Contents

Monomers & Polymers

- Carbohydrates
- Lipids
- Proteins
- Enzymes
- DNA & RNA Structure
- DNA & RNA Replication
- ATP
- Water
- Inorganic ions
- Food Tests

Cells 3.2

- Eukaryotic Cells
- Organelles
- Studying Cells
- Cell Cycle
- Cell membranes
- Immune System + Responses
- HIV
- Monoclonal Antibodies

Exchange + Transport systems

- Heat exchange
- Gas exchange in plants
- Xerophytes
- Gas Exchange in Insects
- Gas exchange in Fish
- Gas exchange in Humans
- Ventilation
- Digestion
- Haemoglobin
- Circulatory system
- Cardiovascular disease
- Xylem
- Phloem
- Mass Flow Hypothesis

Genetic Variation and Information

Monomers & Polymers

Key Terms

- Monomer - A small basic molecular unit i.e.Amino Acid & Monosaccharides
- Polymer - A large complex molecule made of Monomer chains
- Monosaccharides - Carbohydrate Monomer - Fructose or Glucose
- Disaccharides - Molecule made of 2 monosaccharides - Sucrose, Maltose
- Polysaccharides - Carbohydrate formed from 3 + monosaccharides
- Nucleotides - Polynucleotide monomer - Eg Thymine in DNA
- Polynucleotides - Long strand of nucleotides - make up DNA double helix
- Amino Acid - Protein Monomer
- Polypeptide - Molecule made of 2+ amino acids
- Reducing Sugar - Most monosaccharides + some disaccharides - Reduces the ions in Benedict's solution
- Non-Reducing Sugar - Monosaccharides + Disaccharides - do not reduce Benedict's solution
- Hydrolysis Reaction - Reaction uses water molecules to break bonds between molecules.
- Condensation Reaction - Reaction forms bonds between molecules - looses water.

Monomers & Polymers

Key Terms

- Hydrophilic - Attraction to water - Glycerol and Phosphate group molecules in Lipids
- Hydrophobic - Repulsion of water - Fatty acids in lipids
- Saturated Fatty acid - Hydrocarbon chain with no double carbon bonds - Saturated in Hydrogen atoms - straight chain
- Unsaturated Fatty acid - Hydrocarbon chain with double carbon bonds - not 2 hydrogen to every carbon - kinked chain
- Ester bond - The chemical bond which joins a Glycerol molecule to fatty acids - Lipids
- Glycosidic Bond - The chemical bond which joins monosaccharides together - Carbohydrates
- Peptide Bond - The chemical bond which joins amino acids together - Proteins
- Microfibrils - Fibres formed by Hydrogen bonds - give cellulose its rigidity
- Triglyceride - Lipid with 1 Glycerol and 3 Fatty acid molecules
- Phospholipid - Lipid with 1 Glycerol, 2 fatty acid molecules and 1 Phosphate group
- Fatty acid - Hydrocarbon tail which is chemically bonded to a Glycerol molecules in Lipids

Monomers & Polymers

Key Terms

- Solvent - How water surrounds an ionic substance, pulling out ions - causing substance to dissolve.
- Latent heat of vaporisation - The point at which a liquid is turned into a gas. H_2O - relatively high - H Bonds absorb lots of energy before breaking + allowing water to break.
- Specific heat capacity - When a substance can absorb a lot of energy before H Bonds are broken - absorbs heat to cool organisms down.
- Cohesive - H Bonds cause H_2O molecules to stick together.
- Inorganic ion - Ions which do not contain Carbon

Carbohydrates

Reactions

2x Monosaccharides:
- Glucose
- Galactose
- Fructose

Glycosidic bond formed

Condensation Reaction

H_2O Lost

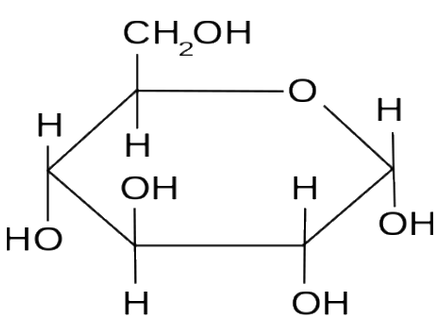
Glycosidic bond Broken

Hydrolysis Reaction

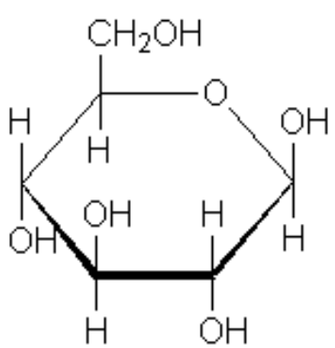
H_2O Used / Gained

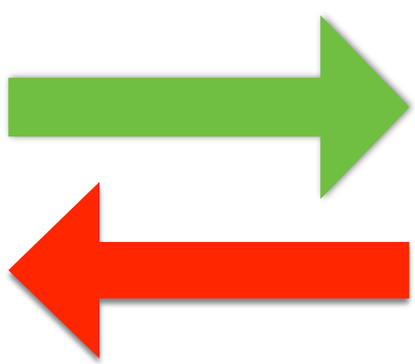
Disaccharides:
- Sucrose
- Lactose
- Maltose

