The chemicals of life

Question Paper

Level	Pre U
Subject	Biology
Exam Board	Cambridge International Examinations
Topic	The origin and evolution of life
Sub Topic	The chemicals of life
Booklet	Question Paper

Time Allowed: **52 minutes**

Score: **/43**

Percentage: **/100**

Part - A

1 Monosaccharides may be used to build a wide variety of biological structures.

Fig. 2.1 shows two simplified β-glucose molecules.

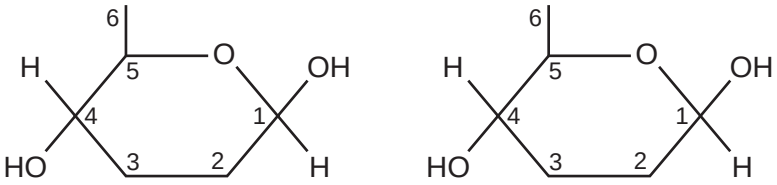

Fig. 2.1

(a) **(i)** Draw a diagram in the space below to show how these molecules can bond together.

[2]

(ii) State the name of the bond you have drawn.

..... [1]

(b) State two similarities and one difference between the structure of ribose and the structure of β-glucose.

similarities

1. .....

2. .....

difference

1. ..... [3]

(c) Another form of glucose is α-glucose.

(i) Describe the advantages to a plant of condensing α-glucose molecules into starch.

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..... [4]

(ii) Suggest why mammals store α-glucose as glycogen rather than as starch.

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..... [1]

[Total: 11]

Part - B

2 The technique of polyacrylamide gel electrophoresis (PAGE) is used to separate and identify proteins. One method of PAGE involves treating proteins with an ionic detergent to dissociate proteins into their constituent polypeptide subunits. Sodium dodecyl sulfate (SDS) is often used for this. Proteins treated with SDS have a uniform net charge on each polypeptide so that during electrophoresis they are separated only on the basis of their relative molecular mass.

After treatment with SDS, proteins are placed in wells cut into a polyacrylamide gel. A dye is added to each sample to show the progress of the samples across the gel. A current is applied to the gel and when the dye reaches a point towards the end of the gel, the current is switched off.

The relative mobility of each polypeptide is calculated as follows:

$$\frac{\text{distance travelled by polypeptide band}}{\text{distance travelled by dye front}}$$

Six proteins, **A**, **B**, **C**, **D**, **E** and **F**, were analysed with SDS-PAGE and the results are shown in Fig. 3.1.

