Water:

Water & Temperature Control

- Water is a dipolar molecule
- Hydrogen's slightly (delta) positive & Oxygen slightly (delta) negative
- Forms Hydrogen bonds

Temperature Control

- High latent heat of vaporisation - large amount of energy required to change from liquid to gas
- Evaporation is an efficient cooling mechanism
- High specific heat capacity - large amount of energy needed to change, temperature
- Thermally stable environment for aquatic organisms
- Aquatic organisms use less energy on temperature control
- Internal temperature of organisms change slowly

Condensation & Ice

- Biological / metabolic reactions require water e.g
- Condensation and Hydrolysis reactions Ice is less dense than water (it floats)
- Ice provides habitat for, organisms e.g Polar Bear
- Ice insulates water below - remains liquid - organisms don't freeze

Transport

- Water is a good solvent - Ionic compounds dissolve in water e.g. Na+
- Cohesion - water molecules stick together (H- bonds)
- Adhesion - water molecules stick to other things (H-bonds)
- Water columns can be pulled up xylem (cohesion-tension theory)

Translocation

- Mass flow from source to sink
- In source/leaf sucrose actively transported into phloem (ATP against concentration gradient)
- By companion cells
- Lowers water potential of sieve tube cell and water enters by osmosis
- Increase in (hydrostatic) pressure causes mass movement towards sink/root
- In root sugars/sucrose used for respiration or converted to starch for storage

Transport Across Membranes

By Diffusion

- Small non-polar molecules
- From high concentration to low concentrationr

By Osmosis

- From a high water potential to a low water potential

Transport Across Membranes

By Facilitated Diffusion

- Channel protein - small charged molecules e.g. Na+
- Carrier protein - large particles e.g. glucose
- Down concentration gradient

By Endocytosis

- Engulfing by cell surface membrane to form vesicle/vacuole
- Uses ATP

By Active Transport

- Carrier protein
- Against concentration gradient
- Using ATP/energy (from respiration)

By Exocytosis

- Fusion of vesicle with cell surface membrane;
- Uses ATP

Proteins

Structure Of Proteins

- Polymer of amino acids
- Joined by peptide bonds
- Formed by condensation
- Primary structure is order of amino acids Secondary structure is folding of polypeptide chain due to hydrogen bonding
- Tertiary structure is 3-D folding due to hydrogen bonding and ionic/disulfide bonds Quaternary structure is two or more polypeptide chains

Carbohydrate Digestion

- Amylase
- Starch to maltose Maltase
- Maltose to glucose Hydrolysis
- Of glycosidic bond

How Mutations Can Create a Non-Functional Protein

- Change/mutation in base/nucleotide sequence (of DNA/gene)
- Change in amino acid sequence/primary structure (of enzyme)
- Change in hydrogen/ionic/disulfide bonds Change in the tertiary structure/shape Change in active site (enzyme) or variable region (antibody)
- Substrate not complementary/cannot bind (to enzyme/ active site)
- No Enzyme-Substrate complex or Antigen- Antibody complex formed

Why Are Enzymes Specific?

- Tertiary structure of enzyme (means)
- Active site is only complementary to substrate (name it if you can)
- Active site changes shape to become complementary (induced fit)
- By forming enzyme-substrate complex

Proteins:

Inhibitors

- Inhibitors reduce / prevent formation of ES complex

> *Competitive Inhibition:*

- Inhibitor similar shape to substrate
- Binds to active site of enzyme
- Inhibition can be overcome by more substrate

> *Non-Competitive Inhibition:*

- Inhibitor binds to site on enzyme other than active site
- Prevents formation of active site / changes (shape of) active site
- Cannot be overcome by adding more substrate

Protein Synthesis

> *Transcription:*

- Strands separate / H-bonds break
- DNA helicase
- Template strand is copied to mRNA
- Free RNA nucleotides attach Complementary/ specific base pairing eg. AU and GC
- RNA polymerase joins nucleotides (on new strand)
- Forming Phosphodiester bonds
- H-bonds reform

