Cambridge Assessment International Education

Cambridge International AS & A Level

Investigating the effect of changing surface area-to-volume ratio on diffusion – Topic questions

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
6a	2017	March	22
1d	2018	March	22
5d	2017	November	21
2b	2017	November	22

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

6 **(a)** A student investigated the effect of changing the surface area to volume ratio on diffusion.

- Two different-sized blocks of agar, **X** and **Y**, were made.
- The agar contained Universal Indicator solution.
- Universal Indicator solution changes colour when acid is added.
- The blocks were placed in dilute hydrochloric acid at the same temperature.
- The student timed how long it took for each block to change colour completely.

Blocks **X** and **Y** are shown in Fig. 6.1. All dimensions are in cm.

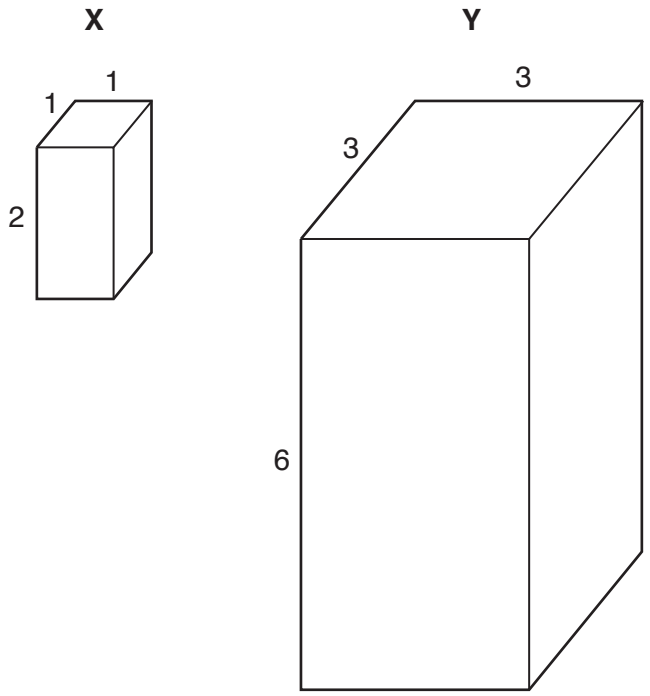

Fig. 6.1

(i) The surface area to volume ratio of block **X** is 5:1.

Calculate the surface area to volume ratio of block **Y**.

Show your working.

[2]

(ii) The student observed that block **X** changed colour completely in a much shorter time than block **Y**.

Explain why.

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..... [2]

(iii) Suggest how the results of this investigation help to explain why plants need a transport system.

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..... [2]

(d) The inner and outer membranes of the mitochondrion have a fluid mosaic structure similar to other cell membranes. They are both approximately 6 to 7 nanometres (nm) thick.

(i) Outline the fluid mosaic model of membrane structure.

There is space below for a diagram.

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..... [3]

(ii) The inner and outer membranes of the mitochondrion differ in the detail of their membrane components. The inner membrane is also much less permeable than the outer membrane.

Suggest **one** way in which the structure of the inner membrane may differ from that of the outer membrane to produce a **less permeable** inner membrane.

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..... [1]

(d) (i) The structure of the cell surface membrane is described as a fluid mosaic.

Explain what is meant by the term *fluid mosaic*.

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(ii) Outline the roles of the cell surface membrane.

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2 Triglycerides and phospholipids are types of lipid.

Fig. 2.1 shows the structure of one type of phospholipid known as phosphatidylcholine. F1 and F2 are fatty acid residues.

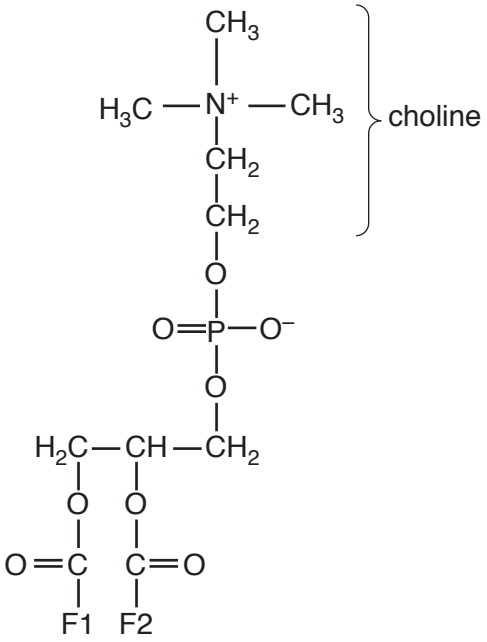

Fig. 2.1

(b) Compare, stating similarities and differences, the structure of the phosphatidylcholine shown in Fig. 2.1 with the structure of a triglyceride molecule.

similarities .....

