Revised AS1 June 2015

The process of meiosis results in haploid daughter cells which show genetic variation.

Give an account of the process of meiosis. Your account should include the stage at which the haploid number of chromosomes is formed and **two** ways in which the process results in genetic variation in daughter cells.

[13]

Three essential points and any **ten** other points from:

- at prophase 1 homologous chromosomes pair up/form bivalents
- chromosomes shorten and thicken/become visible/condense
- chiasma/chiasmata/crossing over occurs
- between non-sister chromatids/homologous chromosomes
- leads to recombinants/new allelic combinations/non-parental allelic combinations
- **which is one cause of variation (essential point)**
- spindle fibres develop
- at metaphase 1 the bivalents (homologous pairs) attach to the spindle fibres
- by their centromeres
- orientation of the bivalents (homologous pairs) is random/independent assortment occurs
- **which is another cause of variation (essential point)**
- at anaphase 1 the spindle fibres contract
- pulling whole chromosomes to opposite poles of the cell/separating homologous chromosomes
- **this is the point at which the haploid number of chromosomes is formed (essential point)**
- nuclear membranes form/two cells produced
- in prophase 2 two sets of spindle fibres form at right angles to the original
- in metaphase 2 individual chromosomes (within each group) attach to the spindle fibres
- by their centromeres **(allow once)**
- in anaphase 2 the spindle fibres contract **(allow once)**
- pulling the chromatids (*do not accept chromosomes*) to opposite poles
- resulting in four groups of (new) chromosomes
- nuclear membranes form/four cells produced **(allow once)**
- chromosomes decondense/become thinner/less visible [13]

Revised AS1 June 2014

Give an account of the process of osmosis in cells and explain the effect of changing external solute concentrations on both animal and plant cells. [13]

Any thirteen points:

- osmosis is the net movement of water across a partially (selectively) permeable membrane
- from an area of higher water potential to an area of lower water potential
- pure water has a water potential of zero
- addition of solutes decreases the solute potential / creates a negative solute potential
- by restricting the movement of free water molecules / by creating hydration shells
- so they decrease the water potential of a solution
- all cells contain a range of dissolved solutes
- if a cell has a lower water potential than its environment (neighbouring cells), then water will move in / if a cell has a higher water potential than its environment (neighbouring cells), then water will move out
- in animal cells, only the dissolved solutes contribute to the water potential
- if animal cells take in water, they may swell and lyse (burst)
- because they have no cell wall
- if animal cells lose water, they will crenate
- the presence of a cell wall in plant cells creates a pressure potential
- thus the water potential of a plant cell = solute potential + pressure potential ($\Psi_{cell} = \Psi s + \Psi p$)
- when plant cells absorb water, they become turgid / the wall resists the inward movement of excess water
- when plant cells lose water, the cell becomes flaccid / the cell membrane begins to pull away from the cell wall / the cell begins to plasmolyse
- however, the membrane remains attached at the plasmodesmata
- if the cell can gain water, it can recover
- further loss of water will result in complete plasmolysis / will result in the plasmodesmata breaking the connection with neighbouring cells
- other appropriate response [13]

Revised AS1 Jan 2014

8 The cell membrane consists of a phospholipid bilayer with various proteins embedded in it. This structure enables different substances to travel through the membrane by either simple diffusion, facilitated diffusion or active transport.

(a) Describe the similarities and differences between simple diffusion, facilitated diffusion and active transport. [6]

(b) Large and small molecules, as well as ions, must be able to travel through the cell membrane. Explain why the different methods of transport named in part **(a)** are necessary to allow each of these substances to pass through and also how they may allow the membrane to be selective. [7]

8 **(a)** Any **six** points from:

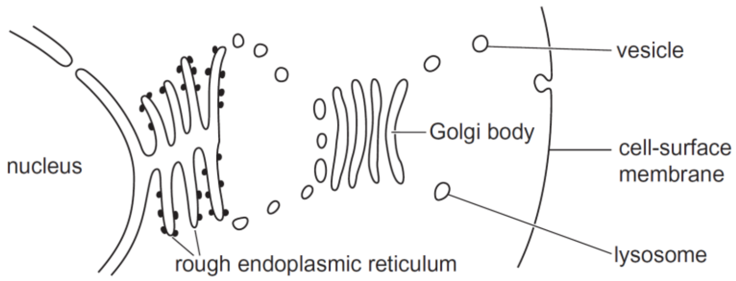
- both simple and facilitated diffusion are passive/require no energy
- and movement is down the concentration gradient
- simple diffusion is possible between the phospholipid molecules
- while facilitated diffusion requires transmembrane proteins
- active transport carries substances against the concentration gradient which requires ATP for energy
- active transport also requires specific carriers
- the carriers undergo a change of shape to move the substance across the membrane
- use of protein carriers in active transport and facilitated diffusion confers selectivity