> *Translation:*

- mRNA moves to ribosome in the cytoplasm
- tRNA binds to mRNA
- tRNA anticodons pair with mRNA codons
- Specific amino acid attached to tRNA
- Formation of peptide bond between amino acids

Cell Division:

DNA Replication

- Strands separate / H-bonds break
- DNA helicase
- Both strands act as templates
- (Free) nucleotides attach Complementary/specific base pairing / AT and GC
- DNA polymerase joins nucleotides (on new strand)
- H-bonds reform
- Semi-conservative replication / new DNA molecules contain one old strand and one new strand

Cell Division:

Meiosis

- Cell division to form gametes (eggs and sperm)
- Two divisions forming four Haploid Daughter cells
- Genetically non identical (due to crossing over and independent assortment)
- Crossing over - creates a new combination of alleles
- Independent assortment - creates a new combination of chromosomes

> *Prophase I:*

- Nuclear membrane breaks down
- Chromosomes condense

> *Metaphase I:*

- Homologous pairs of chromosomes line up next to each other on the equator
- Spindle attaches to chromosomes at the centromere
- Crossing over of chromatids takes place

> *Anaphase I:*

- Homologous pairs separate - one to each pole (independent assortment)

> *Telophase I:*

- Nuclear membranes reforms
- Cell divides (cytokinesis)

> *Prophase II:*

- They never ask about Prophase II (assume as per Prophase I)

> *Metaphase II:*

- Chromosomes line up on the equator
- Spindle attaches to chromosomes at the centromere

> *Anaphase II:*

- Centromeres split
- Chromatids move to opposite poles

> *Telophase II:*

- Nuclear membranes reforms
- Chromosomes uncoil
- Cell divides (cytokinesis)

Cell Division:

Mitosis

- Cell division for growth and repair
- 2 Daughter cells
- Genetically Identical

> *Prophase:*

- Nuclear membrane breaks down
- Chromosomes condense

> *Metaphase:*

- Chromosomes line up on the equator
- Spindle attaches to chromosomes at the centromere Anaphase:
- Centromeres split
- Chromatids move to opposite poles

> *Telophase:*

- Nuclear membranes reforms Chromosomes uncoil
- Cell divides (cytokinesis)

Cell Cycle

> *Interphase:*

- G1 - Cell grows and organelles multiply
- S - DNA Replicates
- G2 - Organelles multiply ready to divide

> *Cell Division:*

- Mitosis or Meiosis

The Immune System:

The Immune Response

> *Phagocytosis:*

- Phagocyte recognise antigens on bacteria as foreign
- Engulf bacteria
- Bacteria in vacuole
- Lysosome fuses with / empties enzymes into vacuole
- Bacteria digested / hydrolysed
- Phagocytes present pathogens antigen (antigen presenting cell)
- Antigens on phagocyte active T-cells (T- lymphocytes)
- T-Killer cells - destroy pathogen
- T-Helper cells present antigens and active B-cells
- Clonal Selection - B-cell with required antibody divides by mitosis to form plasma cells
- Antibodies are complementary to antigen (from antigen - antibody complex)
- B-cells from memory cells
- Secondary response if infected again with same antigen

Vaccines

- Vaccines contain antigens / antigens are injected
- Dead pathogens / weakened pathogens Clonal selection of B-cells (mitosis)
- B-cells produce antibodies Memory cells made/produced
- On second exposure memory cells produce antibodies / become active / recognise pathogens
- Rapidly produce antibodies / produces more antibodies
- Antibodies destroy pathogens
- Secondary Response - don't feel symptoms

Mass Transport in Animals:

Control of Mammalian Heart Beat

- SAN initiates heartbeat / acts as a pacemaker
- SAN sends electrical impulses across atria causing atrial contraction
- AVN delays electrical impulses
- Allowing atria to empty before ventricles contract / ventricles to fill before they contract AVN sends wave of electrical impulses down Bundle of His / Purkyne fibres
- Causing ventricles to contract (from base up) / ventricular systole

