Fluid Mosaic Membranes (4.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 51 marks · about 61 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 2 · February/March 2023 (22) · Q1(b) · 3 marks

(b) All cells have a cell surface membrane. Fig. 1.1 shows a transmission electron micrograph of part of **two** adjacent animal cells, cell 1 and cell 2.

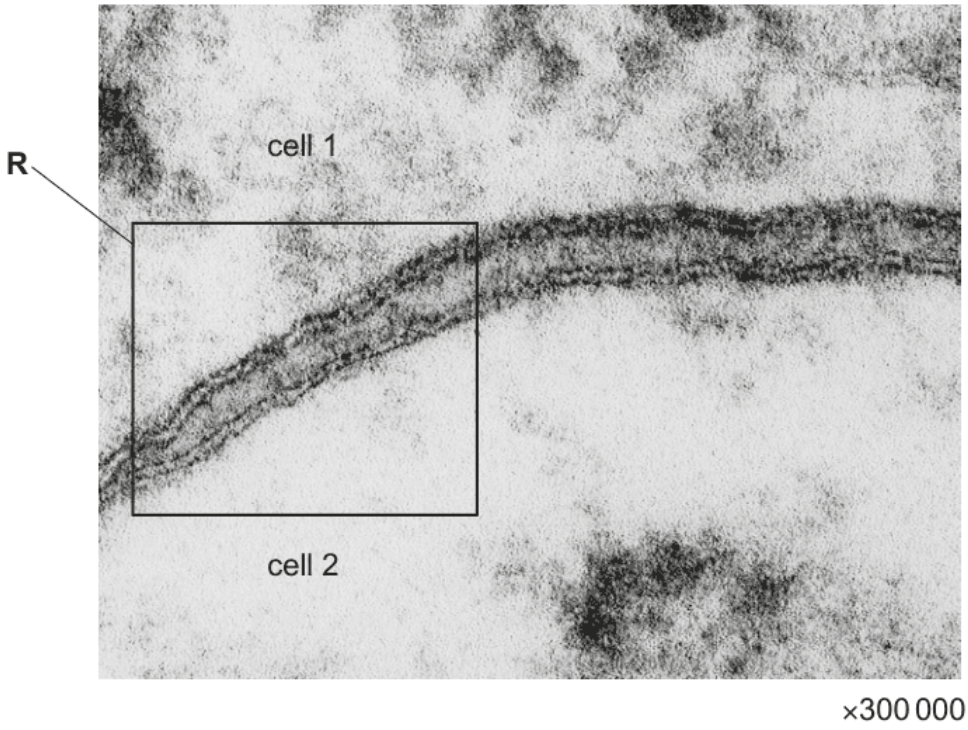


Fig. 1.1

In the space provided, draw a diagram of the region in the box labelled **R** on Fig. 1.1. Your diagram should show the four dark lines.

Label the diagram to identify what is shown by the dark lines and each of the three spaces between them.

space for diagram:

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Question 2 · Paper 2 · October/November 2025 (22) · Q4(a) · 3 marks

4 Bacteria can be classified according to the type of cell wall they have.

Gram-negative bacteria have a cell wall with an outer layer known as the outer membrane.

Gram-positive bacteria do not have an outer membrane, but have a much thicker peptidoglycan layer than Gram-negative bacteria.

Fig. 4.1 is a diagram of a section through the cell wall of a **Gram-negative** bacterium.

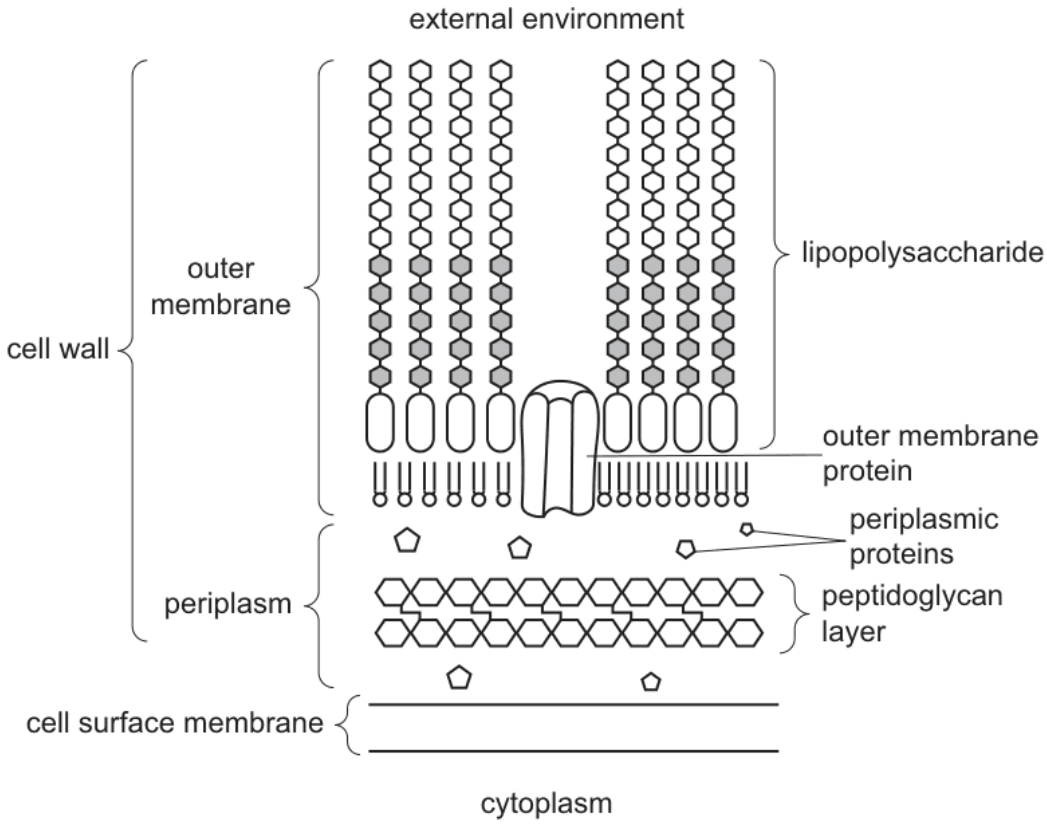


Fig. 4.1

(a) With reference to Fig. 4.1, outline the similarities **and** differences between the outer membrane of a Gram-negative bacterial cell and the cell surface membrane of a **eukaryotic** cell.

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Question 3 · information from earlier in the question

4 **(a)** Scientists have produced structures known as virosomes, which are used in certain vaccines. Virosomes do **not** cause disease.

Fig. 4.1 is a diagram of a section through a virosome used in some vaccinations to protect against the virus which causes influenza.

