

Molecules (Form and function) practice questions

16 questions • 48 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 48

Carbohydrates and lipids **Spec B1.1**

1 PAPER 1A STYLE [1 mark]

Which statement describes a hydrolysis reaction?

- A. ☐ Two monomers are linked by a covalent bond and a water molecule is released.
- B. ☐ A water molecule is split and its $-H$ and $-OH$ are added to the products as a bond is broken.
- C. ☐ A polymer is broken into monomers by the removal of water.
- D. ☐ A monomer is oxidised to release energy for the cell.

2 PAPER 1A STYLE [1 mark]

A molecular diagram shows a ring of five carbon atoms and one oxygen atom, with a sixth carbon outside the ring and an $-OH$ group above the ring on carbon 1. Which molecule is shown, and which polymer is it a monomer of?

- A. ☐ Ribose, a monomer of RNA
- B. ☐ Alpha-glucose, a monomer of glycogen
- C. ☐ Beta-glucose, a monomer of cellulose
- D. ☐ Beta-glucose, a monomer of starch

3 PAPER 1A STYLE [1 mark]

A molecule from an animal has a skeleton of four fused carbon rings, three with six carbons and one with five. Which property would allow it to enter a target cell?

- A. ☐ It is hydrophilic, so it passes through protein channels.
- B. ☐ It is amphipathic, so it forms a bilayer with the membrane.
- C. ☐ It is non-polar, so it diffuses through the hydrophobic core of the phospholipid bilayer.
- D. ☐ It is charged, so it is attracted to the phosphate heads and pulled across.

[6 marks]

Melting points of fatty acids with 18 carbon atoms		
Fatty acid	Number of C=C double bonds	Melting point / °C
Stearic acid	0	69
Oleic acid	1	13
Linoleic acid	2	−5
Linolenic acid	3	−11

[illegible]

[3 marks]

[illegible]

[3 marks]

7

[3 marks]

A small hibernating mammal needs 1850 kJ of energy from its stores over the winter. Oxidation releases about 37 kJ g⁻¹ from triglyceride and about 17 kJ g⁻¹ from glycogen. (a) Calculate the mass of triglyceride needed. [1] (b) Calculate how many times greater the mass of glycogen needed would be. [1] (c) Suggest one further reason why storing the energy as triglyceride is an advantage to the mammal. [1]

Answer =

[illegible]

8

[6 marks]

Compare and contrast carbohydrates and lipids as energy storage compounds in living organisms.

[illegible]

Proteins

Spec B1.2

9

[1 mark]

Between which groups does a peptide bond form when two amino acids are joined?

- A. ☐ The R-group of one amino acid and the R-group of the other
- B. ☐ The carboxyl group of one amino acid and the amine group of the other
- C. ☐ The amine groups of both amino acids
- D. ☐ The alpha carbon of one amino acid and the hydrogen of the other

10 PAPER 1A STYLE

[1 mark]

How many different tripeptides could be made from the 20 amino acids coded for in the genetic code?

- A. ☐ 60
- B. ☐ 400
- C. ☐ 1140
- D. ☐ 8000

11 PAPER 1A STYLE

[1 mark]

HL only

Which bond holds an alpha helix in shape?

- A. ☐ Disulfide bonds between pairs of cysteines
- B. ☐ Ionic bonds between charged R-groups
- C. ☐ Hydrogen bonds between C=O and N-H groups of the polypeptide backbone
- D. ☐ Hydrophobic interactions between non-polar R-groups

12 PAPER 1A STYLE

[1 mark]

HL only

Which protein is conjugated?

- A. ☐ Collagen
- B. ☐ Insulin
- C. ☐ Haemoglobin
- D. ☐ A single alpha helix

Samples of an enzyme from a mammal were kept at different temperatures for 10 minutes, then cooled to 37 °C. The activity of each sample was then measured at 37 °C and given as a percentage of the activity of an unheated sample. The data are for practice. (a) Describe the effect of pre-incubation temperature on enzyme activity. [2] (b) Calculate the percentage decrease in activity between 50 °C and 60 °C. [1] (c) Explain why the activity of the samples kept at 70 °C and 80 °C did not recover when cooled. [2] (d) Suggest why activity was measured at 37 °C for every sample. [1]

Activity after 10 minutes at each temperature (practice data)	
Pre-incubation temperature / °C	Activity / % of unheated sample
20	100
40	98
50	80
60	35
70	6
80	0

[illegible]

Distinguish between essential and non-essential amino acids and outline why people following a vegan diet need to pay attention to protein sources.

[illegible]

15

[4 marks]

HL only

Explain how interactions between R-groups stabilise the tertiary structure of a water-soluble globular protein.

[illegible]

16

[7 marks]

HL only

Explain how the structures of insulin and collagen are related to their functions.