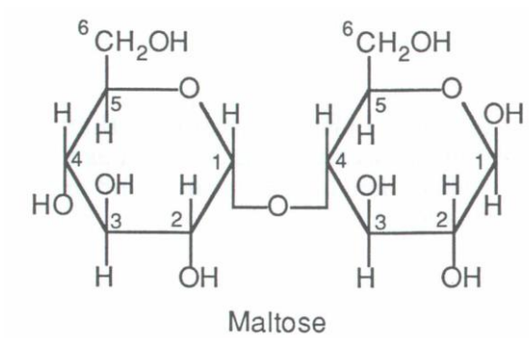
Alpha Glucose



Beta Glucose

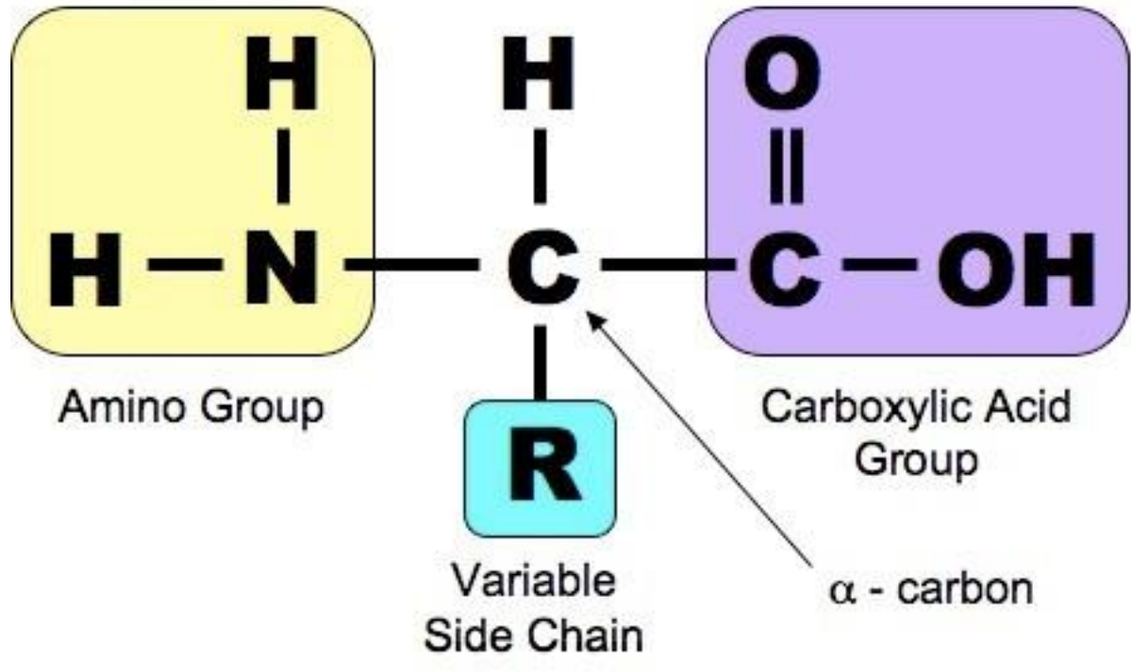






Proteins

- Amino Acids are protein monomers.
  - Dipeptides - 2 amino acids joined by a peptide bond.
  - Polypeptide - 3+ amino acids joined by peptide bonds.
- Proteins are 1+ polypeptide chains



- All living things share the same 22 Amino acids
  - Difference is what makes the carbon-based variable side chain

DNA and RNA

Discovery of DNA

- DNA - 1800's regarded as too simple for Genetic information
  - Chemically complex & different proteins through to carry genetic information

- 1953 - DNA discovered to carry all genetic information

- 1953 - DNA double helix discovered by Crick & Watson

DNA and RNA

DNA replication

1. DNA Helicase (enzyme) breaks hydrogen bonds between polynucleotide chains

   - DNA unzips itself - separate strands formed

2. Exposed polynucleotide strands act as template for new strands.

   - Complementary base pairing - free floating nucleotides are attracted to exposed complementary bases.

   - 2 new identical strands are formed.

3. 2 DNA polymerase (enzymes) move up + down the antiparallel strands

   - Polymerase - catalyses condensation reaction between nucleotide bases

   - Joins bases

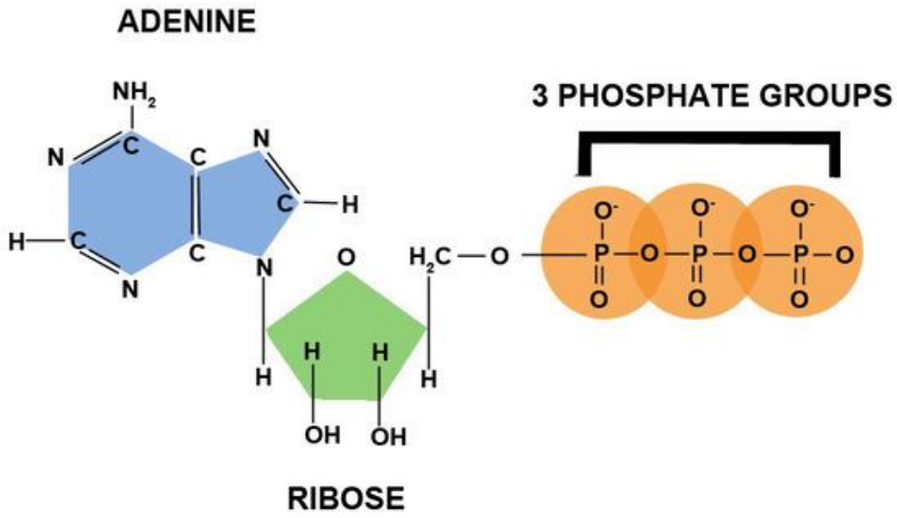
   - Sugar-Phosphate backbone formed

   - 2 DNA strands formed - 1 Original DNA strand & 1 New DNA strand

ATP

General

- Adenosine Triphosphate
- The molecules used to provide energy in all living processes
  - DNA replication
  - Active transport
  - Cell division
  - Protein synthesis



- Ribose Sugar
- Adenine nitrogenous base
- 3 Phosphate groups

- Made of glucose molecules - Glucose molecules cannot directly provide energy to organisms - has to be made into ATP.
  - Energy from glucose made used to make ATP

Water

Properties

Metabolite

- Involved in metabolic reactions including condensation.
  - Condensation & Hydrolysis reactions
  - Hydrolysis reactions require a water molecule to break chemical bonds
- Condensation reactions release a H_2O molecule

- Formation of polypeptide chains from amino acids - Condensations
- Hydrolysis of lactose into glucose + galactose - Hydrolysis

Solvent

- Polarity of water - dissolves ionic lattices + molecules
  - Pulls ions out of lattice
- Metabolic reactions take place in solution
  - Cytoplasm
  - Water is essential for reactions to occur.