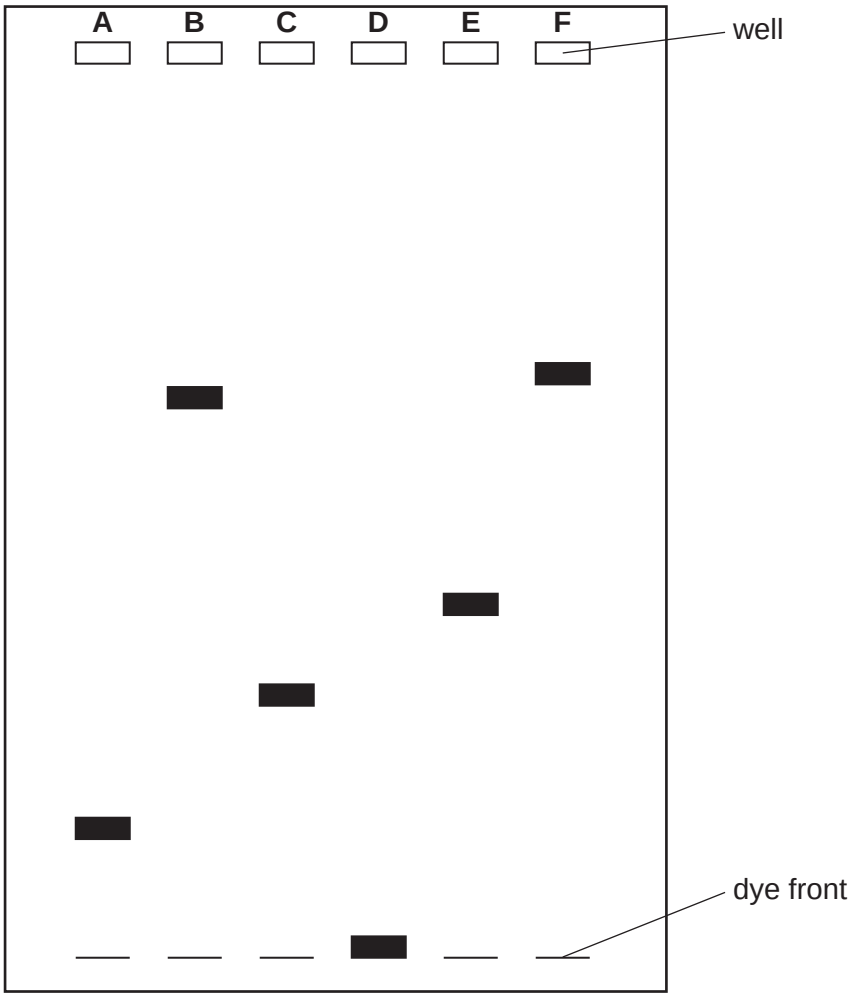


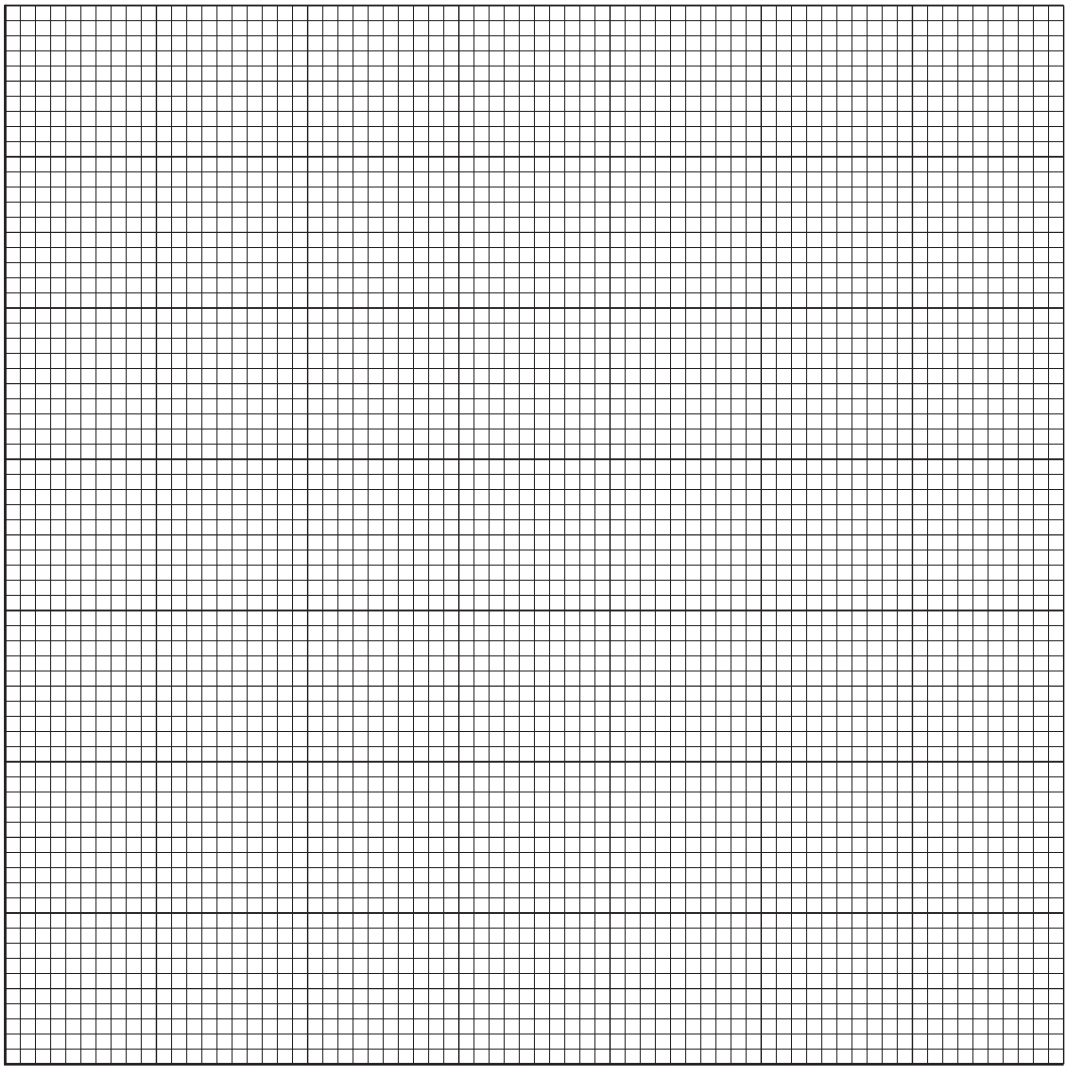
Fig. 3.1

(a) (Calculate the relative mobility of proteins **A**, **B**, **C**, **E** and **F** and add your calculated values to the appropriate spaces in Table 3.1, opposite. [2]

Table 3.1

protein	relative molecular mass	relative mobility
A	29 000	.....
B	68 000	.....
C	unknown	.....
D	17 200	1.00
E	43 000	.....
F	77 000	.....