(b) Any **seven** points from:

- some molecules are hydrophobic/non polar/very small (e.g. oxygen and carbon dioxide)
- and so can pass directly between the phospholipid molecules in the bilayer
- ions are polar/charged/hydrophilic
- and therefore cannot pass between the phospholipid molecules
- therefore they need hydrophilic pores/channel proteins through which to pass
- transport through bilayer/pore/channel is non-selective/but channel selective if gated
- larger polar molecules (such as glucose) depend on protein carriers in the membrane
- which have specific receptor sites *[not active sites]*
- that are complementary to the molecule being carried
- these carriers are therefore selective in what they can carry
- also the relative abundance of different carriers will influence the relative amount of different substances able to cross the membrane [13]

Revised AS1 June 2013

8 Proteins have many roles in cells. For example, enzymes are involved in both extracellular and intracellular digestion, while conjugated proteins provide essential receptors and recognition sites on cell-surface membranes. Within the cell many organelles work together to make and transport these enzymes and conjugated proteins. The following diagram shows the relative positioning of these organelles.



Describe the involvement of each of the following:

- the nucleus and rough endoplasmic reticulum in the production of polypeptides (details of the process of polypeptide synthesis are **not** required)
- the Golgi body in the production of the functional enzymes and conjugated proteins
- vesicles and lysosomes in the transportation of products for secretion or for use within the cell. [13]

8 Any thirteen points from

Nucleus and rough ER

- the nucleolus produces ribosomal RNA/ribosomes
- chromosomes within the nucleus contain the genetic code/DNA has a nucleotide sequence
- that determines the sequence of amino acids in a polypeptide chain
- mRNA carries a copy of this code out of the nucleus/through the nuclear pores
- onto the rough ER/ribosomes
- ribosomes (on RER) are the site of protein/polypeptide synthesis

Golgi body

- ER vesicles containing the newly synthesised (primary) protein bud off RER
- and carry it to the forming face of the Golgi apparatus
- within Golgi the primary protein is modified into the final enzyme
- carbohydrate/lipid may be added to make glycoprotein/lipoprotein
- polypeptides brought together to form quaternary proteins
- prosthetic group may be added

Vesicles and lysosomes

- vesicles then bud off the mature face of Golgi
- secretory vesicles will carry enzymes to the cell-surface membrane
- where they fuse with it/release their enzymes
- other vesicles may carry glyco/lipoproteins to the surface membrane
- where they can become incorporated into the membrane as receptors/ recognition sites
- lysosomes are also budded off Golgi
- they fuse with worn-out organelles that have been enclosed in a membrane/phagocytosed material
- the hydrolytic enzymes (in the lysosome) then digest the old organelle/ phagocytosed material/carry out autolysis [13]

Revised AS1 Jan 2013

8 Viruses such as bacteriophages infect bacterial cells like *Escherichia coli*, while human immunodeficiency virus (HIV) infects a particular type of animal cell.

(a) Describe the similarities and differences in the structure of a bacteriophage virus and the human immunodeficiency virus (HIV). [5]

(b) Describe the similarities and differences in the structure of a bacterial cell and an animal cell. [8]

8 (a) Five marks, with a maximum of four from either part

Similarities

- both non-cellular/lacking typical cellular structure
- both possess a head/capsid composed of protein
- genetic material (DNA/RNA) is located inside capsid/protein coat
- both very small (up to 200 nm approx.)/visible only with electron microscope

Differences

- HIV roughly spherical, while bacteriophage (capsid) is icosahedral (or drawn/described)
- HIV capsid is within a lipid envelope (absent in bacteriophage)
- HIV genome is made of RNA, while bacteriophage genome is made of DNA
- HIV contains the enzyme reverse transcriptase
- bacteriophage has a tail section/(consisting of) a protein sheath around a core/(and) tail fibres attached to a base plate (absent in HIV)
- different proteins on exterior allow each virus to invade different cells
- HIV has glycoproteins, while bacteriophages do not [5]

(b) Eight marks, with a maximum of six differences

Similarities

- both possess a cell membrane/cytoplasm (cytosol)
- cell membrane has fluid mosaic structure/composed of phospholipids and proteins
- both possess ribosomes
- both possess DNA
- both may contain glycogen