- Ions are surrounded by oppositely charged water molecules
  - Totally surrounded 'Dissolved'
- Allows useful substances can be dissolved in water
  - Transported around body.

Cells - 3.2

Cells

Key definitions

- Interphase - Growth and protein synthesis stage of cell cycle
- Mitosis - Cell division stage of cell cycle
- Daughter cell - Genetically identical cell to parent cell
- Chromatids - Condensed chromosomes - strand of X-structure
- Centromere - Region of chromosomes which are attached to spindle fibres
- Binary Fission - The replication of prokaryotic cells
- Viral replication - The replication of viruses using host cells.
- Complementary receptor proteins - Where attachment proteins on viruses only bind to complementary receptor proteins on host cells
- Plasmid - Unattached sections of genes - carry genetic information i.e Antibiotic resistance.
- Cell surface membrane - The membrane which surrounds cells or organelles Regulates the movement of substances in and out of cell
- Partially Permeable - Allows some molecules through whilst preventing others - small molecules diffuse through large molecules require transport proteins
- Phospholipid Bilayer - Made of 2 phospholipid chains - hydrophobic and hydrophilic regions
- Glycoprotein - Protein with a carbohydrate chain attached
- Glycolipid - Lipid with a carbohydrate chain attached
- Cholesterol - Lipid present in cell membranes between phospholipids - increase rigidity and decreases permeability

Cell Replication

Cancer

- Mitosis = Controlled cell division
  - Controlled by genes
- Cancer = Uncontrolled cell division

- Cancer - tumour which invades surround tissue
  - Tumours formed by continuous cell division.

- Treatments — disrupting cell cycle
  - Kill cell tumours & also healthy cells
  - Target growth stage - preventing nucleotide synthesis
  - Target Synthesis stage - Damages DNA - causes cell to kill damaged DNA & cell

Cell Membranes

Phospholipids & Cholesterol

Phospholipids

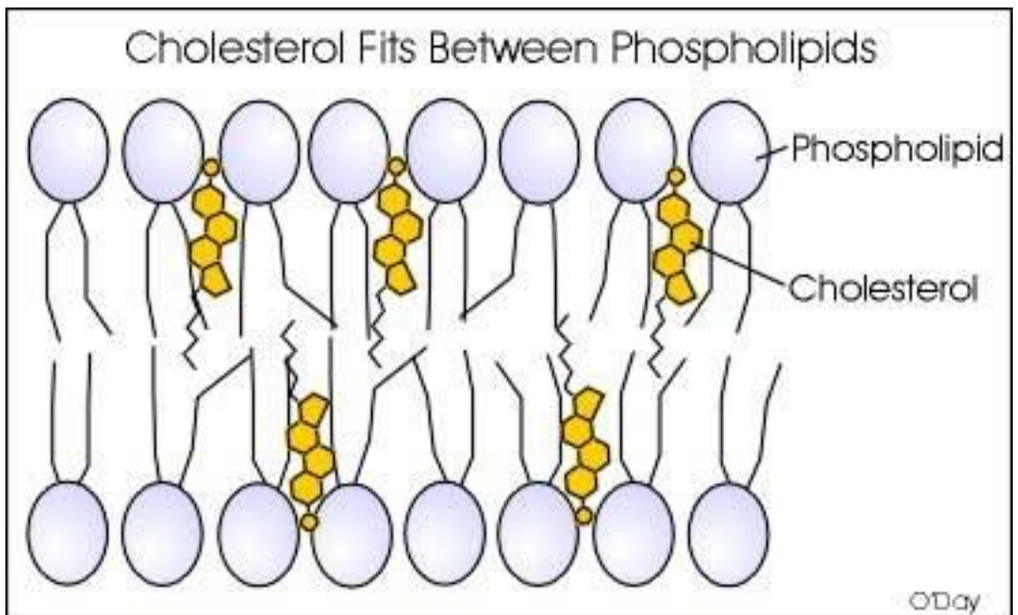
- Acts as a barrier to dissolved substances
  - Hydrophobic Tail - Repels water - prevents solutions from passing into cell
  - Hydrophilic Head - Attracts water - cause phospholipid bilayer to arrange as such

- Centre of bilayer = Hydrophobic - solutions and solutes cannot diffuse through
  - Small molecules can pass through bilayer
    - Phospholipids molecules are not bonded together - gaps between molecules

Cholesterol

- Fits between phospholipid molecules
  - Binds to phospholipid tail
  - Restricts movement

- Increase rigidity - Structural support
  - Reduces permeability - prevents diffusion of molecules
  - Maintains shape of animal cells



Cell Membranes

Factors effecting diffusion

- Concentration Gradient - Higher the concentration gradient = Faster diffusion.
  - Concentration gradient decreases until equilibrium is reached
  - Diffusion decreases (slows down) over time until equilibrium

- Thickness of Surface - Thinner exchange surface = Faster diffusion
  - Molecules have a shorter distance to diffuse through

- Surface Area - Larger surface area = Faster diffusion
  - More possible points of diffusion

