HSC Biology Module 5: Hereditary

Hello Bio students! :)
You got this -- HSC is a marathon not a sprint.

Textbook pdfs:
https://drive.google.com/drive/folders/1g1mSUMuHUf_1-gft4MX7QfEJKDfgkeUk?usp=sharing

How Does Reproduction ensure the Continuity of Species?

5.1.1 # Mechanisms of Reproduction

Asexual reproduction

- One parent required
- Cell replicates and divides
  - ↳ Offspring are genetically identical

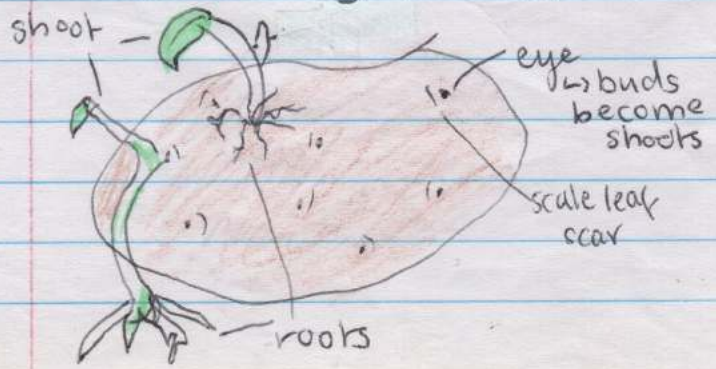
Advantages	Disadvantages
• Energy efficient ↳ No courtship, searching for partner • 1 parent ↳ No meeting of gametes • Quick • Small mating population ↳ If cannot find a mate. ↳ e.g Parthenogenesis • Organisms that are already well adapted	• Low genetic diversity • Inhibits adaptation ↳ Prone to Environmental changes they are not adapted for - cause them to die out. • Disease and nutrient deficiencies ↳ Carried on to offspring

Plants (Asexual)

Bulbs e.g onions

- Underground storage organ.
  Fleshy leaves surround bulbs and eventually
- new shoots develop.

Tubers e.g Potatoes



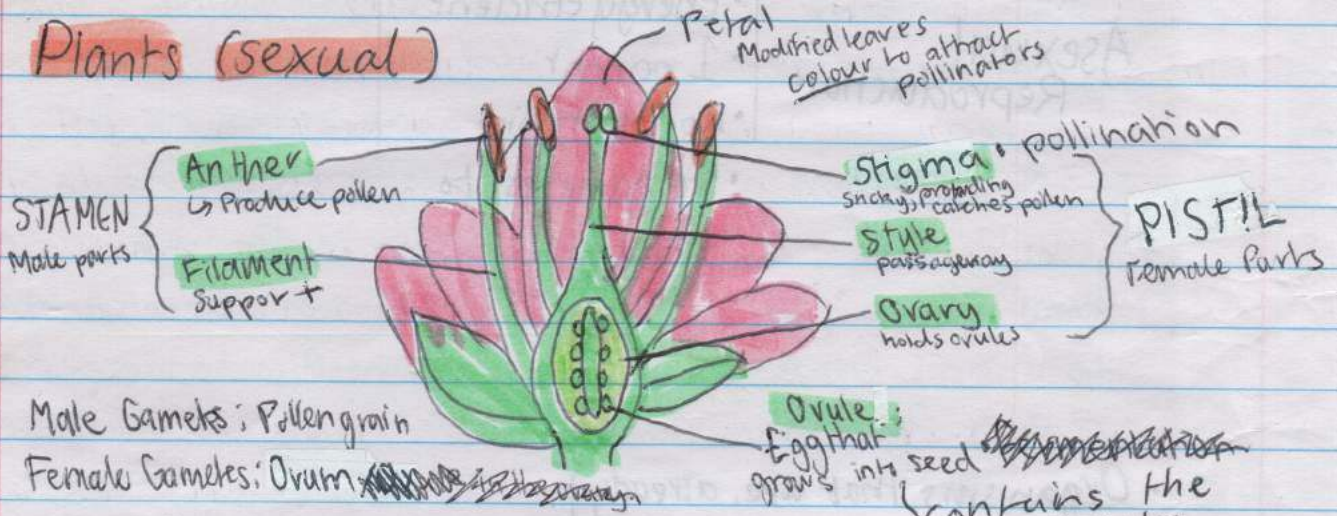
Buds grow on the surface of the tuber and grow new shoots and roots forming a new plant.

Runners e.g Strawberries, Peppermint

Side branches* that grow close to ground & develop plantlets from nodes.

- Rhizomes ⇉ but underground

Plants (sexual)



Male Gametes: Pollen grain

Female Gametes: Ovum

- have a smell to attract pollinators

How do plants make gametes meet?

- Pollinators - bees, birds, insects - butterflies
- Wind

- 2 types of plants: self pollination & cross pollination

self pollination	cross pollination
1 parent	more variety
increased chance of pollination	2 parents
Less variation.	Reduced chance of pollination.

Pollination: Transfer of pollen grains (from male anther) to female stigma.

↳ Ovule then grow into seeds

Sexual Reproduction

- Two parents required *Chromosomes
- Haploid gamete (n*) from each parent joins to create an ~~embryo~~ zygote with a diploid gamete (2n*)
  - ↳ Offspring are genetically unique.

Advantages	Disadvantages
• High genetic diversity ↳ Less prone to environmental changes. • Facilitates adaptation and evolution.	• Requires 2 parents → gametes • Energy costly ↳ Mating and courtship display. • Time and resource consuming • Paused in times of hardship & low resources.

Fertilisation:

The union of female and male gametes ex/in.

★ External Fertilisation: outside female body.

- Better suited to organisms that live in moist, aquatic environments → eggs will not dry out.
- Synchronised release of gametes.

Advantages	Disadvantages
• Little energy required to mate • Large numbers of offspring produced. • Populations in other areas can recover ↓ • Offspring can be spread ↳ Less competition for food + living space.	• Many gametes go unfertilised • Parental care is not given ↳ Offspring are not protected by parents, left to fend for selves. • Gametes + Offspring taken by predators.

Examples:

Staghorn Coral: Shed gametes into water, release pheromones to stimulate other coral to spawn.

Amphibians: Gametes released into fresh water - enourmous amount - high chance of F. + no parental care.

★ **Internal Fertilisation**: inside female body
- Usually occurs on **land** to protect gametes from dehydration and predation.

Advantages	Disadvantages
• Fertilisation is more likely to occur • Embryo is protected from predators and harsh conditions. • Offspring are more likely to survive.	• Higher energy requirement ↳ finding mate, mating, production of gametes: • Less offspring produced. • More energy required to care and raise young

1. **Oviparous development**:
An internally fertilised egg develops a shell and is laid in the external environment. Relies on yolk for nourishment.

Most reptiles: • soft but tough leathery shells • No parental care to these young
• Offspring are born fully functioning → leave, find food + water

Birds: During copulation (having sex) birds rub their cloacas (openings) together and sperm is transferred to the female body.
• hard shell
• Parental care given → they are not born fully-functioning.

Mammals: ○
○ **Monotremes**: e.g Platypus, Echidna
• eggs are incubated • parental care given

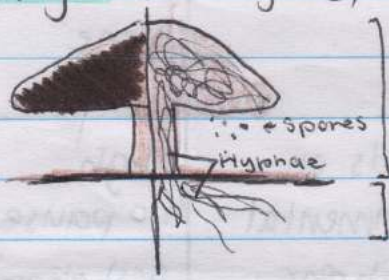
2. **Viriparous development**:
Fertilised egg becomes an embryo nurtured inside the female parent's body, obtaining nutrients through a placenta, born alive.
○ **Eutherians** (placental mamals): e.g rodents, humans, domesticated animals
• Uterus nurtures and protects embryo
• Placenta → nutrients + oxygen + excrete waste
• Large amount of energy given by parental care.
• Increased chance of survival. → Well developed

- Marsupials: e.g kangaroo, wombat, koalas, etc.
  - ★ Neither oviparous or viviparous.
  - Develop internally for a short time then continue embryonic development in a pouch.

