, CROSSING OVER can occur – paired homologous
  - chromosomes may exchange sections of chromosomes at a locus.

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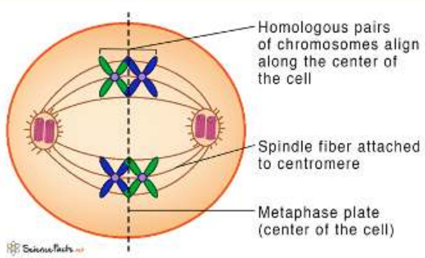
Meiosis: Metaphase 1



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- **Metaphase 1**
  - Parent cell's nuclear membrane breaks down
  - Chromosomes move to the equator/centre of the cell
  - Spindles form

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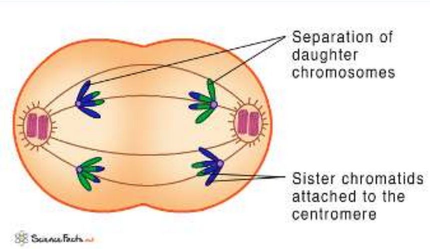
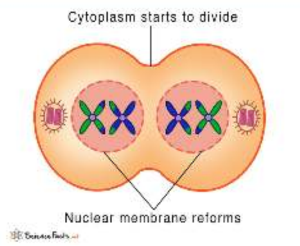
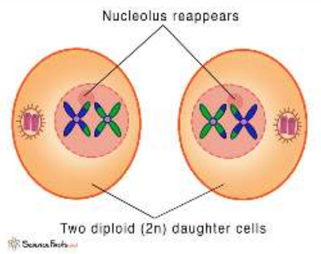
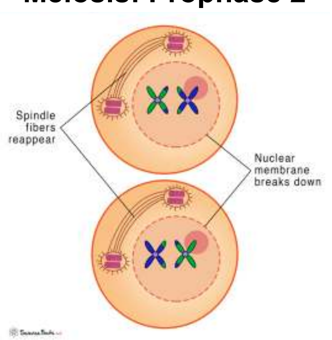
Meiosis: Anaphase 1 	• **Anaphase 1** ○ Network of spindle fibres RANDOMLY separate the chromosomes to opposite ends of the cell.
Meiosis: Telophase 1 	• **Telophase 1** ○ Nuclear membranes form around the separated chromosomes.
Meiosis: Cytokinesis 1 	• **Cytokinesis 1** ○ Cell membrane pinches off to make two daughter cells.
BEGINNING OF THE SECOND SEPARATION DIVISION	
Meiosis: Prophase 2 	• **Prophase 2** ○ Nuclear membranes break down.

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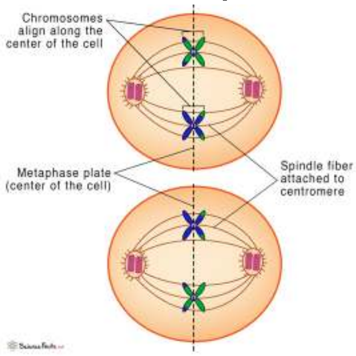
Meiosis: Metaphase 2



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- **Metaphase 2**
  - Chromosomes align at the centre of the cell.

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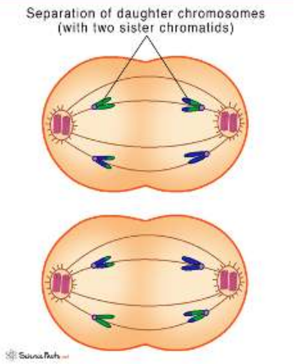
Meiosis: Anaphase 2



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- **Anaphase 2**
  - Network of spindle fibres separate **SISTER CHROMATIDS**
  - Separated chromatids move to opposite ends of the cell

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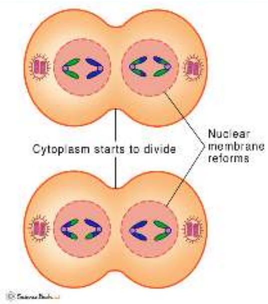
Meiosis: Telophase 2



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- **Telophase 2**
  - Nuclear membranes form around separated chromatids.

