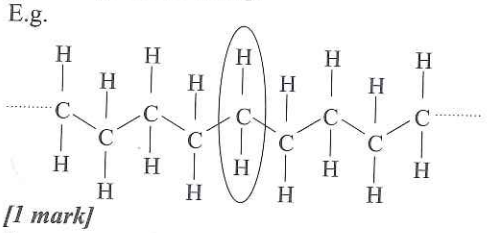
Answers

Topic One — Biological Molecules

Pages 3-4: Biological Molecules — 1

1 A molecule made from a large number of monomers joined together ***[1 mark]***.

2 E.g.



[1 mark]

3 E.g. monosaccharides, amino acids and nucleotides ***[1 mark]***.

1 alpha-glucose/α-glucose ***[1 mark]***

...u must have specified alpha-glucose to get the mark here. Make ...e you know the difference between alpha- and beta-glucose.

2 maltose ***[1 mark]***

3 A water molecule is used ***[1 mark]*** to break/hydrolyse the glycosidic bond in the disaccharide/maltose ***[1 mark]***. This produces the two monomers/alpha-glucose molecules ***[1 mark]***.

1 alpha helix ***[1 mark]***

2 Both secondary and tertiary structures contain hydrogen bonds ***[1 mark]***. Tertiary structures also contain ionic bonds and disulfide bridges ***[1 mark]***.

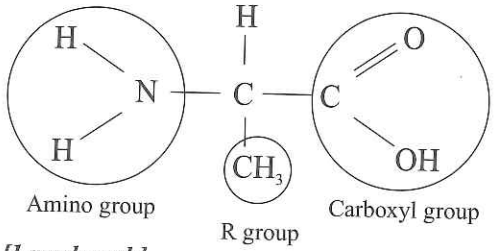
3 Enzymes are proteins that catalyse biological reactions ***[1 mark]***. The tertiary structure affects the shape of an enzyme's active site ***[1 mark]***. The shape of the active site needs to be specific to the shape of the substrate to catalyse the reaction ***[1 mark]***.

4 It is made up of several different polypeptide chains ***[1 mark]***, held together by bonds ***[1 mark]***.

5 A low pH interferes with the bonds in the haemoglobin molecule ***[1 mark]***. This causes its shape to change, so it can no longer bind to oxygen ***[1 mark]***.

Pages 5-8: Biological Molecules — 2

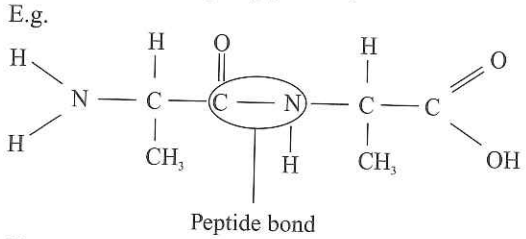
1



[1 mark each]

It has a different R group ***[1 mark]***.

E.g.



[1 mark for the correct diagram, 1 mark for correctly labelling the peptide bond]

water ***[1 mark]***

1.5 The human body contains enzymes (which are not present in the laboratory) ***[1 mark]***. These catalyse the (hydrolysis) reaction that breaks the bond / increase the rate at which the bond is broken down ***[1 mark]***.

2.1 Add Benedict's reagent to the sample and heat in a water bath that has been brought to the boil ***[1 mark]***. A positive result gives a coloured, e.g. yellow/orange/brick-red, precipitate ***[1 mark]***. ✓

2.2

Sample	Type of carbohydrate present ✓		
	Reducing sugar	Non-reducing sugar	Starch
A			
B			
C			

[2 marks for all three correct, otherwise 1 mark for one or two correct answers]

2.3 Any one from: e.g. after testing, they could filter the solutions and weigh the precipitates. / After testing, they could observe the difference in the colour of the precipitates (a green/yellow precipitate indicates less reducing sugar is present than an orange/brick-red precipitate). ***[1 mark]***

2.4 glucose and galactose ***[1 mark]***

3.1 phospholipid ***[1 mark]***

3.2 The phospholipid head is hydrophilic ***[1 mark]***, but the phospholipid tail is hydrophobic ***[1 mark]***. The molecules arrange themselves in this way to prevent the hydrophobic tails from coming into contact with the water ***[1 mark]***.