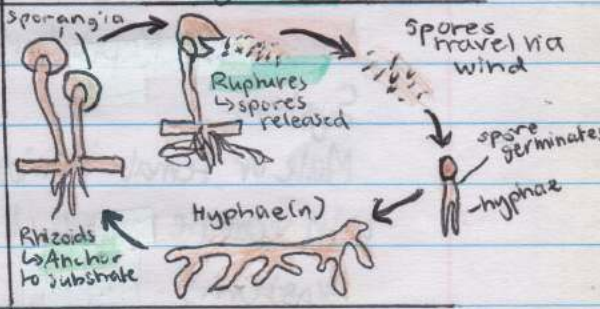
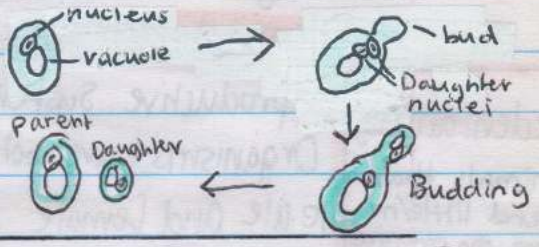
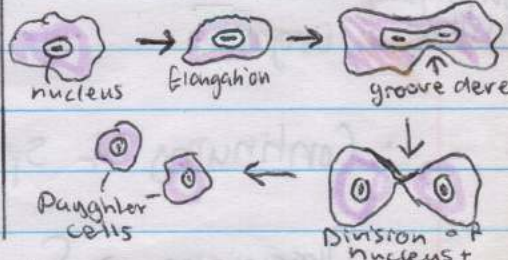
3. Ovo-viviparous: Eggs with yolk for nourishment are retained inside the mother's body until ready to hatch.
   e.g Sharks, some snakes.

Other types of Asexual Reproduction:

Fungi: Eukaryotic, uni/multicellular, heterotrophic organisms



Hyphae	Spores
Threads of cytop. interconnected. -Main fungal body.	Tiny unicellular reproductive cells produced in large volumes.

Type of Reproduction	Example	Description	Diagram
Spore Formation	Fungi -mould -mushrooms	Spores are produced in sporangia and are released -Travel long distances by wind	
Budding	Fungi -Yeast cells Protists Jellyfish, hydra, brain coral.	Adult organism produces small bud that separates or produces a chain.	
Binary Fission	Bacteria Protists ↳Amoeba	Unicellular organisms split into two.	

Protists: Eukaryotic organism that is not a true animal, plant or fungi. Unicellular.

Characteristic	Internal	Both	External
Gametes Released	Large no. of sperm small no. of eggs		Large number of both gametes
Fertilisation	Occurs in female reproductive system	Sperm fertilises egg	Occurs in external aquatic environment
Chance of fertilisation	High	Chance increases with [gametes proximity]	Low
Result of fertilisation	Zygote (internal)	Development requires a watery medium.	Zygote (external developm.)
No. of Offspring	Small (but survival rate is high)	- No. of gametes - Survival rate	High (but survival rate is low.
Parental Care	Yes		None
Breeding Frequency	Low, seasonal (gestation)	Depends on environmental conditions	High (no pause for gestation)

Gestation(n): Pregnancy

Unisexual Reproductive System:	Advantages	Disadvantages
Male or Female individuals with separate reproductive systems.	Less energy is required to maintain 1 set of reproductive organs.	Mating Rituals are required which use time and energy.
Hermaphrodite Reproductive System: Organisms have both Male and female sex organs.	- Organism does not require a partner. - Benefits sedentary organisms.	A larger amount of energy is required to maintain 2 sets of reproductive organs.

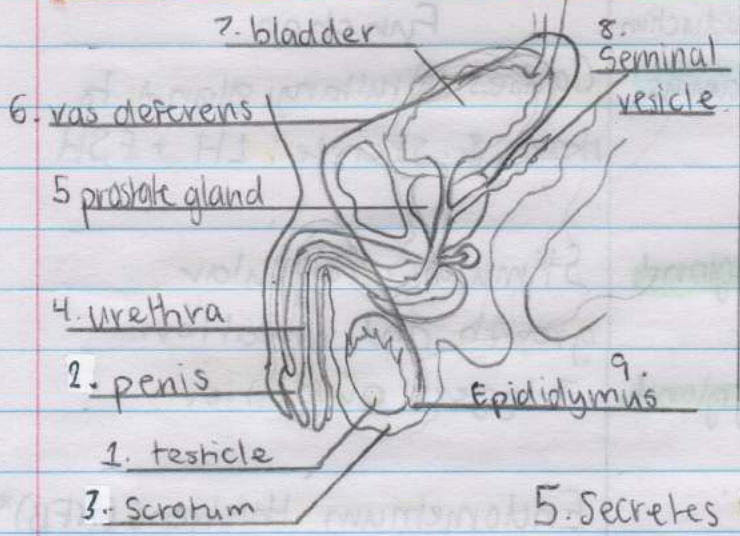
Sedentary(adj): Animals that spend little/no time on physical activity.

- Continuity of Species:

Organism → Survives → Growth → Reproduce → Inherit genes → Continuity

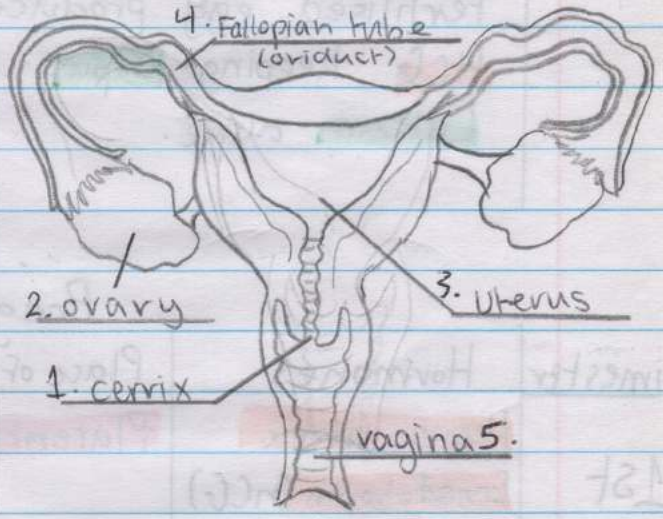
5.1.2

Fertilisation, Implantation, Pregnancy & Birth



Functions

1. Male gonads. Produce gametes + testosterone. (meiosis)
2. Organ used in intercourse to introduce sperm through semen in female tract.
3. Double-walled pouch: Regulates temperature → optimal sperm product.
4. Empties urine from bladder.
5. Secretes fluid to nourish + allow sperm to swim.
6. Sperm duct: epididymus → urethra.
7. Organ that stores urine.
8. Secretes fluid (mix w/ sperm + prostate)
9. Coiled tubule where sperm is temporarily stored and mature.



1. Channel that opens up into the vagina: Menstrual blood exits + Sperm enters uterus.
2. Small gonads containing cells that divide to make egg (ovum) cells. Ovulation occurs on 14th day.
3. Muscular organ where endometrium thickens. Egg implants + foetus housed. Fertilisation not shed.
4. Tube that transports the ovum, fertilisation occurs here.
5. Sperm is introduced here.

Ovulation:	Endometrium:	Fertilisation:	Gonads:
The release of mature (1) ovum once every 28 d.	The lining of the uterus	Fusion of two gametes (n) to form a diploid (2n) zygote.	Organ that produces gametes

Menstrual Cycle

Day	Hormone	Place of Production	Function
1	Gonadotropin-releasing hormone (GnRH)	Hypothalamus	Causes Pituitary gland to make & secrete: LH + FSH
1-14 peak	Follicle-stimulating hormone (FSH)	Pituitary gland	Stimulates follicular growth and ovulation
1-14 peak	Lutenising Hormone (LH)	Pituitary gland	Triggers ovulation
3-4d before ↑ 13/14 then ↓ peak	Oestrogen	Follicle Corpus Luteum	Endometrium thickens (NFB)* Inhibits LH, FSH and GnRH * production prevent follicle growth
15-28	Progesterone *	Corpus Luteum	Thicken + maintain lining.