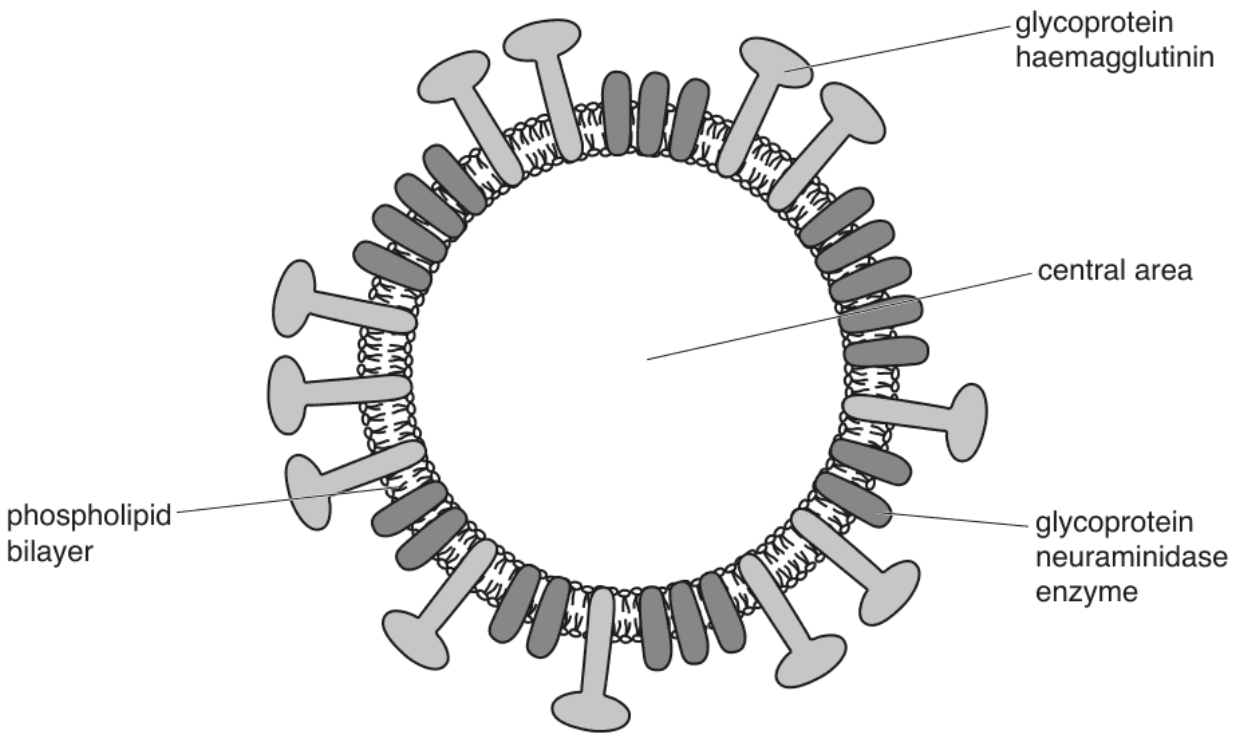


Fig. 4.1

Question 3 · Paper 2 · October/November 2022 (21) · Q4(a)(ii) · 2 marks

(ii) Explain how the structure of the virosome shown in Fig. 4.1 suggests that the central area of the virosome is aqueous.

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Question 4 · information from earlier in the question

3 T-helper lymphocytes and Leydig cells are two types of mammalian cells. The main role of T-helper lymphocytes and Leydig cells is to synthesise and secrete cell-signalling molecules.

- T-helper lymphocytes synthesise proteins known as cytokines.
- Leydig cells synthesise the steroid (lipid) hormone testosterone from cholesterol. Leydig cells also synthesise cholesterol.

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(c) Testosterone molecules and cytokine molecules are transported in the circulatory system to reach their target cells. Testosterone molecules are able to enter their target cells and bind to receptors within the cytoplasm.

Question 4 · Paper 2 · February/March 2021 (22) · Q3(c)(ii) · 2 marks

(ii) Cytokine molecules are not able to enter their target cells.

Suggest **and** explain why cytokine molecules are **not** able to cross the cell surface membrane to enter their target cells.

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(b) The walls of alveoli contain some specialised epithelial cells called type II epithelial cells. These cells secrete surfactant. Surfactant helps to prevent the alveoli collapsing during breathing.

Surfactant contains phospholipid, cholesterol and protein.

The components of surfactant are synthesised in the rough endoplasmic reticulum and smooth endoplasmic reticulum and then passed to the Golgi body.

The surfactant that is produced is stored in secretory organelles called lamellar bodies.

The surfactant in the lamellar bodies is released onto the surface of the alveolar epithelium by exocytosis, as shown in Fig. 5.2.

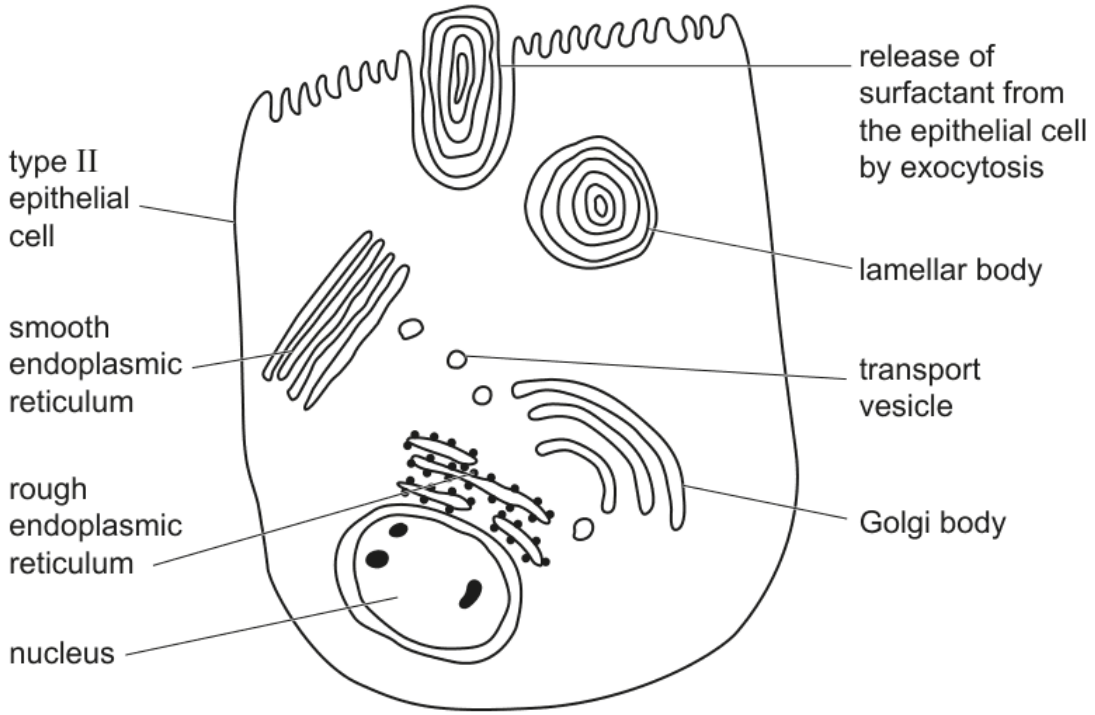


Fig. 5.2

(i) Each lamellar body is surrounded by a single membrane.

