

**A-PLUS BIOLOGY**

# **Exam Practice Biological Molecules**

**for AQA A-Level Biology**

## **ANSWER GUIDE**

Companion to the A-Plus Biology Exam Practice Biological Molecules workbook

Original, independent practice material • Not official AQA material • Not endorsed by AQA

Companion workbook title: A-Plus Biology Exam Practice Biological Molecules for AQA A-Level Biology

This is an original, independent practice resource. It is not official AQA material and is not endorsed by AQA. The guide follows the specified question numbering, topic coverage and mark allocations. As the workbook prompts are not reproduced here, each scheme gives the definitive scientific content and indicative marking points without inventing alternative question wording. Award equivalent wording where it communicates the same biological meaning.

## Section totals

- Monomers and polymers, Q1-Q2: 4 marks
- Carbohydrates, Q3-Q5: 9 marks
- Lipids, Q6-Q7: 6 marks
- Proteins, Q8-Q9: 6 marks
- Enzymes, Q10-Q13: 14 marks
- DNA, RNA and replication, Q14-Q16: 10 marks
- ATP, Q17: 3 marks
- Water, Q18-Q19: 5 marks
- Inorganic ions, Q20: 3 marks
- Mixed Mini-Test, Q21-Q30: 40 marks

Whole pack: 100 marks across exactly 30 questions.

## Monomers and polymers — 4 marks

Q1

2 marks

### Answer and explanation

A condensation reaction joins two monomers by forming a covalent bond and releasing a molecule of water. Repeated condensation reactions can build a polymer.

### Indicative marking points

1 mark for the formation of a covalent bond between monomers; 1 mark for the release of water.

Q2

2 marks

### Answer and explanation

Hydrolysis breaks a covalent bond using water. Water is added across the bond, separating a polymer or larger molecule into smaller units.

### Indicative marking points

1 mark for water being used/added; 1 mark for a covalent bond being broken and the molecule split into smaller units.

## Carbohydrates — 9 marks

Q3

3 marks

### Answer and explanation

$\alpha$ -glucose and  $\beta$ -glucose are isomers with the same molecular formula,  $C_6H_{12}O_6$ , but differ in the position of the hydroxyl group attached to carbon 1. In  $\alpha$ -glucose this group is below the plane of the ring; in  $\beta$ -glucose it is above the plane.

### Indicative marking points

1 mark for the same molecular formula; 1 mark for identifying the difference at carbon 1; 1 mark for correctly distinguishing the hydroxyl-group orientation in the two isomers.

Q4

3 marks

### Answer and explanation

Starch is a plant storage polysaccharide made from  $\alpha$ -glucose. Amylose has unbranched chains with  $\alpha$ -1,4 glycosidic bonds that coil; amylopectin has  $\alpha$ -1,4 bonds and  $\alpha$ -1,6 bonds at branch points. Its compact structure makes it suitable for storage, and it is insoluble, so it does not significantly affect water potential.

### Indicative marking points

1 mark for identifying starch as an  $\alpha$ -glucose polymer; 1 mark for accurate amylose/amylopectin bonding or branching; 1 mark for a valid storage adaptation, such as compactness or insolubility/no significant effect on water potential.

Q5

3 marks

### Answer and explanation

Glycogen is a highly branched  $\alpha$ -glucose storage polysaccharide in animals and fungi; its branches allow rapid glucose release. Cellulose consists of  $\beta$ -glucose joined by  $\beta$ -1,4 glycosidic bonds. Alternate monomers are inverted, and hydrogen bonds between parallel chains form strong microfibrils that provide plant cell-wall strength.

### Indicative marking points

1 mark for glycogen as a highly branched  $\alpha$ -glucose storage molecule; 1 mark for cellulose as  $\beta$ -glucose joined by  $\beta$ -1,4 bonds with alternate monomers inverted; 1 mark for hydrogen-bonded microfibrils providing tensile strength.

## Lipids — 6 marks

Q6

3 marks

### Answer and explanation

A triglyceride consists of one glycerol molecule joined to three fatty acids by three ester bonds formed in condensation reactions. A phospholipid has glycerol, two fatty acids and a phosphate-containing group. Its phosphate head is hydrophilic and its fatty-acid tails are hydrophobic, so phospholipids form bilayers in water.

### Indicative marking points

1 mark for triglyceride components and ester bonds; 1 mark for phospholipid components, including phosphate; 1 mark for the hydrophilic head/hydrophobic tails and their bilayer arrangement.