? Pregnant ?	? Not Pregnant ?
Fertilised egg produces HCG keeping Corpus Luteum alive.	Corpus Luteum degenerates → Drop in progesterone + oestrogen → GnRH, FSH, LH ↑ menstruation restarts

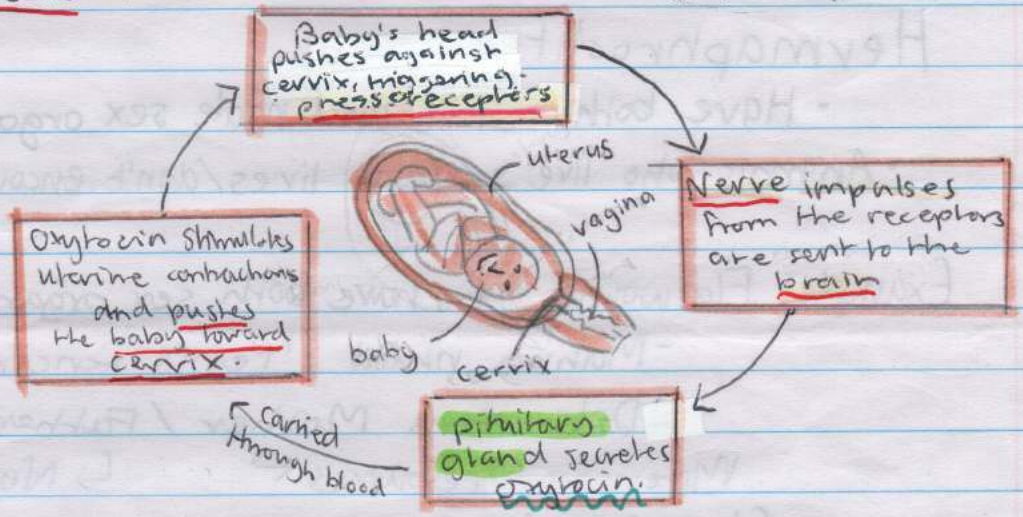
Pregnancy

Trimester	Hormones	Place of Production	Events
1st 0-12 weeks	Human chronic Gonadotropin (hCG)	Placenta	• hCG maintains Corpus Luteum • Placenta develops
	Oestrogen + Progesterone - enlarged uterus - mucous plug - breast growth - growth of placenta.	Corpus Luteum	• hCG levels increas rapidly for the first 8-12 weeks • Interaction with hypothalamus and pituitary → no GnRH, LH, FSH
2nd 13-26 weeks	Oestrogen + Progesterone	Placenta	• hCG declines ↳ Corpus Luteum degenerates • O + P keep increasing to maintain pregnancy.
3rd 27-40 wks	Oestrogen	Placenta	• Oestrogen induces Oxytocin receptors to form on uterus wall.
	Oxytocin	Posterior Pituitary	

Trimester	Hormones	Place of Production	Events
3rd 27-40 wks	Progesterone → breasts get ready to produce milk	Placenta	• Baby + Mother Pituitary produce ↑ oxytocin → Muscular contractions toward cervix.
	Prostaglandins → Stimulate contractions	Placenta	

Labour: Positive Feedback Loop

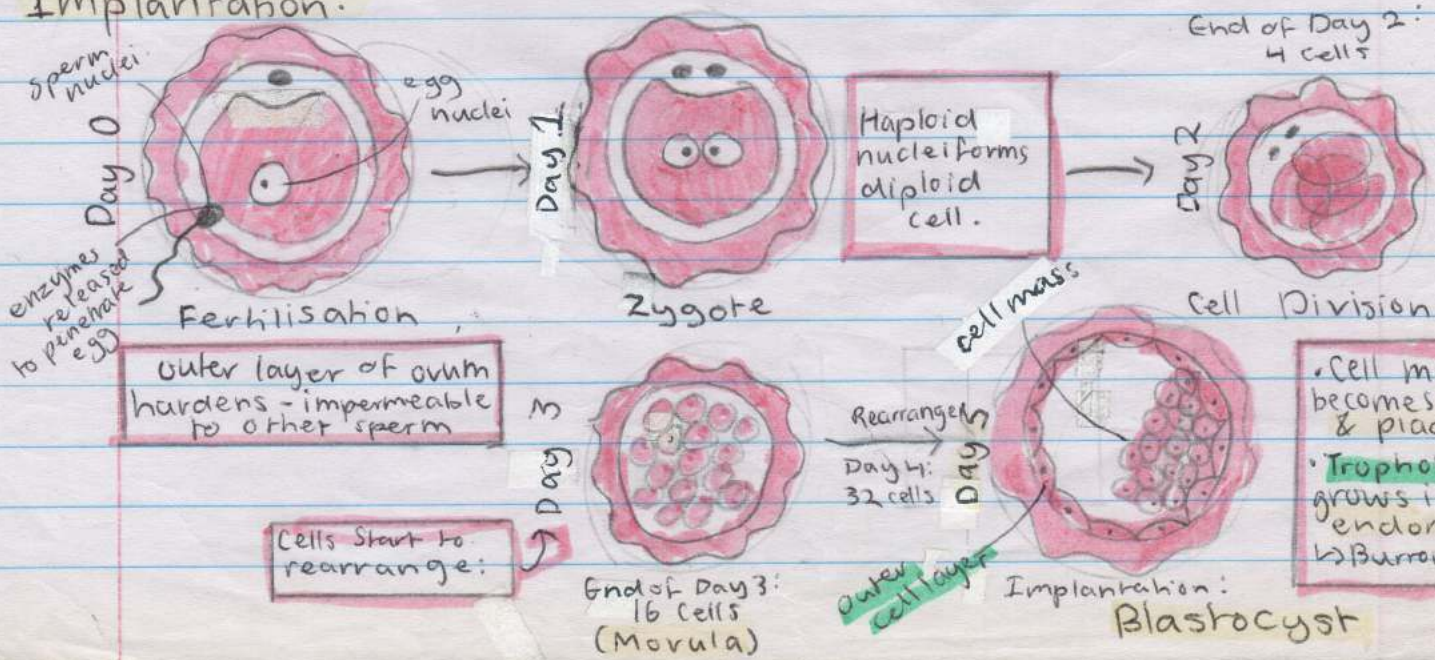
→ Stimulus is recognised and the exacerbates the effects of the small disturbance (stimulus).



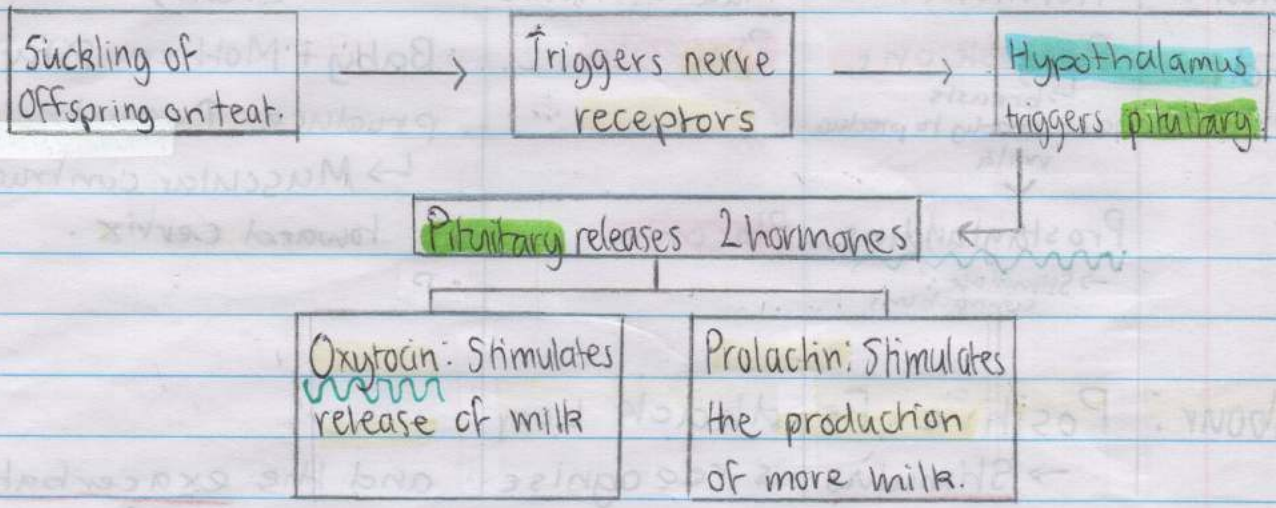
Oestrus
Sexual behaviours that increase around time of ovulation.