Draw a diagram to show the arrangement of phospholipid molecules in the membrane surrounding the lamellar body.

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Question 6 · Paper 2 · October/November 2023 (21) · Q5(b)(ii) · 2 marks

(ii) Scientists studying the production and secretion of lung surfactant have discovered that a reduction in cholesterol in the cell surface membrane of type II epithelial cells reduces the secretion of surfactant.

Suggest why secretion of surfactant is affected by a reduction in cholesterol in the cell surface membranes of type II epithelial cells.

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Question 7 · Paper 2 · October/November 2025 (21) · Q1(a) · 3 marks

1 Fig. 1.1 shows a diagram of the fluid mosaic model of the structure of the cell surface membrane.

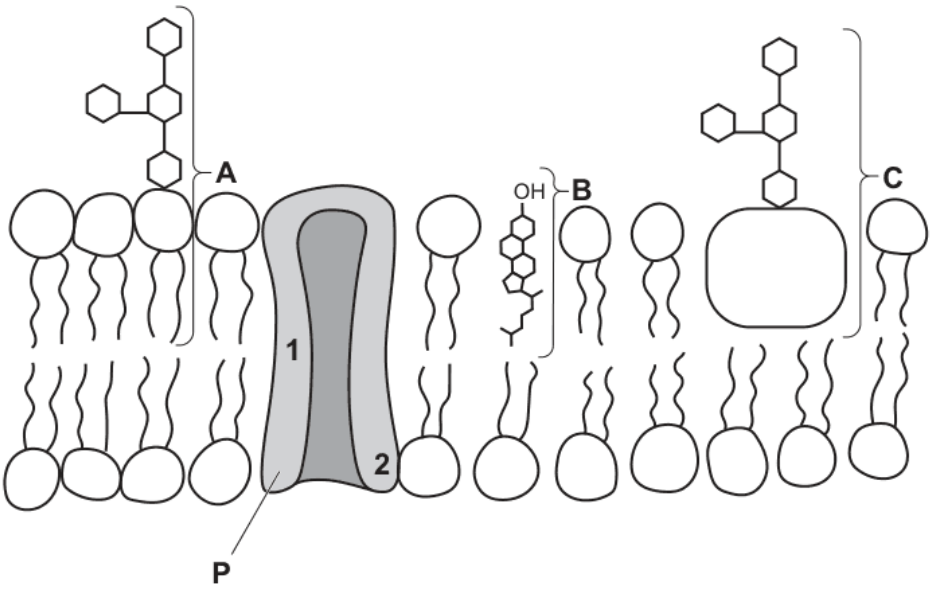


Fig. 1.1

(a) Name the structures labelled **A**, **B** and **C** in Fig. 1.1.

A .....

B .....

C .....

[3]

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Question 8 · information from earlier in the question

1 **(a)** Fig. 1.1 is a diagram representing part of the phospholipid bilayer of a cell surface membrane.

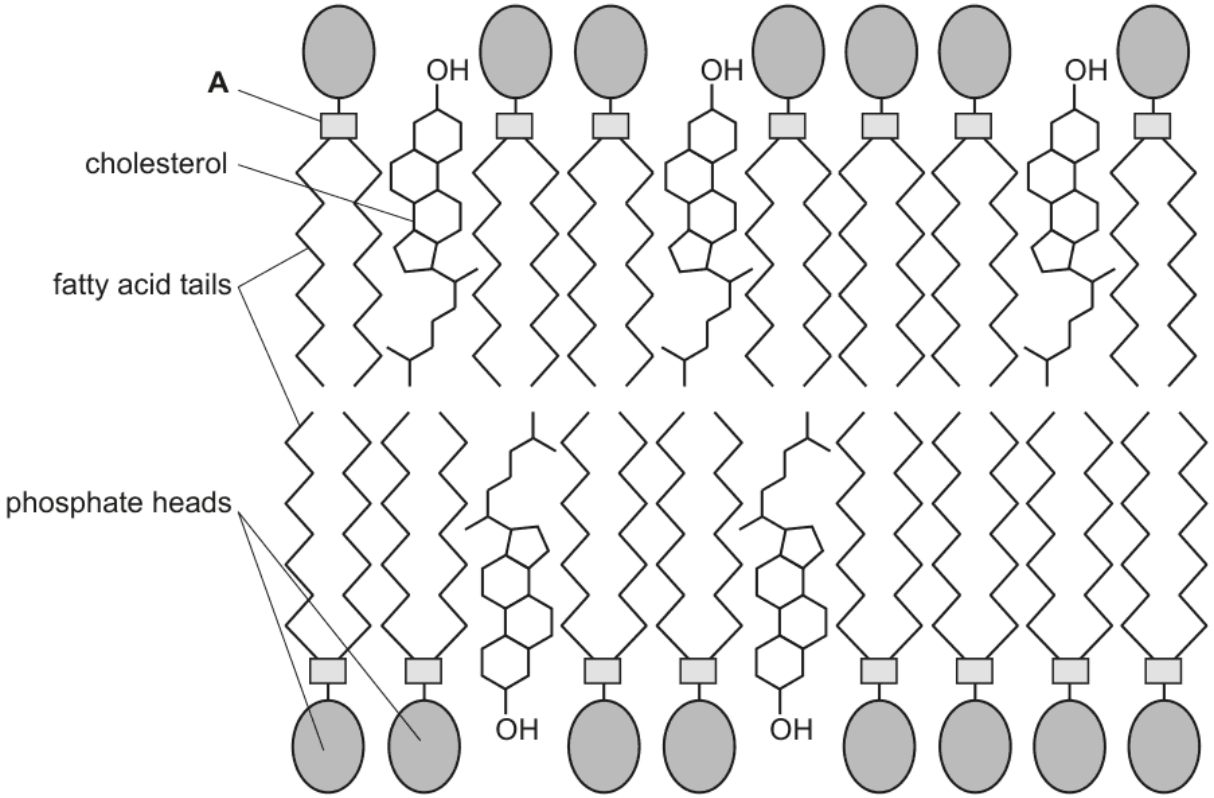


Fig. 1.1

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Question 8 · Paper 2 · February/March 2024 (22) · Q1(a)(ii) · 1 mark

(ii) Cholesterol is an important lipid component of many cell surface membranes. Fig. 1.2 shows the structure of a cholesterol molecule.