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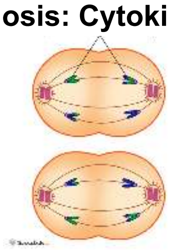
Meiosis: Cytokinesis



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- **Cytokinesis**
  - Membranes pinch off to make FOUR different haploid daughter cells (gametes)

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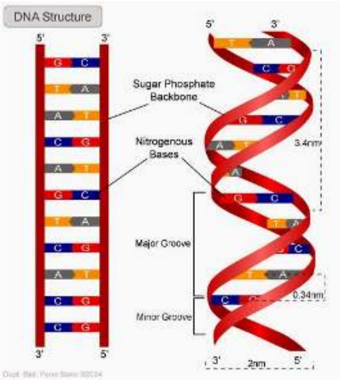
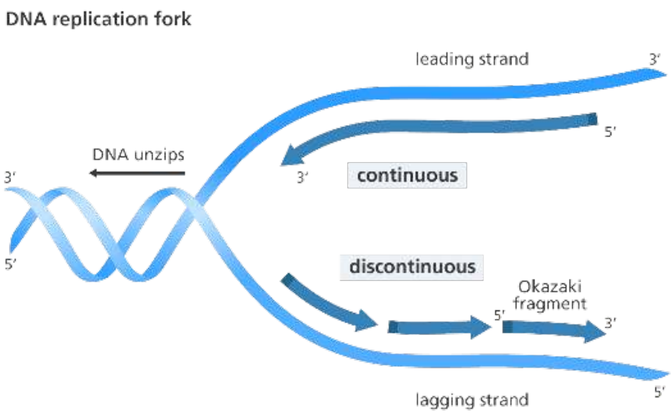
Watson & Crick DNA Model

 	
	• DNA is a double-helical structure made up of two polynucleotide strands (deoxyribose sugar
	• attached to a nitrogenous base, plus a phosphate molecule).
	    ○ Nitrogenous bases are adenine, thymine, guanine and cytosine.
	• Strands are joined by hydrogen bonds
	    ○ AT has a double bond and CG has a triple bond.
	• Phosphates are attached to sugars by a covalent bond
	• **DNA** → Nitrogenous base sequence determines who we are.
	• **NUCLEUS** → **CHROMOSOMES** → wrapped around histones → double helix → bases

DNA Synthesis

 	
	1. Helicase causes the DNA double helix to UNWIND (i.e. go from twist to straight).
	2. Helicase disrupts the weak hydrogen bonds between nucleotide bases, causing the two strands to SEPARATE
	3. Nucleotides are ADDED against each single strand.
	    - A short strand of RNA (primer) is made by primase and attaches to DNA.
	    - DNA polymerase picks up free nucleotide units and inserts them opposite their complementary base partner (AT/CG).
	- This process is antiparallel - that is; each DNA strand has a **3' prime end and 5 prime** ends on opposite ends. Nucleotides are always added from the THREE prime (leading) end!
	4. Replication ERRORS are identified and CORRECTED, and the DNA strand is SEARCHED.
	- DNA polymerase corrects base pair errors by splicing out the incorrect base and replacing it with the correct base.
	- Ligase seals the two strands together and the final pairing is checked by another DNA polymerase.
	- However, 1 in 10 billion base pairs may stll be incorrect despite checking, and this is how mutations occur

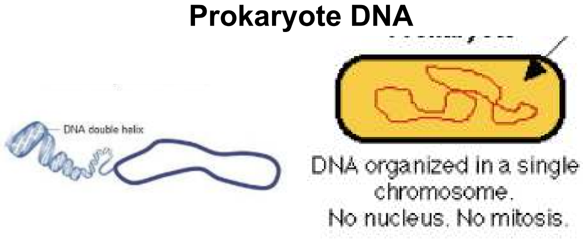
Inquiry Question 3:

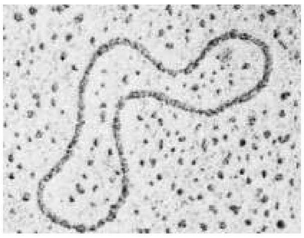
Why is polypeptide synthesis important?

DOT POINTS:

- *construct appropriate representations to model and compare the forms in which DNA exists in eukaryotes and prokaryotes*

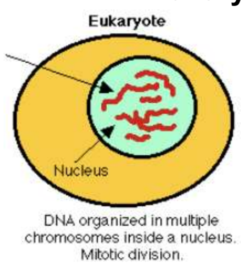
Prokaryote DNA

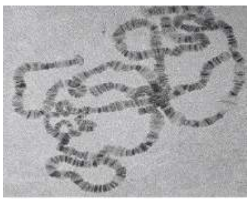


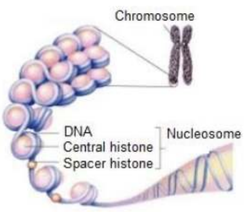


- Prokaryotes are single-celled organisms
- Eg. Bacteria
- DNA is found in a dense region of the cytoplasm called the **nucleoid**
- There is **one** chromosome per cell.
- It has a circular-shaped chromosome without ends (no telomeres)
- DNA can also be found as small rings of non-chromosomal DNA called plasmids.
- DNA is not packaged.
- There is much less DNA than in eukaryotes.
- There is less non-coding DNA (introns) than in eukaryotes.
- Have double-stranded DNA and mRNA.
- The translation of mRNA into amino acids is the same.