I.E - Microvilli - adapted for dissuasion - Thin, large surface area

Cell Membranes

Factors effecting Osmosis

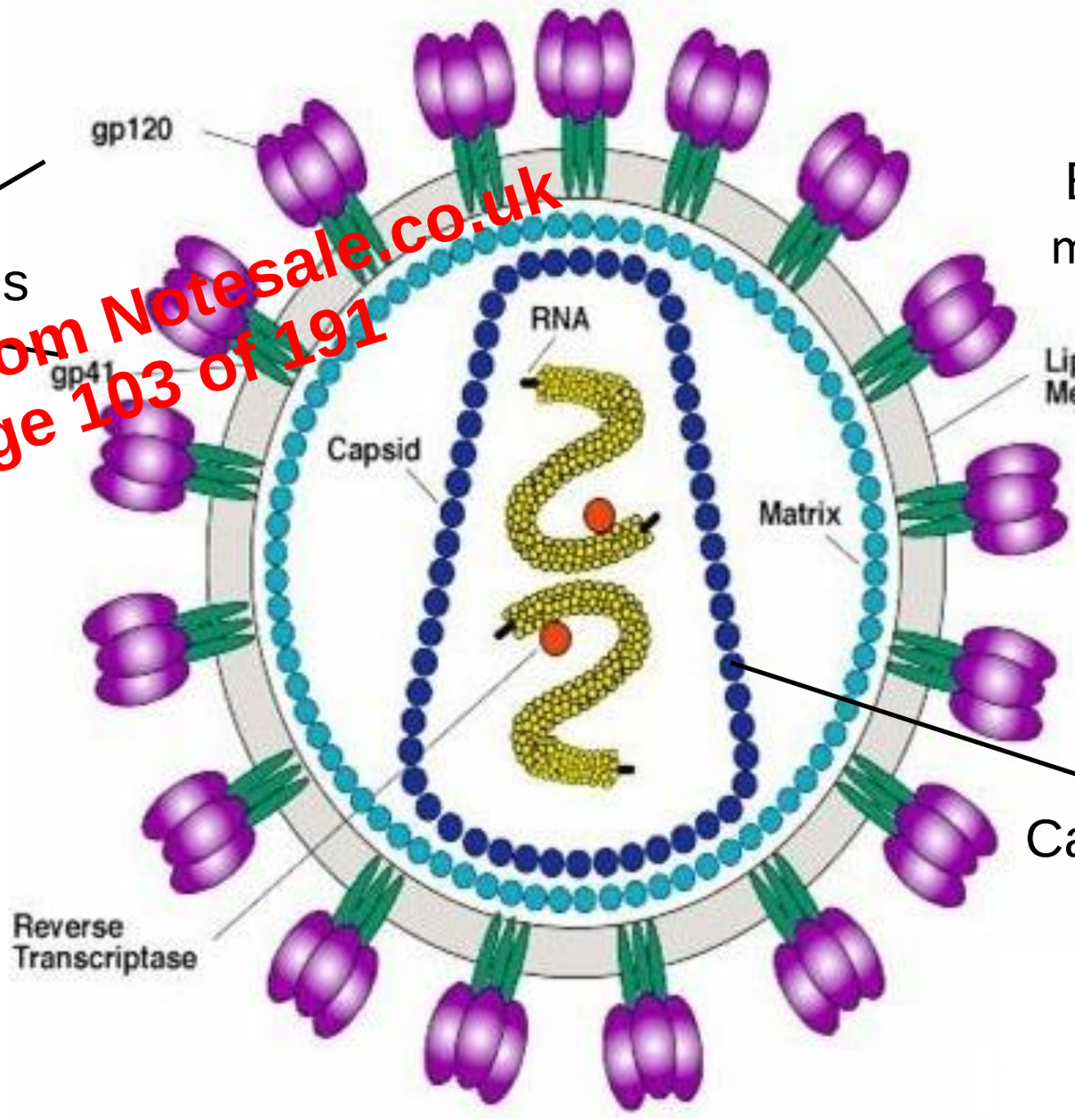
- **Water potential (ψ) Gradient** - Higher water potential = faster osmosis
  - As Osmosis occurs, WP(ψ) become equal - levelling off Rate of Osmosis

- Thickness of Surface - Thinner surface = shorter distance = faster Osmosis

- Surface Area - Larger SA = Faster Osmosis.

HIV

Structure



Attachment Proteins
Allow HIV to attach to helper T-cells

Envelope - Cell Membrane - made of lipid bilayer from host cell

Capsid - Contains HIV genetic information (RNA)

Reverse Transcriptase
Used to make complementary DNA strand from Viral RNA

HIV

Replication

1. Attachment proteins attaches to receptor proteins on cell membrane of Helper CD4 T-cells.

2. The capsid is released into the cell - uncoats within the cell, releasing HIV RNA into the host cell cytoplasm.

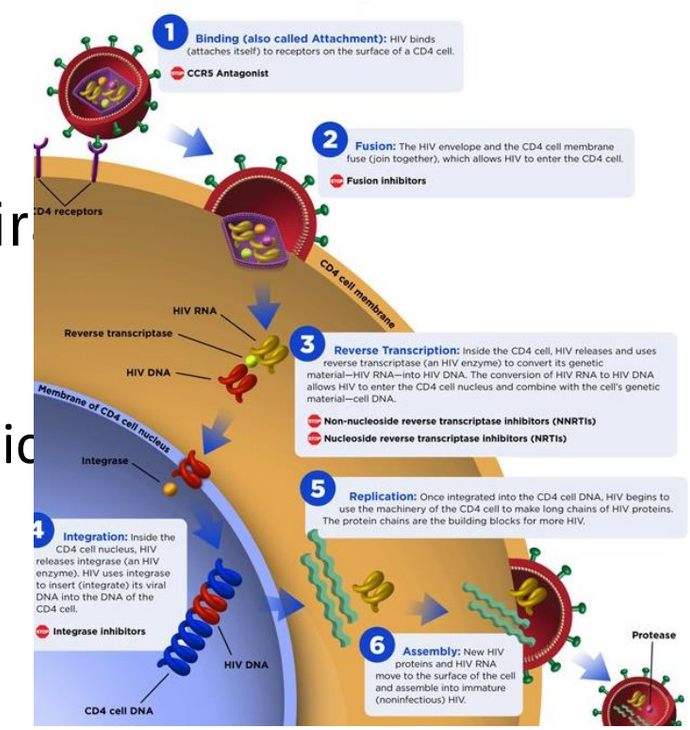
3. Reverse transcriptase is used to make a complimentary strand of DNA from the Viral RNA template - complementary base pairing

