

Describe the process of mitosis, drawing a diagram (8)

- Cell cycle: interphase – G1, S, G2, M phase
- Interphase processes:
 - o DNA replication
 - o Organelle duplication
 - o Cell growth
 - o Transcription/translation
 - o Obtaining nutrients
 - o Cellular respiration
- Roles of mitosis:
 - o Tissue repair
 - o Growth
 - o Asexual reproduction
 - o Development of embryo
- Prophase – supercoiling and condensing, nuclear membrane dissolves, centrosomes move to poles and spindles form
- Metaphase – spindles attach to centromeres, contract, middle, line up
- Anaphase – contraction, sister chromatids separate, poles, separate chromosomes
- Telophase – decondense, membrane reforms, cytokinesis begins
- Cytokinesis – division of cells into two genetically identical cells

Explain how water is the medium of life, comparing to methane (8)

- Hydrogen bonding – polar associations
- Cohesive and adhesive – high surface tension – capillary action
- Solvent properties:
 - o Ionic/polar (hydrophilic) substances dissolve
 - o Important medium for metabolism and transport
- Thermal properties:
 - o Can absorb large amounts of heat energy before changing state – hydrogen bonds
 - o Very high specific heat capacity
 - o Very effective coolant (evaporation of sweat requires heat from body)
- Other properties:
 - o Transparent – for photosynthesis and vision
 - o Expands when frozen – less dense – floats on water
- Vs methane:
 - o Polar vs non-polar
 - o Higher heat capacity
 - o Higher boiling point

Compare fibrous and globular proteins

- Fibrous: long and narrow, structural function, repetitive amino acid sequence, less sensitive to changes in pH, temperature, e.g.s collagen, myosin, fibrin, insoluble in water
- Globular: round, functional, irregular AA sequence, sensitive, e.g.s enzymes, haemoglobin, insulin, soluble in water

Discuss two models of enzyme activity

- Lock and Key
 - o Enzyme and substrate complement one another's shapes and chemical properties exactly
 - o Active site and substrate share specificity
- Induced fit
 - o Active site not a rigid fit for substrate
 - o Changes conformation to accommodate
 - o Stresses substrate bonds and induces catalysis

Explain lactose intolerance and how milk is made lactose free

- Lactase digests lactose into glucose/galactose
- Lactase is fixed to an inert surface e.g. alginate beads
- These are immobilised enzymes – fixed to a static surface to prevent enzyme loss
- Improves separation of product and purity of yield
- Milk is passed over the surface to become lactose free
- Benefits:
 - o Provides dairy to lactose-intolerant people
 - o Increases sweetness of milk naturally
 - o Reduces crystallisation and production times for cheese

Compare RNA and DNA

- Both polymers of nucleotides
- In DNA sugar is deoxyribose
- In RNA it is just ribose
- DNA = thymine
- RNA = uracil
- DNA = double stranded
- RNA = single stranded

Describe the process of translation

- Ribosomes are site of translation – ribosomal RNA and protein
- Small unit - mRNA binding site
- Large unit – 3 tRNA binding sites (EPA)
- Multiple ribosomes (polysome) can translate single mRNA sequence simultaneously
- INITIATION:
 - o Messenger RNA transported to ribosome, binds to small unit
 - o Moves in 5'-3' direction to start codon
 - o Ribosome reads an mRNA sequence in base triplets called codons
 - o Each codon codes for specific amino acid
 - o Amino acids are transported to ribosomes by transfer RNA
 - o Each tRNA aligns opposite a codon via a complementary anticodon – binds to the start codon
 - o Large subunit aligns to the tRNA molecule at P site and forms complex with small sub-unit
- Elongation:
 - o A tRNA molecule pairs with next codon on A site
 - o Ribosome covalently attaches amino acid in P site to amino acid in A site via peptide bond
 - o Ribosome moves along one codon position and deacylated tRNA molecule released from E site
 - o Elongation and translocation continue
- Termination:
 - o When ribosome reaches STOP codon, polypeptide release and ribosome disassembled into subunits
 - o tRNA: amino acids are attached by tRNA activating enzymes
 - o Joins ATP to an AA and the charged AA is linked to tRNA
 - o Creates high energy bond which ribosomes use to synthesise peptide bonds
 - o Each tRNA enzyme is specific to particular AA but may bind multiple tRNA
 - o In eukaryotes, free ribosomes synthesise intracellular proteins
 - o Bound ribosomes synthesise extracellular proteins

- Amphibians
 - Have a moist skin (permeable to gases)
 - Reproduce via external fertilisation
 - Breathe through skin and are ectothermic
- Mammals
 - Covered in skin (and keratin hair follicles)
 - Have internal fertilisation (and lactation)
 - Breathe via lungs and are endothermic

Outline structural and molecular evidence that help produce clades

- Structural
 - Not always reliable
 - Related species may have distinctive, homologous features
 - Unrelated species may have similar, analogous features
- Molecular
 - Comparison of DNA or AA sequence
 - Related species will have sequences with more similarities
 - AA sequences will accumulate differences at a slower rate to DNA sequences
 - If a sequence accumulates mutations at constant rate time of divergence can be calculated based on number of mutations between 2 species