Eukaryote DNA





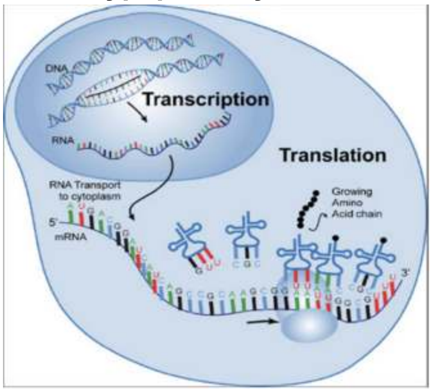


- Eukaryotes are multicellular organisms
- Eg. Animals, plants etc
- DNA is found in the **nucleus**
- There are **many** chromosomes per cell.
- It has linear-shaped, thread-like chromosomes without ends (no telomeres)
- DNA can also be found in mitochondria and chloroplast.
- DNA is tightly packed, coiled around proteins called histones forming nucleosomes.
- There is much more DNA than in prokaryotes.
- There is more non-coding DNA (introns) than in prokaryotes.
- Have double-stranded DNA and mRNA.
- The translation of mRNA into amino acids is the same.

DOT POINTS:

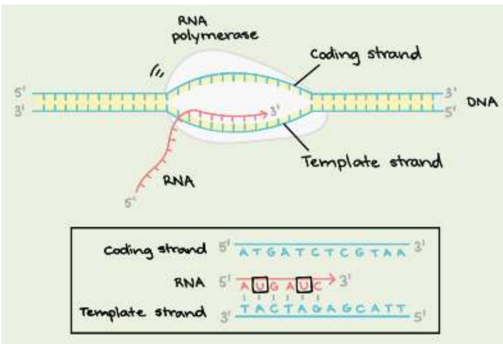
- *model the process of polypeptide synthesis, including:*
  - *transcription and translation*
  - *assessing the importance of mRNA and tRNA in transcription and translation*
  - *analysing the function and importance of polypeptide synthesis*
  - *assessing how genes and environment affect phenotypic expression*
- *investigate the structure and function of proteins in living things*

Polypeptide Synthesis



- A polypeptide is a molecule made up of a chain of many amino acids, and one or more polypeptides folded and joined together form a protein.
- The path from a DNA molecule to the production of a protein:
  DNA → RNA → amino acids → polypeptide → protein
- All cells function through their proteins.
- DNA stores genetic information to control the production of proteins.
- Polypeptide synthesis allows for the creation of new proteins for the organism to use
- Includes two processes which are:
  - Transcription
  - Translation

Transcription

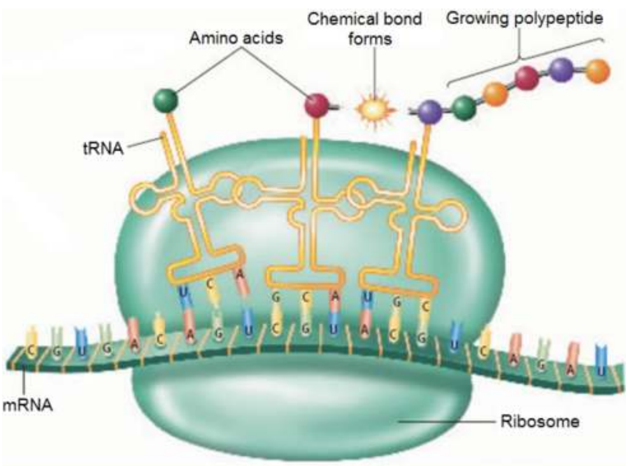


- The process by which DNA is copied to RNA – happens in the nucleus.

