4. Cell Membranes and Transport

4.1 Fluid Mosaic Membranes

Paper 2

Question Paper

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

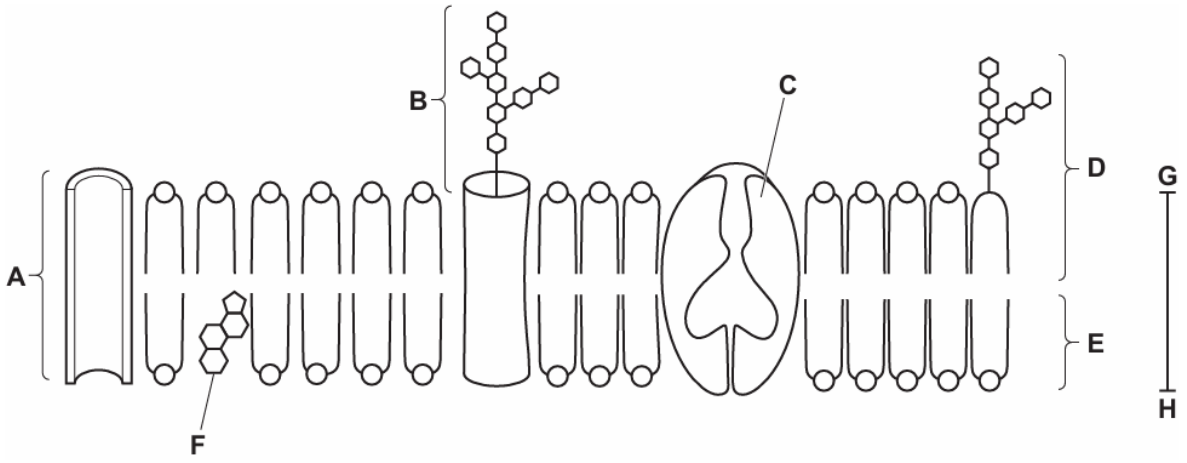


Fig. 1.1

(a) (i) State the approximate thickness of the membrane as shown by the line **G**–**H**.

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(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

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2 People who become infected with human immunodeficiency virus (HIV) are at risk of developing HIV/AIDs, particularly if antiretroviral therapy (ART) is not available.

(d) *P. jirovecii* can adhere (attach) to squamous epithelial cells of the alveoli and to the network of fibrous proteins that support the alveolar wall, known as the extracellular matrix (ECM). Examples of proteins in the ECM are elastin and collagen.

Adhesion (attachment) of *P. jirovecii* to alveolar epithelial cells and the ECM stimulates the growth of its population.

(i) Cell surface glycoproteins known as gpA glycoproteins are essential in allowing *P. jirovecii* cells to adhere to alveolar epithelial cells and ECM proteins.

Suggest how a gpA glycoprotein is able to adhere to alveolar epithelial cells and ECM proteins.

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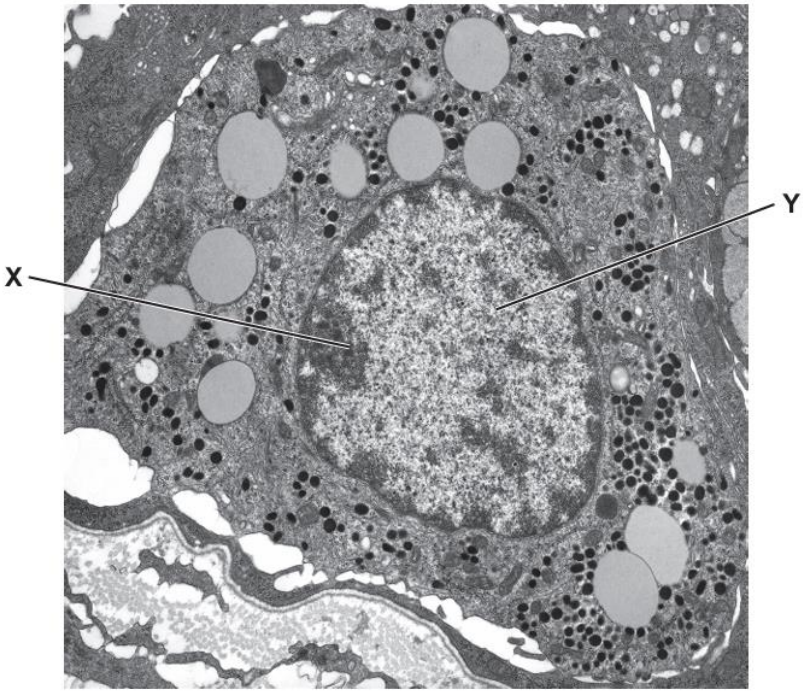
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3 Fig. 2.1 is a transmission electron micrograph showing a section of a specialised epithelial cell found in the lining of the stomach. This cell produces extracellular proteins that are released into the bloodstream.