[illegible]

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B [1]

2. [1]

C C [1]

3. [1]

C C [1]

4. [6]

- (a) oleic acid [1]
- (b) 74 °C [1] Accept 74 without unit; do not accept 64
- (c) more C=C double bonds, lower melting point / negative correlation [1] Accept: largest decrease between 0 and 1 double bond
- (d) double bonds cause bends / kinks in the hydrocarbon chain [1]
- (d) chains cannot pack closely together so attractions between them are weaker / less energy needed to melt [1] OWTTE
- (e) oils stay liquid at the temperatures of plant tissues / plants are not endotherms, so stores remain fluid / easy to mobilise [1]

5. [3]

- polymer of alpha-glucose [1]
- highly branched / coiled so compact, storing much glucose in a small space [1]
- large molecule so relatively insoluble / no osmotic effect / does not leave the cell [1]
- many chain ends so glucose added or removed quickly by condensation / hydrolysis [1]
- max 3

6. [3]

- glycoproteins are proteins with carbohydrate chains attached on the outer surface of the plasma membrane [1]
- carbohydrate chain acts as a marker / antigen recognised by other cells [1]
- ABO antigens on red blood cells differ in the carbohydrate chain / A and B have an extra sugar, O has neither [1]
- antibodies bind to antigens not present on the recipient's own cells, causing agglutination / so transfused blood must be matched [1]
- max 3

7. [3]

- (a) $1850 \div 37 = 50$ g [1]
- (b) glycogen mass = $1850 \div 17 = 108.8$ g; $108.8 \div 50 = 2.2$ times [1] Accept 2.1-2.2; ECF from (a)
- (c) glycogen is stored with water, so the real difference in mass is greater / triglyceride also provides thermal insulation / insoluble so no osmotic effect [1]

8. [6]

- both contain carbon, hydrogen and oxygen / are carbon compounds [1]
- both are made by condensation and mobilised by hydrolysis [1]
- both are insoluble in their storage form so have little osmotic effect [1]
- carbohydrates are stored as starch in plants and glycogen in animals [1]
- lipids are stored as triglycerides / in adipose tissue in animals / as oils in seeds [1]
- lipids release about twice as much energy per gram when oxidised (about 37 kJ g⁻¹ compared with 17 kJ g⁻¹) [1]
- glycogen is stored with water so is heavier per unit of energy; triglycerides are stored without water [1]
- carbohydrates for short-term storage, lipids for long-term storage [1]
- glucose can be released from glycogen / starch more rapidly, from many branch ends [1]
- triglycerides also act as thermal insulation; polysaccharide stores do not [1]
- glucose is soluble and transported easily, so it is the form carried in blood rather than stored [1]
- max 6

9. [1]

B B [1]

10. [1]

D D [1]

11. [1] HL only

C C [1]

12. [1] HL only

C C [1]

13. [6]

- (a) little / no loss of activity up to 40 °C [1]
- (a) above 40 °C activity falls, steeply between 50 °C and 70 °C / no activity at 80 °C [1]
- (b) $(80 - 35) \div 80 \times 100 = 56\%$ [1] Accept 56.25 %
- (c) the enzyme was denatured / its three-dimensional shape / active site changed [1]
- (c) hydrogen bonds / weak bonds broken by increased vibration; denaturation is (usually) permanent so cooling does not restore the shape [1]
- (d) so that any difference in activity is due only to the effect of the pre-incubation / irreversible change / to control temperature during the assay [1]

14. [3]

- essential amino acids cannot be synthesised by the body / must be obtained from food [1]
- non-essential amino acids can be made from other amino acids [1]
- some plant proteins contain little of certain essential amino acids [1]
- so vegans need a variety of plant protein sources / combine e.g. legumes and cereals [1]
- max 3

15. [4] HL only

- hydrogen bonds form between polar R-groups [1]
- ionic bonds form between positively charged ($-\text{NH}_3^+$) and negatively charged ($-\text{COO}^-$) R-groups [1]
- R-groups become charged by gaining / losing hydrogen ions [1]
- disulfide (covalent) bonds form between pairs of cysteines [1]
- hydrophobic / non-polar R-groups cluster together in the core, away from water [1]
- polar / charged R-groups on the surface keep the protein soluble [1]
- max 4

16. [7] HL only

- primary structure / amino acid sequence determines how each protein folds [1]
- insulin is a globular protein / compact rounded shape [1]
- insulin has two polypeptide chains linked by disulfide bonds / non-conjugated quaternary structure [1]
- hydrophilic R-groups on the surface make insulin soluble, so it is transported in blood plasma [1]
- precise shape binds a specific insulin receptor on target cells [1]
- binding triggers uptake of glucose by target cells / lowers blood glucose [1]
- collagen is a fibrous protein / long, narrow and insoluble [1]
- three polypeptides wound into a triple helix / non-conjugated quaternary structure [1]
- hydrogen bonds between the chains / every third amino acid is glycine, allowing tight packing [1]
- molecules cross-linked side by side into fibrils [1]
- high tensile strength, so it resists pulling forces in tendons / ligaments / skin [1]
- max 7