PROCESS

- Enzyme RNA polymerase binds to the DNA at the promoter
- The DNA unwinds. The template strand is copied in the 5' → 3' direction to form mRNA.
  - The mRNA formed is referred to as pre-mRNA.
  - It needs to be modified so that it consists only of the base sequence that will code for the protein.
- The modified mRNA (mature mRNA) then moves from the nucleus into the cytoplasm.

Translation



- The process in which RNA is used to produce proteins – happens in ribosomes.

PROCESS

- The mRNA molecule attaches to a ribosome.
- The ribosome moves along the mRNA molecule. The mRNA sequence is read by the ribosome in triplets of bases called codons.
- At one end of the tRNA are three unpaired bases which attach to mRNA while the unpaired side attaches to amino acids
- Anticodons on tRNA molecules align opposite appropriate codons according to complementary base pairing (e.g. AUG = UAC).
- Ribosomes catalyse the formation of peptide bonds between adjacent amino acids until it reaches a stop codon
- Translation ceases as it has reached the end of the polypeptide chain

<table>
<tr>
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<td>THINGS TO REMEMBER:
● Methionine (codon AUG) is the start codon for the synthesis of a polypeptide.</td>
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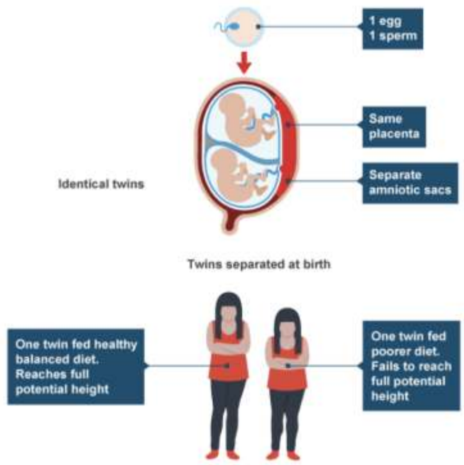
<tr>
<td>Factors Affecting Phenotypic Expression

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<td>● Genotype: the genetic make-up of an individual organism.
● Phenotype: the observable physical or biochemical characteristics of an individual organism, determined by both genetic make-up and environmental influences,
● Genotype + Environment → Phenotype
● The main two factors that affect phenotypic expression are genes and environment

Genes
● Due to hereditary genes, you may be more inclined to receive a certain disease more than others, especially if there is history of that disease within your family
    ○ Genes affect phenotypes such as eye colour and blood type

Environment
● Differences in phenotype caused by environmental factors are not passed from one generation to the next.
    ○ A person with dark skin tone due to excessive sun bed use will not pass this on to her children. They have no effect on the person's genotype so therefore cannot be passed on.</td>
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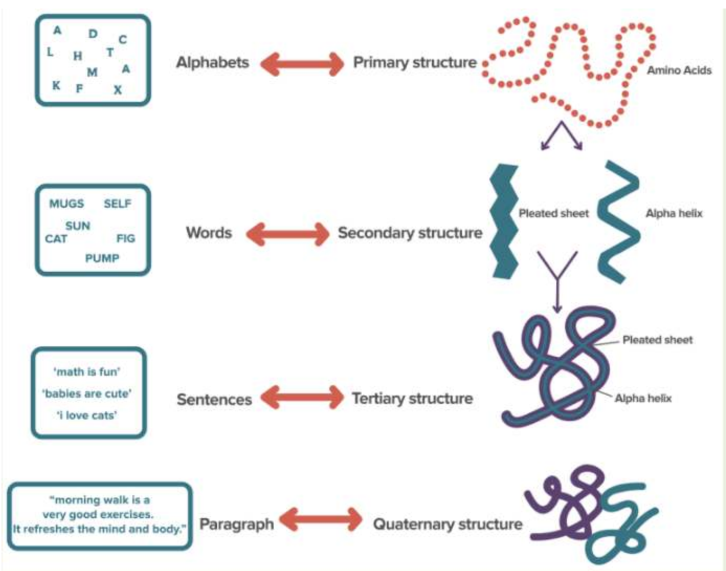
<tr>
<td>Protein Structure and Function

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<td>● Proteins are biological polymers composed of amino acids.
● There are two general classes of protein molecules:
    ○ globular proteins
        ■ generally compact, soluble, and spherical in shape.
    ○ fibrous proteins.
        ■ typically elongated and insoluble.
● There are 4 levels of protein structure
    ○ Primary Structure - 1°
        ■ the sequence of amino acids. There are 20 different amino acids that can link together with peptide bonds in a vast number of different combinations.
    ○ Secondary Structure - 2°
        ■ The polypeptide chain then folds up in various ways.
        ■ Most proteins will have sections that fold into a coiled α-helix and</td>
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other sections that fold into a β-pleated sheet.