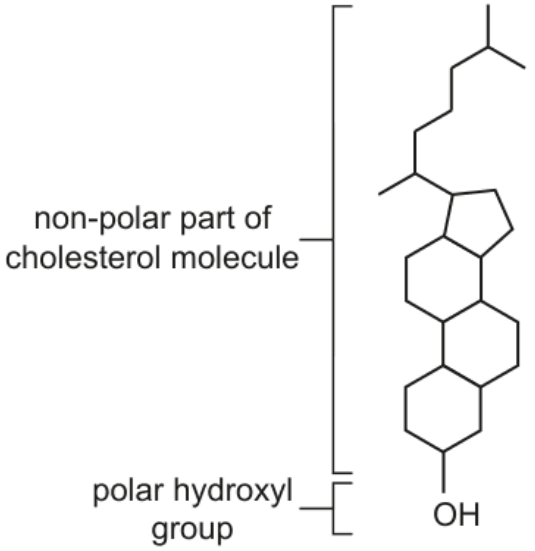


Fig. 1.2

Using the information in Fig. 1.2, explain the orientation (positioning) of cholesterol molecules in the phospholipid bilayer, as shown in Fig. 1.1.

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Question 9 · Paper 2 · February/March 2024 (22) · Q1(a)(iii) · 1 mark

(iii) State **one** role of cholesterol in phospholipid bilayers.

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Question 10 · information from earlier in the question

1 Fig. 1.1 is a diagram showing part of a cell surface membrane of an animal cell.

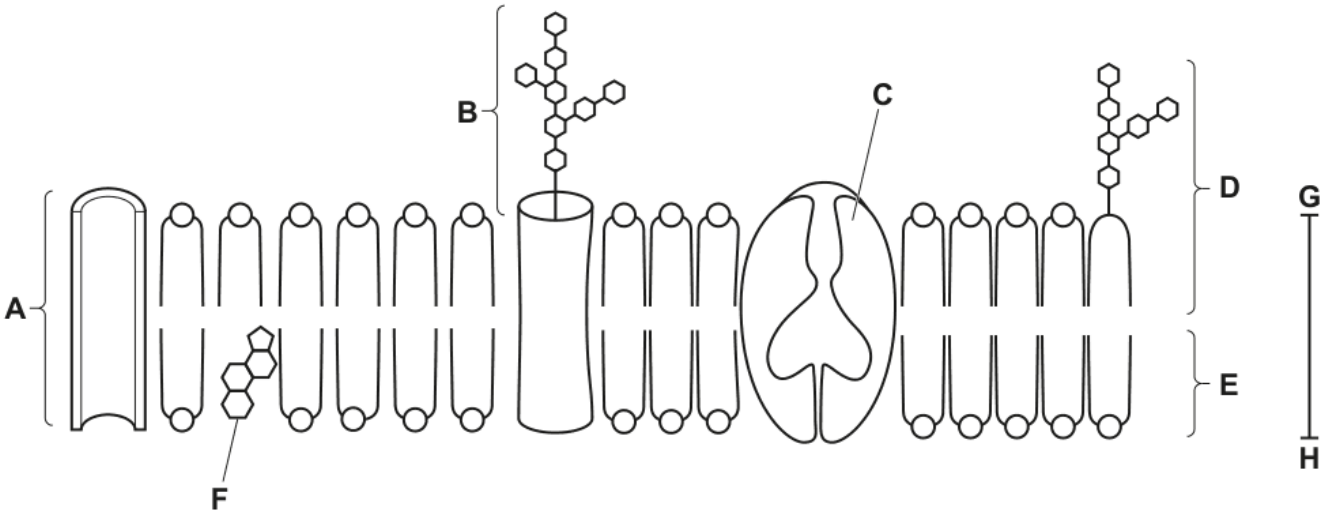


Fig. 1.1

Question 10 · Paper 2 · May/June 2024 (21) · Q1(a)(ii) · 4 marks

(ii) Complete Table 1.1 to show:

- the names and functions of the components of the cell surface membrane
- the letters of the labels in Fig. 1.1 that identify each component.

Table 1.1

component	function	letter on Fig. 1.1
channel protein		
phospholipid		
	receptor for cell signalling	
		F

[4]

Question 11 · Paper 2 · February/March 2025 (22) · Q2(b)(ii) · 1 mark

(ii) Many glycoproteins in the cell surface membrane are involved in cell signalling.

State the role in cell signalling of glycoproteins in cell surface membranes.

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Question 12 · information from earlier in the question

5 Arachidonic acid is a fatty acid that is a common component of phospholipids.

Phospholipids can be used as a source of arachidonic acid when it is metabolised within cells in an enzyme-catalysed pathway known as the cyclooxygenase (COX) pathway.

The final products of the COX pathway can be different in different cell types, causing a range of responses. In some cells, the products are involved in the inflammatory response, which is a response by the body to infection. In other cells, cell division is stimulated.

Fig. 5.1 shows the **first reaction** in the COX pathway. This reaction is catalysed by an enzyme known as COX-2.

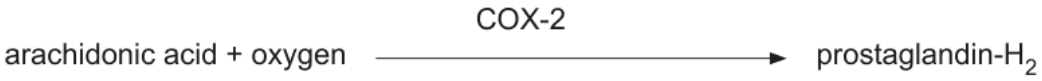


Fig. 5.1

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(d) Fig. 5.3 shows the molecular structure of arachidonic acid. Not all hydrogen atoms are shown.