Mammals excluding higher primates:
Female species that display oestrus reabsorb the endometrium if fertilisation does not occur.

Implantation:



Lactation:



Hermaphrodites:

- Have both female and male sex organs.
- Animals who live solitary lives/don't encounter opposite sex.

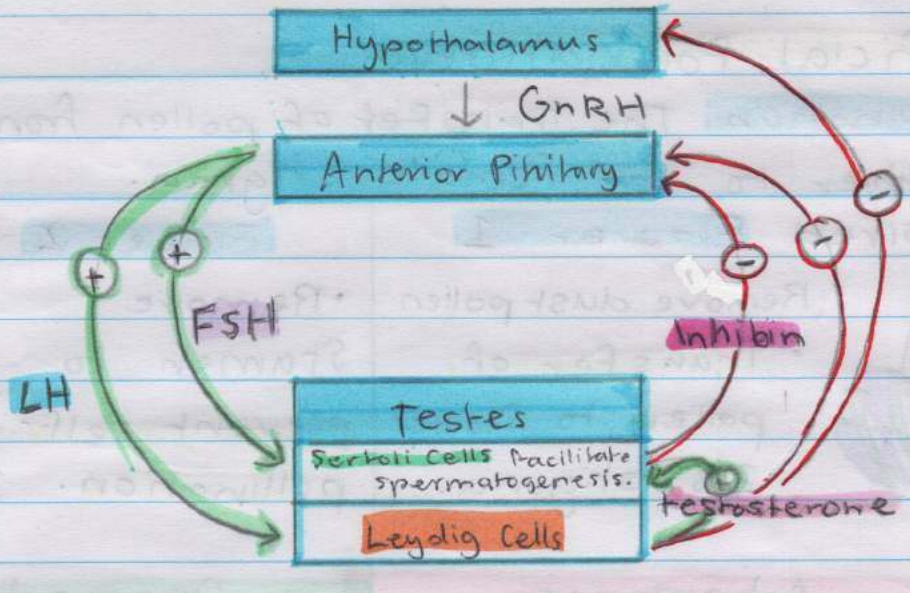
Example: Flatworms who have both sex organs:

- Mating ritual 'Penis fencing'
- Determines Mother / Father
  - More energy/resources ↩
  - ↳ No responsibility.

Clownfish:

- Colony → 1 largest female & 1 dominant male
- Sequential hermaphroditism
  - ↳ Change sex if female dies (event)

Male Reproductive Cycle:



	Hormone	Function
GnRH	Follicle Stimulating Hormone (FSH)	Stimulates the production of a protein by Sertoli cells to maintain testosterone production.
GnRH	Lutenising Hormone	Stimulates Leydig Cells to produce testosterone.
	Testosterone	Send signals to Sertoli cells to facilitate spermatogenesis. Inhibits secretion of LH + FSH.
	Inhibin - Sertoli Cells	When sperm count is too high inhibin is produced, lowering FSH + LH levels.

Negative Feedback Revision:

- Continuous Loop
- Responds to change (stimulus)
- Decreases initial stimulus
- Hormones must be in balance
- Homeostasis

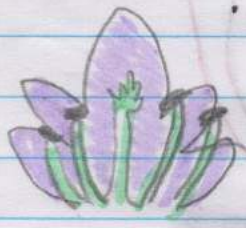
5.1.3

Agricultural Reproductive Technologies

Artificial Pollination:

Pollination: The transfer of pollen from the male anther to the female stigma.

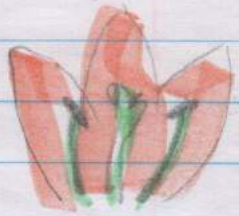
Desired Flower 1



- Remove dust pollen
- Transfer of pollen to flower 2's stigma.

Flower 2

- Remove Stamen to prevent self-pollination.



Advantages	Disadvantages
• Pollinate Flowers (2) with pollen from plants with desireable traits such as: colour, size, yield • Useful, easy, cheap.	• No gurantee for traits. • Reduced genetic variation. ↳ Environmental change. • Time consuming.

Example: **Orchids**

- As a result of A.P → over 70000 hybrids

Vanilla

- Only 1 species of bee in Mexico can fertilise.
  ↳ Overcome this through A.P + increase yield.

Artificial Insemination:

Sperm from a selected male with desirable traits is **artificially transferred to a female.**

↳ Cows, sheep (production of meat, wool), endangered species.

Advantages	Disadvantages
• Inseminate large nos. of females. • Transport semen + storage.	• No gurantee • Reduced genetic variation

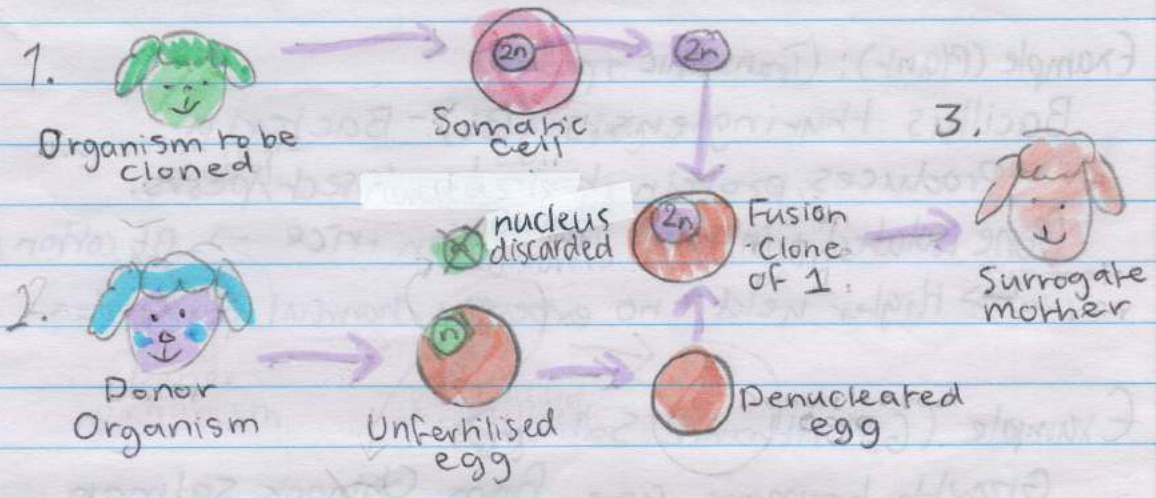
Selective Breeding: Male introduced to flock of females.

Cloning:

Process by which genetically identical copies of an organism is made.
↳ Mostly used in plant/fruit agriculture.

Advantages	Disadvantages
• Cloned plants have identical requirements and grows/yields similarly. • Guaranteed to express desired traits.	• Disease susceptibility • expensive, limited advantages. • Ethicality.

