Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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* 7 9 9 1 4 4 5 4 2 3 *

**BIOLOGY** **9700/22**

Paper 2 AS Level Structured Questions **October/November 2025**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

**INFORMATION**

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.


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[Turn over

1 The wall of the small intestine is highly folded to form villi. Between the villi are infoldings known as crypts of Lieberkühn.

Fig. 1.1 is a diagram of a section through a single villus and a crypt of Lieberkühn.

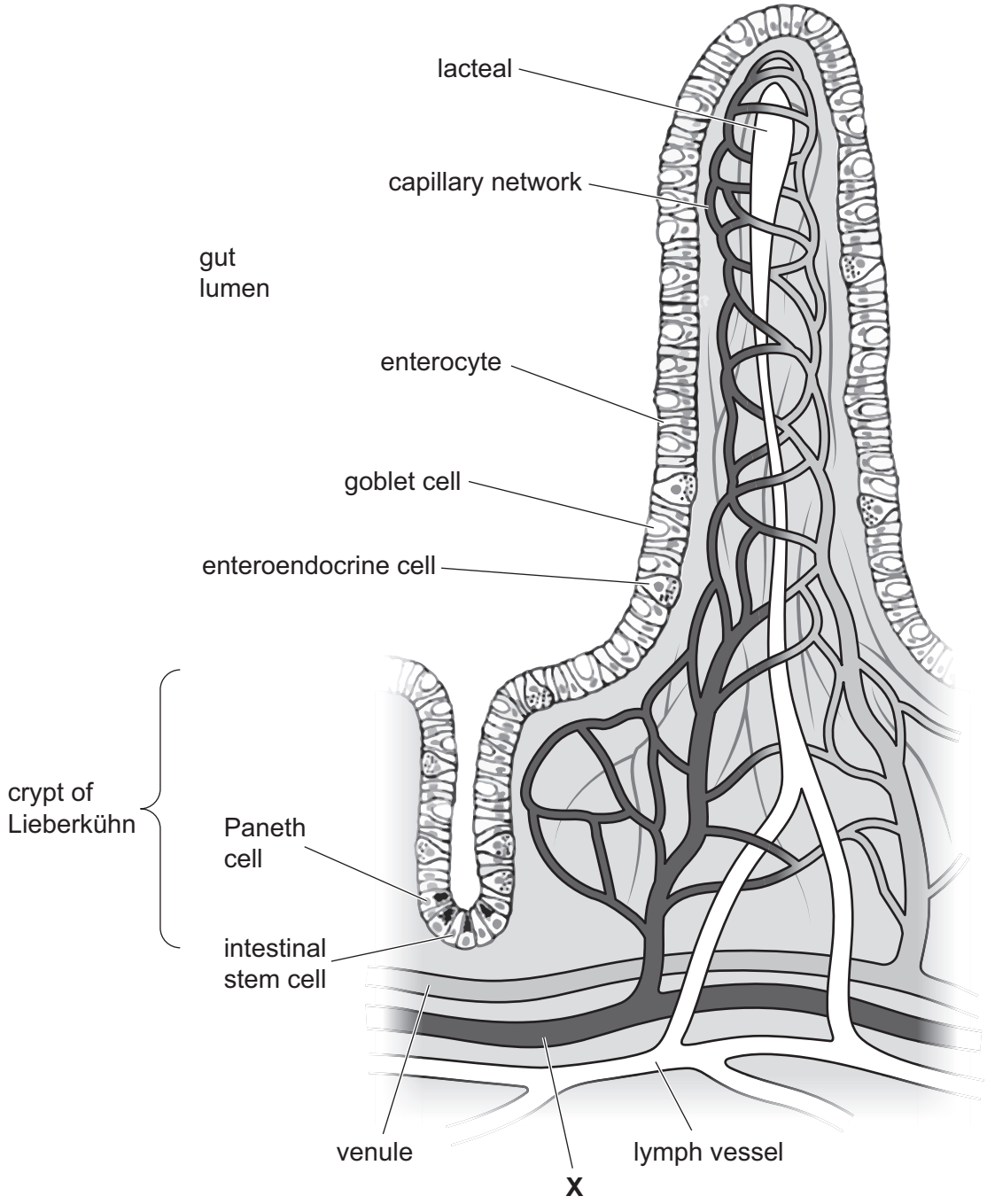



**Fig. 1.1**

Fig. 1.1 shows that the epithelium of the villus contains mainly goblet cells and cells known as enterocytes. Both cell types have microvilli on the apical surface (surface facing the gut lumen).