Mass Transport in Animals

Heart Disease

- Atheroma is cholesterol / plaque / lipoprotein / LDL / fatty material
- In artery wall / endothelium of artery Atheroma linked to blood clot / thrombosis Blocks coronary artery / artery supplying heart muscle / tissue / cells
- Reduces oxygen / glucose supply (to heart muscle / tissues / cells)
- (Heart muscle / tissue / cells) unable to respire / dies

Adaptations of Arteries

> *Elastic Tissue:*

- Elastic tissue stretches under pressure / when heart beats
- Recoils / springs back
- Evens out pressure / flow
- Muscle contracts
- Reduces diameter of lumen / vasoconstriction / constricts vessel
- Changes flow / pressure

> *Epithelium:*

- Epithelium smooth
- Reduces friction/blood clots/less resistance

How is X Adapted for Efficient Gas Diffusion?

- Large surface area
- Many capillaries provide a large surface area (So) fast diffusion
- Thin epithelium
- (So) short diffusion distance / pathway
- (So) fast diffusion
- Ventilation / circulation
- Maintains a diffusion / concentration gradient (So) fast diffusion

The Bohr Effect

- Increased Respiration
- Increased C02 in blood
- Blood becomes more acidic which lowers haemoglobin's affinity for oxygen / haemoglobin releases more oxygen / oxygen is released quicker / oxygen dissociates/ unloads more readily
- To muscles/tissues/cells
- For high/rapid respiration
- Oxyhaemoglobin dissociation curve shifts to the (Bohr - Right)

Mass Transport in Animals

Insects Gas Exchange & Water Loss

> *Gas Exchange:*

- Air enters through (open) spiracles Through tracheae
- Diffusion gradient in trachea
- Tracheae associated with all cells/closely associated with cells
- Oxygen diffuses into cells Ventilation replacing air in tracheae

> *Water Loss:*

- Body covered with (waterproof) waxy cuticle
- Spiracles are able to close

Formation and Return of Tissue Fluid

> *Formation:*

- High blood / hydrostatic pressure / pressure filtration
- Forces water / fluid out
- Large proteins remain in capillary

> *Return:*

- Low water potential in capillary / blood Due to (plasma) proteins
- Water enters capillary / blood
- By osmosis
- Correct reference to lymph

Oxygen Loading and Unloading in the Lungs

- Haemoglobin has a high affinity for oxygen and forms oxyhaemoglobin
- In red blood cells
- Oxygen loading in lungs / at high p.O2
- Unloads/ releases O2 to respiring cells/ tissues / at low p.O2
- Unloading linked to higher carbon dioxide concentration

Fish Gills

- Large surface area provided by lamellae/ filaments
- Increases diffusion/makes diffusion efficient Thin epithelium/ distance between water and blood
- Water and blood flow in opposite directions (countercurrent)
- Maintains a high concentration gradient along all of the lamellae
- As water always next to blood with lower concentration of oxygen
- Circulation replaces blood saturated with oxygen
- Ventilation replaces water (as oxygen removed)

Methods of Studying Cells

Transmission Electron Microscope

> *Advantages*

- Small objects can be seen
- Wavelength of electrons shorter
- TEM has high resolution

> *Limitations:*

- Cannot look at living cells
- Must be in a vacuum
- Must cut section / thin specimen Preparation may create artefact Does not produce colour image

Cell Fractionation

- Cell homogenisation to break open cells
- Filter to remove (large) debris/whole cells
- Use isotonic solution to prevent damage to mitochondria/organelles
- Keep cold to prevent/reduce damage by enzymes
- Centrifuge pellets formed
    - nuclei
    - chloroplasts (if present)
    - mitochondria
    - ribosomes (last)

Magnification and Resolution

- Small objects can be seen