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AS Level Biology

Topic 1: Biological Molecules

AQA Biology (7401) | Mark Scheme | 100 marks

Instructions

- Answer **all** questions.
- In calculations show your working and give your answer to an appropriate number of significant figures.
- In extended-response questions you should write in clear, well-organised continuous prose.
- There are 15 questions in this paper. The total mark is **100**.

1. This question is about monomers and polymers.

(a) Define the term *monomer*. **(1)**

✓ a smaller/single molecule (unit) from which larger molecules (polymers) are made (1)

(b) Name the type of reaction that joins two monomers together and releases a molecule of water. **(1)**

✓ condensation (reaction) (1)

(c) Name the type of reaction in which a bond between two monomers is broken by the addition of water. **(1)**

✓ hydrolysis (1)

2. This question is about carbohydrates.

(a) Name the bond formed between two monosaccharides in a disaccharide. **(1)**

✓ glycosidic bond (1)

(b) Name the disaccharide formed from two molecules of α-glucose. **(1)**

✓ maltose (1)

(c) Name the two monosaccharides that join together to form sucrose. **(2)**

✓ glucose (1)
✓ fructose (1)

(d) Name the disaccharide found in milk and the two monosaccharides that form it. **(2)**

✓ lactose (1)
✓ glucose and galactose (1)

3. A student carried out food tests on an unknown solution.

(a) Describe how the student could test the solution for the presence of a reducing sugar, and state the positive result. **(3)**

✓ add Benedict's (solution) (1)
✓ heat / place in a water bath (1)
✓ positive result = colour change from blue to (brick/orange-) red precipitate (1)

(b) The student found no reducing sugar was present. Describe how they could then test for a non-reducing sugar. **(3)**

✓ boil/heat the sample with dilute hydrochloric acid (then neutralise with sodium hydrogencarbonate) (1)
✓ then carry out the Benedict's test again (heat with Benedict's) (1)
✓ a (brick-)red precipitate now shows a non-reducing sugar was present (1)

(c) State the reagent used to test for starch and the colour change for a positive result. **(2)**

✓ iodine (in potassium iodide) solution (1)
✓ orange/brown to blue-black (1)

4. This question is about polysaccharides.

(a) Name the two polysaccharides that make up starch. **(2)**

✓ amylose (1)
✓ amylopectin (1)

(b) Explain how the structure of glycogen makes it a good storage molecule in animal cells. **(3)**

✓ it is insoluble so does not affect water potential / does not draw water in by osmosis (1)
✓ it is compact / coiled so large amounts can be stored (1)
✓ it is highly branched so glucose can be released/added rapidly (many ends for enzymes) (1)

(c) Cellulose is a structural polysaccharide. Describe how the structure of cellulose is related to its function in plant cell walls. **(4)**

✓ made of β-glucose monomers (1)
✓ alternate molecules are inverted/rotated 180° (1)
✓ forming long straight chains held together by hydrogen bonds (1)
✓ chains grouped into microfibrils giving strength/rigidity to the cell wall (1)

5. This question is about the structure of glucose.

(a) State the general formula of a hexose monosaccharide. **(1)**

✓ $C_6H_{12}O_6$ (1)

(b) α-glucose and β-glucose are isomers. State what is meant by the term *isomers*. **(1)**

✓ molecules with the same molecular formula but a different arrangement of atoms (1)

(c) State one property of glucose that makes it suitable for transport in the blood. **(1)**

✓ soluble (in water) (1)

6. This question is about lipids.

(a) Name the two types of molecule that join to form a triglyceride. **(2)**

✓ glycerol (1)
✓ (three) fatty acids (1)

(b) Name the bond formed between glycerol and a fatty acid. **(1)**

✓ ester bond (1)

(c) Explain the difference between a saturated and an unsaturated fatty acid. **(2)**

✓ a saturated fatty acid has no carbon-carbon double bonds (only single bonds) (1)
✓ an unsaturated fatty acid has one or more carbon-carbon double bonds (1)

(d) Describe how the structure of a phospholipid differs from that of a triglyceride. **(2)**

✓ a phospholipid has only two fatty acids (1)
✓ one fatty acid is replaced by a phosphate group (1)

7. This question is about the role of phospholipids in membranes.

(a) State what is meant by the term *hydrophilic*. **(1)**

✓ attracted to / interacts with water (1)

(b) Explain why phospholipids form a bilayer when placed in water. **(3)**

✓ the phosphate head is hydrophilic so faces/interacts with water (1)
✓ the fatty acid tails are hydrophobic so point away from water (1)
✓ so heads face outwards to the water and tails face inwards, forming a bilayer (1)

8. This question is about proteins.

(a) Name the monomer from which proteins are made. **(1)**

✓ amino acid (1)

(b) Name the bond formed between two amino acids in a dipeptide. **(1)**

✓ peptide bond (1)

(c) Draw or describe the general structure of an amino acid, naming the groups present. **(3)**

✓ a central carbon atom (1)
✓ an amine group (NH_2) and a carboxyl group (COOH) (1)
✓ an R group / variable (side) group and a hydrogen atom (1)

(d) Describe how a dipeptide is formed from two amino acids. **(2)**

✓ a condensation reaction occurs (1)
✓ forming a peptide bond and releasing a molecule of water (1)

9. This question is about the structure of proteins.

(a) Describe what is meant by the *primary structure* of a protein. **(1)**

✓ the sequence/order of amino acids (in the polypeptide chain) (1)

(b) Describe the *secondary structure* of a protein, including the bonds involved. **(2)**

✓ folding/coiling of the chain into an α-helix or β-pleated sheet (1)
✓ held by hydrogen bonds (1)