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Goblet cells are involved in the production of mucus.

Enterocytes are adapted for the absorption of the soluble products of digestion. These products enter the circulatory system.

**(a)** A student incorrectly stated that an enterocyte has many **cilia** on its apical surface.

Explain the difference between a cilium and a microvillus.

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**(b)** Suggest **one** role of the mucus produced by the goblet cells of the villus.

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**(c)** In Fig. 1.1, blood vessel **X** delivers blood to the capillary network of the villus, where tissue fluid is formed. Some of the fluid passes back into the capillaries and then into the venule.

**(i)** Blood vessel **X** receives blood from an artery.

Name the type of blood vessel represented by **X**.

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**(ii)** Describe the formation of tissue fluid in the capillary network of the villus.

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**(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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**(e)** Paneth cells, which are secretory cells, are located between intestinal stem cells at the base of the crypt of Lieberkühn, as shown in Fig. 1.1.

A Paneth cell has a very different appearance to an intestinal stem cell.

Fig. 1.2 is a transmission electron micrograph of a Paneth cell.

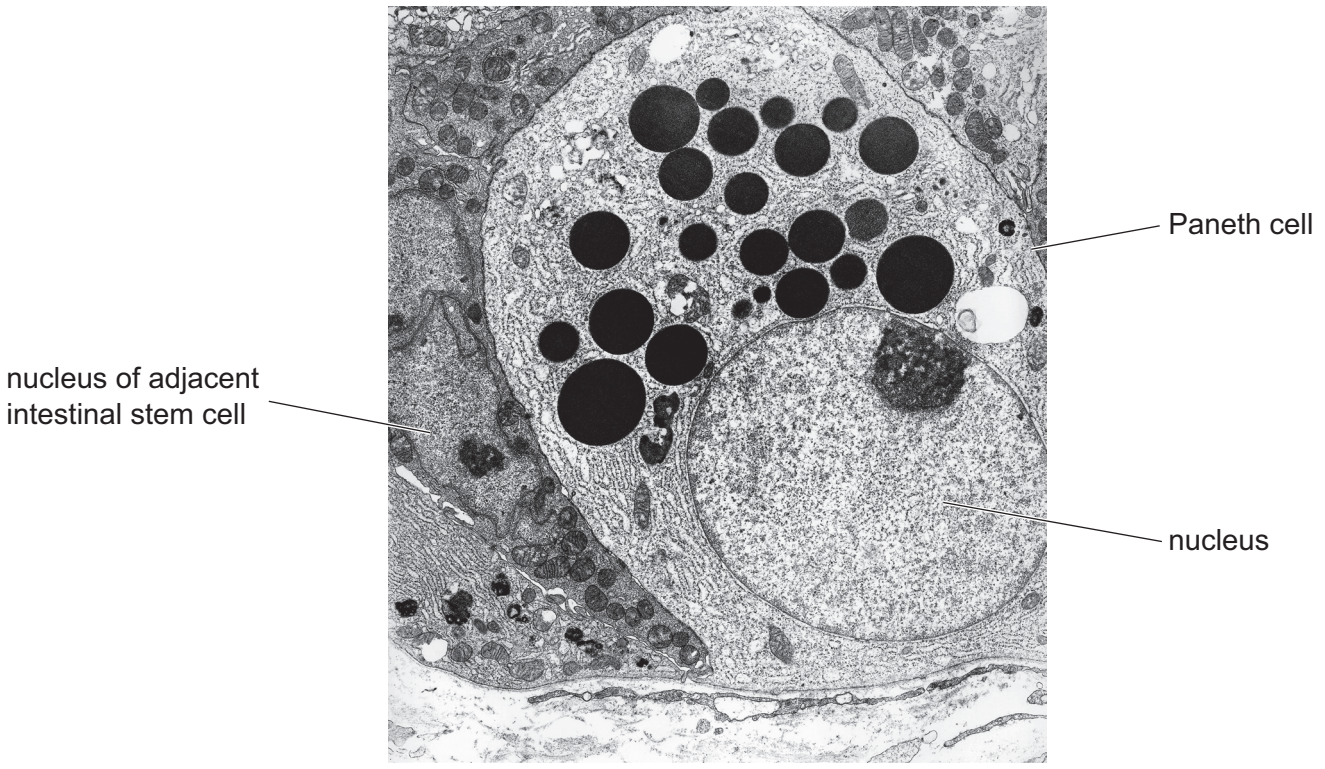



**Fig. 1.2**



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**(i)** Paneth cells are formed following the mitotic division of an intestinal stem cell during a cell cycle.