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Fig. 2.1

(b) The cell in Fig. 2.1 releases ghrelin, a small protein that acts as a cell signalling molecule.

Fig. 2.2 shows the sequence of amino acids in a ghrelin molecule.

The amino acid serine (Ser) in position 3 in Fig. 2.2 has been modified by the addition of a saturated fatty acid chain.

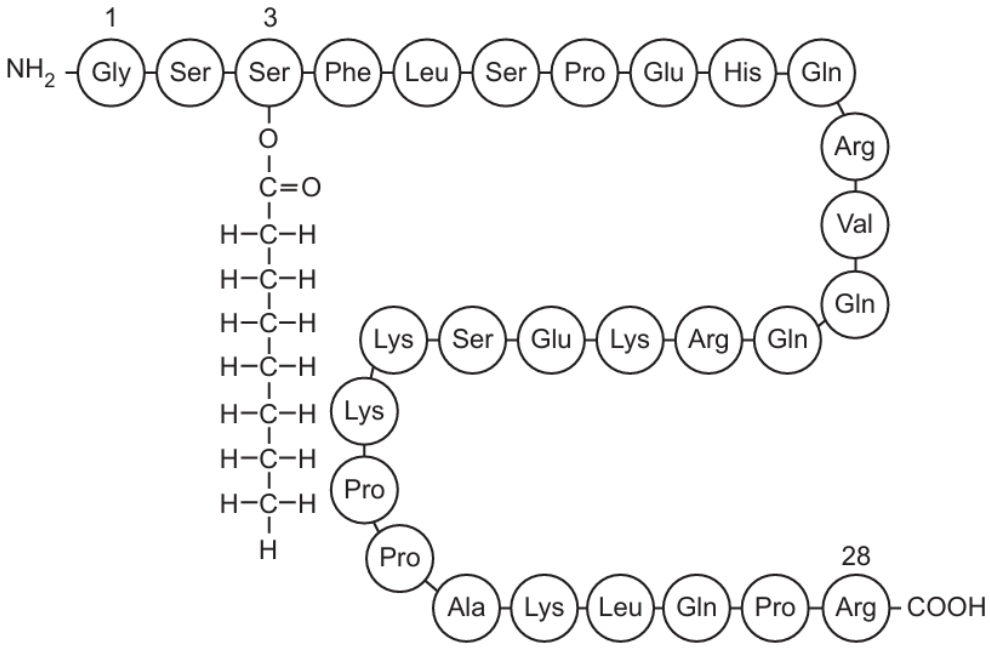


Fig. 2.2

(iii) The addition of the fatty acid chain allows ghrelin to function as a cell signalling molecule.

Suggest how the addition of this fatty acid chain allows a ghrelin molecule to act as a cell signalling molecule.

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4 Fig. 5.1 is a photomicrograph of a transverse section of a bronchus in the lungs.