Q7

3 marks

### Answer and explanation

A saturated fatty acid has no carbon-carbon double bonds; an unsaturated fatty acid has one or more. To test for lipid, shake the sample with ethanol, then add water. A cloudy white emulsion indicates lipid; a clear solution is a negative result.

### Indicative marking points

1 mark for the distinction based on carbon-carbon double bonds; 1 mark for dissolving/shaking the sample with ethanol and adding water; 1 mark for identifying a cloudy white emulsion as a positive result.

## Proteins — 6 marks

Q8

3 marks

### Answer and explanation

Amino acids have a central carbon bonded to an amino group, a carboxyl group, a hydrogen atom and a variable R group. Amino acids join by peptide bonds in condensation reactions. The amino-acid sequence is the primary structure; folding produces higher levels of structure, stabilised by interactions including hydrogen bonds, ionic bonds and disulfide bridges.

### Indicative marking points

1 mark for the general amino-acid structure or role of the variable R group; 1 mark for peptide-bond formation by condensation; 1 mark for sequence/primary structure and a correct structural interaction or level of folding.

**Answer and explanation**

In the Biuret test, add Biuret reagent to the sample. A lilac or purple colour indicates peptide bonds and therefore protein; a blue result is negative. The test detects peptide bonds, not a particular protein or amino-acid sequence.

**Indicative marking points**

1 mark for adding Biuret reagent; 1 mark for a lilac/purple positive result; 1 mark for linking the result to peptide bonds/protein, or identifying blue as negative.

## Enzymes — 14 marks

**Answer and explanation**

A substrate binds at an enzyme's active site. In the induced-fit model, binding causes the active site to change shape slightly, improving complementarity and helping catalyse the reaction. Products are released, and the enzyme can be used again. Enzymes lower activation energy; they do not change the reaction's overall free-energy change.

**Indicative marking points**

1 mark for substrate binding at the active site; 1 mark for induced fit/a shape change; 1 mark for catalysis or reduced activation energy; 1 mark for product release and enzyme reuse, or for correctly stating that the enzyme is not used up.

**Answer and explanation**

Increasing temperature initially increases kinetic energy and collision frequency, so the rate rises up to an optimum. Above the optimum, bonds maintaining the enzyme's tertiary structure are disrupted; the active site changes shape and fewer substrates bind, so the rate falls. A pH change can also alter charges and disrupt bonds, changing the active site and lowering activity away from the optimum.

**Indicative marking points**

1 mark for increased kinetic energy/collision frequency below the optimum; 1 mark for an optimum rate; 1 mark for denaturation/active-site change above the optimum; 1 mark for explaining that pH can alter charges or bonds and reduce substrate binding/activity.

### Answer and explanation

At low substrate concentration, increasing substrate concentration increases the rate because enzyme-substrate complexes form more often. At high substrate concentration, the rate approaches a maximum as active sites become occupied; enzyme concentration then limits the rate. Increasing enzyme concentration can raise the maximum rate if sufficient substrate is available.

### Indicative marking points

1 mark for the increasing rate at low substrate concentration; 1 mark for the plateau explained by active-site saturation; 1 mark for the effect of enzyme concentration or the correct limiting-factor explanation.

Q13

3 marks

### Answer and explanation

A competitive inhibitor binds at the active site and competes with substrate; increasing substrate concentration can reduce its effect. A non-competitive inhibitor binds elsewhere and changes enzyme activity or active-site shape; adding more substrate does not overcome its effect. In practical data, compare rates using the same time interval and control relevant variables such as temperature, pH, enzyme concentration and substrate concentration.

### Indicative marking points

1 mark for competitive inhibition at the active site/competition with substrate; 1 mark for non-competitive binding elsewhere and its effect, or the contrasting effect of more substrate; 1 mark for a valid controlled-variable, rate-comparison or data-interpretation point.

## DNA, RNA and replication — 10 marks

Q14

3 marks

### Answer and explanation

A nucleotide consists of a pentose sugar, a phosphate group and a nitrogen-containing base. DNA contains deoxyribose and the bases A, T, C and G; RNA contains ribose and uses U instead of T. DNA nucleotides are joined in a polynucleotide strand by phosphodiester bonds; complementary DNA bases pair A-T and C-G.

### Indicative marking points

1 mark for the three parts of a nucleotide; 1 mark for an accurate DNA/RNA sugar or base distinction; 1 mark for correct phosphodiester linkage or complementary base pairing.

Q15

3 marks

### Answer and explanation

In double-stranded DNA, A pairs with T and C pairs with G. Therefore, if a sample contains 30% A, it contains 30% T; the remaining 40% is shared equally by C and G, giving 20% C and 20% G. The percentages total 100%.