Complete the cell cycle shown in Fig. 1.3 by naming, **in sequence**, the stages of mitosis.

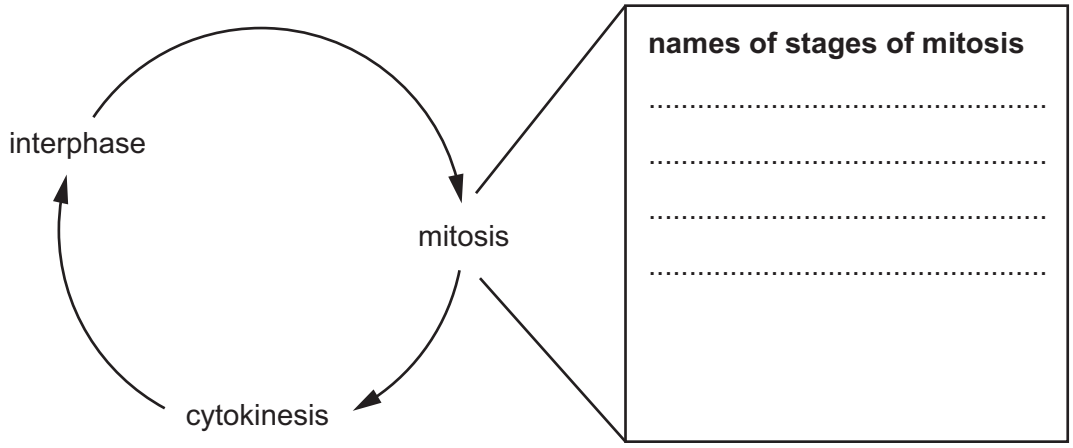



**Fig. 1.3**

[1]

**(ii)** One of the functions of a Paneth cell is to synthesise and secrete peptides and proteins that act against pathogens in the gut lumen.

State **and** explain the evidence, **visible in Fig. 1.2**, which suggests that a Paneth cell:

- is a secretory cell
- synthesises many peptides and proteins.

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**(iii)** Explain why a Paneth cell has a very different appearance to an intestinal stem cell.

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[Total: 14]



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**2** Cholera is an infectious intestinal disease caused by a bacterial pathogen.

**(a)** Name the species of bacterium that causes cholera.

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**(b)** The World Health Organization (WHO) recommends a number of different approaches for the prevention and control of cholera. Two of these are:

- Authorities should provide access to safe drinking water.
- Individuals and communities should practise preventive personal hygiene.

Suggest **and** explain how these two approaches help in the prevention and control of cholera.

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**(c)** Mass vaccination using an oral cholera vaccine (OCV) can be carried out in situations where there is a high risk of people developing the disease.

Passive immunisation involves transferring antibodies into a person for the prevention or treatment of an infectious disease. Some of the infectious diseases for which passive immunisation is available use monoclonal antibody. Passive immunisation for cholera using monoclonal antibody could be available in the future.

**(i)** Complete Table 2.1 to compare an OCV and passive immunisation for cholera:

- fill in the empty box in **row 1**
- circle the correct answers from the choices given in **rows 3**, **4** and **5**.

**Table 2.1**

| row | feature | oral cholera vaccine | passive immunisation for cholera |
|---|---|---|---|
| **1** | component causing the desired response | | antibody |
| **2** | type of immunity gained | artificial active | artificial passive |
| **3** | stimulates production of memory lymphocytes | yes / no | yes / no |
| **4** | length of time needed to have an effect | shorter<br>same<br>longer | longer<br>same<br>shorter |
| **5** | duration of immunity | shorter<br>same<br>longer | longer<br>same<br>shorter |

[4]

**(ii)** The production of monoclonal antibodies for treatment involves the formation of hybridoma cells from two different cell types.

Name the **two** types of cell that fuse to form a hybridoma cell **and** explain why this fusion is necessary.