Differences

- bacterial cell is much smaller (up to 10 μm) than an animal cell (up to 100 μm)
- a cell wall surrounds a bacterial cell, but not an animal cell
- bacterial cell may also have a capsule/pili
- cell membrane of an animal cell contains cholesterol (absent in bacterial cell membrane)
- ribosomes in a bacterial cell are smaller than those in an animal cell
- DNA linear in an animal cell while bacterial DNA is circular
- DNA associated with histone/proteins in animal chromosomes while bacterial DNA lacks protein (is naked)
- bacterial cells may contain plasmids, while animal cells do not
- genetic material is enclosed in a nuclear membrane in animal cells/they possess a nucleus
- bacterial cell contains no membrane-bound organelles/membrane systems, while animal cell does (e.g. mitochondria/endoplasmic reticulum/Golgi body/lysosomes) ***[not** chloroplasts]*/bacteria are prokaryotic while animal cells are eukaryotic
- centrioles/mitotic spindle/microtubules present in animal cells, but not in bacterial cells [8]

Revised AS1 June 2012

8 Starch, glycogen and cellulose are three polysaccharides found in living organisms. Give an account of the similarities and differences in their structure and describe their role and distribution. [13]

8 Thirteen points, with a maximum of seven from each section

Similarities and differences in structure:

- all three have (1,4) glycosidic links/formed by condensation reactions
- starch and glycogen contain alpha-glucose
- there are two components of starch, amylose and amylopectin
- in amylose the long chain of monomers is wound into a helix
- amylopectin is branched due to additional 1,6 (glycosidic) links
- glycogen is similar to amylopectin but more branched
- cellulose is composed of beta-glucose
- and forms straight chains (because every second glucose is 'upside-down')
- parallel chains are held together by hydrogen bonds/cross linkage

Role and distribution:

- starch and glycogen are both glucose/energy stores
- starch is found in chloroplasts/storage tissue (e.g. seeds/roots/tubers)
- glycogen is found in muscle/liver cells/fungi
- the helix/branching makes the molecules more compact (for storage)
- glycogen/amylopectin are more readily hydrolysed due to more terminal ends (for enzymes to work on)
- starch/glycogen are insoluble so exert no osmotic effect/cannot leach out of the cell
- cellulose offers tensile strength to plant cell walls
- layers of cellulose are arranged at varying angles to each other, which adds to the tensile strength [13]

Revised AS1 Jan 2012

9 In complex organisms, cells are organised into tissues which are then organised into organs. The ileum is an example of an organ. Describe the structure and function of the different tissue layers in the ileum and, where appropriate, their constituent cells. [13]

9 Any thirteen points

- on the outside, the serosa provides a supportive/protective layer
- inside this is the muscularis externa
- containing both longitudinal and circular muscles
- which are responsible for pendular movements/local constrictions which mix food and enzymes together
- and for peristalsis which moves food along the ileum
- inside this is the submucosa
- which contains blood vessels/lymphatic vessels/connective tissue
- the muscularis mucosa is involved in movement of the villi
- which improves contact between the absorbing surfaces and the digested food
- the mucosa is the innermost layer/in contact with food
- (it is deeply folded into) villi to increase the surface area/nutrient absorption
- in the centre of each villus there is a lacteal into which the fats are absorbed
- and a network of blood capillaries into which monosaccharides/amino acids are absorbed
- (between) the villi are the crypts of Lieberkühn
- where Paneth cells are responsible for producing new epithelial cells/have an anti-microbial function to protect the stem cells at the base of the crypts
- the surface of the villi is covered with columnar epithelium
- epithelial cells have microvilli to increase surface area/absorption
- and mitochondria to provide ATP/energy for active transport
- goblet cells secrete mucus
- which lubricates the ileum/protects the cells from enzyme action [13]

Revised AS1 June 2011

9 Give an account of the structure of proteins and their roles in the cell-surface membrane. [13]

9 Thirteen points, with at least six from each section

Structure:

- the primary structure is the **sequence of amino acids** in a polypeptide chain
- amino acids are linked by **peptide bonds/condensation reactions** (between $-NH_2$ and -COOH groups)
- the secondary structure is when the polypeptide chain winds into a **alpha helix and beta pleat**
- (the helix is) held in shape by **hydrogen bonds** (between -NH and -C=O groups)
- the tertiary structure is when the helix folds further into a **globule** (making it more compact)
- this is held in shape by **bonds between neighbouring R-groups**
- such as hydrogen bonds, ionic bonds, disulphide bridges and hydrophobic interactions **[any two]**
- the quaternary structure is when **more than one polypeptide** is present in the protein
- fibrous protein lack a tertiary structure
- conjugated proteins also have a **non-protein part/prosthetic group [appropriate example]**

Role in cell-surface membrane:

- proteins stabilize membrane structure
- may act as hydrophilic channels
- that allow polar molecules (e.g. ions) to diffuse through the membrane
- aquaporins are specific protein channels through which water can travel
- some transmembrane proteins may act as carriers that can change shape
- each carrier/channel is specific to one substance (only fits one substance)
- some are used for facilitated diffusion
- others are used for active transport which requires energy expenditure
- membrane bound enzymes
- glycoproteins/lipoproteins act as recognition sites/antigens on the outer surface of a cell
- act as receptors
- act to anchor the cytoskeleton
- other appropriate role