### Indicative marking points

1 mark for applying A = T; 1 mark for determining the remaining 40% after accounting for A and T; 1 mark for C = G = 20% (accept equivalent correct working and values).

Q16

4 marks

### Answer and explanation

During semi-conservative replication, DNA helicase breaks hydrogen bonds and separates the strands. Each original strand acts as a template; free DNA nucleotides pair by complementary base pairing. DNA polymerase forms phosphodiester bonds in the new strands. Each daughter DNA molecule contains one original strand and one newly synthesised strand. In Meselson-Stahl-style evidence, cells first grown with heavy nitrogen and then transferred to light nitrogen produce DNA of intermediate density after one generation, supporting semi-conservative replication; after two generations, intermediate and light DNA are expected.

### Indicative marking points

1 mark for strand separation and each strand acting as a template; 1 mark for complementary base pairing; 1 mark for DNA polymerase/phosphodiester-bond formation; 1 mark for the one-old/one-new outcome or correctly interpreting the intermediate-density evidence after one generation.

## ATP — 3 marks

Q17

3 marks

### Answer and explanation

ATP consists of adenine, ribose and three phosphate groups. Hydrolysis removes the terminal phosphate:  $\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{P}_i$ . The reaction releases usable energy, and inorganic phosphate can phosphorylate another molecule, making it more reactive or changing its properties.

### Indicative marking points

1 mark for ATP structure; 1 mark for hydrolysis to ADP and inorganic phosphate; 1 mark for energy transfer and/or phosphorylation of a molecule.

## Water — 5 marks

Q18

2 marks

**Answer and explanation**

Water is polar, so it forms hydrogen bonds and dissolves many ionic and polar substances. It is therefore an effective transport medium for dissolved substances, for example in blood plasma or plant phloem.

**Indicative marking points**

1 mark for polarity/solvent properties; 1 mark for a linked transport or solution function.

Q19

3 marks

**Answer and explanation**

Hydrogen bonds between water molecules give water a high specific heat capacity, helping aquatic habitats resist rapid temperature change. Water also has a high latent heat of vaporisation, so evaporation removes substantial heat and cools organisms. Cohesion between water molecules helps maintain an unbroken column in xylem.

**Indicative marking points**

1 mark for high specific heat capacity linked to temperature stability; 1 mark for high latent heat of vaporisation linked to evaporative cooling; 1 mark for cohesion linked to water transport in xylem or another valid property-function link.

**Inorganic ions — 3 marks**

Q20

3 marks

**Answer and explanation**

Hydrogen ions affect pH and can influence enzyme activity. Iron ions are required in haemoglobin, where iron binds oxygen. Sodium ions contribute to co-transport and the sodium gradient across membranes. Phosphate ions are components of ATP, nucleotides and phospholipids.

**Indicative marking points**

Award 1 mark for each correct ion-role link, up to 3 marks. Accept any three accurate links from hydrogen, iron, sodium and phosphate.

**Mixed Mini-Test — 40 marks**

Suggested practice time: 45 minutes (my recommendation; not an official exam duration).

Q21

4 marks

**Answer and explanation**

Two glucose molecules can join by condensation, forming a glycosidic bond and releasing water. Hydrolysis adds water to break a glycosidic bond and release smaller carbohydrate units. The bond type in a disaccharide depends on the monosaccharides and their linkage; for example, maltose contains an  $\alpha$ -1,4 glycosidic bond.

**Indicative marking points**

1 mark for condensation joining monomers; 1 mark for glycosidic-bond formation; 1 mark for hydrolysis using water to break the bond; 1 mark for a correct example or accurate distinction between the reactions.

Q22

4 marks

**Answer and explanation**

In the iodine test, add iodine solution to the sample. A blue-black colour indicates starch; yellow-brown indicates no starch. A positive result is consistent with iodine associating with the coiled amylose component of starch. Use a water control and compare samples under the same conditions.

**Indicative marking points**

1 mark for adding iodine solution; 1 mark for blue-black as positive; 1 mark for yellow-brown as negative or a valid explanation involving amylose; 1 mark for an appropriate control or fair comparison.

Q23

4 marks

**Answer and explanation**

A triglyceride contains glycerol and three fatty acids joined by ester bonds. It is a long-term energy store because it contains many energy-rich carbon-hydrogen bonds. A phospholipid has two fatty acids and a phosphate-containing head; its hydrophilic head and hydrophobic tails suit it to forming a cell-surface membrane bilayer.