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[Total: 12]

**3** The gene *LCT* codes for the enzyme lactase. In babies, lactase synthesis is necessary for digesting lactose, the sugar found in milk.

Another gene, *MCM6*, has introns that have a regulatory role in the expression of gene *LCT*. Gene *MCM6* codes for a protein that has **no** involvement in lactase synthesis.

As children get older, the *MCM6* introns are responsible for a decrease in lactase synthesis. This decrease in lactase synthesis is known as lactase non-persistence.

**(a)** *LCT* and *MCM6* are located on the same chromosome in humans.

Suggest differences between gene *LCT* and gene *MCM6*, **other than** their locations in different positions on the same chromosome.

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**(b)** With reference to the process of lactase synthesis, explain the relationship between:

- a transcribed strand and a primary transcript
- a primary transcript and messenger RNA (mRNA).

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**(c)** A mutation in a regulatory intron of *MCM6* allows lactase synthesis to continue. This is known as lactase persistence. In this mutation, the number of nucleotides in the intron remains the same, but one of the nucleotides is different to the original nucleotide.

State the type of mutation that is the cause of lactase persistence.

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**(d)** Fig. 3.1 summarises the reaction catalysed by lactase.

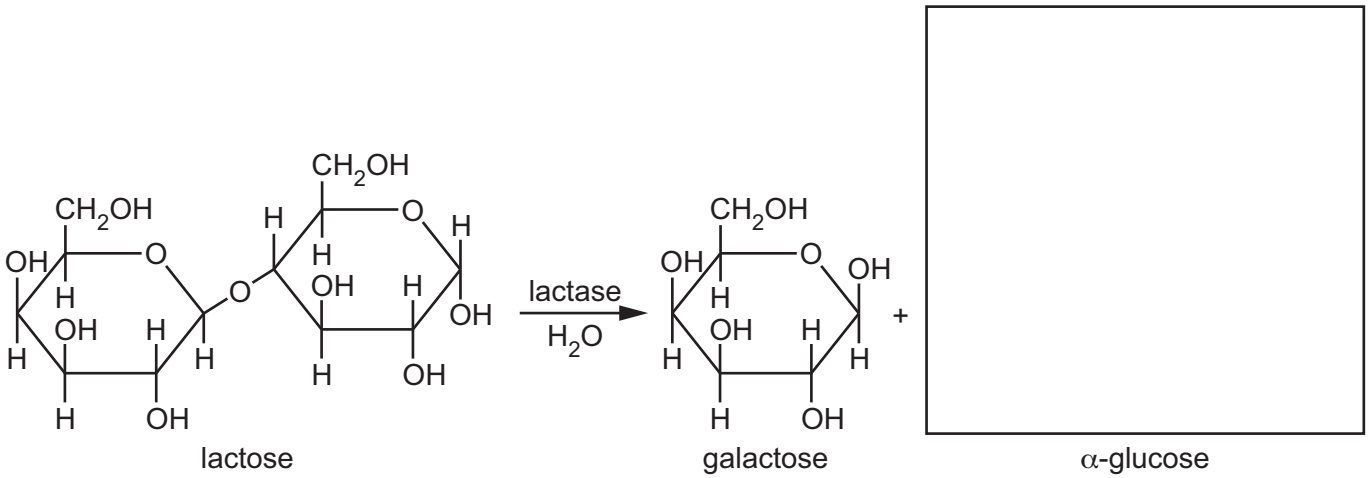



**Fig. 3.1**

Draw the ring structure of α-glucose in the box provided to complete Fig. 3.1. [1]

**(e)** Some people with lactase non-persistence may be lactose intolerant. They may have symptoms, such as abdominal pain, if their diet contains lactose.

**(i)** Lactase supplements (tablets) can be taken before milk or milk-based products are consumed to avoid symptoms of lactose intolerance.

A student compared the activity of two different concentrations of a lactase supplement using an artificial substrate, ONPG, instead of lactose.

A solution of ONPG is colourless, but the hydrolysis of ONPG by lactase releases a coloured product.

The student planned to follow the progress of the reaction for each concentration of lactase using a colorimeter.

Explain why the student chose to use a colorimeter to follow the progress of the reaction for each concentration of lactase.

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**(ii)** The lactose in milk can be hydrolysed using immobilised lactase or using lactase free in solution (free lactase). This results in milk and milk products that do not contain lactose and so are suitable for lactose-intolerant people.