4. Double stranded DNA is made and inserted into Human DNA

5. Host cell replicates the viral RNA and enzymes are used to make vir proteins from the Viral DNA code.

6. The produced proteins and RNA are assembled into new viruses whic leave the host cell to infect other CD4 cells.

- Once viruses leaves cell Host cell DIES



HIV

Development into AIDS

- HIV develops into AIDS - causes the immune system to deteriorate and fail overtime

- Initial Infection - HIV replicates rapidly
  - Causes flu like symptom
  - Helper T-Cells population decreases - Killed by HIV
- Latency Period - HIV replication drops to lower levels
  - No symptoms

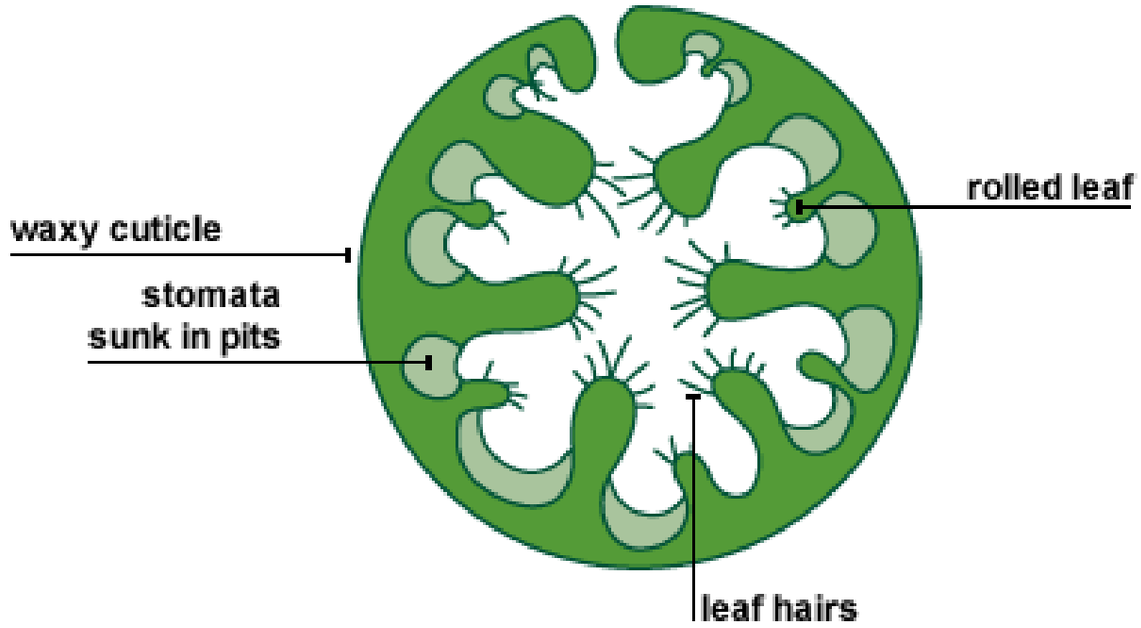
- AIDS - When helper T-cells population falls below a given point.

3.3 Exchange & transport systems

Xerophytes

Plants which have specially adapted to live in warm, dry or windy environments - where water loss is a problem.

- Stomata - Sunk into pits to trap water
  - Reduces Conc. gradient between Water & Air
    - Prevents water evaporating from the leaf
- Leaf hairs - Surround the epidermis to trap water vapour around the stomata.
- Curled Leaf - protect the stomata from wind - Windy conditions increase diffusion and evaporation rate
- **Reduced N˚ of Stomata**- Reduces the number of places where water can escape.
- Waxy Cuticles - Increase diffusion distance - reduces evaporation.



Haemoglobin - Affinity for Oxygen

The tendency a molecule has to bind with Oxygen

- Haemoglobin's affinity for Oxygen varies - depending on conditions.
  - Partial Pressure of Oxygen (pO_2)
- $\underline{pO_2}$ is the measure of Oxygen concentration
  - Greater Concentration of dissolve O_2 in cells - the higher the pO_2

- As pO_2 increases = Haemoglobin's affinity for oxygen increases too
  - Oxygen loads onto O_2 where the pO_2 is high - **Alveoli's**
  - Oxygen unloads where the pO_2 is lower - Respiring cells

