Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/23**

Paper 2 AS Level Structured Questions **May/June 2022**

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. Any blank pages are indicated.

DC (LK/CT) 302731/2

[Turn over

1 The trachea of the gas exchange system branches into two airways, each of which enters a lung.

(a) Name the airways that branch from the trachea to enter the lungs.

..... [1]

(b) The lower part of the trachea receives blood from arteries that branch from the aorta. Different arteries carry blood from the heart to the alveoli of the lungs.

State the differences between the arteries supplying the lower part of the trachea and the arteries that supply blood to the alveoli of the lungs.

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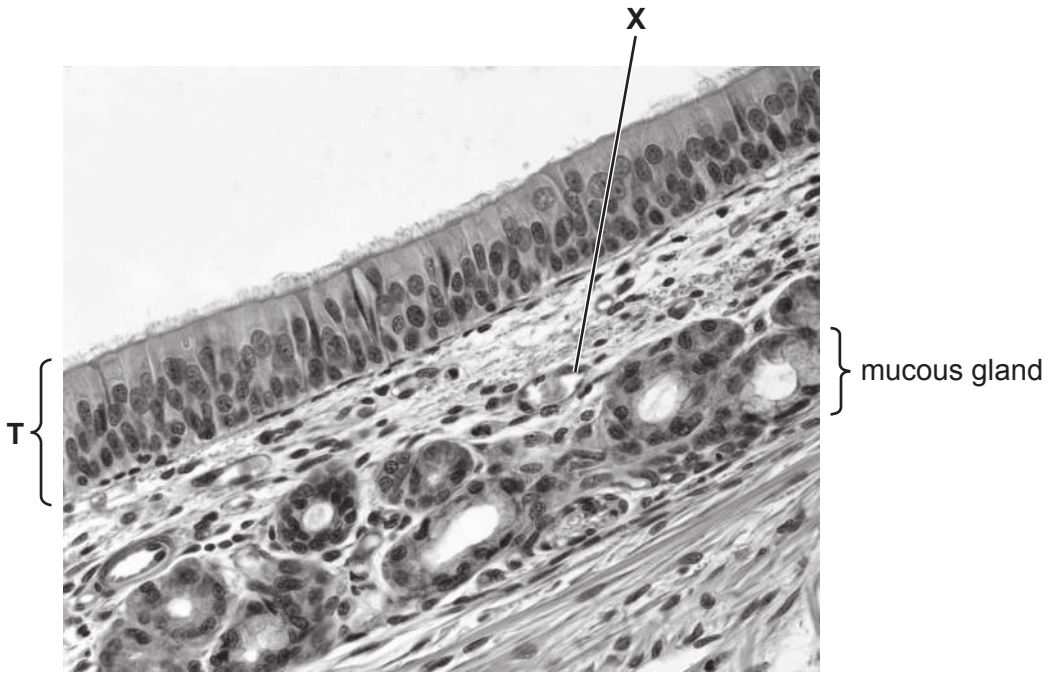
..... [2]

(c) Fig. 1.1 is a photomicrograph of a section through part of the trachea.



magnification ×360

Fig. 1.1

(i) In Fig. 1.1, one of the tissues in the trachea is labelled **T**.

Describe the structural features of tissue **T** visible in Fig. 1.1.

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..... [3]

(ii) Identify structure **X** in Fig. 1.1 **and** outline the features that helped your identification.

structure **X** = ...

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..... [3]

[Total: 9]

2 Bacterial cells are prokaryotic. The cells of plants are described as eukaryotic.

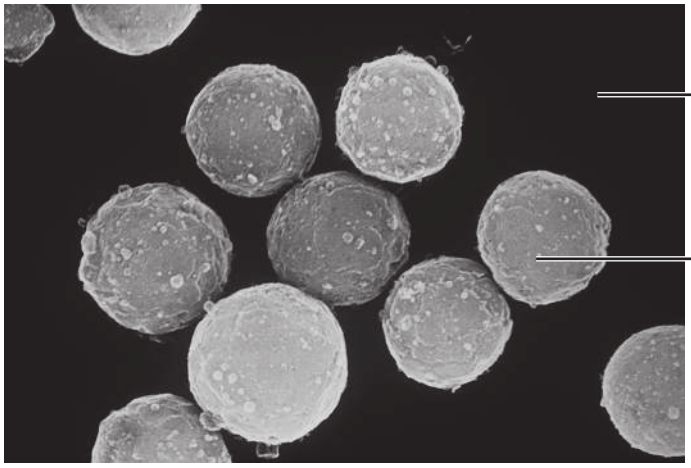
(a) Complete the passage comparing a bacterial cell with a plant cell.

A bacterial cell and a plant cell have a cell wall, but the main component of the bacterial cell wall is ..... and not cellulose. The same organelle is used for protein synthesis in both cell types, but a bacterial cell only has smaller, 70S, ... A bacterial cell does not have a large ..... surrounded by a tonoplast.

[3]

(b) Protoplasts are plant cells that have had their cell walls removed by treatment with enzymes. Scientists often use protoplasts when researching ways to improve the yield of crop plants.

Fig. 2.1 is a scanning electron micrograph of protoplasts of cells from the tobacco plant, *Nicotiana tabacum*.



magnification ×256

Fig. 2.1

Explain why scientists keep the protoplasts in a solution that has the same water potential as the cell.

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..... [2]

After protoplast treatment, the cells can be stimulated to synthesise new cell wall material.

Fig. 2.2 is at a higher magnification than Fig. 2.1 and shows a scanning electron micrograph of part of a protoplast in an early stage of cell wall synthesis.