3.3 E.g. they make up cell membranes ***[1 mark]***. The hydrophobic regions act as a barrier to water-soluble substances ***[1 mark]***.

4.1 Fatty acid 2 has a double bond between two carbon atoms, whereas fatty acid 1 does not ***[1 mark]***. This means that the fatty acid 1 is saturated and fatty acid 2 is unsaturated ***[1 mark]***.

4.2 Three fatty acids combine with one glycerol molecule ***[1 mark]*** in a series of three condensation reactions ***[1 mark]***. These form ester bonds between the glycerol and fatty acids ***[1 mark]***.

4.3 E.g. triglycerides are used for storage of energy ***[1 mark]*** because they're insoluble / they contain lots of chemical energy ***[1 mark]***.

4.4 Shake some of the sample to be tested with ethanol until it dissolves, then pour into a test tube of water ***[1 mark]***. If a lipid is present, a white emulsion will form ***[1 mark]***.

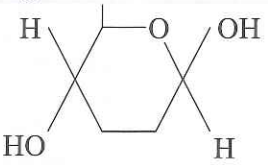
4.5 Lipids cannot dissolve in water so if they are present, they form an emulsion ***[1 mark]***.

Pages 9-12: Biological Molecules — 3

1.1 E.g. it has lots of side branches ***[1 mark]***, meaning stored glucose can be released quickly ***[1 mark]***.

Remember, glycogen is the main energy storage molecule in animals.

1.2 E.g.



[1 mark]

In alpha-glucose the OH/hydroxyl group and the H/hydrogen on the right-hand side are reversed ***[1 mark]***.

You could have drawn the full skeletal formula for beta-glucose here instead.

1.3 It allows cellulose molecules to form strong fibres/microfibrils ***[1 mark]***, which provide structural support/support the cell wall ***[1 mark]***.

1.4 Advantage: e.g. it is more compact ***[1 mark]***.
Disadvantage: e.g. it can't be broken down as quickly ***[1 mark]***.

2.1 At low temperatures, the rate of the reaction is slow because the kinetic energy of the enzyme and substrate molecules is low ***[1 mark]***. As temperature increases to the optimum, the rate increases as there are more successful collisions between enzymes and substrate molecules ***[1 mark]***. At temperatures higher than the optimum, the rate decreases as the enzyme is denatured ***[1 mark]***.

2.2 Enzyme B because it has the higher optimum temperature ***[1 mark]***, which will allow it to function at the higher temperatures found in a tropical climate ***[1 mark]***.

2.3 The rate of reaction would be lower across the whole temperature range ***[1 mark]***.

2.4 The insecticide molecule is a similar shape to enzyme A's substrate ***[1 mark]***. The insecticide molecule occupies enzyme A's active site ***[1 mark]*** so the substrate cannot fit and the respiration reaction cannot be catalysed ***[1 mark]***. This interrupts the respiration process and kills the insect ***[1 mark]***.

3.1 Add a few drops of sodium hydroxide to a solution of the sample ***[1 mark]***, then a few drops of copper (II) sulfate solution ***[1 mark]***. A colour change from blue to purple/lilac is a positive result ***[1 mark]***.

3.2 Its parallel chains and cross linkages make it physically strong ***[1 mark]***.

3.3 E.g. Protein B: an enzyme ***[1 mark]***.
Protein C: an antibody ***[1 mark]***.

Enzymes are usually proteins that are roughly spherical, so B could be an enzyme. The two light and two heavy polypeptide chains are typical of an antibody, so C is likely to be an antibody.

3.4 Channel proteins transport molecules and ions across cell membranes ***[1 mark]***. The hydrophobic regions are repelled by water and the hydrophilic regions are attracted to it ***[1 mark]***. This causes the protein to fold up and form a channel through the membrane (through which water soluble molecules can pass) ***[1 mark]***.

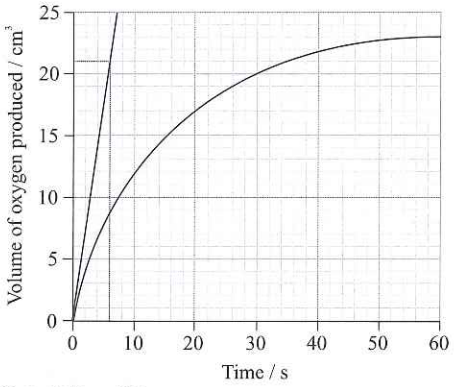
4.1 The independent variable is enzyme concentration and the dependent variable is the volume of oxygen produced ***[1 mark]***.