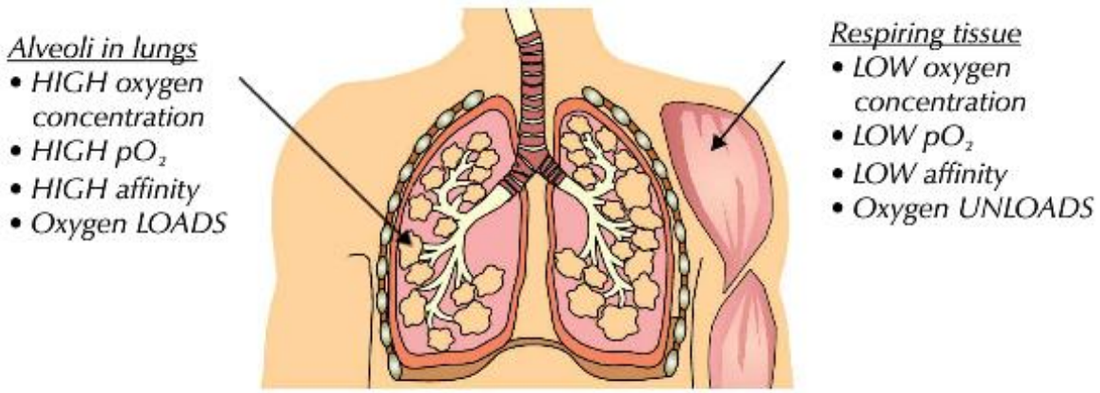
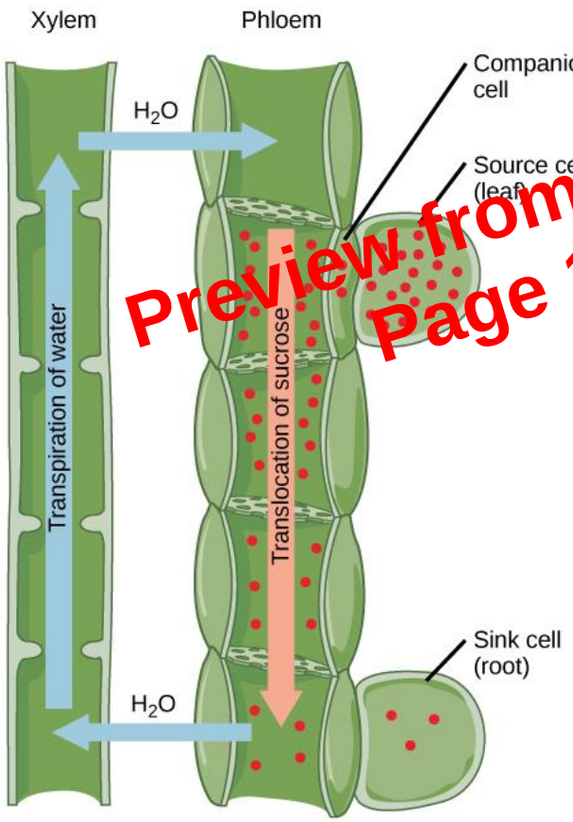


Figure 3: *Oxygen loading and unloading in the body.*

Plant transport

Phloem

Transports dissolved substances around the plant



- Sieve-like elements are living cells which form the transporting tube - No nucleus
  - Each sieve cell has a companion cell for each sieve tube element
    - Conducts the living functions fro sieve cells

- Phloem allows translocation to happen
  - The movement of assimilates from <u>source cells to sink cells</u>

- Enzymes maintain the concentration gradient from <u>source to sink cells</u>

- Catalyse reactions to change assimilates
  - Ensures concentration gradient

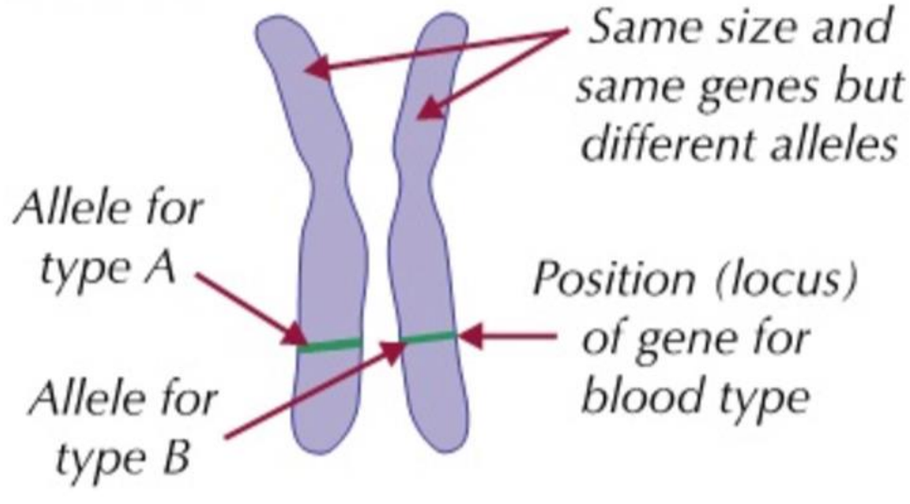
DNA, Genes & Chromosomes

Homologous Chromosomes

Homologous pairs - Pairs of matching chromosomes

- Same size
- Sam shape
- <u>Different Alleles</u>

- Alleles coding for a specific characteristic (Polypeptide chain)
- Found in the same fixed position - Locus
  - Chromosomes are identical



DNA + Protein synthesis

Transcription Cont.

3. RNA Polymerase moves down DNA strand
   - RNA polymerase moves down the DNA strand separating DNA bases
   - Assembling mRNA
     - Hydrogen bonds reform once RNA polymerase has passed
     - DNA recoils after RNA polymerase moves on