• example



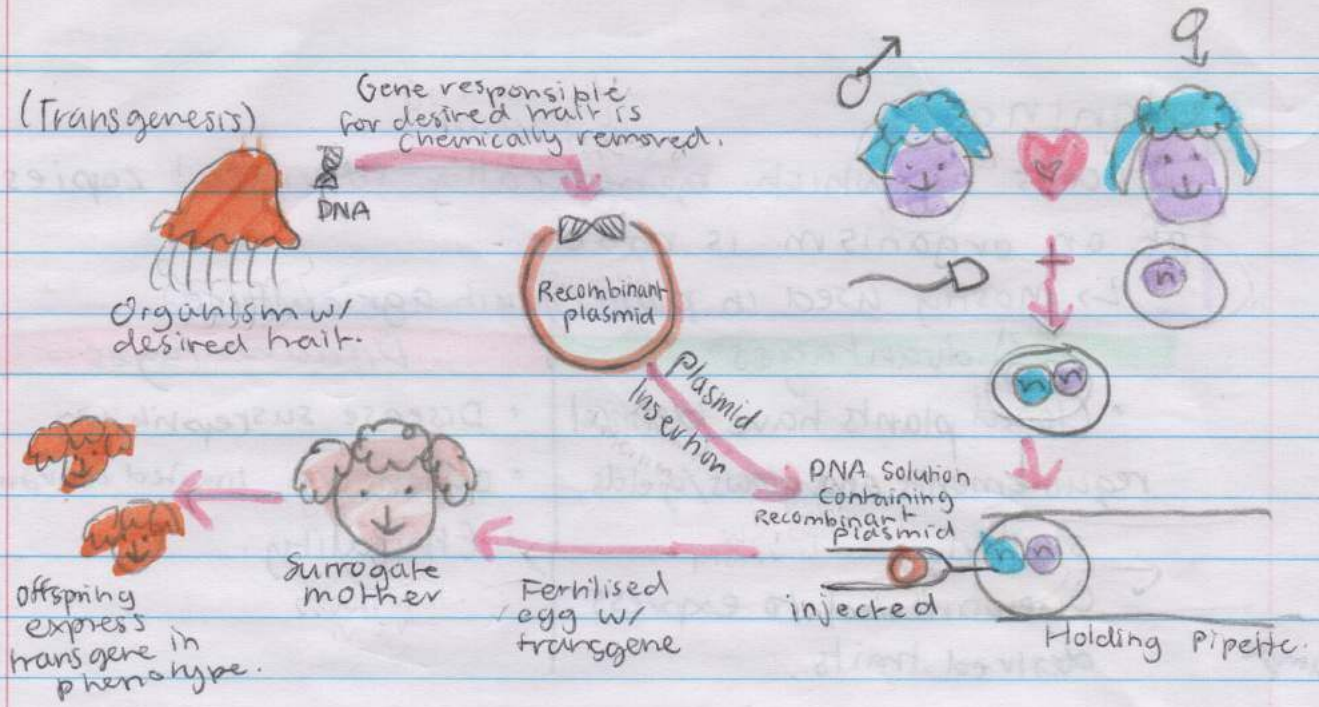
Transgenesis:

Process by which a gene is removed from one species into the genome of another species.

• Initial increase in genetic variation. Cloning of Transgenic organism leads to reduced genetic variation.

Advantages	Disadvantages
• Guaranteed to express desired traits. • Increased yield + nutritional val. • Reduced use of harmful chemicals such as insect killers	• Disease susceptibility • Reduced genetic variation • Trade issues w/ non-GMO* countries • Long term effects on human health unknown

* GMO - Genetically Modified Organisms



Example (Plant): (Transgenic species)

Bacillus thuringiensis (Bt) - Bacteria

- Produces protein toxic to insect/pests.

Gene isolated + inserted into cotton + rice → Bt cotton/rice.

↳ Higher yield + no expensive/harmful pesticides.

Example (GM Atlantic Salmon)

Growth hormone gene from Chinook salmon.

Gene that switches on the growth hormon from ocean pout.

↳ Grow all year round + 11x faster, higher yield.

Impact of scientific knowledge:

- Accumulated through rigorous/independent testing.
- Contributions of:
  - Chargaff (A-T; G-C)
  - Watson and Crick (DNA structure)
- All organisms have the same basic building blocks: DNA.

Continuity of Species

Reproduction: Produces new individuals.
↳ If no reproduction: - extinction
↳ disease + environmental change
- No variation, no yield

Asexual: High yield of offspring in stable environments.
Sexual: Variation, evolution, survival of env. change. disease.
↳ Favourable traits to subsequent generations.

Note: Agricultural practices → can negatively impact.

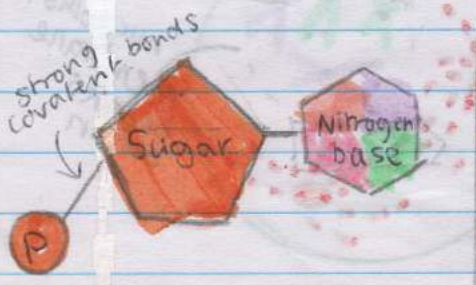
How important is it for genetic material to be replicated exactly?

5.2.1 Processes of Cell Replication

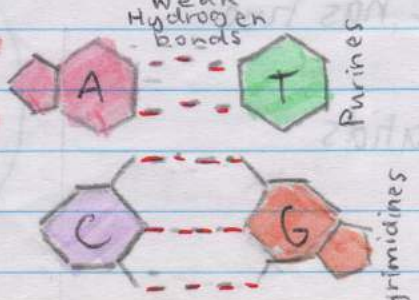
Models in science: Simplified representation of a complex system/concept.

Advantages	Disadvantages
· Predictive power	· Not accurate
· Increased understanding	· Over simplification → misled.
· Future research	· Lack of detail.

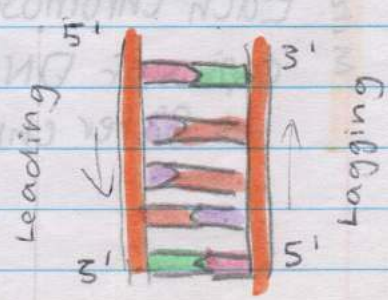
Watson & Crick DNA model (1953):
DNA is a double-stranded helical molecule.
- Two sugar-phosphate backbones
- Pairs of Nitrogenous bases held by hydrogen bonds.



Nucleotide



Pairings



DNA is antiparallel

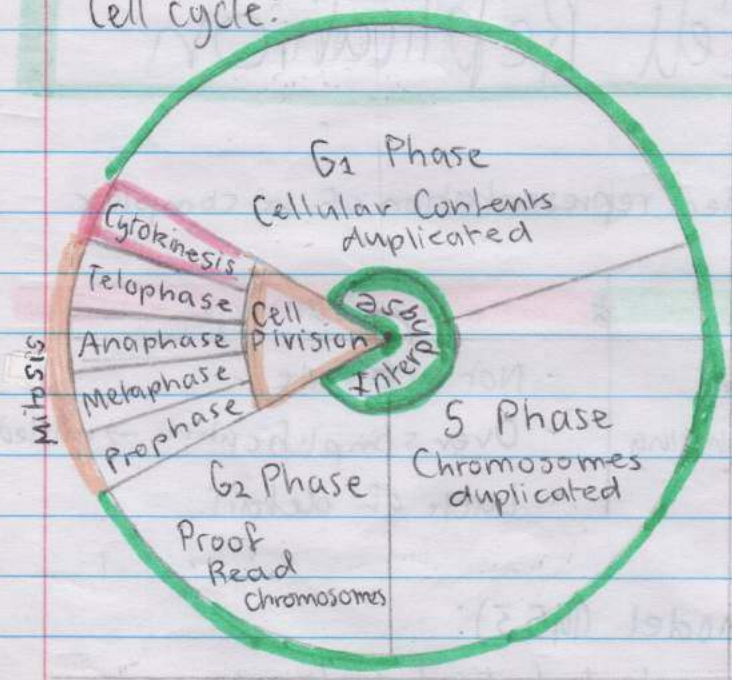
Mitosis

Plays an important role in:

- Growth → Cell assimilation, enlargement, differentiation.
- Repair/Replacement of damaged tissue/worn-out cells
- Asexual Reproduction
- Genetic stability → Precise & equal distribution of chromosomes (same number/genetic information)

Embryonic Cell	Adult Stem Cell
• divide repeatedly	• Pre-specialised
• pluripotent (any tissue)	• Multipotent
• Tissue regeneration	• Cells of one tissue type.
• Comes from egg/zygote.	

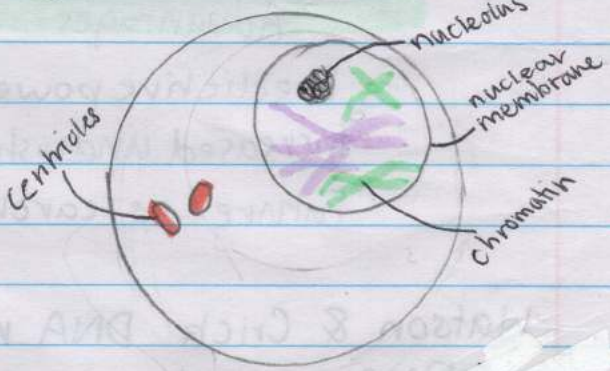
Cell cycle:



Interphase:

Chromatin duplicates

DNA replicates and are joined by a centromere.