4.2 ± 0.5 cm^3 ***[1 mark]***

4.3 E.g. collected the gas in a measuring cylinder with a smaller resolution ***[1 mark]***.

4.4 $\text{Rate} = \frac{17}{20}$
$= \mathbf{0.85\ cm^3\ s^{-1}}$
[1 mark for 0.85, 1 mark for the correct units]

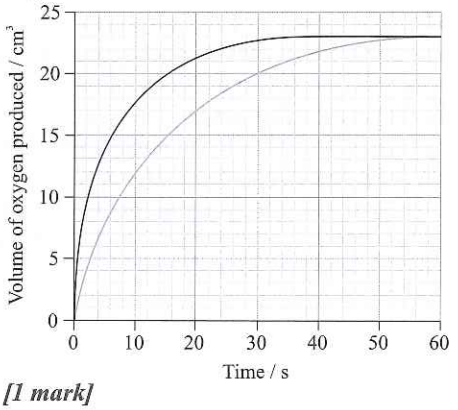
4.5



E.g. $\text{rate} = \frac{21}{6.0}$
$= \mathbf{3.5\ cm^3\ s^{-1}}$
[1 mark, accept anything from 3.2 $cm^3\ s^{-1}$ to 3.8 $cm^3\ s^{-1}$]

Tangents can be tricky things to draw accurately so the examiners will usually accept answers that are a bit below or a bit above what they got themselves — even so, try to draw your line as carefully as you can.

4.6 E.g.



[1 mark]

Don't worry if your line's not exactly like this. You just need to make sure it's steeper than the original but still starts and plateaus at the same values.

Pages 13-15: More Biological Molecules

1.1 E.g. it is involved in the co-transport of glucose/amino acids across cell membranes ***[1 mark]***.

1.2 E.g. a higher concentration of hydrogen ions lowers the pH ***[1 mark]***, so the internal environment becomes more acidic ***[1 mark]***.

1.3 Nitrate ions contain nitrogen/N ***[1 mark]*** which forms part of the organic base in DNA ***[1 mark]***.

2.1 Because water has a high latent heat of vaporisation ***[1 mark]***, a lot of energy is removed from the kangaroo's body when the water in the saliva evaporates from its forearms ***[1 mark]***. This reduces the kangaroo's body temperature ***[1 mark]***.

2.2 Water has a high specific heat capacity *[1 mark]*, which means it doesn't heat up as quickly as the air *[1 mark]*.

2.3 There is strong cohesion between water molecules *[1 mark]*. This allows water to travel in a column up the xylem/tube-like transport cells in a tree trunk *[1 mark]*.

1.1 phosphodiester bond *[1 mark]*

1.2 condensation reaction *[1 mark]*

1.3 The molecule contains uracil/U bases (in place of thymine/T bases) *[1 mark]*.

1.4 Complementary/specific base pairing *[1 mark]* means that hydrogen bonds will form between the base pairs A and U, and C and G *[1 mark]*. Because the two halves of the RNA sequence are complementary, it causes the RNA strand to fold into a stem-loop structure *[1 mark]*.

1.1 DNA helicase separates the nucleotide strands / causes the DNA helix to unwind *[1 mark]* by breaking the hydrogen bonds between bases *[1 mark]*. DNA polymerase joins the nucleotides in the new DNA strand together *[1 mark]* by catalysing condensation reactions between the nucleotides *[1 mark]*.

1.2 It is known as a nucleotide derivative because it has a similar structure to a(n) (adenine) nucleotide *[1 mark]* but it has been modified with the addition of two more phosphate groups *[1 mark]*.