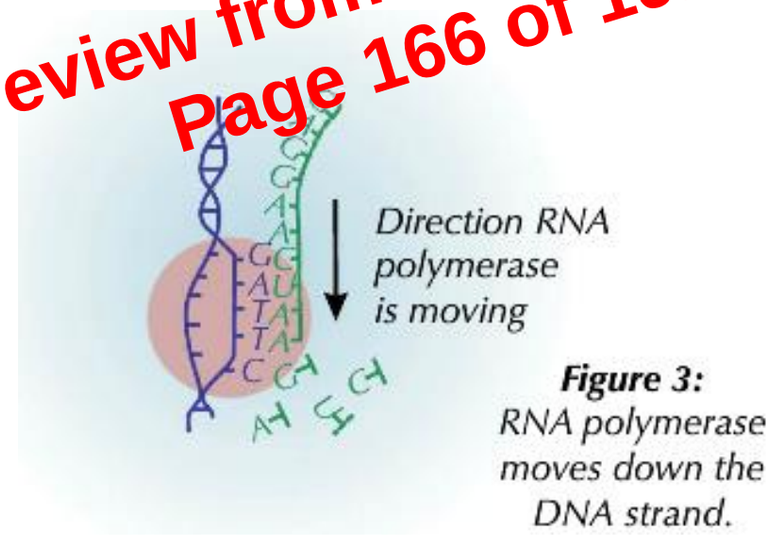


Figure 3: *RNA polymerase moves down the DNA strand.*

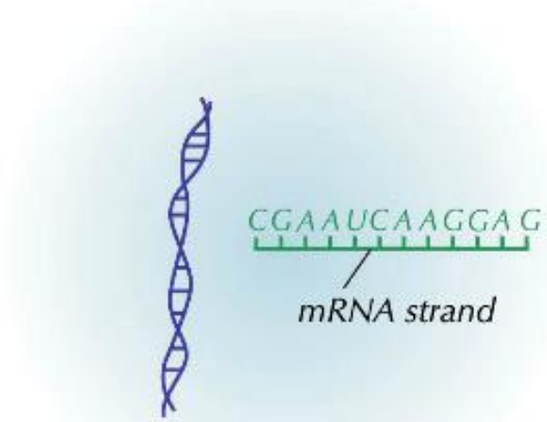


Figure 4: *mRNA detaches from the DNA.*

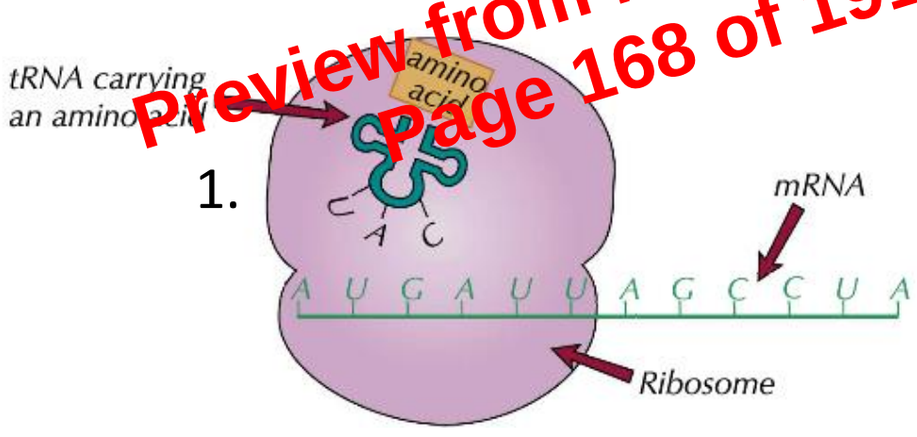
4. RNA polymerase reaches stop signal in DNA
   - RNA polymerase stops making mRNA + detaches from DNA strand
     - mRNA leaves nucleus form nuclear pores
     - Travels into cytoplasm heading for ribosomes

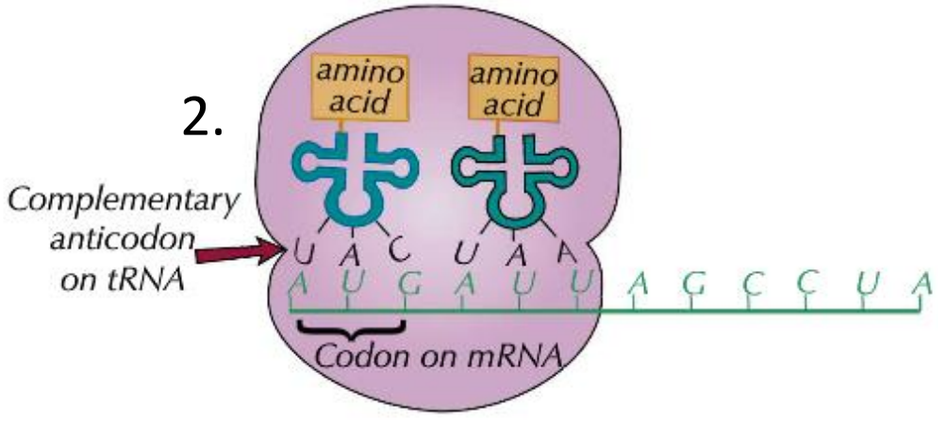
DNA + Protein synthesis

Translation

Occurs in ribosomes in the cytoplasm of all cells
Amino acids are joined together by peptide bonds to form polypeptide chains

1. mRNA attaches to a ribosome
   - tRNA molecules carry amino acids to ribosome
     - Amino acid - tRNA bond formed from ATP hydrolysis - <u>energy coupling</u>





2. tRNA anticodon complementary to mRNA codon
   - tRNA with a complementary anticodon moves into the Ribosome
   - tRNA attaches itself to mRNA codon - complementary base paring
   - 2nd tRNA molecule attaches to next codon in the same way

   - Amino acids carried by tRNA undergo condensation reaction - dipeptide chain produced