Tertiary Structure - 3°

a precise 3D structure formed by the folding of secondary structures into a complex shape
held together by links made between secondary structures.

Quaternary Structure - 4°

Some complex proteins are comprised of more than one polypeptide chain. Each polypeptide chain is referred to as a subunit.

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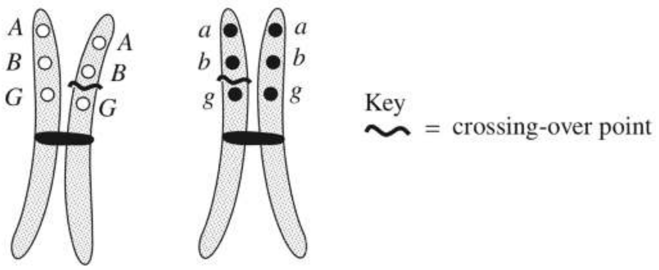
Inquiry Question 4:

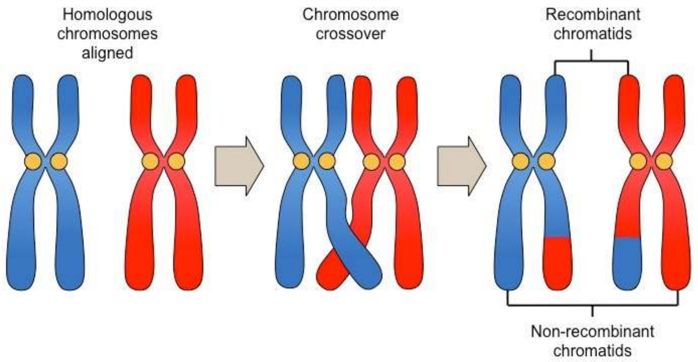
How can the genetic similarities and differences within and between species be compared?

DOT POINTS:

- *conduct practical investigations to predict variations in the genotype of offspring by modelling meiosis, including the crossing over of homologous chromosomes, fertilisation and mutations*

Crossing Over of Homologous Chromosomes



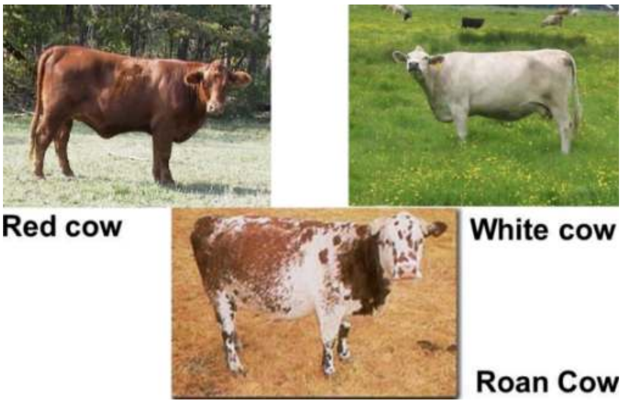


- Crossing over is a cellular process that happens during meiosis when chromosomes of the same type are lined up
- Refers to the exchange of DNA between paired homologous chromosomes (one from each parent) that occurs during the development of egg and sperm cells
- In prophase I, homologous chromosomes undergo a process called synapsis, whereby they pair up to form a bivalent
  - The homologous chromosomes are held together at points called chiasmata
- Crossing over of genetic material between non-sister chromatids can occur at these chiasmata
  - As a result of this exchange of genetic material, new gene combinations are formed on chromatids
- Once chiasmata are formed, the homologous chromosomes condense as bivalents and then are separated in meiosis
  - If crossing over occurs then all four haploid daughter cells will be genetically distinct (sister chromatids are no longer identical)

DOT POINTS:

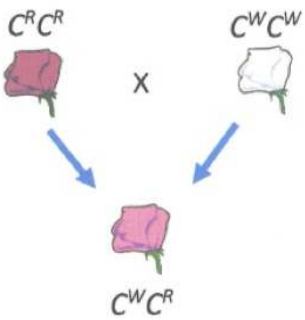
- *model the formation of new combinations of genotypes produced during meiosis, including but not limited to:*
  - *interpreting examples of autosomal, sex-linkage, co-dominance, incomplete dominance and multiple alleles*
  - *constructing and interpreting information and data from pedigrees and Punnett squares*