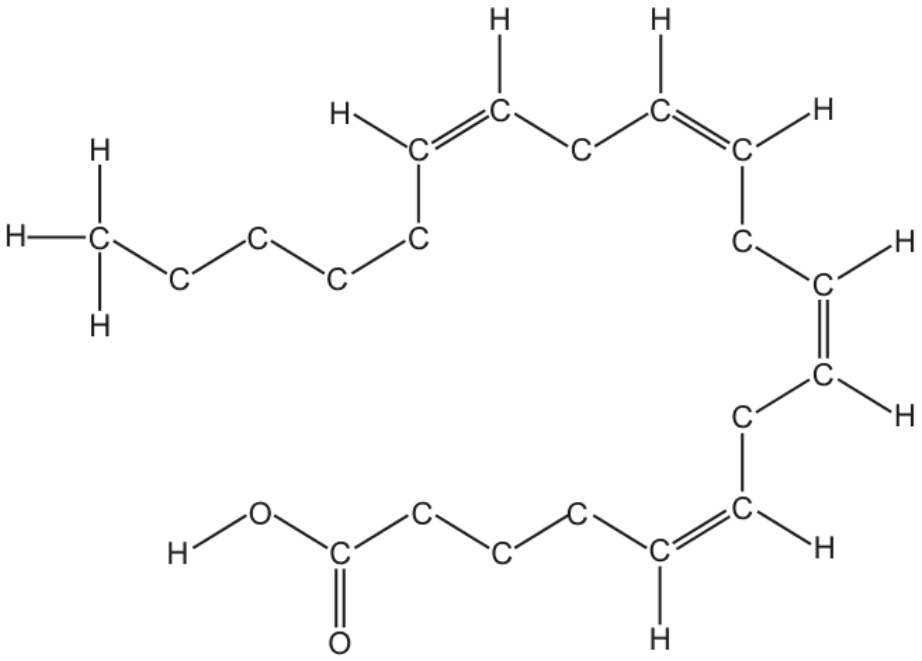


Fig. 5.3

With reference to Fig. 5.3, explain why increasing the proportion of phospholipids with arachidonic acid in a cell will increase the fluidity of the cell surface membrane of the cell.

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Question 13 · Paper 2 · May/June 2023 (21) · Q3(a) · 1 mark

3 Fig. 3.1 shows some fruits (grapes) of the grapevine, *Vitis vinifera*.

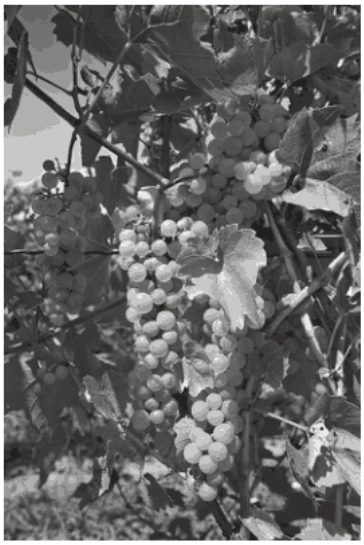


Fig. 3.1

Sucrose is transported in the phloem of the grapevine to the fruits. In the fruits, sucrose is hydrolysed by the enzyme sucrase, which is found in cell walls. The glucose and fructose produced by the hydrolysis of sucrose pass through membrane proteins, known as hexose transporters, into the cytoplasm of the fruit cells.

(a) State why membrane proteins are required for the movement of molecules, such as glucose, across cell surface membranes into cells.

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Question 14 · Paper 4 (A level) · October/November 2020 (42) · Q7(a) · 2 marks

7 Insulin is transported around the body in the blood. The cells of the liver, muscle tissue and adipose (fat) tissue have receptors for insulin.

(a) State:

- the precise cellular location of the insulin receptors
- the type of biological molecule that forms an insulin receptor.

location .....

type of biological molecule .....

[2]

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Question 15 · information from earlier in the question

3 Bacteria may be classified according to differences in cell wall structure. The differences are shown by using the Gram stain.

- A Gram-positive bacterium has a cell wall mainly composed of a thick layer of peptidoglycan (murein).
- A Gram-negative bacterium has a more complex cell wall. This wall is composed of a much thinner layer of peptidoglycan and an outer layer known as the outer membrane.

Escherichia coli is a Gram-negative bacterium.

Fig. 3.1 is a diagram through the cell surface membrane **and** the cell wall of *E. coli*.

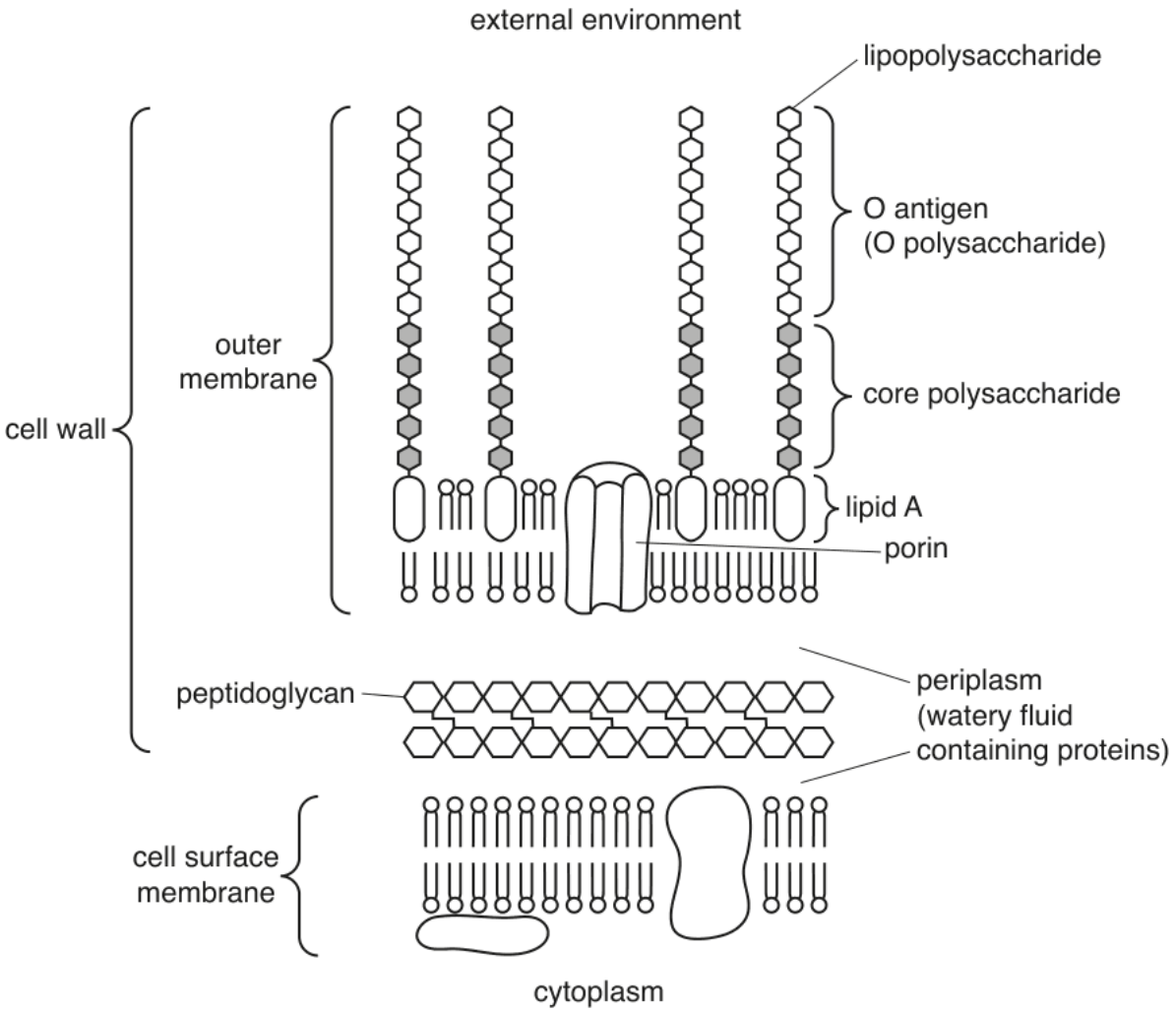


Fig. 3.1

(b) The outer membrane contains transport proteins called OmpF porins. These porins allow the passive movement of water, ions and small, polar molecules across the outer membrane. Each OmpF porin is formed from three identical polypeptides.