[13]

Section B

Quality of written communication is awarded a maximum of 2 marks in this section. [2]

8 **(a)** Give an account of the structure of the nucleic acids, DNA and RNA. [8]

(b) Describe the process of DNA replication. [5]

8 **(a)** **Any eight points**

Nucleic acids (common features):
- nucleic acids are chains of nucleotides
- (a nucleotide) consists of a pentose sugar, a phosphate and a nitrogenous (organic) base/purine and pyrimidine [*or by diagram*]
- the sugars and phosphates are joined to form the spine [*or by diagram*]
- by phosphodiester/condensation/covalent bonds

DNA and RNA (comparisons):
- in DNA the pentose sugar is deoxyribose, while in RNA it is ribose
- DNA is a double chain/double helix, while RNA is single stranded
- hydrogen bonds between the bases form the double chain (in DNA)
- in DNA the bases are adenine, thymine, cytosine and guanine
- in DNA adenine (A) always pairs with thymine (T), while cytosine (C) pairs with guanine (G)/a purine binds to a pyrimidine
- in DNA the two strands run anti-parallel to each other
- a DNA molecule is much longer than an RNA molecule (allow converse)
- in RNA thymine is replaced by uracil
- there are three forms of RNA – ribosomal, messenger and transfer

[8]

(b) **Any five points**
- DNA replication is said to be semi-conservative, because each new molecule contains one old strand and one new strand
- the two sides of the DNA molecule are “unzipped” from one end
- by DNA helicase
- each strand acts as a template for the formation of new strands
- free nucleotides enter opposite their complementary bases (A opposite T and C opposite G)
- DNA polymerase catalyses the joining up of the nucleotides
- by condensation reactions [5]

Revised AS1 June 2010

8 Enzymes are sensitive to a number of factors. The three graphs in this question illustrate the influence of three independent variables on the activity of an enzyme. For each of the three graphs

- identify the independent variable
- describe trends evident in the graph
- explain the trends described [13]

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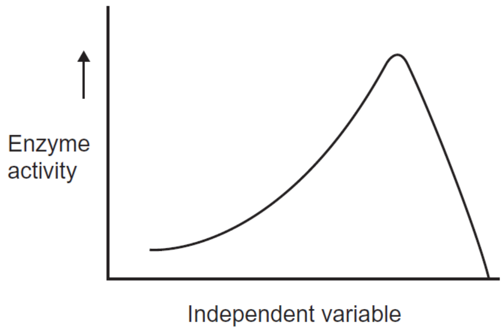

- identify the independent variable
- describe trends evident in the graph
- explain the trends described

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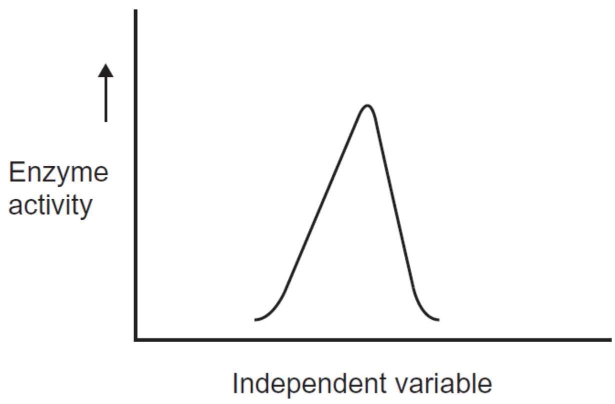

- identify the independent variable
- describe trends evident in the graph
- explain the trends described

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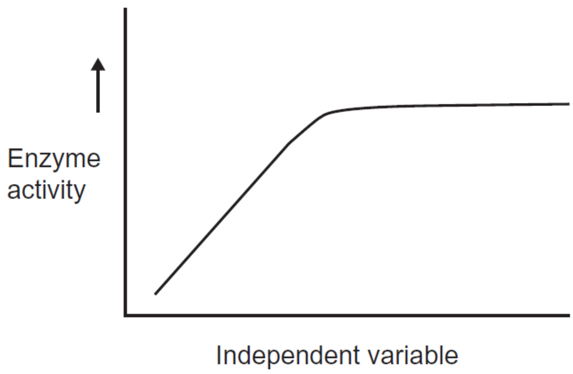

8 Any thirteen points

First graph:
Independent variable:
- temperature

Description of trends:
- at low temperatures, an increase in temperature causes an increase in activity
- activity reaches a maximum at the optimum temperature/at high temperatures the enzyme activity decreases rapidly