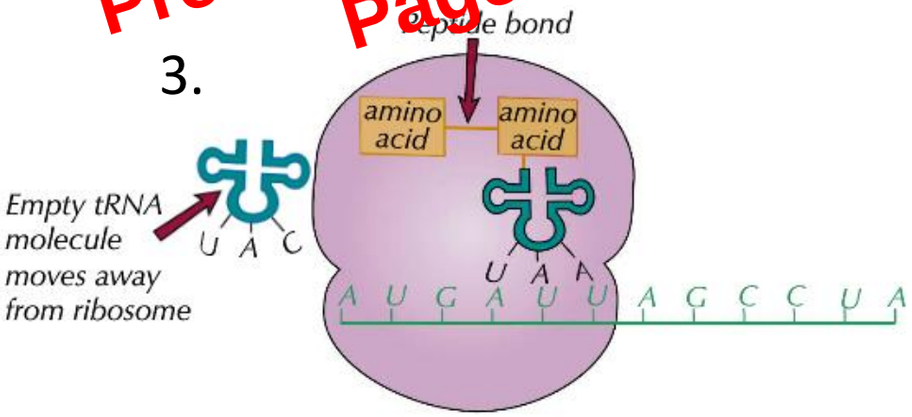
DNA + Protein synthesis

Translation

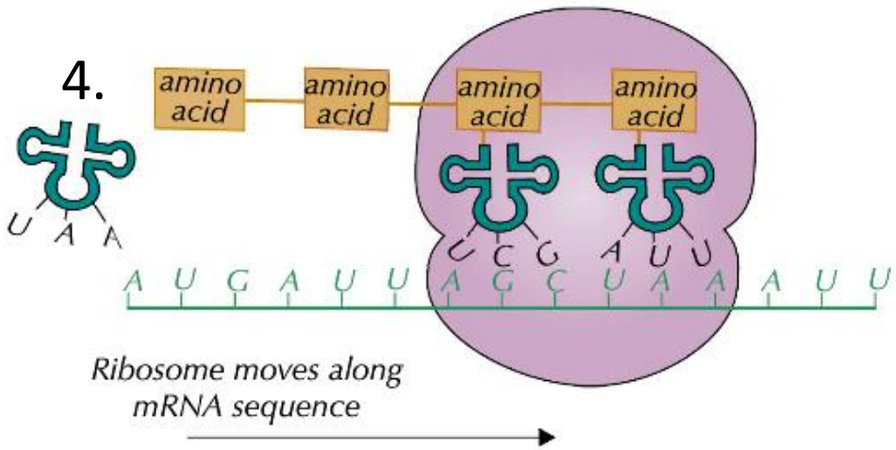
3. Original tRNA molecule moves out of ribosome
   - Amino acid molecules carried by tRNA left behind

NB - Ribosomes join A Acids once their tRNA it complementary to the codons and in correct order

3.



4.



4. Process continues until stop codon is reached
   - Polypeptide moves out of ribosome
     - Protein is produced
   - Translation is complete

mRNA - Opposite bases to DNA
Uracil replaces thymine
tRNA - Opposite bases to mRNA
Uracil replaces thymine

Genetic diversity, mutations + Meiosis

Mutations

Genetic mutations - Change in base sequence of chromosomes

- Arrises spontaneously in DNA replication
  - Base deletion - When a base is physically removed from a genetic code
  - Base substitution - When a new base is swapped with the original base in a genetic code

Base Deletion	Base Substitution

- Always alters the genetic code
  - Causes shift in genetic code
	- Smaller problem than Base deletion
	  - Genetic code is degernate
	  - Chance that mutation codes for the same protein
	- Amino Acid sequence is not always changed

Mutagenic agents - Increase the chance of a spontaneous mutation occurring

- UV radiation
- Ionising radiation
- Chemicals + Viruses

Genetic diversity, mutations + Meiosis

Meiosis

Diploid cells - Body cells - Full set of chromosomes

- Diploid number of chromosomes
- Chromosome from each parent

Humans have 23 chromosome pairs - 46 Chromosomes

Diploid N˚ = 2(23) = 46

2*n* - Homologous chromosome pairs

Cell Division which takes place in reproductive organs

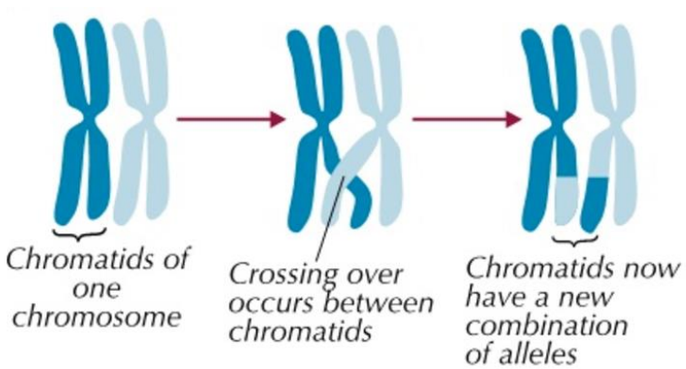
- Diploid - Haploid
- Only in Eukaryotic organisms

Genetic diversity, mutations + Meiosis

Genetic Variation

Crossing over of chromosome

- Meiosis I — Homologous chromosomes come together and pair up
  - Chromatids twist around each other
  - Bits of chromatids swap over
  - Same genes - Homologous pairs - genes in the same position
    - Different combination of alleles
- Results in haploid daughter cells all having different chromatids - Increased genetic variation



Independent segregation of chromosomes

- Homologous pairs are made up of chromosomes from maternal and paternal sides
- Separation of chromosomes in Meiosis I is completely random
  - Random what chromosomes end up in daughter cells
- Daughter cells have different combinations of chromosomes

'Shuffling' of chromosomes increases genetic variation

Species & Taxonomy

Phylogenetic Classification

- Phylogenetic classification attempts to arrange organisms into smaller groups based on <u>evolutionary origins</u> and relationships
  - Smaller groups - more closely related

- Hierarchy system which diverges into different species
  - Each divergence represents a common ancestor
  - Closer divergence = more closely related species

- Groups do not overlap
  - Each group is called a taxon