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Question 15 · Paper 2 · May/June 2018 (22) · Q3(b)(ii) · 4 marks

(ii) Suggest **and** explain the features of an OmpF porin as a membrane transport protein.

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Question 16 · Paper 2 · October/November 2025 (22) · Q1(d) · 3 marks

(d) In response to the presence of compounds in the gut lumen, enteroendocrine cells synthesise and release peptides (short chains of amino acids) that are cell-signalling molecules. One of these cell-signalling molecules is known as GLP-1.

GLP-1 initiates a number of responses in different body cells. Some of these responses include:

- the increase in release of the hormone insulin from cells in the pancreas
- the decrease in release of acid from cells in the stomach.

Outline, **in sequence**, the main stages involved in the process of cell signalling by GLP-1.

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Question 17 · Paper 2 · May/June 2024 (23) · Q5(a) · 2 marks

5 Cyclin-dependent kinases (CDKs) are enzymes that regulate the cell cycle.

(a) Cell signalling by ligands causes the activation of CDKs in target cells.

Outline the main stages in the process of cell signalling by ligands that can cause specific responses in target cells.

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Question 18 · Paper 4 (A level) · May/June 2024 (41) · Q2(a)(i) · 2 marks

2 **(a)** Coordination in humans involves two main systems: the nervous system and the endocrine system. Paracrine cell signalling is a third way in which coordination occurs. In paracrine signalling, one cell secretes a chemical that diffuses a short distance to act upon cells that are very near to the secreting cell.

(i) Identify **one** similarity and **one** difference between paracrine cell signalling and cell signalling that occurs as part of the endocrine system.

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Question 19 · Paper 2 · October/November 2022 (23) · Q5(a)(i) · 2 marks

5 Cathelicidin LL-37 is a cell signalling compound that stimulates many different cells in humans. One role of cathelicidin LL-37 is stimulating the production of endothelial cells in the formation of capillaries during wound healing.

(a) **(i)** Explain how it is possible for many different cell types to respond to the same cell signalling compound.

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Question 20 · information from earlier in the question

3 In mammals, some cell signalling molecules are steroid (lipid) hormones. These hormones are transported in the bloodstream to reach capillary networks.

At a capillary network, hormones pass out of the blood into tissue fluid.

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Hormone **S** is a steroid hormone involved in cell signalling.

Fig. 3.2 shows the sequence of events that occurs when hormone **S** enters a target cell.

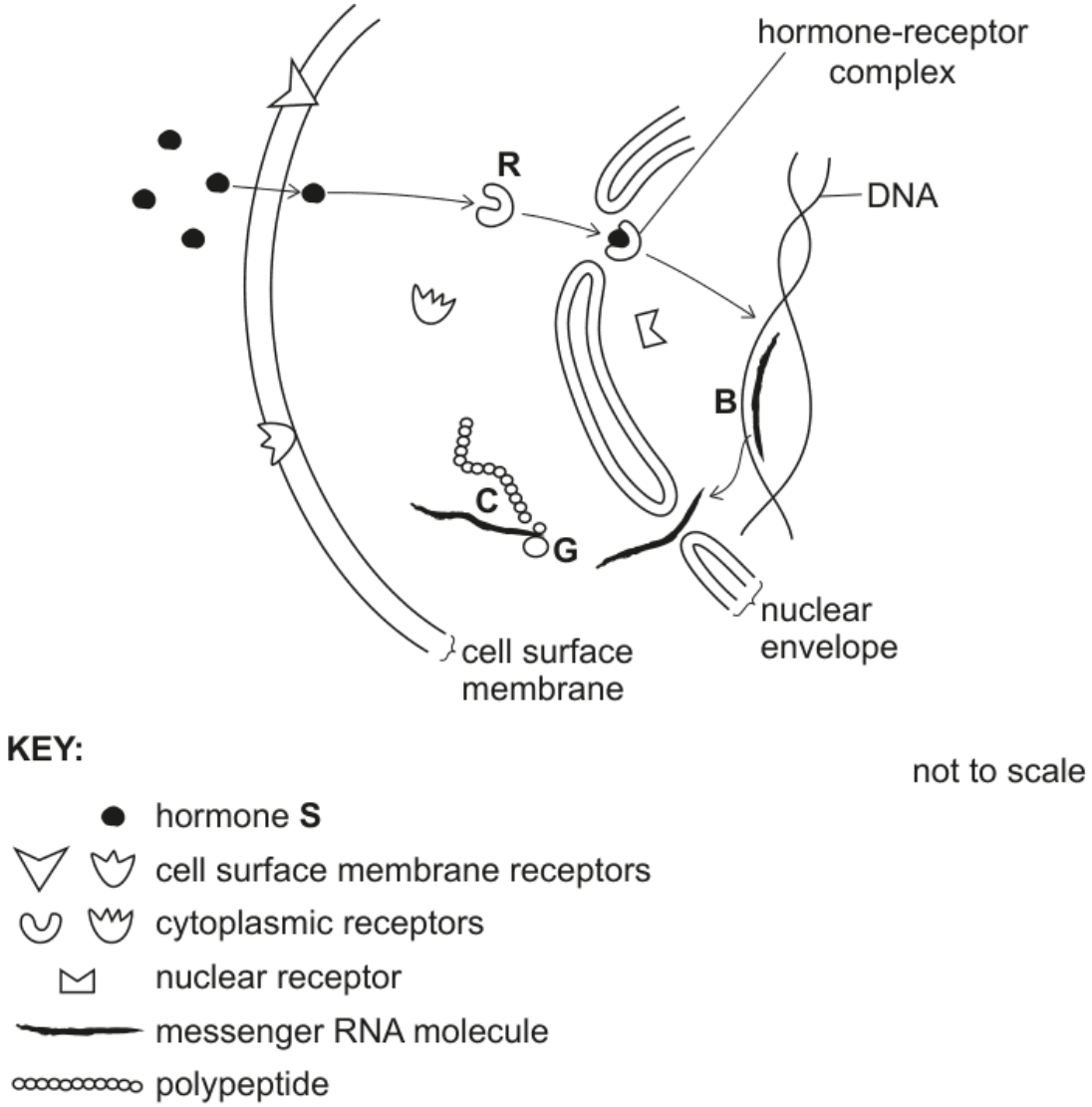


Fig. 3.2

Question 20 · Paper 2 · May/June 2021 (22) · Q3(c) · 1 mark

(c) The target cell can respond to other cell signalling molecules in addition to hormone **S**. The cell has receptors in the cell surface membrane, in the cytoplasm and in the nucleus.