Scientists carried out an investigation to compare the activity of lactase immobilised in very small magnetic beads (magnetic microspheres) with free lactase, at different temperatures and at different pH values.

Fig. 3.2 shows the activity of immobilised lactase and the activity of free lactase at 5 different temperatures.

Fig. 3.3 shows the activity of immobilised lactase and the activity of free lactase at 8 different pH values.

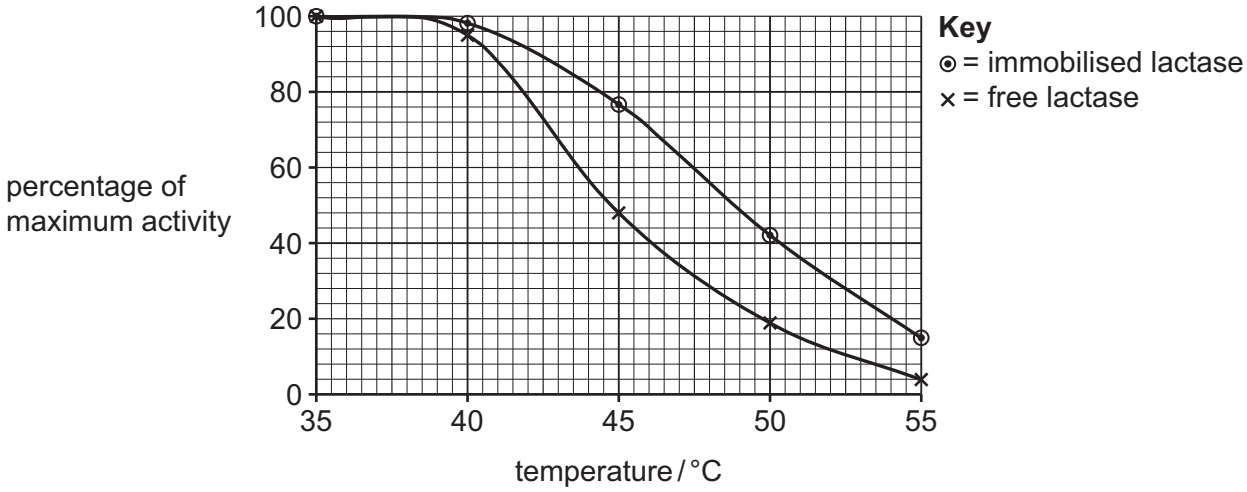



**Fig. 3.2**

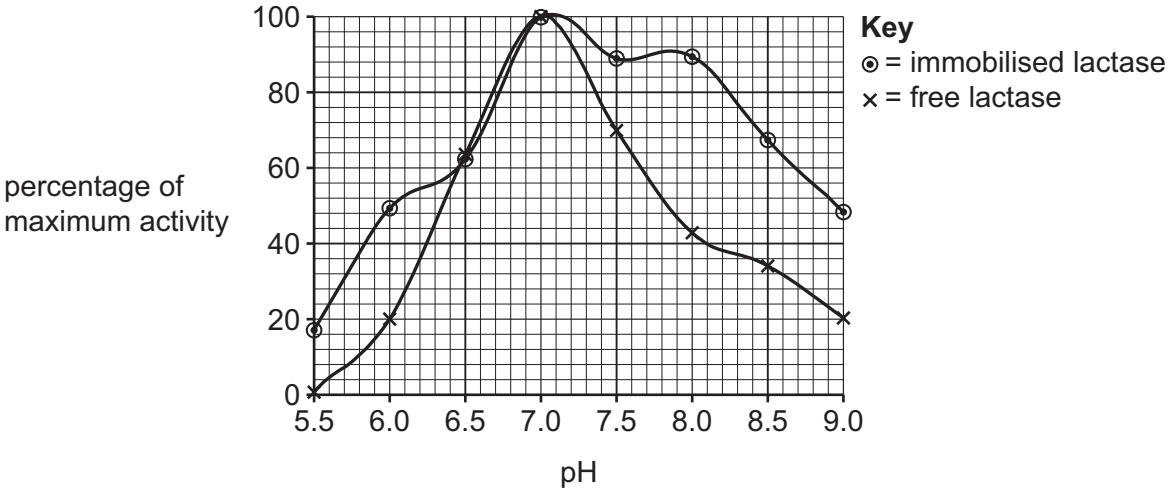



**Fig. 3.3**

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One advantage of using magnetic microspheres with immobilised lactase is that they can be easily recovered using an electric field and reused.

