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Answer exam questions with information in the same order as shown below. Review related videos for elaboration and clarification on topics.

1. The Biological Molecules

1.1 Water & Temperature Control

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

1.2 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

1.3 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

1.4 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)

1.5 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

Online Academy Video Tutorials:

1. 3.1.7 An Introduction To Water (7:31)
2. 3.1.7 Water as a Solvent (4:42)
3. 3.1.7 Water Temperature Control (7:24)
4. 3.1.7 Water - Summary (2:45)

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2. Transport Across Membranes

2.1 Water & Temperature Control

By Diffusion

- Small nonpolar molecules
- From high concentration to low concentration

By Osmosis

- From a high water potential to a low water potential

By Facilitated Diffusion

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

By Active Transport

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

By Endocytosis

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

By Exocytosis

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

Online Academy Video Tutorials:

1. 3.2.3 Transport Across Membranes - Diffusion (11:38)
2. 3.2.3 Transport Across Membranes - Osmosis (5:59)
3. 3.2.3 Transport Across Membranes - Active Transport & Co-Transport (3:18)
4. 3.2.3 Transport Across Membranes - The Absorption of Glucose (7:02)

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3. Proteins

3.1 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

3.2 How Mutation 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

3.3 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

3.4 Carbohydrate Digestion

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

3.5 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

3.6 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

Online Academy Video Tutorials:

1. 3.1.4.1 The Structure & Function Of Proteins (7:23)
2. 3.1.4.2 Factors Affecting the Rate of Enzyme Controlled Reactions - Inhibitors (6:45)
3. 3.1.5.2 DNA Replication (11:02)
4. 3.3.3 Digestion and Absorption of Carbohydrates & Lipids (8:26)
5. 3.1.4.2 Enzymes (6:46)
6. 3.1.4.2 The Enzyme Question (4:40)
7. 3.4.2 Protein Synthesis: Transcription (9:44)
8. 3.4.2 Protein Synthesis: Translation (8:56)

3.7 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

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4. Cell Division

4.1 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)

4.2 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)

4.3 Cell Cycle

Interphase:

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

Cell Division:

- ☐ Mitosis or Meiosis

Online Academy Video Tutorials:

1. 3.4.3 Meiosis (12:17)
2. 3.2.2 Mitosis (13:28)

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5. The Immune System

5.1 The Immune Response

Phagocytsis:

- 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

5.2 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

5.3 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

Online Academy Video Tutorials:

1. 3.2.4 The Immune System - Vaccines & Antigenic Variability (7:26)
2. 3.2.4 The Immune System - Phagocytosis (8:11)
3. 3.2.4 The Immune System - T-cells & B-cells (8:46)
4. 3.2.4 The Immune System - Antibodies, Primary & Secondary Response (8:48)
5. 3.3.4.1 Cardiovascular Disease (5:50)

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6. Mass Transport in Animals

6.1 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

6.2 Adaptations of Arteries

Elastic Tissue:

- Elastic tissue stretches under pressure/when heart beats
- Recoils/springs back
- Evens out pressure/flow

Muscles:

- Muscle contracts
- Reduces diameter of lumen/vasoconstriction/ constricts vessel
- Changes flow/pressure

Epithelium:

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

6.3 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

6.4 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

6.5 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)

6.6 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)

6.7 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

6.8 Oxygen Loading and Unloading in Lung:

- 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

Online Academy Video Tutorials:

1. 3.3.2 Gas Exchange in Insects & Fish (8:25)
2. 3.3.4.1 Haemoglobin and Bohr Effect (8:55)
3. 3.3.4.1 Comparing Haemoglobin in Different Organisms (6:44)
4. 3.3.4.1 The Formation and Return of Tissue Fluid (8:56)
5. 3.3.4.1 Blood Vessels (5:34)

7. Methods of Studying Cells

7.1 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

Online Academy Video Tutorials:

1. 3.2.1.3 Methods of Studying Cells - Cell Fraction (6:02)
2. 3.2.1.3 Methods of Studying Cells - Microscopes (5:36)

7.2 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)