Explanation:
- at lower temperatures, an increase in temperature causes enzyme and substrate to move more quickly/to have greater kinetic energy so that they collide more frequently/form more enzyme-substrate complexes
- at higher temperatures, bonds that maintain enzyme structure (tertiary structure of protein) are broken/the specific shape of the active site is altered

Second graph:
Independent variable
- pH

Description of trends:
- activity is at a maximum at the optimum pH
- an increase or decrease in pH causes a decrease in enzyme activity

Explanation:
- at optimum pH the shape of the active site best facilitates the attachment of the substrate/at non-optimal pH the substrate attaches less readily
- ionic bonds in the tertiary structure/charges in R-groups may be disrupted with changes in pH

Third graph:
Independent variable:
- substrate/enzyme concentration

Description of trends:
- at low concentrations, an increase in concentration increases enzyme activity
- at high concentrations, an increase in concentration does not cause a further increase in enzyme activity/activity levels off/enzyme becomes the limiting factor (for substrate concentration)

Explanation:
- an increase in concentration increases the chance of collisions between enzyme and substrate/enzyme-substrate complexes being formed
- at high substrate concentrations, the enzymes are fully saturated by substrate molecules and the rate cannot increase any more/at high enzyme concentrations, levelling-off only occurs if the substrate is not in excess (i.e. is limited) [13]

Revised AS1 January 2010

8 **(a)** Describe the behaviour of the chromosomal material during a cell cycle involving mitosis. [8]

(b) Describe how the behaviour of chromosomes differs during the processes of mitosis and meiosis. Explain the consequences of these differences [5]

8 **(a)** Behaviour of chromosomes during a cell cycle with mitosis:

Any eight points

- during G1/and G2 of interphase the chromosomal material is unwound/ appears as chromatin
- some of this is inactive, heterochromatin
- while some is active, euchromatin
- during the S phase of interphase DNA is replicated
- chromosomes are replicated as new histones bind to the DNA/DNA replication is semi-conservative
- during prophase chromosomes condense (coil and fold up) and become apparent
- each chromosome appears as a pair of chromatids
- during metaphase chromosomes attach to the spindle fibres at the cell equator
- attachment occurs via their centromeres
- during anaphase chromatids are pulled apart/separate
- and move to opposite poles
- during telophase chromosomes begin to unwind again/change to diffuse active form/chromatin
- cells divide into two during cytokinesis halving the amount of chromosomal material
- daughter cells contain the same chromosome number as the parent cell [8]

(b) Different behaviour of chromosomes during mitosis and meiosis:

Any five points

- mitosis involves the separation of the chromatids into new daughter cells
- thus maintaining the same chromosome number as the parent cell (allow if not awarded in part (a))
- the daughter cells are genetically identical to the parent cell
- during prophase I of meiosis the homologous chromosomes pair to form bivalents
- while chiasmata (points of fusion) occur between chromatids of the homologous pair
- the consequence of this is the recombination/crossing-over of alleles on different chromosomes
- during the first division of meiosis the homologous chromosomes are separated into two intermediary daughter cells
- since the homologous pairs arrive randomly on the spindle/the chromosomes are independently assorted when subsequently separated
- in the second division of meiosis the chromatids are separated
- meiosis results in the production of haploid cells
- which are genetically variable [5]

8 Give an account of the process of osmosis and its effect in animal and plant cells. [15]

8 The process of osmosis:

At least four points (i.e. maximum six points)

- osmosis is the diffusion of water/passive movement of water
- through a differentially permeable membrane/phospholipid bilayer
- from a region of high water potential to a region of lower water potential
- water potential has two components, the solute potential and the pressure potential/$\psi_{cell} = \psi_s + \psi_p$
- water potential of pure water is zero since all of the water molecules are free/water potential is a measure of the free energy of the water molecules in a system
- in solutions, some of the water molecules form a shell around the solutes (and are no longer free)/reference to hydration shells
- the presence of solutes causes the solute potential to be negative
- pressure potential arises as a result of fluid being in a confined space/is generally positive

Effects in animal and plant cells:

At least seven points (i.e. maximum nine points)

- in a hypotonic/dilute solution cells will gain water
- animals cells will swell and eventually burst
- since animal cells have no cell wall/plant cells do not burst since they possess a cell wall
- in plant cells the protoplast swells and pushes against the cell wall
- the point at which the protoplast is just touching the cell wall is known as incipient plasmolysis
- thereafter a wall pressure/turgor develops and resists further uptake of water
- until the cell becomes fully turgid when no more water can enter
- in a hypertonic/concentrated solution cells will lose water
- animal cells may be said to crenate
- in plant cells the protoplast (cytoplasm/vacuole) shrinks and pulls away from the cell wall/cells become plasmolysed
- except at points where adjacent protoplasts are joined via plasmodesmata
- in an isotonic solution there is no net movement of water [13]