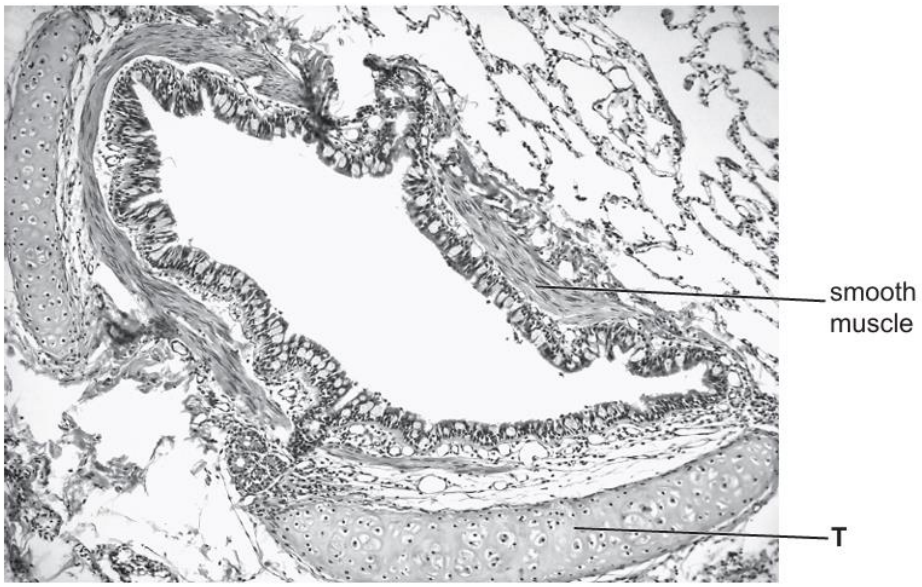


Fig. 5.1

(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.

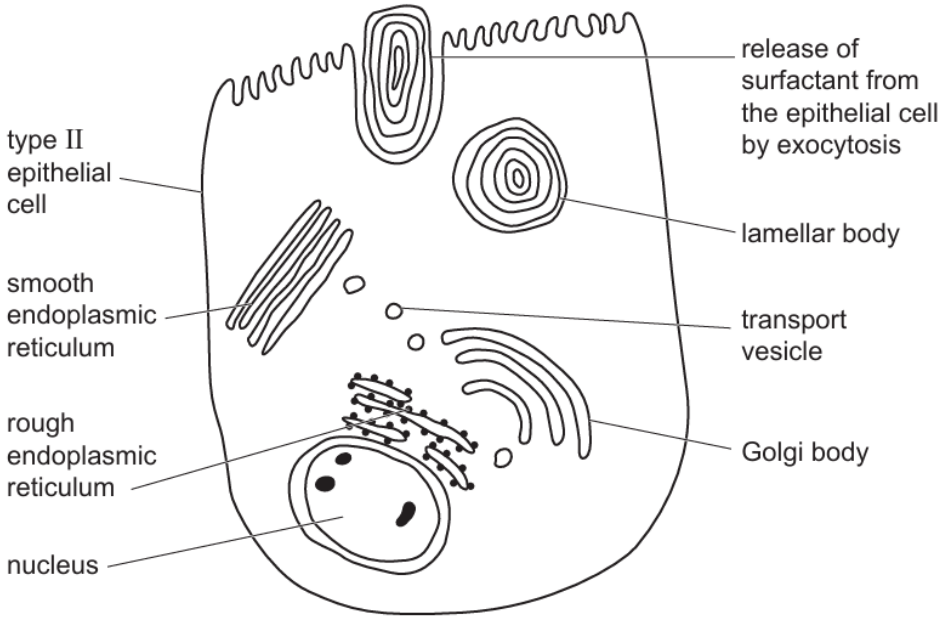


Fig. 5.2

(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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(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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5 **(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.