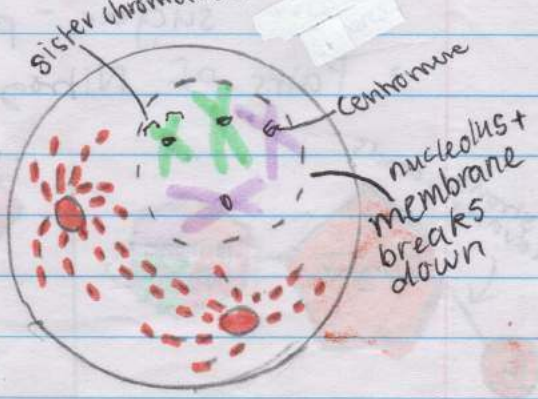
Mitosis

Prophase:

Chromatin shorten/thickens

Each chromosome has two copies of DNA

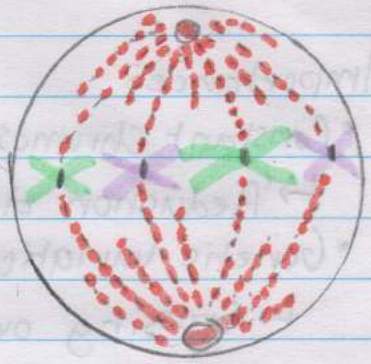
↳ Sister chromatids



Mitosis

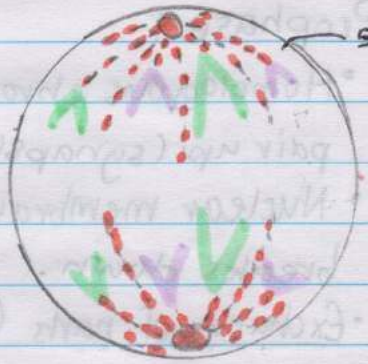
Metaphase:

Chromosomes align along the equator of the cell.
Attach to spindle fibre by centromere.
Split longitudinally.



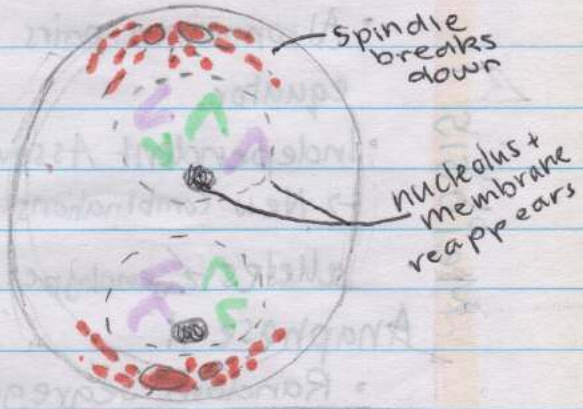
Anophase:

Centromere separates sister chromatids → chromosomes.
Chromosomes pulled to opposite ends. (Spindle contracts).



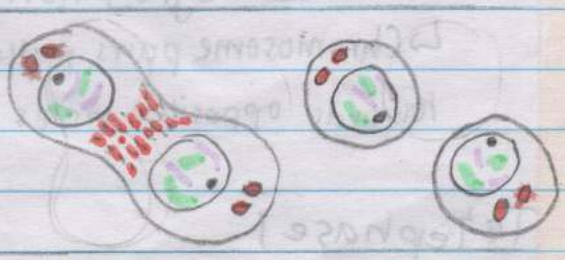
Telophase:

Spindle breaks down.
Nuclear membrane/nucleolus reappears.

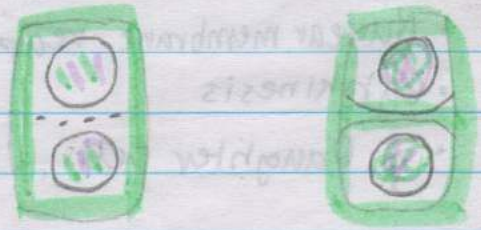


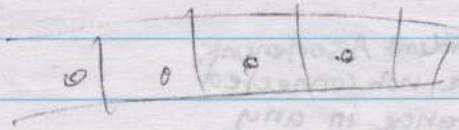
Cytokinesis (Division of cytopla)

Animal: Constricts in centre.
Pinches off



Plant: Cell plate forms during telophase
↳ Using spindle fibres.
Cell wall forms.



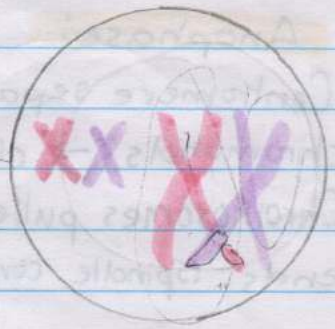


Meiosis

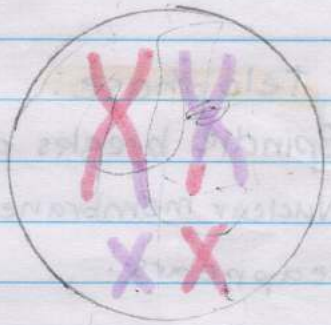
Importance:
- Constant chromosome number from gen to gen.
  - ↳ 'Reduction division' 46 → 23
- Genetic variation
  - ↳ Crossing over + independent assortment

Meiosis I

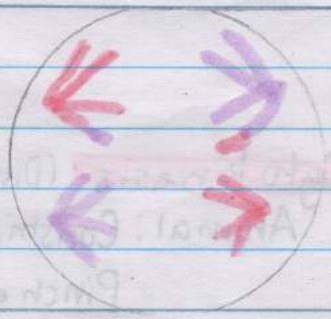
Prophase I
- Homologous chromosomes pair up (synapsis)
- Nuclear membrane + nucleolus breaks down.
- Exchange of parts (Crossing Over)



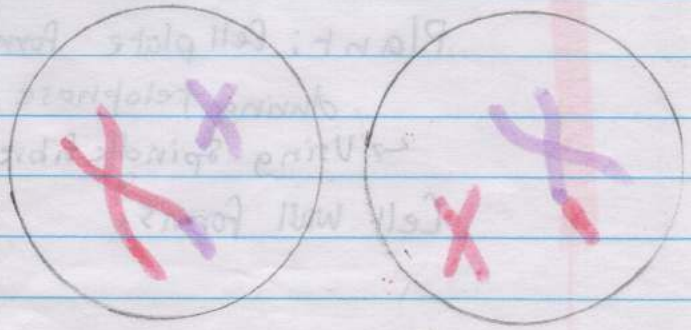
Metaphase I
- Chromosome pairs align at the equator.
- Independent Assortment:
  - ↳ New combinations of chromosomes/alleles/genotypes.



Anaphase I
- Random Segregation:
  - ↳ Chromosome pairs pulled towards opposite poles.



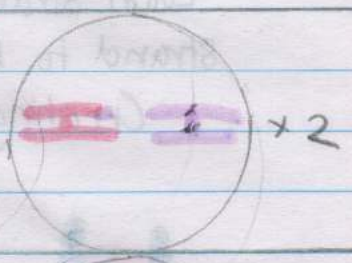
Telophase I
- Nuclear membrane reappears
- Cytokinesis
- 2 Daughter cells



Independent Assortment:
Pairs are not connected
can arrange in any way/independently
↳ combinations of pat/mat alignment.

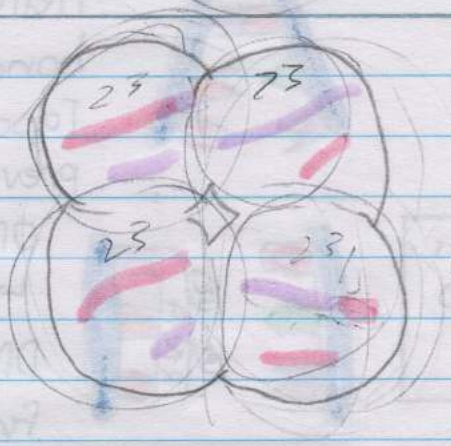
Prophase II
- Nuclear membrane + nucleolus gone
- Spindle fibre formation.

Metaphase II
- Chromosomes arrange along equator.