With reference to Fig. 3.2 and Fig. 3.3, explain why the results indicate that there are **other** advantages in using immobilised lactase instead of free lactase to produce lactose-free products.

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[Total: 13]

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**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.

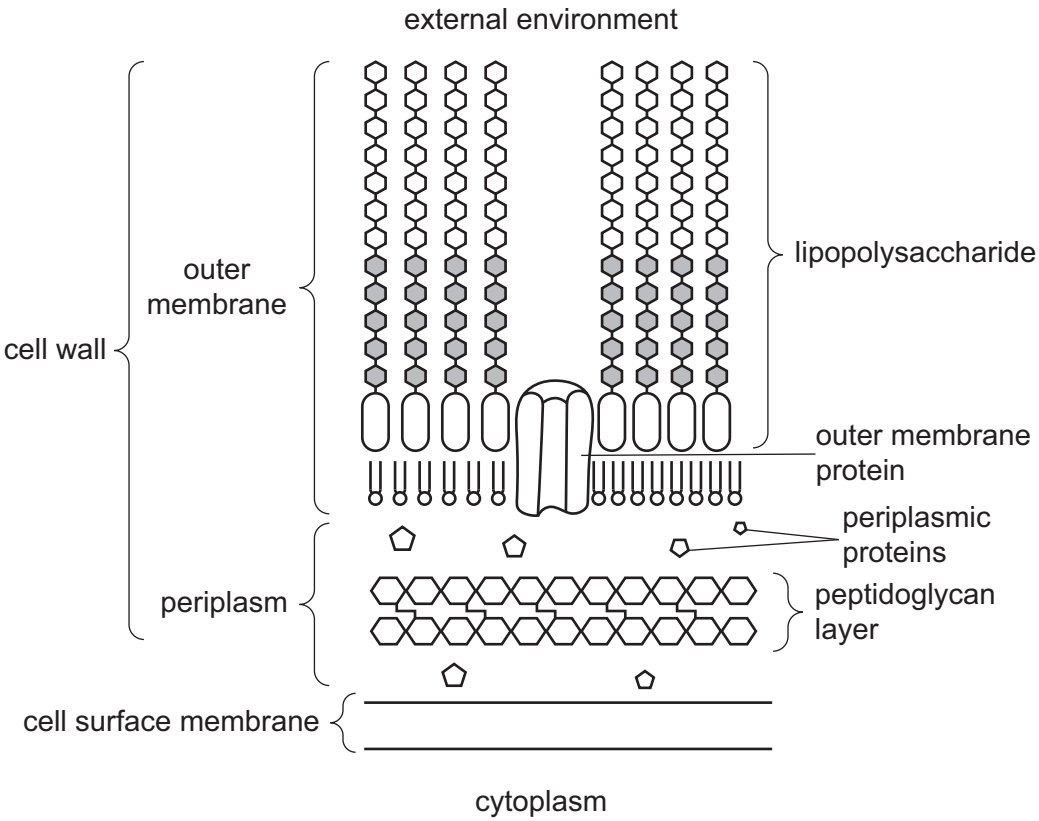



**Fig. 4.1**

**(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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**(b)** Pathogenic and non-pathogenic Gram-negative bacteria can produce extracellular vesicles. Fig. 4.2 summarises how two types of extracellular vesicle, OMVs and O-IMVs, are formed.

O-IMVs are formed from the outer membrane and the cell surface membrane. O-IMVs can contain ATP and DNA.