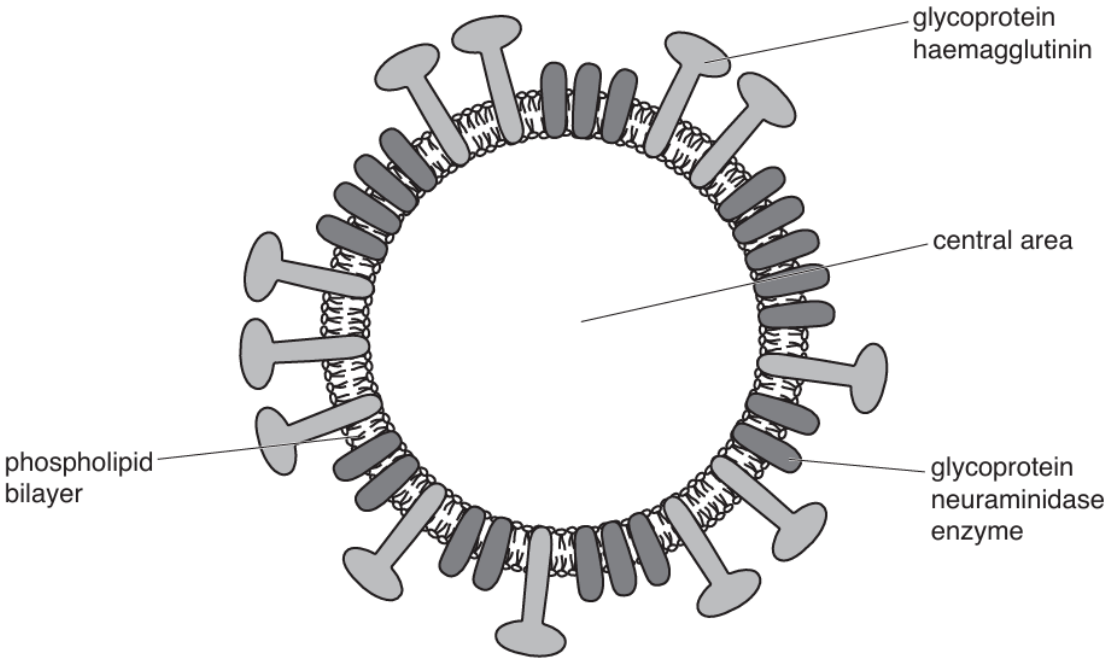


Fig. 4.1

(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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6 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.

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.