Codominance



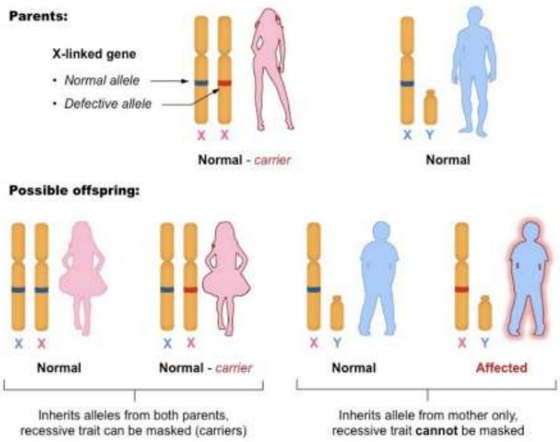
- Both alleles are expressed, creating a new phenotype.
- Heterozygotes which have one allele for red and one for white coat colour, have a roan appearance – both red and white hairs are present, not in patches but interspersed.
- Special genetic notation is used to represent codominance.
  - A letter is chosen to represent the gene for example, C for colour.
  - The alleles are written as superscripts next to the gene.
    - Each letter is a capital as they are both expressed
  - Red would be C^R and white would be C^W. The roan cow would be represented as C^RC^W.

Incomplete Dominance



- A blending of the features of the two alleles expressed, giving a hybrid that is intermediate
- Red snapdragon flowers crossed with white snapdragon flowers give pink flowers.
- Special notation is used to represent alleles that do not show complete dominance.
  - A letter is chosen to represent the gene – for example, C for colour.
  - The alleles are written as superscripts next to the gene, so the allele for red would be C^R and the allele for white would be C^r

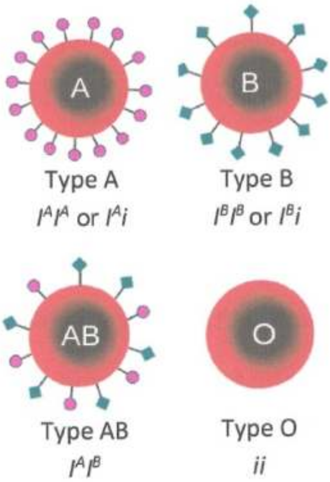
Sex-Linkage



- Sex chromosomes carry genes that determine the sexual characteristics of a person → Determines if they are male or female.
- **Females** have a pair of similar sex chromosomes - their genotype is represented as **XX** (**homogametic**)
- Sex chromosomes of **males** appear to be different (**heterogametic**) and their genotype is represented as **XY**.
- Examples of sex-linked genes: colour-blindness, haemophilia, baldness, muscular dystrophy, eye colour in Drosophila fruit flies.
- The alleles of that gene (e.g. N = dominant allele, n = recessive allele) and the type of chromosome on which it is carried (X or Y) must be shown in the genetic cross. The alleles are written as superscripts next to the chromosome.
- Examples:
  - X^NX^N = homozygous (dominant trait expressed) female.

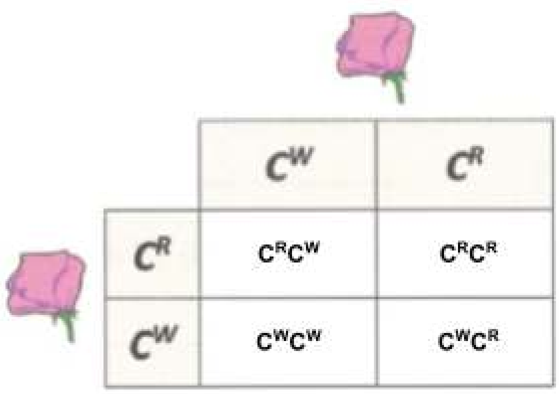
- X^NX^n = heterozygous (dominant trait expressed) carrier female.
- X^nX^n = homozygous (recessive trait expressed) female.
- X^NY = (dominant trait expressed) male.
- X^nY = (recessive trait expressed) male.
- Note that only 1 recessive allele needs to be present for the trait to be expressed.