1.3 It catalyses the breakdown of ATP *[1 mark]* into ADP and inorganic phosphate *[1 mark]*.

1.4 The results show that DNA replication will not occur in the absence of ATP or when ATP hydrolase is inactive *[1 mark]*. This indicates that the breakdown of ATP (by ATP hydrolase) is essential for DNA replication *[1 mark]*. A possible explanation is that DNA replication requires energy and/or inorganic phosphate released by the breakdown of ATP *[1 mark]*.

pic Two — Cells

es 16-18: Cell Structure and Division — 1

The student could have placed the root tip on a microscope slide and cut 2 mm/a small section from the very tip of it *[1 mark]*. Then used a mounted needle to break the tip open and spread the cells out thinly *[1 mark]*. Then added a few drops of stain, e.g. ethano-orcein or toluidine blue O, and left it for a few minutes *[1 mark]*. Then placed a cover slip over the cells and pushed down firmly *[1 mark]*.

Any two from: e.g. worn goggles/gloves / taken care with glass beakers/slides/cover slips / taken care with sharp tools. *[1 mark for each correct answer]*

Root tips are actively growing so the cells here will be undergoing mitosis/dividing *[1 mark]*.

E.g. if a cell contains visible chromosomes this indicates that it is dividing *[1 mark]*.

$$\text{mitotic index} = \frac{\text{number of cells with visible chromosomes}}{\text{total number of cells observed}}$$

$80 + 240 = 320$ cells in total

$240 \div 320 = \mathbf{0.75}$

[2 marks for the correct answer, otherwise 1 mark for the correct working]

2.1 E.g. because electron microscopes have a higher resolution *[1 mark]* so they can be used to look at smaller objects (like bacteria) in more detail *[1 mark]*.

2.2 A transmission electron microscope/TEM *[1 mark]*. E.g. transmission electron micrographs show a 2D cross section through a sample as seen in Figure 1 *[1 mark]*.

2.3 Any two from: e.g. a prokaryotic cell is smaller than a eukaryotic cell. / There is no nucleus present in a prokaryotic cell. / A prokaryotic cell contains no membrane-bound organelles. / Ribosomes are smaller in a prokaryotic cell than in a eukaryotic cell. / The DNA in a prokaryotic cell is circular, not linear. / A prokaryotic cell may contain plasmids. *[2 marks]*

2.4 Human cells have no cell wall, so the drugs will have no effect on them *[1 mark]*.

2.5 WNV has an attachment protein on its surface *[1 mark]* which binds to the complementary $\alpha_v\beta_3$ integrin present on human cells *[1 mark]*. If $\alpha_v\beta_3$ integrin isn't functioning on human cells, WNV wouldn't be able to invade and reproduce inside these cells *[1 mark]*.

3.1 Similarities: any one from: e.g. a sperm cell and a bacterial cell can both have a flagellum *[1 mark]*. / A sperm cell and a bacterial cell both have a cell membrane *[1 mark]*.

Differences: any one from: e.g. a sperm cell has a nucleus but a bacterial cell has circular DNA floating freely in the cytoplasm *[1 mark]*. / A bacterial cell has a cell wall but a sperm cell only has a cell membrane *[1 mark]*.
[Maximum 2 marks available]

3.2 The flagellum requires ATP to move, which is generated by mitochondria *[1 mark]*.

3.3 E.g. a transmission/scanning electron microscope *[1 mark]* because these have a higher resolution than light microscopes, which would be needed to study the internal detail of mitochondria *[1 mark]*.

3.4 As the function of sperm is to deliver the genetic material to the egg, it isn't necessary for it to make lots of proteins for cell growth and repair / having lots of organelles may reduce its motility *[1 mark]*. A mitotic body cell is undergoing mitosis/division *[1 mark]*, so it requires ribosomes for cell growth prior to division *[1 mark]*.

Pages 19-21: Cell Structure and Division — 2

1.1 A cell that carries out a particular function *[1 mark]*.

1.2 E.g. each cell would only contain one nucleus. / Each nucleus would contain the same amount of genetic material. *[1 mark]*

1.3 The role of cell type A is to ingest invading pathogens because a greater percentage of the cell contains lysosomes than cell type B *[1 mark]*. Lysosomes are necessary to digest pathogens once they have been ingested by the cell *[1 mark]*. The role of cell type B is to secrete enzymes because a greater percentage of the cell contains rough endoplasmic reticulum than cell type A *[1 mark]*. This organelle is covered with ribosomes which synthesise proteins, such as enzymes / is responsible for folding and processing proteins, such as enzymes *[1 mark]*.