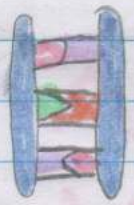
Anaphase II
- Separated sister chromatids move to opposite poles

Telophase II
- Nucleolus + Nuclear membrane here
- Spindle apparatus dissociates
- Cytokinesis
  ↳ 4 daughter cells

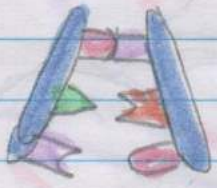


DNA Replication

Double-stranded nature makes copying possible:
↳ Each strand is a template for the 'new' complementary strand to be made.
- Creating a new DNA molecule.

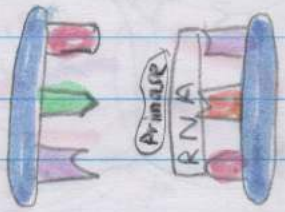


Sphase (DNA Synthesis):
Helicase unwinds DNA

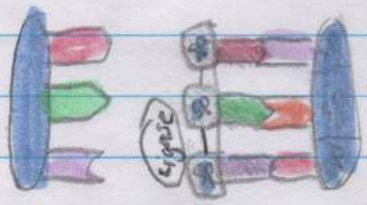


Helicase breaks apart weak Hydrogen bonds.
Topoisomerase binds to DNA and prevents coiling.

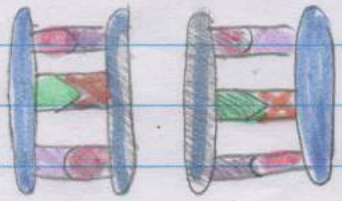
Nucleotides float freely in the nucleus



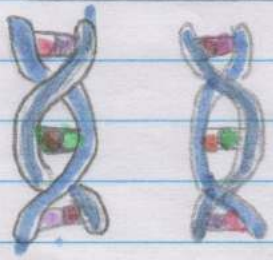
DNA Primase forms an RNA primer.
↳ Starting point for DNA polymerase.
DNA Polymerase starts attaching nucleotides from RNA primer



Ligase glues Phosphate and sugar together.



DNA Polymerase builds new strand from 5' to 3'. (Leading Strand)
Lagging Strand is the 3' to 5' strand.
Ligase fills the gaps on lagging Strand.



Replication is semi-conservative.
1 old/original is conserved 1 new.
DNA Polymerase proof-reads and corrects DNA base pair errors.

Importance of Fidelity of Replication: (accurate/precision)
- Hereditary: Genetic Material carried on to subsequent generations.
- Gene Expression: Correct function, codes for proteins.

5.2.2 Effect of Cell Replication on Continuity of Species

Mitosis

- Exact Replication
- 2 daughter cells
- All somatic cells
  - ↳ All over the body

Meiosis

- Crossing Over
- Independent assortment
- Random segregation.
- ½ original chromosome number
- 4 daughter cells
- Only in sexual organs

Effect

Individuals

- Grow
- Repair damaged tissue + cells
- Genetic Stability (maintain)
- Normal functioning

Overall survival

Species

- Asexual production.

- Right amount of chromosomes
  - ↳ Fertilisation
- Overcome changes in external environment → natural selection
  - ↳ survival + continuity

Negative Repurcussions

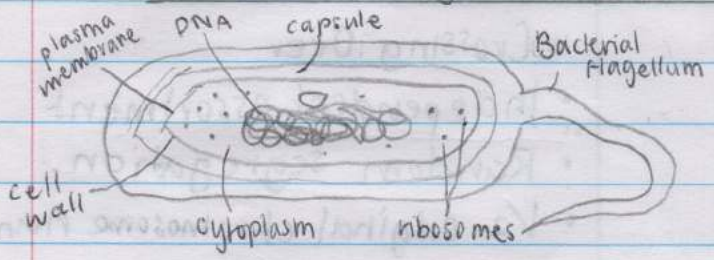
- Incorrect DNA replication
  - ↳ Faulty genes
  - ↳ Growth/spread of cancer cells
  - ↳ Mutations
  - ↳ Proteins → coordinate bodily functions + survival.
- Positive mutations may benefit.

- Missing/Extra chromosomes
  - ↳ Genetic disorders inhibit individuals survival
- Passed onto subsequent generations.

Why is polypeptide synthesis important?

5.3.1 DNA in Prokaryotes and Eukaryotes

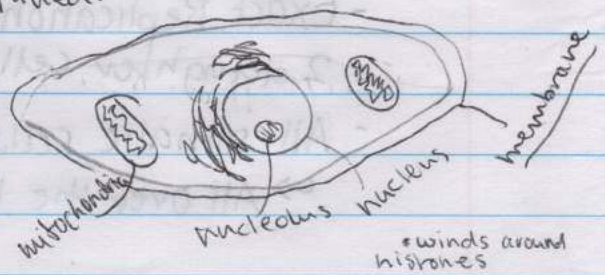
Prokaryotes



- Supercoiled and looped around a scaffold.
- Single circular chromosome
- No introns (non-coding DNA) Only exons (genes that code proteins)

Eukaryotes

simplified.



- Multiple, linear chromosomes found in the nucleus.
- Contain introns (interrupt sequence)
  - non coding regions

Non-Chromosomal DNA

Plasmids

- Small rings, no introns
- Selective advantages - resistance to antibiotics
- Replicate independently.
- no introns

Mitochondrial (mtDNA)

- Small circular molecule
- Replicate independently.
- produces its own proteins for functioning. - no introns

Chloroplast DNA (cpDNA)

- double stranded circular molecule
- no introns

★ genetic code is universal
↳ Same nucleotides coding for same 20 amino acids with specific 3 letter codon during polypeptide synthesis that can be recognised by every organism.

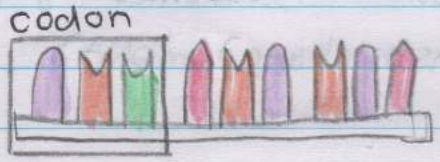
↳ This allows genetically modified organisms to work.

5.3.2

Polypeptide Synthesis.

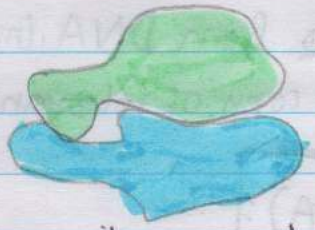
RNA - ribose sugar
DNA - deoxyribose sugar

mRNA



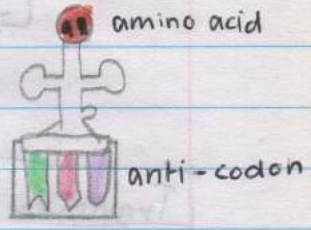
messenger

rRNA



ribosomal

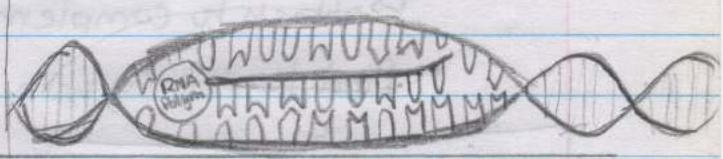
tRNA



transfer

Nucleus — transcription

Section of gene identified for copying.
RNA Polymerase • Unzips
• Builds nucleotides (mRNA)

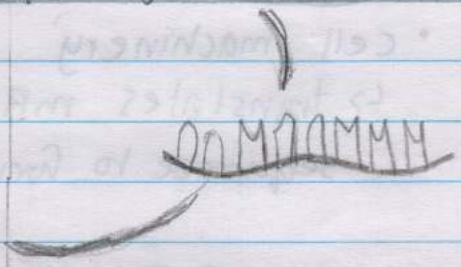


Complementary bases copied except thymine is now uracil.

Only a section of DNA is copied.
↳ Gene that codes for protein.

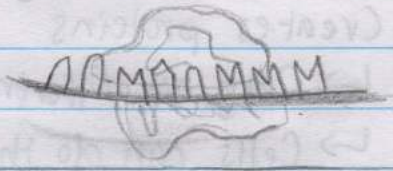
mRNA mores out of pore in nucleus.

Start + Stop codons.

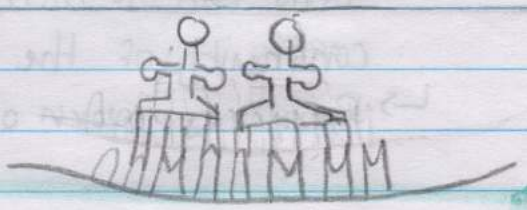


Cytoplasm — translation

rRNA reads codons and identifies matching tRNA.