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differences .....

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.....[4]

Question	Answer	Marks
6(a)(i)	surface area : volume = 1.67 : 1 **; ; A** 1.7 : 1, 5 : 3 *if incorrect,* ***allow*** *one mark for working* surface area = 90 mm^2 and volume = 54 mm^3 *calculations:* surface area — volume — ratio 6 × 3 × 4 (sides) = 72 mm^2 — 6 × 3 × 3 — 90 : 54 3 × 3 × 2 (sides) = 18 mm^2	**2**
6(a)(ii)	(block **X**) has higher, surface area to volume ratio / SA:V **;** OR (block **X**) has more surface area proportionately per unit volume / AW **;** reference to shorter distance for diffusion to centre **;**	**2**
6(a)(iii)	*two from:* 1 diffusion (rate) too slow **; A** idea of cannot rely on diffusion 2 reference to distances too far to reach all, cells / tissues **;** 3 time taken is too long / AW **;**	**2**

Question	Answer	Marks
1(d)(i)	**I** glycocalyx **I** glyco / carbohydrate chains **A** points from labelled diagram 1 phospholipid <u>bilayer</u> **;** *plus any **two** from:* 2 fatty acid core / fatty acid tails orientated inwards **;** 3 protein **;** 4 further detail of proteins **;** e.g. integral and peripheral / AW scattered (in phospholipid bilayer) 5 cholesterol **;**	**3**
1(d)(ii)	*any **one** relevant suggestion:* reduced gaps between membrane molecules **;** higher proportion of phospholipids with saturated fatty acids / ora **;** fewer unsaturated fatty acids so, fewer 'kinks' in tails / closer packing **;** higher proportion of cholesterol molecules **;** fewer, channel / carrier / transport, proteins **;** smaller diameter of channels in non-specific channel proteins **;** fewer types of (specific), transport / carrier, proteins **;** AVP **;** e.g. fewer, aquaporins / channels for water	**1**

Question	Answer	Marks
5(d)(i)	*fluid* *idea of* phospholipid (and protein) molecules, move about / diffuse (within their monolayer) **;** *mosaic* protein (molecules), interspersed / scattered / AW **; A** different / AW, proteins **;**	**2**
5(d)(ii)	*any four from* 1 barrier between cytoplasm and, external environment / AW **;** e.g. tissue fluid **A** protects, organelles from damage / from pathogens, **I** keeps cell contents in / membrane surrounds the organelles 2 cell signalling **or** has receptors for, cell signalling substance / hormone / neurotransmitter / AW 3 cell recognition / acts as cell surface antigen **;** 4 cell-to-c ll adhesion **;** 5 site for, enzymes / catalysing reactions **;** 6 anchoring the cytoskeleton / AW **;** 7 selection of substances that enter or leave a cell **;** AW 8 formation of hydrogen bonds with water for stability **;** 9 AVP **;** e.g. *ref. to*, changing shape of cell / flexibility of cells e.g. phagocytosis	**4**

Question 2

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(b)</td><td>
allow, fatty acids / fatty acid tails / hydrocarbon chains, for fatty acid residues

both have / similarities (max 3)
glycerol (residue) ;

fatty acids ; I ref. to saturation, R both have, two / three, fatty acids

ester, bonds / linkages ;

C <u>and</u> H <u>and</u> O ;

double bonds ; A both have C=O

differences (max 3)
<table>
<tr><th>triglyceride / fat / oil / lipid</th><th></th><th>phosphatidylcholine / phospholipid</th></tr>
<tr><td>no, choline / nitrogen
A no / small / delta, charges</td><td>or</td><td>has, choline / nitrogen ;
A choline / nitrogen, ion
A charged / ionic</td></tr>
<tr><td>three fatty acid residues
or one extra fatty acid residue ;
A triglyceride has three ester bonds</td><td></td><td>R if comparison includes phosphatidylcholine and the number of fatty acid residues is incorrect</td></tr>
<tr><td>no, phosphate (group) / phosphorus
A no, phosphoester / phosphodiester bond</td><td>or</td><td>has phosphate ;
A has phosphoester / phosphodiester bond</td></tr>
</table>
</td><td>4</td></tr>
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