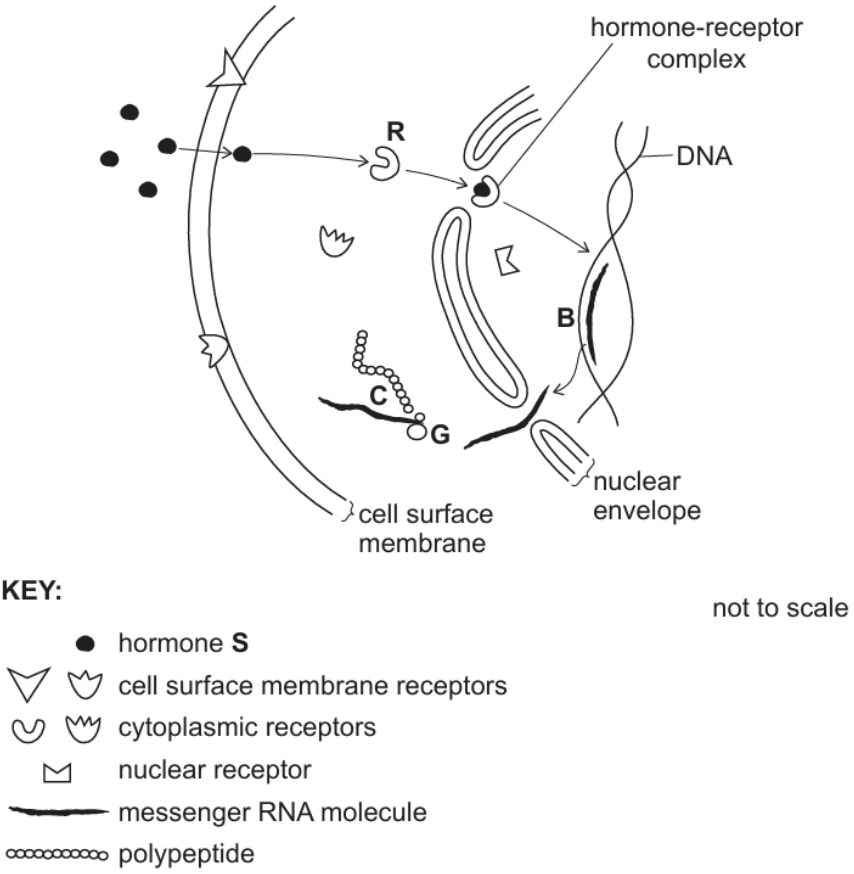


Fig. 3.2

(b) Explain why hormone **S**, shown in Fig. 3.2, does not need to pass through a transport protein to enter the cytoplasm of the target cell.

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(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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7 There are two types of cell, prokaryotic and eukaryotic. Bacterial cells are prokaryotic and plant cells are eukaryotic.

(b) One role of the cell surface membrane of bacterial cells and plant cells is the transport of substances into and out of cells.

Explain how membrane carrier proteins and membrane channel proteins are involved in the transport of substances into and out of cells.

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8 The high blood pressure at the arterial end of a capillary network results in some components of blood leaving the capillaries and forming tissue fluid. At the venous end, the presence of plasma proteins allows movement of water by osmosis back into the capillaries.

Fig. 2.1 is a diagram showing a capillary network. The lymph vessels and the blood vessels at the arterial and venous ends of the network are also shown.

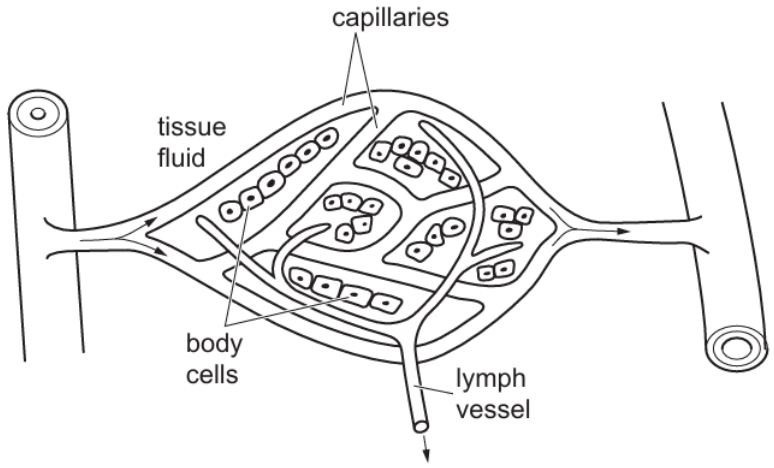


Fig. 2.1

(e) Albumin transports some cell signalling molecules from the cells where they are synthesised to their target cells. The cell signalling molecules bind to specific cell surface membrane proteins on the target cells.

Name the type of membrane protein to which the cell signalling molecules bind.

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9 **(b)** **(i)** The cell surface membranes of the respiring cells have a role in regulating the exchange of substances between the cells of the body and the blood.

Draw a diagram in the space below to show the arrangement of phospholipid molecules in the cell surface membrane.

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(ii) Cholesterol is a molecule found in the cell surface membrane.

Describe **one** role of cholesterol in the cell surface membrane.

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10 Linoleic acid is an unsaturated fatty acid that is found in some triglycerides and some phospholipids.

Phospholipids are components of cell membranes.

Fig. 2.1 shows a molecule of linoleic acid.