Outline adaptations of the villi which help efficient absorption

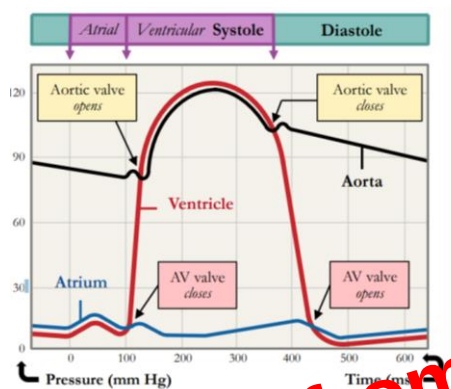
- Finger-like mucosal projections
- Increase surface area of epithelium
- Microvilli
- Rich blood supply
- Single layer epithelium
- Lacteal
- Intestinal crypts
- Membrane proteins

Outline mechanical and chemical digestion

- Mechanical: Breakdown of food via physical actions
 - Chewing
 - Churning (squeezing of stomach)
 - Segmentation (intestinal contractions)
- Chemical: Breakdown via chemical agents
 - Stomach acids (low pH)
 - Bile
 - Enzymes

Outline the cardiac cycle

- Systole
 - As atria contract, atrial pressure exceeds ventricular pressure
 - AV valves open and blood flows into ventricles
 - As ventricles contract, $V_p > A_p$
 - AV valves close – first heart sound
 - Pressure builds until $V_p > \text{Arterial } p$
 - Semilunar valves open and blood flows into arteries
- Diastole
 - As blood flows into arteries, V_p drops
 - Backflow closes SL valves – second heart sound
 - When $V_p < A_p$ the AV valves open and cycle repeats



Discuss causes and symptoms of heart disease

- Risk factors
 - Genetics
 - Obesity
 - Diseases
 - Diet
 - Exercise
 - Smoking
 - Sex (gender)
- Coronary thrombosis caused by clots within coronary arteries
 - Vessels damaged by cholesterol deposition (atherosclerosis)
 - Deposits reduce vessel diameter and increase blood pressure
 - Stress damages arterial walls and is repaired with fibrous tissue
 - Vessel wall loses elasticity and forms atherosclerotic plaques
 - If a plaque ruptures, blood clotting is triggered, forming a thrombus
 - If thrombus blocks blood flow, a myocardial infarction ensues
- This is coronary heart disease

Outline the process of clotting

- Prevents pathogenic entry
 - o Injured cells and platelets release clotting factors
 - o Factors convert prothrombin into thrombin
 - o Thrombin in turn converts fibrinogen to fibrin
 - o Fibrin forms mesh – blocks injured site
 - o Clotting factors also cause platelets to become sticky and form solid plug (clot)
- Coagulation cascade
- If this occurs in coronary arteries → myocardial infarction

Discuss the formation of antibodies

- Macrophages/phagocytes engulf and digest pathogens
 - o Contain pseudopodia which surround pathogen and internalise pathogen in vesicle
 - o Vesicle may fuse with lysosome to digest pathogen
 - o Present pathogen's antigens on self
 - o Become antigen presenting cell (APC)
- Present these antigens to T-helper cells
 - o T-helper cells activate antigen-specific B cells (clonal selection)
- B cells divide and differentiate into plasma cells
 - o These produce large quantities of specific antibodies specific to antigen
 - o Some B cells differentiate into memory cells

Outline passive and active immunity

- Passive
 - o Breastfeeding
 - o Across placenta
 - o Monoclonal antibodies
- Active
 - o Normal response to infection
 - o Immunity via vaccination

Outline cause and effects of HIV

- Retrovirus
- Infects helper T cells
- Usually transmitted via exchange of bodily fluids
- Integrated into genome of infected T helper cells
- Inactive for long time, then lyses T helper cell as it spreads
- Inability to produce antibodies – loss of immunity

Discuss the process of lactation

- Production and secretion of milk by maternal mammary glands
- Controlled by oxytocin and prolactin
 - o Prolactin secreted by anterior pituitary in response to PRH from hypothalamus
 - o Develops mammary glands and production of milk
 - o Effects inhibited by progesterone which prevents milk production from occurring prior to birth
- Oxytocin is responsible for the release of milk from the mammary glands
 - o Produced in the hypothalamus and secreted by neurosecretory cells that extend into posterior pituitary
 - o Triggered by stimulation of sensory receptors in breast by suckling infant
 - o Positive feedback loop – results in continuous oxytocin secretion until feeding ends

Outline iodine role

- Thyroxin contains iodine in chemical structure
 - o Cannot be produced if iodine is deficient in the diet
 - o Iodine deficiency therefore affects thyroid gland
 - o Affects thyroxin production
- Iodine deficiency will develop enlarged thyroid gland – goitre

Discuss high altitude training

- At high altitudes air pressure is lower – lower partial pressure of O₂
- Makes it more difficult for haem to take up and transport O₂
- Respiring tissue receives less O₂ – headaches, fatigue, rapid pulse
- Adaptations
 - o More erythrocytes / higher haem count with higher affinity / higher vital capacity / more myoglobin and more vascularisation / kidneys produce alkaline urine / greater lung SA and larger chest size

Discuss emphysema and treatments

- Walls of alveoli lose elasticity – abnormal enlargement of alveoli – lower total surface area for gas exchange
- Holes – bullae
- Cause – smoking – chemical irritants damage walls – phagocytes – elastase – breaks down elastic fibres (can be genetic)
- Treatments:
 - o Bronchodilators / corticosteroids / elastase enzyme inhibitor / O₂ supplementation / surgery / lung transplant