Multiple Alleles



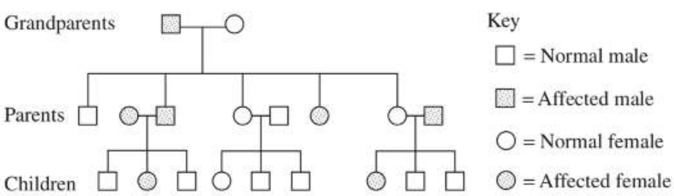
- There can be more than two possible alleles that determine a particular gene,
- Rabbit fur colour and human blood groups both have multiple alleles for a single gene.
- With multiple alleles, there are alleles that are more dominant over the other, meaning that if that allele is present in the organism that it will override the other allele
  - Eg. in rabbits
  - Black/brown fur (C+) is dominant over the other three alleles. These other three alleles have a hierarchy of dominance: chinchilla (grey-ish) is incompletely dominant over Himalayan (white with black tips), and Himalayan is dominant over white.
  - Eg. in blood
  - The ABO blood group system has four possible phenotypes: blood types A, B, AB and O. These phenotypes are created by three alleles: I^A, I^B and i. The allele i is recessive.

Punnet Squares

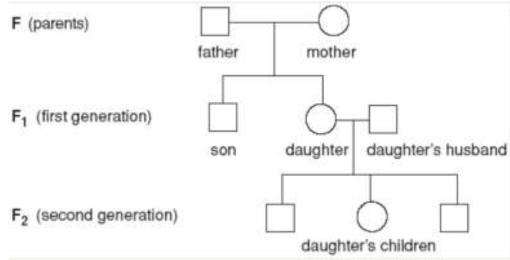


- A punnet square displays the alleles that the offspring that two organisms could potentially have
- Can calculate percentages and ratios from punnet squares
  - **Genotypic** Ratio: 1 C^WC^W: 2 C^WC^R: 1 C^RC^R
  - **Phenotypic** Ratio: 1 red: 2 pink: 1 white
- Always has the result of 4 different types of offspring
-

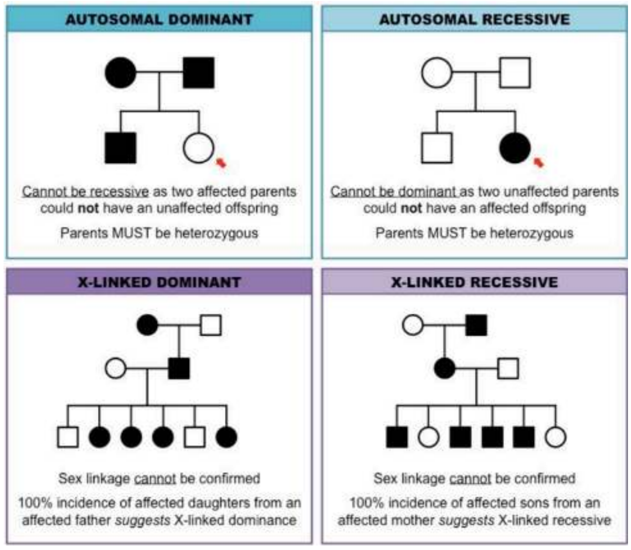
Pedigrees



- A record of the features of family members. It can help you to examine and explain the inheritance of the feature.



- can be used to determine patterns of inheritance across generations in a family, e.g. if a trait is dominant or recessive, and if the trait is on one of the autosomes, or on a sex chromosome.



DOT POINTS:

- *collect, record and present data to represent frequencies of characteristics in a population, in order to identify trends, patterns, relationships and limitations in data, for example:*
    - *examining frequency data*
    - *analysing single nucleotide polymorphism*

Frequency Data

Refer to Practical 'Frequencies of Human Height'

Height (cm)	*Frequency in Sample (tally)*
150-155	3
156-160	9
161-165	14
166-170	6
171-175	7

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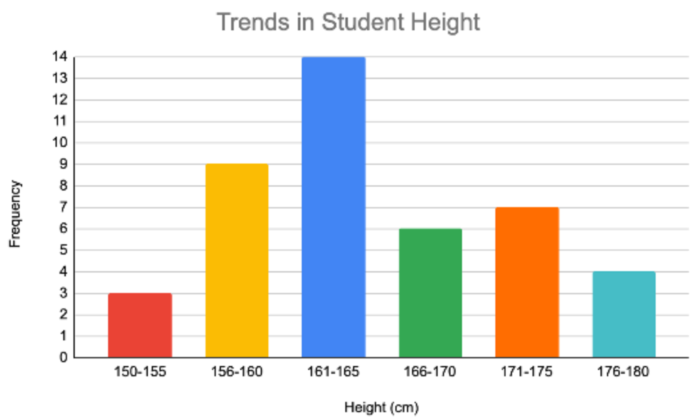