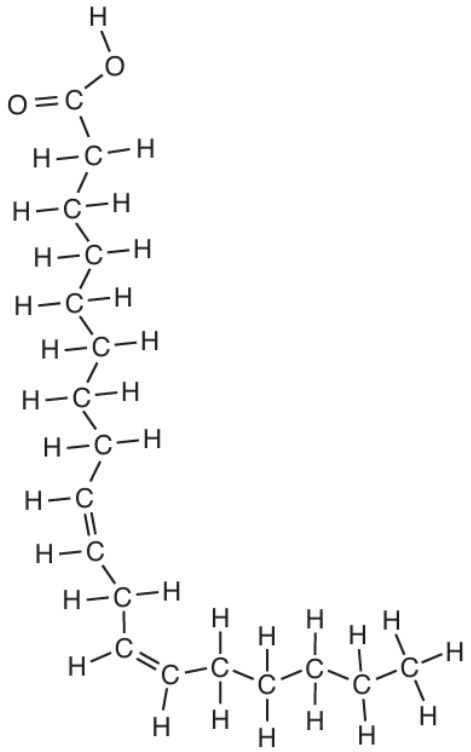


Fig. 2.1

(a) The composition of cell membranes of plants changes in response to changes in temperature.

At the start of the cold season there is an increase in the proportion of phospholipids with unsaturated fatty acids in the chickpea, *Cicer arietinum*. Chickpea plants that do not make this change do not survive.

Suggest how the increase in the proportion of phospholipids with unsaturated fatty acids helps plants, such as chickpea, survive decreases in temperature.

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(c) Platelets metabolise linoleic acid to produce a molecule known as thromboxane.

Thromboxane is released by platelets when blood loss occurs. Thromboxane acts on smooth muscle cells in the walls of arteries. This causes arteries to constrict, which reduces blood flow.

Explain why the constriction of arteries following blood loss is an example of cell signalling.

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11 Cells contain carbohydrates, proteins, lipids and nucleic acids.

(b) Explain how the structure of phospholipids allows the formation of the phospholipid bilayer of cell membranes.

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12 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*.