(c) Describe the *tertiary structure* of a protein and name three types of bond that hold it in shape. **(4)**

✓ the overall 3-D shape of the polypeptide (further folding) (1)
✓ hydrogen bonds (1)
✓ ionic bonds (1)
✓ disulfide bridges/bonds (1)

(d) Describe what is meant by the *quaternary structure* of a protein. **(2)**

✓ a protein made of more than one polypeptide chain (1)
✓ the arrangement of these chains (relative to each other) (1)

10. A student tested a solution for protein.

(a) Name the test used to identify the presence of protein and describe the procedure. **(2)**

✓ the biuret test (1)
✓ add sodium hydroxide solution then copper(II) sulfate solution (1)

(b) State the colour change seen for a positive result. **(1)**

✓ blue to purple/lilac/violet (1)

11. This question is about enzymes as biological catalysts.

(a) State what is meant by the term *enzyme*. **(1)**

✓ a (biological) catalyst that speeds up a reaction (without being used up) (1)

(b) Explain how an enzyme lowers the activation energy of a reaction. **(3)**

✓ the substrate binds to the active site forming an enzyme-substrate complex (1)
✓ this puts strain on bonds in the substrate / brings reactants together / changes shape (1)
✓ so less energy is needed for the reaction to occur (lower activation energy) (1)

(c) Explain the difference between the 'lock and key' model and the 'induced fit' model of enzyme action. **(3)**

✓ in the lock and key model the active site is a fixed/complementary shape to the substrate (1)
✓ in the induced fit model the active site changes shape (slightly) as the substrate binds (1)
✓ this change moulds the active site around the substrate / makes the fit closer (to put strain on bonds) (1)

12. A student investigated the effect of temperature on the rate of an enzyme-catalysed reaction.

(a) Describe and explain how increasing temperature from 10 °C to 40 °C affects the rate of reaction. **(3)**

✓ rate increases (1)
✓ molecules have more kinetic energy so move faster (1)
✓ more frequent successful collisions between enzyme and substrate / more enzyme-substrate complexes form (1)

(b) Above the optimum temperature the rate decreases. Explain why. **(3)**

✓ the enzyme denatures (1)
✓ hydrogen/ionic bonds break, changing the tertiary structure / shape of the active site (1)
✓ the substrate can no longer bind / no enzyme-substrate complexes form (1)

(c) Explain how a change in pH away from the optimum can reduce the rate of an enzyme-catalysed reaction. **(3)**

✓ H^+/OH^- ions interfere with/break hydrogen and ionic bonds in the enzyme (1)
✓ the tertiary structure / shape of the active site changes (1)
✓ the substrate is no longer complementary so fewer enzyme-substrate complexes form (1)

13. This question is about enzyme inhibition.

(a) Describe how a *competitive inhibitor* reduces the rate of an enzyme-catalysed reaction. **(3)**

✓ it has a similar shape to the substrate (1)
✓ so it binds to / blocks the active site (1)
✓ preventing the substrate from binding, so fewer enzyme-substrate complexes form (1)

(b) Explain how the effect of a competitive inhibitor can be reduced by increasing the substrate concentration. **(2)**

✓ more substrate molecules are present to compete with the inhibitor (1)
✓ so substrate is more likely to bind to the active site / the inhibitor is outcompeted (1)

(c) Describe how a *non-competitive inhibitor* reduces enzyme activity. **(3)**

✓ it binds to the enzyme at a site other than the active site (allosteric site) (1)
✓ this changes the shape of the active site (1)
✓ so the substrate can no longer bind / no enzyme-substrate complexes form (1)

14. The graph below shows that as substrate concentration increases, the rate of an enzyme-catalysed reaction increases then levels off at a maximum value.

(a) Explain why the rate of reaction increases as substrate concentration increases (at low concentrations). **(2)**

✓ more substrate molecules / more frequent collisions between substrate and active sites (1)
✓ so more enzyme-substrate complexes form per unit time (1)

(b) Explain why the rate levels off at high substrate concentrations. **(2)**

✓ all the active sites are occupied / the enzyme is the limiting factor (1)
✓ adding more substrate has no further effect (until more enzyme is added) (1)

15. This question is about testing for lipids and interpreting biochemical tests.

(a) Describe how the emulsion test is used to test for the presence of a lipid, and state the positive result. **(3)**

✓ add ethanol to the sample and shake/mix (to dissolve the lipid) (1)
✓ then add (an equal volume of) water and mix (1)
✓ a (milky) white emulsion forms if a lipid is present (1)

(b) A student wanted to find which of four solutions contained both a reducing sugar and protein. Describe how they could test for each, and state the positive results. **(4)**

✓ reducing sugar: heat with Benedict's solution (1)
✓ positive = blue to (brick-)red precipitate (1)
✓ protein: add the biuret reagent (sodium hydroxide then copper(II) sulfate) (1)
✓ positive = blue to purple/lilac (1)

(c) Suggest why a student should use the same volume of each solution and the same volume of reagent when comparing the results of these tests. **(2)**

✓ to make it a fair test / so it is a valid comparison (1)
✓ so any difference in colour/precipitate is due to the content of the solution (not the volumes) (1)

(d) The Benedict's test is described as a qualitative test. Describe how the test could be made semi-quantitative to compare the concentration of reducing sugar in different solutions. **(4)**

✓ use a (colorimeter or a) colour standard / known concentrations of reducing sugar (1)
✓ carry out the test on the same volume of each, heating for the same time (1)
✓ compare the colour / amount of red precipitate produced (a deeper red indicates more reducing sugar) (1)
✓ filter and weigh the precipitate / use a colorimeter to measure absorbance for a numerical comparison (1)