**Indicative marking points**

1 mark for triglyceride components; 1 mark for ester bonds or condensation formation; 1 mark for a valid energy-storage property; 1 mark for phospholipid structure linked to bilayer function.

Q24

4 marks

**Answer and explanation**

A globular protein's specific three-dimensional shape is determined by its amino-acid sequence and folding. Interactions including hydrogen bonds, ionic bonds and disulfide bridges help stabilise that shape. If temperature or pH disrupts these interactions, the protein may denature and lose its function. A positive Biuret test is lilac or purple because the reagent detects peptide bonds.

#### Indicative marking points

1 mark for the sequence/folding determining shape; 1 mark for a correct stabilising interaction; 1 mark for denaturation and loss of function; 1 mark for the correct Biuret positive result and peptide-bond link.

Q25

4 marks

#### Answer and explanation

In an enzyme practical, calculate rate consistently, for example product formed divided by time or substrate used divided by time. Compare treatments only when other relevant variables are controlled, including temperature, pH, enzyme concentration and substrate concentration. Repeat measurements and use a mean to reduce the influence of random error; identify anomalous results and treat them transparently. A change in rate should be attributed to the tested variable only if the comparison is fair.

#### Indicative marking points

1 mark for a valid rate calculation; 1 mark for controlling relevant variables; 1 mark for repeats/mean or appropriate treatment of anomalous data; 1 mark for a justified conclusion tied to the data and fair test.

Q26

4 marks

#### Answer and explanation

In DNA, A pairs with T and C pairs with G. If double-stranded DNA has 18% guanine, it has 18% cytosine, so  $G + C = 36\%$ . The remaining 64% is  $A + T$ ; equal pairing gives 32% adenine and 32% thymine. The four percentages total 100%.

#### Indicative marking points

1 mark for  $C = G = 18\%$ ; 1 mark for finding  $A + T = 64\%$ ; 1 mark for  $A = T = 32\%$ ; 1 mark for correct, consistent working or a total of 100%.

Q27

4 marks

#### Answer and explanation

DNA helicase separates the strands by breaking hydrogen bonds. Each strand is a template for complementary nucleotide pairing. DNA polymerase joins nucleotides by forming phosphodiester bonds. Semi-conservative replication produces molecules containing one parental strand and one new strand; after one generation in light nitrogen following growth in heavy nitrogen, DNA is of intermediate density.

### Indicative marking points

1 mark for helicase/strand separation; 1 mark for template-directed complementary pairing; 1 mark for DNA polymerase/phosphodiester bonds; 1 mark for the semi-conservative outcome or correct intermediate-density evidence.

Q28

4 marks

### Answer and explanation

ATP hydrolysis is  $\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{P}_i$ . The reaction transfers usable energy to cellular processes. Phosphate may be transferred to another molecule, phosphorylating it and changing its reactivity or shape. ATP is regenerated from ADP and phosphate using energy from respiration or, in photosynthetic cells, light-dependent reactions.

### Indicative marking points

1 mark for the correct hydrolysis equation/products; 1 mark for energy transfer; 1 mark for phosphorylation and its consequence; 1 mark for a valid description of ATP regeneration.

Q29

4 marks

### Answer and explanation

Water's polarity makes it a solvent for many ions and polar molecules, enabling transport in aqueous fluids. Hydrogen bonding gives water a high specific heat capacity, helping stabilise temperature. Cohesion helps maintain continuous water columns in plant xylem. Evaporation requires substantial energy because of water's high latent heat of vaporisation, enabling cooling.

### Indicative marking points

Award 1 mark for each accurate water property linked to a valid biological function, up to 4 marks; accept solvent/transport, thermal stability, cohesion/xylem transport and evaporative cooling.

Q30

4 marks

### Answer and explanation

Hydrogen ions influence pH and therefore the charges and activity of enzymes. Iron ions are present in haemoglobin and enable oxygen binding. Sodium ions are involved in membrane transport, including co-transport driven by sodium gradients. Phosphate ions form part of ATP and nucleotides, and also occur in phospholipids.

### Indicative marking points

Award 1 mark for each correct ion-role link: hydrogen-pH/enzyme activity; iron-haemoglobin/oxygen binding; sodium-gradient/co-transport; phosphate-ATP/nucleotides/phospholipids.

## Mark-allocation check

Topic sections total  $4 + 9 + 6 + 6 + 14 + 10 + 3 + 5 + 3 = 60$  marks. The Mixed Mini-Test is 40 marks. The complete guide covers Q1–Q30 and totals 100 marks.