Revised AS1 January 2009

8 Describe the structure of the cell surface membrane, and explain how its structure determines how molecules pass through. [15]

Thirteen points, at least five in each section

8 Structure of cell surface membrane:

- bilayer of phospholipids
- polar (charged/hydrophilic) phosphate ends outermost
- non-polar (hydrophobic) hydrocarbon chains innermost
- phospholipid layers impregnated with protein
- and glycoprotein/glycolipid
- some proteins are peripheral (or extrinsic) while some are integral (transmembranal or intrinsic)
- proteins have hydrophobic regions in contact with the lipid layer with hydrophilic regions facing out
- carbohydrate (glycocalyx) is found on the outer face only/involved in cell recognition
- movement of the phospholipids with a mix of proteins has given rise to the term "fluid-mosaic" model
- cholesterol may be found (in animal cells) among the hydrocarbon chains/ within the hydrophobic region/influences the "fluidity" of the membrane

Movement of molecules across the membrane:

- lipid-soluble/non-polar molecules can diffuse through the phospholipid layers
- water/O_2/CO_2 move through the phospholipid layers (since they are such small molecules)
- polar molecules (ions, etc.) cannot move through the phospholipid layers
- movement is achieved by special transport proteins/channel proteins
- carrier proteins are specific for a particular type of molecule (or ion)/have specific receptor regions to which the transported molecule/ion attaches
- the number of carriers in the membrane determines the rate of facilitated diffusion/the rate of uptake
- facilitated diffusion is a passive process/takes place along the concentration gradient
- active transport involves movement against the concentration gradient
- active transport involves the expenditure of energy/usage of ATP
- the carrier protein change its three-dimensional shape (transferring the molecule across the membrane in the process)

[13]

AS1 January 2009

8 Give an account of the structure and function of the following cell organelles.

- Golgi apparatus
- Mitochondrion
- Chloroplast [10]

8 **Ten points, at least three in each section.**

Golgi apparatus:

- vesicles containing protein join with the formative (cis-) face of the Golgi apparatus
- the Golgi is a stack of membrane-lined flattened cavities/cisternae
- within the Golgi apparatus protein is modified/stabilised/refined/packaged
- carbohydrate may be added to form glycoprotein
- quaternary structure of proteins may be formed
- vesicles containing the glycoprotein are pinched off the mature (trans-) face of the Golgi/Golgi forms lysosomes

Mitochondrion:

- mitochondria are bounded by a double membrane
- the inner membrane is convoluted to form cristae/are the site of the ETC
- suspended material within the mitochondrion is known as the matrix/the matrix is the site of the Krebs cycle
- the mitochondrion is the organelle of aerobic respiration
- synthesises ATP
- contains mitochondrial DNA

Chloroplast:

- the chloroplast is surrounded by an envelope/double membrane
- contains an internal system of membranes known as lamellae
- organised into thylakoids that are stacked to form grana
- the lamellae (thylakoids) contain chlorophyll pigments that absorb light/are the site of the light dependent reaction
- the chloroplast matrix is known as the stroma/the stroma is the site of the light independent reaction
- synthesised products are stored as starch grains (and lipid droplets)/ chloroplast DNA is present [10]

AS1 June 2008

8 Give an account of the distribution and role of carbohydrates, including monosaccharides, disaccharides and polysaccharides. [10]

8 Ten points at least two in each section

Monosaccharides:

- ribose (a pentose) is a component of RNA
- deoxyribose (also a pentose) is a component of DNA
- α-glucose (a hexose) is a building unit of glycogen/starch
- β-glucose (also a hexose) is a building unit of cellulose
- monosaccharides are soluble and may thus be moved through the cell membrane
- glucose is the form in which carbohydrate is transported via the circulatory system in mammals
- monosaccharides (hexoses) may readily be respired to release energy/produce ATP
- fructose is a monosaccharide found in fruit and honey

Disaccharides:

- maltose is the intermediate product of starch hydrolysis/is found in germinating seeds such as barley
- it consists of two α-glucose units
- sucrose is the main form in which energy is transported through a plant
- it also acts as an energy storage compound (for example, in beet, carrots and onions)
- it consists of glucose and fructose

Polysaccharides:

- starch is the main energy storage compound in plants
- it consists of a mixture of two polysaccharides, amylose and amylopectin
- it is initially stored in chloroplasts/finally stored in roots/tubers/seeds
- glycogen/amylopectin is highly branched and so is more readily hydrolysed/is compact
- glycogen is the energy storage carbohydrate in animals
- it occurs in the liver and muscle of mammals (and occurs in fungi)
- polysaccharides are insoluble and therefore are osmotically inactive
- cellulose forms the main constituent of plant cell walls
- it consists of long, straight parallel chains cross-linked by hydrogen bonds
- the cellulose wall has high tensile strength/prevents the cell lysing in hypotonic solution
- polysaccharides can form glycoproteins that provide recognition sites on cell membranes [10]