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176-180	4

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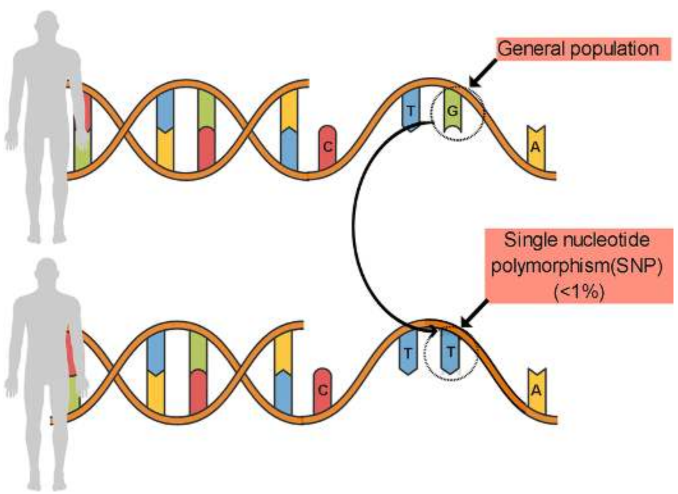
Single Nucleotide Polymorphism (SNP)



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- The most common type of variation in DNA is a single base substitution, known as a Single Nucleotide Polymorphism (SNP). For example, an adenine in one sequence of DNA is placed where a cytosine is located in another.
- SNPs occur roughly once in every 300 base pairs. This means there are 10 million SNPs in the entire genome (genome = 3 billion nucleotides)
- Are categorised into
    - **Coding:**
        - change the protein product of the gene
    - **Non-Coding:**
        - affect how much protein is produced from the affected gene

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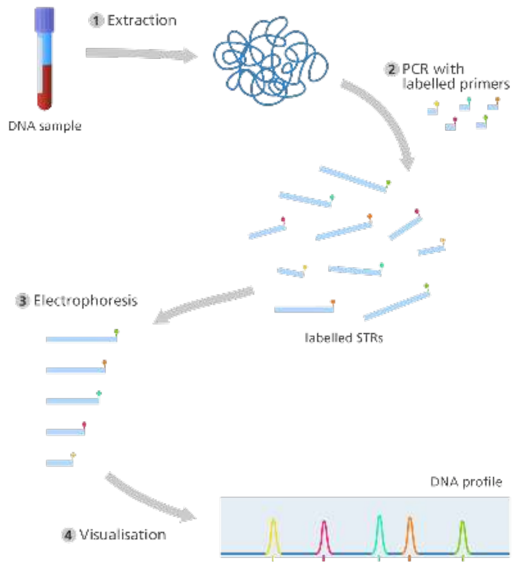
Inquiry Question 5:

Can population genetic patterns be predicted with any accuracy?

DOT POINTS:

- *investigate the use of technologies to determine inheritance patterns in a population using, for example:*
  - *DNA sequencing and profiling*

DNA Profiling



- Is the use of DNA tests to establish identity or relationships.
- Most individuals of the same species have nearly identical DNA. But the DNA sequence at certain locations, or loci, throughout the genome varies among individuals.
  - variations can be used to distinguish one individual from another

DNA Fingerprinting:
- is a method that was used in the past to identify an individual.
- DNA variations studied in DNA fingerprinting are called minisatellites (or variable number of tandem repeats – VNTR).

DNA Profiling:
- DNA is taken from a biological sample
- Uses polymerase chain reaction (PCR) to produce copies of STR sequences

DNA Sequencing

- DNA sequencing is the process of determining the sequence of nucleotide bases (As, Ts, Cs, and Gs) in a piece of DNA.
- The sequence tells scientists the kind of genetic information that is carried in a particular DNA segment.
  - scientists can use sequence information to determine which stretches of DNA contain genes and which stretches carry regulatory instructions, turning genes on or off.
- Requires breaking the DNA of the genome into many smaller pieces, sequencing the pieces, and assembling the sequences into a single long "consensus."

DOT POINTS:

- *investigate the use of data analysis from a large-scale collaborative project to identify trends, patterns and relationships, for example:*
  - *the use of population genetics data in conservation management*
  - *population genetics studies used to determine the inheritance of a disease or disorder*
  - *population genetics relating to human evolution*

Population Genetics Data - Conservation Management 	● Tasmanian Devils suffer from a facial tumour disease DFT ○ Have become endangered due to this disease ○ Involves them receiving tumours around the mouth which can then make it harder for them to eat which leads to them dying of starvation