(ii) Plot, on the grid below, a graph of the relative molecular mass of proteins **A**, **B**, **D**, **E** and **F** against their relative mobility. [4]



(b) Use your graph to find the relative molecular mass of protein **C**.

Explain how you arrived at your answer.

relative molecular mass of protein **C**: .....

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..... [2]

[Total: 8]

3 The hawksbill turtle, *Eretmochelys imbricata*, shown in Fig. 1.1, is classified as critically endangered by the International Union For Conservation of Nature (IUCN).

This turtle is slow-growing, with females only reaching breeding age at around 30 years old. Nesting sites are undisturbed tropical sandy beaches. It is omnivorous and its diet includes sea sponges that contain sharp crystals of silica. Many of these sponges contain toxins that are lethal to other animals. The turtle can also feed on venomous jellyfish, as it is resistant to the effects of the venom.

Fig. 1.1

(a) *E. imbricata* occupies a unique niche in its ecosystem. With reference to the information given, suggest **one** adaptation which enables it to survive successfully in this niche.

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..... [1]

(b) Suggest two factors which contribute to *E. imbricata* becoming a critically endangered species.

1 .....

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2 .....

..... [2]

(c) Explain why species become endangered when their population falls to very low numbers.

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..... [2]

(d) In recent years, marine biologists have begun to fit small satellite transponders to the shells of some sea turtles. This enables the biologists to track the movements of the turtles. Some turtles have been found to travel over 1000 km from the nest site where they hatched.

Explain the importance of this tracking in protecting sea turtles.

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..... [3]

[Total: 8]

4 Cell membranes consist mainly of proteins and phospholipids. The arrangement of these molecules in cell membrane structure is described by the fluid mosaic model.

(a) Give **one** example of the function of proteins in membranes.

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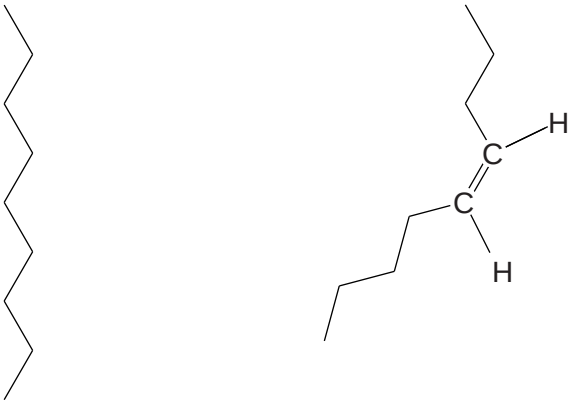
..... [1]

(b) Fatty acid chains of natural membrane phospholipids may be saturated or *Z*-unsaturated. Unsaturated fatty acid chains include one or more double bonds.



saturated fatty acid chain

Z-unsaturated fatty acid chain

Fig. 2.1

(i) Explain why a membrane whose phospholipids contain mainly *Z*-unsaturated fatty acids has a greater fluidity than one whose phospholipids predominantly contain saturated.

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..... [3]

(ii) Explain why the presence of phospholipids with *Z*-unsaturated chains eases the passage of small, non-polar molecules, such as oxygen, through membranes.

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..... [3]

(c) In an experiment, a mouse cell and a human cell were fused. The cell surface membranes of mouse and human cells possess species-specific proteins. The species-specific proteins did not remain at opposite ends of the fused cell, but became intermingled.

Explain what this observation suggests about membrane structure.

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..... [2]

[Total: 9]

5 Nitrogen is important in the synthesis of proteins.
Producing protein is an important aspect of plant growth.

(a) Name two types of nitrogen-containing organic molecules that are essential to enable a maize plant to produce proteins.

1 .....

2 ..... [2]

Protein production influences crop yield. The effects of nitrogen availability and plant density on yield of maize plants were investigated. Table 2.1 shows the results of this investigation.

Table 2.1

density / number of maize plants per m^2	mean yield of grain / g m^{-2}	mean yield of grain per plant / g	mean yield of grain / g m^{-2}	mean yield of grain per plant / g
	high nitrogen availability		low nitrogen availability	
4	811	203	477	119
8	1254	157	674	84
12	1309	109	635	53
16	1376	86	531	33
20	1444	72	498	25
24	1297	54	383	16

(b) With reference to Table 2.1, describe the patterns shown in the data **and** suggest possible explanations for them.

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..... [5]

[Total: 7]