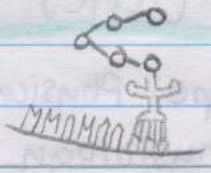


tRNA has anticodon - matches.
Carries Amino Acid
↳ Line up in sequence



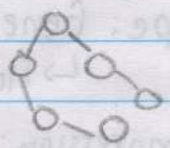
Pephide bonds form AA-AA

tRNA leaves



Amino Acid Chain Stays
↳ Until Stop Codon

Polypephide folds
• Protein.



Messenger RNA (mRNA)

- Intermediate molecule
  - ↳ Carries info from DNA (nucleus) → Binds to Ribosomes (cytoplas)
    (transcribed copy of relevant instructions from DNA)

Transfer RNA (tRNA):

- 3 unpaired bases (anticodon)
  - ↳ attach to complementary codon (mRNA)
- Bind temporarily with amino acid based on anticodon.

Ribosomal RNA (rRNA):

- cell 'machinery'
  - ↳ translates mRNA into correct amino acid sequence to form a polypeptide/protein.

Importance of Polypeptide Synthesis

- Creates proteins
  - ↳ Carry out different functions in our bodies
  - ↳ Cells can do their job in order to ensure continuity of the individual.
  - ↳ Replaces worn out proteins

5.3.2.4 How Genes + Environment Affect Phenotype

Phenotype: Physical appearance, structure, behaviour and physiology of an organism. (contributes to / produces)

Genotype: Genetic makeup of an individual
  - ↳ Homozygous dominant/recessive or heterozygous

Gene Expression: Process by which information is used in the synthesis of a functional gene product (protein).

Epigenetics on and off gene.

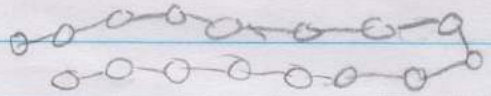
5.3.3 Structure & Function of Proteins

Structure:

- long chains of amino acids → polypeptides
- folded specifically
- Carbon, Hydrogen, Oxygen, Nitrogen
  - ↳ Form amino acids → 20
- Held together by Peptide bonds

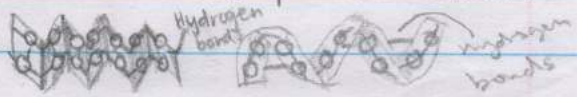
1. Primary Structure

- Basic linear chain structure



2. Secondary Structure

- three-dimensional arrangement
- Hydrogen bonds
  - ↳ Twist into spiral (alpha helix)
  - ↳ Fold into pleated sheet.

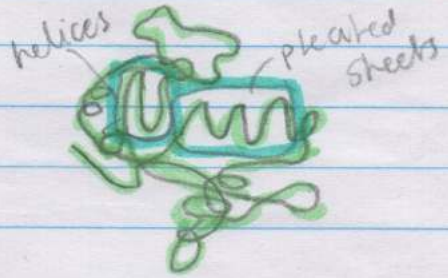


4. Quanternary Structure

- 2 or more peptide chains

3. Tertiary Structure.

- Force of Attraction between helices & pleated sheets
- More complex 3d shape



Function:

- Proteins are reusable and reactions with binding molecules are reversible.

Structural e.g collagen, elastin, keratin

- Fibrous and stringy
- Found in connective tissues: skin, cartilage, bone, tendons, ligaments.
  - Shells in invertebrates
  - Hair, nails and hooves in vertebrates.
- Maintain cell shape

Movement e.g Actin, Myosin

- Allow muscle to contract
- Found in Microfilaments in cells → contraction of cytoplas
  - ↳ Pinch off during cell division
  - ↳ Crawling movement of prokts.

Enzymes e.g **lactase** • metabolic functioning

- Catalyse chemical reactions in cells.
- Enzyme active site is specific $\xrightarrow{\text{shape}}$ ability to function.

Signalling/Communication e.g insulin, membrane proteins

- Regulate interaction with external environment of cells
  - ↳ Intake/output of molecules
- Hormone insulin regulates blood-glucose.
- Growth Hormone promotes growth + metabolic functions.
  - ↳ Triggers responses in target cells functioning

Defensive: Antibodies/immunoglobins (antigens)

- Recognise foreign invaders → bind → signal other cells.

Histones

Stores

Transport + Storage e.g Haemoglobin, Ferritin (iron), casein (amino acids)

- Bind to ligands and release when/where needed.
- Haemoglobin has an affinity for oxygen
  - ↳ When high, binds.
  - ↳ When low loses affinity and release.
  - ↳ Change shape - adapts to do its job/function.

Sensory e.g opsins

- Change shape or biochemical activity in response to stimuli
- Opsins proteins in the retina.
  - ↳ light absorbed → change in molecular arrangement.
  - ↳ Trigger a series of reactions.

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

5.4.1

Variations in Genotype in Offspring

Meiosis

Mendel's laws of genetics / inheritance:

1. Dominance: hybrid offspring will only inherit the dominant trait in phenotype.
2. Segregation: The segregation of allele pairs during meiosis. (re-united during fertilisation - one allele from each parent.)
3. Independent Assortment: Alleles for each different trait seperate independently

Fertilisation:

Random fusion of two gametes.

- Unisexual animals produce more variability than hermaphrodites
- Cross-fertilisation produces more variability than self-fertilisation.

Mutations:

Occur in S phase (DNA replication)

5.4.2 Formation of New Combinations of Genotypes

Autosomal Inheritance

- non-sex chromosomes
- Dominant autosomal inheritance
  - ↳ single copy of allele is enough for gene to be expressed.
- Homozygous e.g FF
- Heterozygous e.g Ff
- Autosomal recessive inheritance
  - ↳ two copies of the recessive alleles is needed.

	B	b
B	BB	Bb
b	Bb	bb

3:1

	b	b
B	Bb	Bb
B	Bb	Bb

4:0

Sex-Linked Inheritance

- sex chromosomes
- inheretid in different ratios.
  - ↳ more frequent in men as they do not have the ability to be a carrier
- can be dominant/recessive

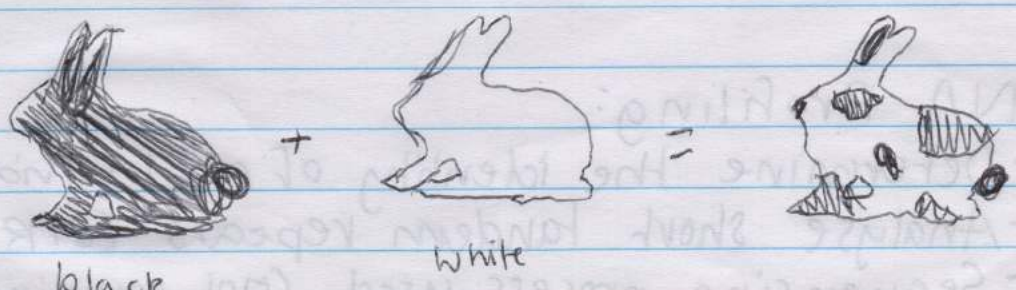
	X^B	X^B
X^b	X^BX^b	X^BX^b
Y	X^BY	X^BY

Incomplete Dominance

- Blend of phenotypes of either type of homozygote.

Codominance

- Both alleles are expressed separately.



Can polygenic patterns be predicted w accuracy?

5.5.1 Technology determining Inheritance Patterns.

DNA Sequencing:

(PCR) Polymerase Chain Reaction
- used to amplify a 'target DNA'
- Compare DNA to other samples through gel electrophoresis.

Gel Electrophoresis.
- Separates molecules based on size and electric charge.
- Gel matrix acts as a sieve
  - ↳ -tively charged particles move toward positive electrode.
  - ↳ Small molecules move further + easier.

Process of PCR
- Denaturation - DNA heated to separate it at 95°C.
- Annealing - DNA primer attaches to the 3' ends of target sequence. (55°C)
- Elongation - Heat-tolerant DNA Polymerase copies DNA strand at 72°C.

Sequencing Process:
DNA Extraction → PCR → electrophoresis → Computer Scanning
(restriction enzyme)

DNA Profiling:
- Determine the identity of an individual.
- Analyse short tandem repeats (STR's)
- Sequencing process used (not scanning)