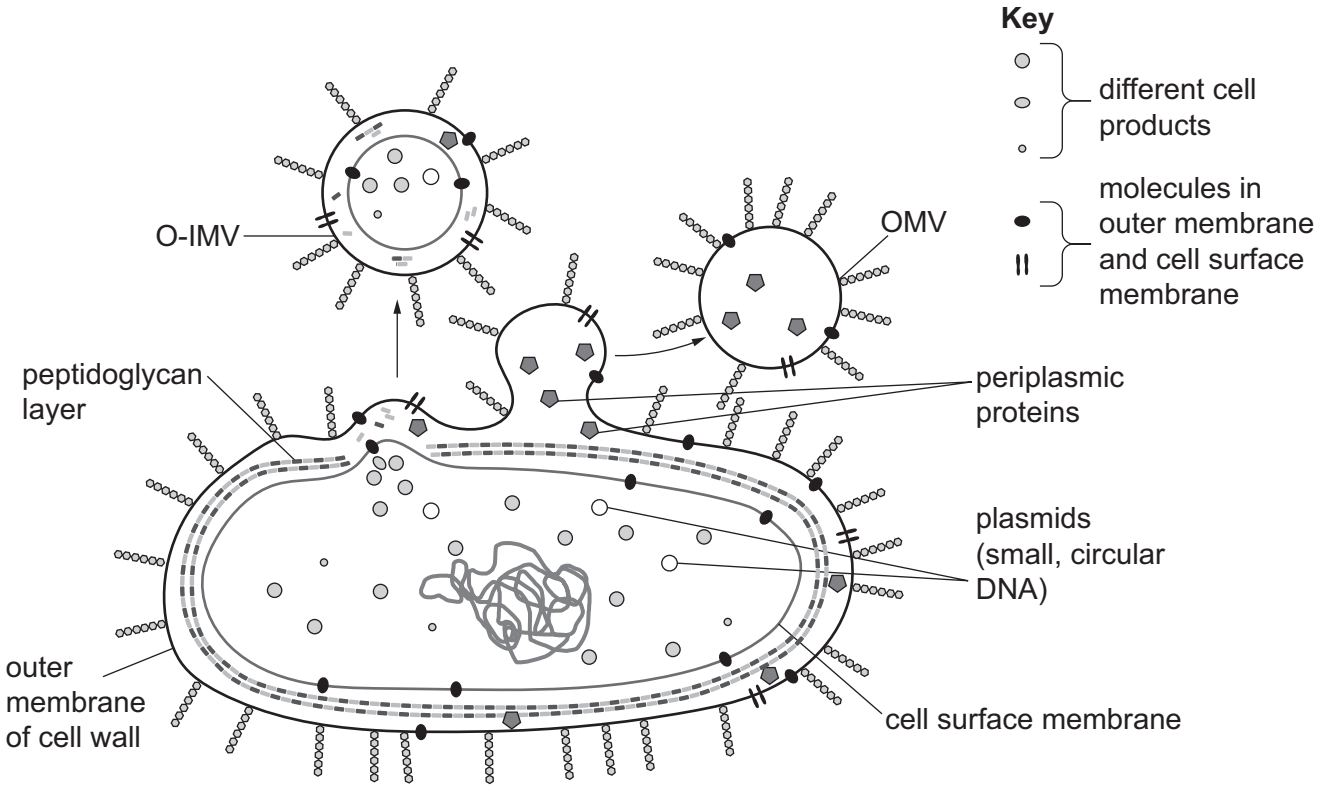



**Fig. 4.2**

**(i)** With reference to Fig. 4.2, suggest why fewer O-IMVs are formed than OMVs.

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..... [1]

**(ii)** Suggest why ATP is found within O-IMVs but **not** in OMVs.

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**(iii)** Suggest **and** explain why the discovery that O-IMVs contain DNA has implications for antibiotic resistance.

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[Total: 7]



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**5** A plant that is described as a mesophyte has evolved to grow in conditions that do not normally experience water stress (low availability of water).

**(a)** Fig. 5.1 is a diagram of a cross section through the leaf of a herbaceous dicotyledonous mesophyte.

Complete Fig. 5.1 by naming structure **A** and tissue layer **B**.