Explain why hormone **S** binds only with receptor **R** in the cytoplasm and **not** with the other receptors shown in Fig. 3.2.

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Question 21 · information from earlier in the question

3 The response of the human body to tissue damage depends on the types of tissues involved. Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue of the gas exchange system contains stem cells.
- Liver tissue contains cells in a non-dividing state that can enter a cell cycle when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

Question 21 · Paper 2 · October/November 2018 (22) · Q3(c) · 3 marks

(c) Following liver tissue damage, chemicals are produced and released into the circulation. These chemicals are able to stimulate the liver cells to help tissue repair.

Explain how this is an example of cell signalling.

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Question 22 · Paper 2 · May/June 2017 (22) · Q5(d) · 4 marks

(d) Some alveolar cells produce a surfactant that helps to prevent the collapse of alveoli on exhalation. Too much surfactant decreases the efficiency of gas exchange in the alveoli.

A glycoprotein known as GM-CSF is released by some cells of the immune system when there is too much surfactant in the alveoli. Excess surfactant is then broken down by alveolar macrophages.

Receptors for GM-CSF are on the cell surface membranes of alveolar macrophages.

Explain how maintaining the correct quantity of surfactant in the alveoli is the result of a cell signalling mechanism.

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Mark schemes

Question 1 · Paper 2 · February/March 2023 (22) · Q1(b) · 3 marks

1(b)	*diagram showing:* dark line(s) labelled as phosphate heads **;** **A** phospholipid heads clear area(s) between pairs of dark lines labelled as, fatty acid tails / hydrocarbon chains / hydrophobic core / AW **;** **R** if pointing to intercellular space clear area between the two cell surface membranes labelled as, interstitial fluid / tissue fluid / extracellular matrix / intercellular space **;** **A** intercellular, area / region	**3**

Question 2 · Paper 2 · October/November 2025 (22) · Q4(a) · 3 marks

4(a)	*any **three** from:* *max 2 for similarities, max 2 for differences* *similarities, both have* phospholipids **;** channel / transport, protein **; A** intrinsic / integral / transmembrane, protein **R** carrier / pump, protein a bilayer / two layers **;** *differences* *do not need to have 'outer membrane' 'bacterial' if context is clear* (bacterial outer membrane) has lipopolysaccharides **; ora** (cell surface membrane / eukaryote) has, phospholipid bilayer / both layers with phospholipids **; ora** *if ora also given (bacterial) only has outer layer of (outer) membrane with phospholipids, can also award mp1* AVP **;;** e.g. cell surface membrane has, glycocalyx / glycolipids / glycoproteins cell surface membrane has cholesterol outer membrane does not have extrinsic proteins	**3**

Question 3 · Paper 2 · October/November 2022 (21) · Q4(a)(ii) · 2 marks

4(a)(ii)	heads / phosphate, (groups) of phospholipids are hydrophilic **or** fatty acid tails of phospholipids are hydrophobic **;** **A** heads are hydrophilic and tails are hydrophobic heads / phosphates, point towards the centre (of the virosome so, must be aqueous / water present) **; ora** *for tails*	**2**

Question 4 · Paper 2 · February/March 2021 (22) · Q3(c)(ii) · 2 marks

3(c)(ii)	*any **two** from* hydrophilic / water soluble / polar **;** cannot cross, hydrophobic core (of phospholipid bilayer) / AW **;** too large (to pass through gaps in fatty acid tails) **;** no (specific), transport / carrier, proteins **;**	**2**

Question 5 · Paper 2 · October/November 2023 (21) · Q5(b)(i) · 2 marks

5(b)(i)	phospholipid with a head and two tails **;** bilayer shown **;**	**2**

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Question 6 · Paper 2 · October/November 2023 (21) · Q5(b)(ii) · 2 marks

5(b)(ii)	*any **two** from:* cholesterol regulates the fluidity of the membrane ; membrane less able to fuse with the lamellar body ; AVP ;	**2**

Question 7 · Paper 2 · October/November 2025 (21) · Q1(a) · 3 marks

1(a)	**A** glycolipid ; **B** cholesterol ; **C** glycoprotein ;	**3**

Question 8 · Paper 2 · February/March 2024 (22) · Q1(a)(ii) · 1 mark

1(a)(ii)	*any **one** from:* hydroxyl / polar, group, interacts with, phosphate heads ; **A** idea that both are, polar / hydrophilic **A** hydroxyl group, faces aqueous environment / AW, as it is, polar / hydrophilic non-polar part, in region of / AW, fatty acid tails / AW, as both are, non-polar / hydrophobic ; **A** non-polar part is hydrophobic so, in centre of membrane / away from aqueous environment	**1**

Question 9 · Paper 2 · February/March 2024 (22) · Q1(a)(iii) · 1 mark

1(a)(iii)	*any **one** from:* maintains / regulates, fluidity of membrane ; **A** detail e.g. reduces fluidity at high temperature / increases fluidity at low temperature / AW maintains / regulates, (mechanical) stability of membrane ; AW prevents entry of, hydrophilic substances / polar substances / ions ; without cholesterol membranes would easily rupture flat ring *(structure)* interferes with the movement of fatty acid tails reduces lateral movement of phospholipids	**1**

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Question 10 · Paper 2 · May/June 2024 (21) · Q1(a)(ii) · 4 marks

1(a)(ii) — *one mark per row – name and letter must agree in row 3 – glycolipid and glycoprotein*
If no rows are correct or one row is correct, mark by column to give max 2 if one or two columns are correct