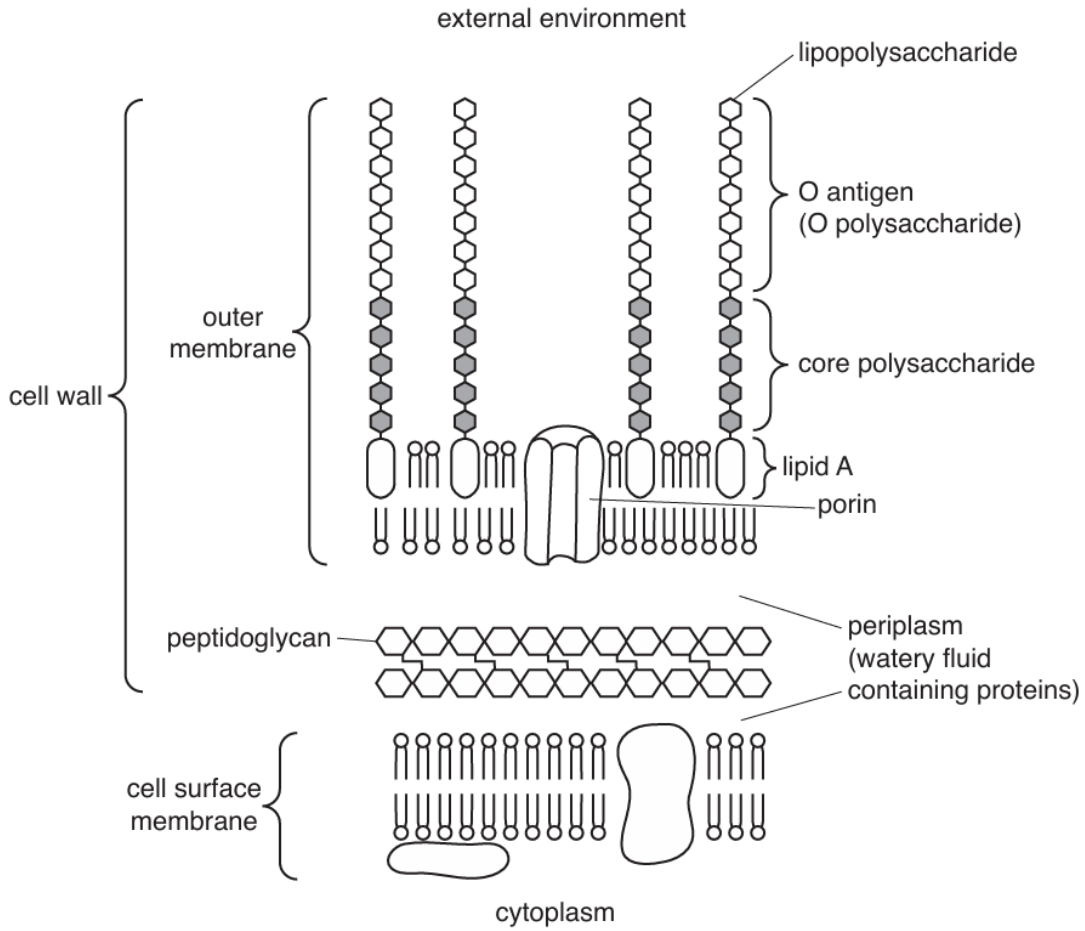


Fig. 3.1

(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.

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

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13 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.

(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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14 Fig. 4.1 is a photomicrograph of a cross-section of a tubular structure in the kidney made from epithelial cells.

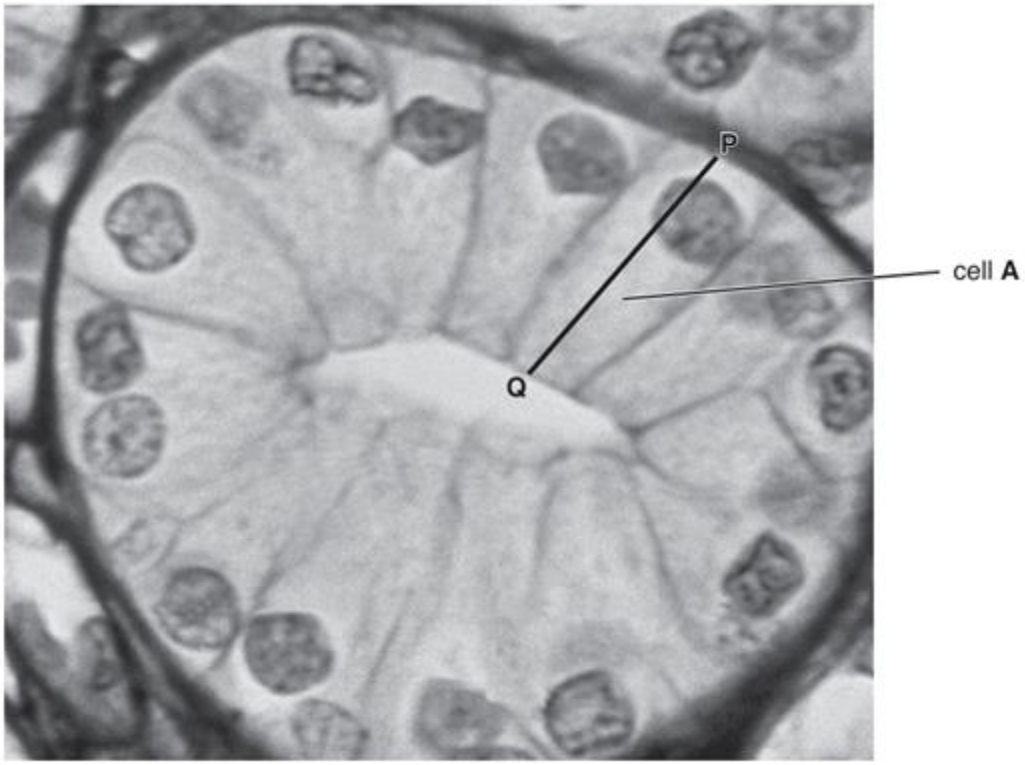


Fig. 4.1

(b) Some epithelial cells in the kidney release the protein vascular endothelial growth factor (VEGF). This protein is a cell signalling molecule that stimulates cell division in endothelial cells in blood vessels.

(ii) Explain how a cell signalling molecule, such as VEGF, can lead to a response in a cell.

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