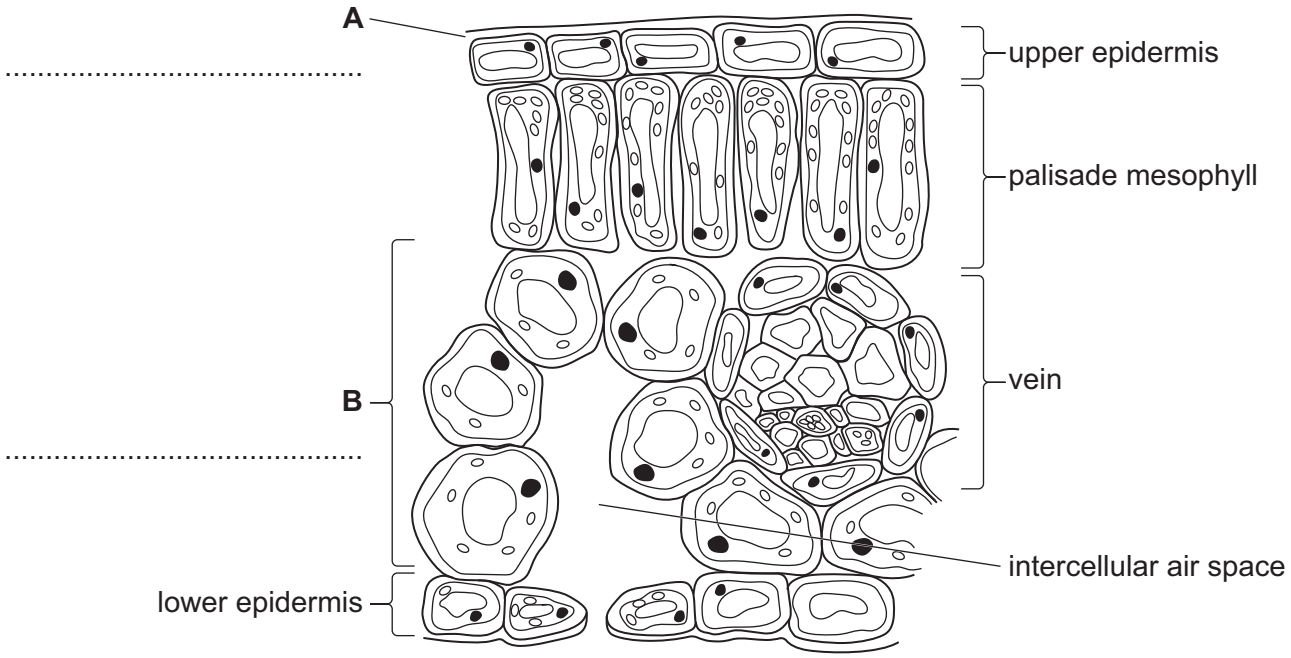



**Fig. 5.1**

[2]

**(b)** In **xerophytes**, some of the structural features shown in Fig. 5.1 are modified as adaptations for surviving conditions of water stress.

Complete **Table 5.1** to show how the structural feature listed may be modified in the leaf of a **xerophyte**.

Each feature should have a **different** example of a modification.

**Table 5.1**

| **structural feature in Fig. 5.1** | **one example of a xerophytic adaptation** |
|---|---|
| structure **A** | |
| upper epidermis | |
| lower epidermis | |

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**6** In the pulmonary circulation of a mammal, deoxygenated blood becomes oxygenated when red blood cells pass through alveolar capillaries and haemoglobin within the cells combines with oxygen.

The blood returns to the heart to be pumped around the systemic circulation.

**(a)** Describe the sequence of events occurring in the heart that allows blood returning in the pulmonary circulation to then enter the systemic circulation.

You should include in your description:

- the names of the relevant blood vessels of the pulmonary circulation and systemic circulation that are connected to the heart
- reference to blood pressure changes that cause the opening and closing of valves.

You **do not** need to include details of control of the cardiac cycle.

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**(b)** Fig. 6.1 is a drawing of a haemoglobin molecule to show its globular structure.

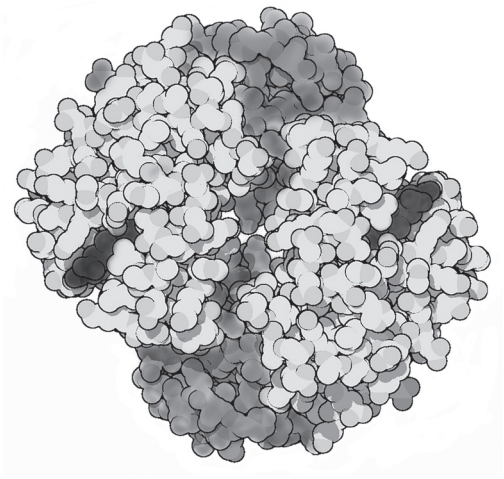


**Fig. 6.1**

**(i)** Describe the quaternary structure of a haemoglobin molecule.

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**(ii)** Outline how a haemoglobin molecule can become fully saturated with oxygen to form oxyhaemoglobin.

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[Total: 9]

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