4

component	function	letter on Fig.1.1	
channel protein	facilitated diffusion **or** transport of, water / ions / water soluble substances / polar molecules / charged substances / hydrophilic substances **I** named examples of each category	**A**	;
phospholipid	forms a bilayer **or** a role within bilayer e.g. barrier to, water soluble / polar substances / ions allows diffusion of, fat soluble / non-polar, substances allows fluidity / provides stability / forms a hydrophobic core / AW	**E**	;
glycoprotein **A** glycolipid	receptor for cell signalling	**B** **D**	;
cholesterol	gives (mechanical) stability / maintains fluidity / regulates fluidity / barrier to water soluble substances **or** at low temperatures, maintains or increases fluidity / prevents close packing **A** prevents hydrophobic 'tails' interacting at low temperatures **or** at high temperatures, stabilises the membrane / decreases fluidity	**F**	;

Question 11 · Paper 2 · February/March 2025 (22) · Q2(b)(ii) · 1 mark

2(b)(ii)	act as receptors / bind to ligands, qualified ;	**1**

Question 12 · Paper 2 · May/June 2022 (23) · Q5(d) · 3 marks

5(d) — *any **three** from:* **3**

phospholipids may be, used in / added to, the (cell surface) membrane ;

arachidonic acid, is unsaturated / polyunsaturated ;

has, C=C / (carbon-carbon) double bonds ;
allow ecf if stated as saturated

unsaturated fatty acid tails, have kinks / not linear / AW ;
A double bonds produce, kinks / AW

increased distance between, phospholipids / other fatty acid tails ;
A phospholipids cannot pack closely together

less hydrophobic interactions between phospholipid (molecules) ;

Question 13 · Paper 2 · May/June 2023 (21) · Q3(a) · 1 mark

3(a)	polar / water soluble / hydrophilic, substances cannot pass through the, phospholipid bilayer / hydrophobic core (in cell surface membranes) ; **I** too large / active transport / facilitated diffusion / (hydrophobic) fatty acid 'tails'	**1**

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Question 14 · Paper 4 (A level) · October/November 2020 (42) · Q7(a) · 2 marks

7(a)	cell surface membrane / plasma membrane ; glycoprotein / protein / polypeptide ; **R** channel protein	**2**

Question 15 · Paper 2 · May/June 2018 (22) · Q3(b)(ii) · 4 marks

3(b)(ii)	*four from:* 1 channel protein ; **A** pore protein / has a pore / has a channel 2 channel / pore, can form from polypeptides **or** (protein) has quaternary structure ; 3 hydrophilic R-groups, on amino acids lining channel / face inwards (towards channel) ; **A** hydrophilic, lining / channel **A** water-filled, channel / AW **A** idea that passage is through hydrophilic region of protein 4 allows facilitated diffusion ; **A** diffusion alone if in context of through the protein but **R** if via phospholipid bilayer 5 increases permeability for, movement of water / osmosis ; **I** faster 6 no (specific) binding sites / (channel) not specific / not selective / allows more than one type of substance through / AW ; 7 globular ; 8 AVP ; e.g. ref. to hydrophobic part of protein, faces / interacts with, hydrophobic, region / core / fatty acid tails ref. to hydrophilic parts of, protein / polypeptide, extend into, external environment / periplasm / aqueous regions / AW	**4**

Question 16 · Paper 2 · October/November 2025 (22) · Q1(d) · 3 marks

1(d)	*any **three** from*: *after, secreted / released, by enteroendocrine cells* transport of, peptide / GLP-1 / ligand, in, blood / circulation ; to, target cells (which are cells of the, stomach / pancreas) ; binding of, peptide / GLP-1 / ligand, to receptor ; *context can be cell surface membrane or intracellular* *ref. to*, specificity / complementary ; *must be in correct context of GLP-1 binding to receptor* (binding) triggers / sets off / AW, events within (target) cell (leading to the response) ; **A** examples e.g. signal transduction / triggers enzyme cascade	**3**

Question 17 · Paper 2 · May/June 2024 (23) · Q5(a) · 2 marks

5(a)	*any **two** from*: cells secrete ligands **or** transport of ligands, through blood / in circulatory system ; ligands bind to (complementary / specific) receptors ; *context of target cells* (binding) sets off reactions within the (target) cell / triggers secondary messengers / sets off an enzyme cascade ; **A** cyclic AMP for secondary messengers	**2**

Question 18 · Paper 4 (A level) · May/June 2024 (41) · Q2(a)(i) · 2 marks

2(a)(i)	**1** *similarity:* both involve a (signalling), chemical / ligand / molecule ; **2** *difference:* endocrine chemical / hormone, travels in blood / circulatory system (but paracrine chemical travels by diffusion) ;	**2**

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Question 19 · Paper 2 · October/November 2022 (23) · Q5(a)(i) · 2 marks

5(a)(i)	*any **two** from:* **1** *idea of* the cells have the, same receptor / specific receptor (for LL-37) **;** **2** on cell (surface) membrane / inside cell **;** **3** (shape of) receptor is complementary to (shape of), cathelicidin / signalling compound / ligand **;** **I** antigen **R** active site	**2**

Question 20 · Paper 2 · May/June 2021 (22) · Q3(c) · 1 mark

3(c)	**Reject** if hormone S or receptor **R** described as an antigen or enzyme complementary (shape) to / only fits into / specificity for (binding to), **R** / receptor **;**	**1**

Question 21 · Paper 2 · October/November 2018 (22) · Q3(c) · 3 marks

3(c)	*any three from* **1** chemicals (released) are cell signalling, molecules / compounds **;** **2** liver cells, are target cells **;** **A** liver tissue for liver cells **3** binding of, chemicals / cell signalling molecules, to receptors (of liver cells) **;** **R** receptor cells **4** *ref. to* specificity (of receptors) / chemicals complementary to receptors **;** *if **R** above, then allow ecf for idea of complementary* **5** (specific) response is, cell enters the cell cycle / mitosis / cell division **;** **A** DNA replication **6** AVP **;** e.g. *idea of* communication between cells suggestion of detail following binding, e.g. second messenger activated / enzyme cascade /signal transduction / phosphorylation events / enzyme activation **I** cascade of reactions	**3**

Question 22 · Paper 2 · May/June 2017 (22) · Q5(d) · 4 marks

5(d)	*accept (the) glycoprotein for GM-CSF throughout* **1** (excess surfactant) stimulates immune system cells **;** **2** release / secretion, of, GM-CSF **;** **I** produce **3** GM-CSF is a signal **or** GM-CSF is a signalling, molecule / protein / glycoprotein **;** **A** messaging molecule **4** binds to / combines with / AW, (cell surface membrane) receptors (on alveolar macrophages) **;** **5** *ref. to* specificity **;** **A** described as GM-CSF receptor complementary shape for GM-CSF **6** leads to / sets off / triggers / AW, response (in the cell) / removal of surfactant **;** *in context of macrophage* **A** stimulates **7** detail **;** e.g. triggers secondary messenger activates enzymes / enzyme cascade signal transduction phosphorylation events	**max 4**

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