AS1 January 2008

8 Give an account of the structural and functional differences between animal and plant cells. [10]

8 Ten points with a maximum of three in any one section

Chloroplast:
- plant cells may possess chloroplasts surrounded by a double membrane/ envelope
- contain an internal membrane system, lamellae/thylakoids/grana
- and a matrix known as stroma
- chlorophyll (and other pigments) are contained on the internal membranes (site of light-dependent reactions)
- while light-independent reactions take place in the stroma

Cell wall:
- plant cells possess a cellulose cell wall while animal cells lack a cell wall
- cellulose fibrils are composed of chains (of β-glucose) linked by H-bonds
- the cell wall prevents the cell lysing in hypotonic/high water potential conditions
- since a wall pressure develops to negate the high turgor pressure

Plasmodesmata:
- plant cells are connected via plasmodesmata/channels of interconnecting cytoplasm
- allowing direct movement of molecules between cells

Centrioles
- animal cells possess centrioles/plant cells lack centrioles
- centrioles are organelles containing microtubules
- in animal cells centrioles produce the spindle
- in plant cells the spindle is produced from "free" microtubules

Cytokinesis:
- animal cells divide via a cleavage furrow
- whereby the membrane is pulled in by microtubules along the equatorial plane
- plant cells divide via the production of a cell plate/phragmoplast
- from coalescing vesicles produced by Golgi bodies/dictyosomes

Vacuoles:
- plant cells normally possess vacuoles
- the sap vacuole is surrounded by the tonoplast
- it stores nutrients and excretory products

Lysosomes:
- animal cells possess lysosomes
- that contain powerful hydrolytic enzymes
- involved in intracellular digestion/autolysis

Carbohydrate storage:
- plant cells have starch grains while animal cells may have glycogen
- any plant cell may contain starch, glycogen is confined to muscle/liver cells
- starch consists of amylose and amylopectin/glycogen is more highly branched
- other appropriate responses [10]

AS1 January 2007

8 Give an account of the structure of DNA and RNA and outline their functions. [10]

8 DNA:

Any five from

- DNA consists of two strands running antiparallel/held by H-bonds
- each strand is a chain of nucleotides held together by condensation bonds
- each nucleotide (in DNA) consists of deoxyribose, phosphate and an organic base
- deoxyribo-nucleotides contain the bases adenine, guanine, cytosine and thymine/base pairing occurs between the two strands, specifically adenine with thymine, and guanine with cytosine (purine pairs with pyrimidine)
- DNA exists in two functional states, heterochromatin and euchromatin
- the base sequence of the sense strand represents the genetic code
- it is responsible for the production of mRNA/and ultimately the synthesis of a polypeptide **[allow below if not awarded here]**
- DNA is also capable of self replication/semi-conservative replication
- in eukaryotes, the DNA is coated with histone protein/in prokaryotes the DNA is "naked" (lacks the histone protein coat)

RNA:

Any five from

- RNA consists of a single strand of ribo-nucleotides
- ribo-nucleotides consist of ribose, phosphate and an organic base/ ribo-nucleotides contain the bases adenine, guanine, cytosine and uracil
- there are three types of RNA, namely messenger-RNA, ribosomal-RNA and transfer-RNA
- the function of mRNA is to carry the genetic code into the cytoplasm
- the order of bases determines the order with which amino acids are brought together (during the synthesis of a polypeptide)/determines the primary structure of the protein/reference to translation
- rRNA is synthesised in the nucleolus/rRNA forms part of the structure of ribosomes
- to which mRNA attaches prior to the synthesis of a polypeptide/ which act as the site of polypeptide synthesis
- tRNA carries amino acids to the mRNA
- tRNA also possesses an anticodon which base pairs with a specific codon on the mRNA [10]

AS1 January 2006

8 Give an account of the role of each of the following in the synthesis and secretion of a glycoprotein (such as mucus from cells lining the respiratory and digestive systems).

- rough endoplasmic reticulum
- Golgi apparatus
- secretory vesicles [10]

8 **Ten points (with at least three from each section)**

Rough endoplasmic reticulum:

- the rough endoplasmic reticulum is a system of membrane-lined flattened cavities (cisternae) encrusted with ribosomes
- attached ribosomes are the sites of synthesis of the protein component
- ribosomes hold messenger RNA (transcribed from DNA) which directly codes for amino acid sequencing/reads codons on mRNA
- synthesised protein passes through the endoplasmic reticulum membrane and accumulates in the cavities of the endoplasmic reticulum
- vesicles containing the protein are pinched off the rough ER
- transporting the synthesised protein to the Golgi apparatus

Golgi apparatus:

- vesicles containing protein join with the formative face of the Golgi apparatus
- the Golgi is a stack of membrane-lined flattened cavities (cisternae)
- within the Golgi apparatus the protein is modified/glycoprotein is formed
- carbohydrate is added
- protein structure is as a result stabilised
- vesicles containing the glycoprotein are pinched off
- the mature face of the Golgi apparatus

Secretory vesicles:

- vesicles are small (usually less than 100 nanometers in diameter), spherical and bound by a single membrane
- vesicles containing the glycoprotein move towards the cell surface membrane
- on arriving there the membrane of the vesicle coalesces with the cell surface membrane
- the contents – the glycoprotein – move to the exterior/is secreted
- the process is known as exocytosis
- the vesicle membrane is incorporated into the cell surface membrane (as it has the same phospholipid bi-layer structure) [10]

AS1 June 2005

8 Give an account of cell division, to include the following.

- mitosis
- cytokinesis and other phases of the cell cycle. [10]

8 Mitosis:

Any five from

- mitosis consists of four stages: prophase, metaphase, anaphase and telophase
- during prophase chromosomes shorten and thicken/condense
- each chromosome consists of two chromatids joined at the centromere
- a system of microtubules, the spindle, forms
- centrioles migrate to poles
- the nuclear membrane breaks down and the nucleolus disappears
- during metaphase the chromosomes are aligned along the equator of the spindle
- with chromosomes attached to spindle fibres by their centromeres
- during anaphase the centromeres holding the chromatids together split in two
- and the chromatids/newly independent chromosomes of each pair are pulled by the spindle fibres to opposite ends of the cell
- during telophase the two groups of chromosomes reach opposite poles of the cell and the nuclear membrane forms around each group/chromosomes become diffuse [5]

Cytokinesis and other phases of the cell cycle:

Any five from

- cytokinesis follows mitosis
- cytokinesis is the division of the whole cell/splitting cytoplasm/produces two identical cells
- in animal cells this involves the formation of a division furrow (developed when microfilaments pull the surface membrane inwards)
- in plant cells division involves the formation of a cell plate (developed when vesicles formed centrally fuse with one another)
- the phases after cytokinesis in preparation for the next mitotic division are collectively known as interphase/the next phases of the cell cycle are G_1, S and G_2
- in the initial G1 phase new proteins are synthesised, while RNA is produced in the nucleolus/cell growth
- in G1 cell organelles are produced
- in the S phase DNA replication occurs
- description of semi-conservative replication
- in G2 centrioles (if present) replicate
- and mitochondria and chloroplasts divide/energy built up for mitosis [5]

AS1 January 2005

8 Give an account of the structure and function of lipids, to include the following.

- triglycerides
- phospholipids

[10]

8 Triglycerides:

Any five points

- a triglyceride consists of glycerol and three fatty acids
- glycerol is a three carbon molecule
- fatty acids have long hydrocarbon chains
- synthesis involves a condensation reaction/breakdown involves hydrolysis/bonded by ester bonds
- since there are hundreds of kinds of fatty acids there are hundreds of kinds of triglyceride
- saturated fatty acids (or triglycerides) have a full complement of hydrogen/unsaturated fatty acids (or triglycerides) have double bond(s) in the hydrogen chain
- triglycerides containing unsaturated fatty acids are oils (liquid, common in plants)/triglycerides containing saturated fatty acids are fats (solid, common in animals)/triglycerides may be either fats (in animals) or oils (in plants)
- a major function of triglycerides is as an energy store
- a triglyceride yields more energy than the equivalent mass of carbohydrate
- triglycerides are also stored in the skin of mammals where they act as a heat insulator/buoyancy/protection around internal organs (e.g. kidneys)/oils for waterproofing
- triglycerides may conjugate with other molecules, e.g. with carbohydrates to form glycolipids [5]

Phospholipids:

Any five points

- phospholipids are triglycerides in which one of the fatty acids is replaced by a phosphate group
- the phosphate group is (negatively) charged/polar
- so the glycerol-phosphate end of the phospholipid is soluble in water/hydrophilic
- while the fatty acid ends are insoluble in water/hydrophobic
- phospholipids form the basis of the structure of cell membranes where they form a bilayer
- with the hydrophilic heads outermost/with the hydrophobic tails innermost
- phospholipids may move about horizontally within the membrane/ phospholipids determine the fluidity of the membrane
- the fluidity of the membrane is affected by the nature of the phospholipids (e.g. phospholipids with short fatty acids or with unsaturated fatty acids are more fluid than others)
- non-polar molecules which can dissolve in lipid diffuse very quickly through cell membranes/acts as a barrier to water-soluble molecules (or ions)
- phospholipid bilayers may readily coalesce allowing exocytosis/have flexibility allowing endocytosis [5]