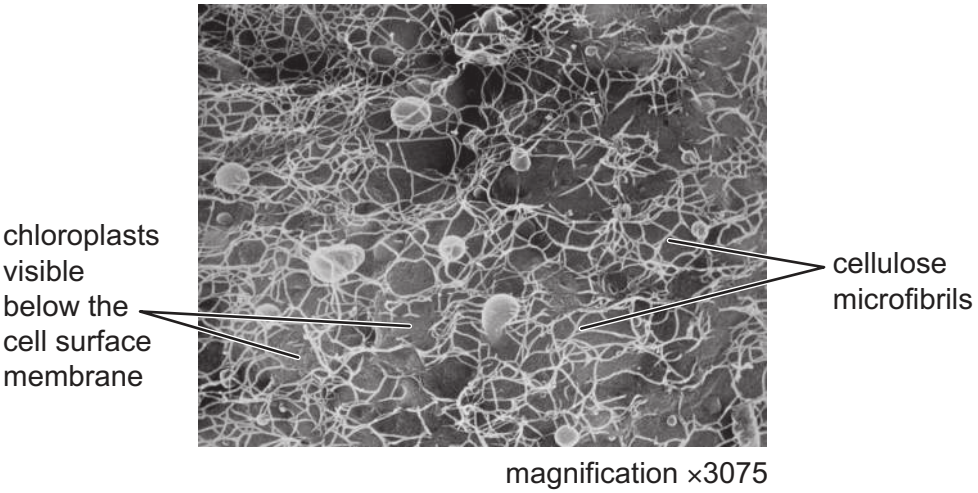

Fig. 2.2

(c) The cellulose microfibrils visible in Fig. 2.2 will form cellulose fibres. Each microfibril is formed from cellulose molecules. Each cellulose molecule is a polymer of β-glucose.

(i) Describe the structure of a cellulose molecule **and** a cellulose microfibril.

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..... [3]

(ii) Name **one** substance that may be added to the network formed by the cellulose microfibrils in the formation of a cell wall.

..... [1]

(d) Name the type of plant cell that could have been used to produce the protoplast shown in Fig. 2.2.

..... [1]

[Total: 10]

3 *Hakea* spp. are xerophytic plants native to Australia. The leaves of *Hakea* have adaptations for a xerophytic mode of life.

(a) Fig. 3.1 is a photomicrograph of a transverse section of part of a leaf of *H. laurina*.

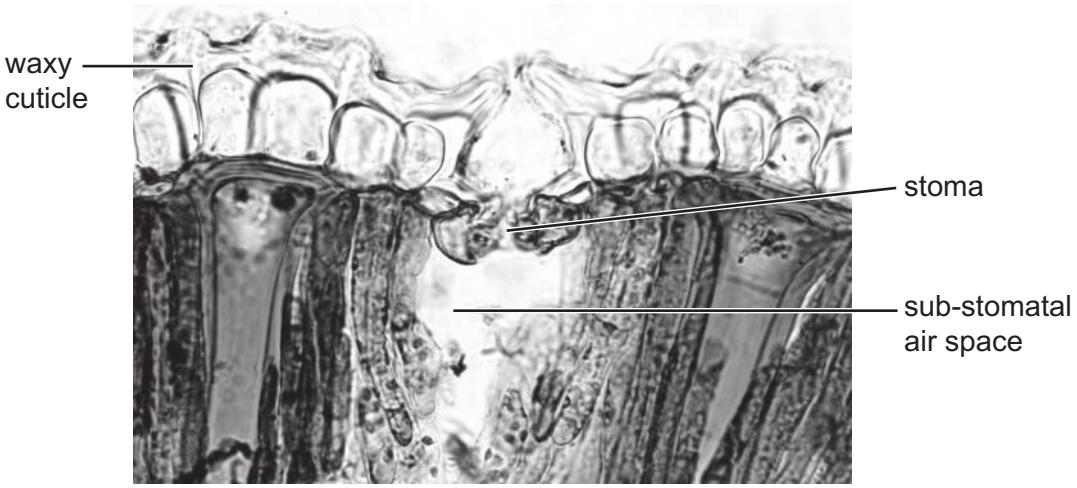

Fig. 3.1

Describe the xerophytic features of the waxy cuticle and the stoma shown in Fig. 3.1 **and** explain how these features adapt the plant to a xerophytic mode of life.

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..... [3]

(b) When the availability of phosphate ions and other soil nutrients is limited, a number of changes occur in the roots of *Hakea* spp.:

- Regions of meristematic tissue are active for a few days.
- Root clusters are formed. A root cluster is a dense arrangement of tiny side roots known as rootlets.
- Most of the epidermal cells of the rootlets are root hair cells.
- Rootlets release compounds into the soil that make phosphates and other mineral ions more soluble for uptake.
- Uptake of phosphate ions and the absorption of water from the soil increases.

(i) Meristem cells have a similar role to stem cells in animals.

Suggest how meristematic tissue activity leads to the formation of root clusters.

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..... [3]

(ii) Organic anions (negatively charged organic compounds) are released into the soil by rootlets. The concentration of these organic anions can become higher in the soil solution than in the rootlet cells.

Suggest **and** explain how the concentration of organic anions in the soil solution can become higher than in the rootlet cells.

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..... [3]

(iii) Explain how the formation of root clusters can lead to an increase in the uptake of phosphate ions and absorption of water from the soil solution.

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..... [2]

[Total: 11]

4 There are many different forms of *Vibrio cholerae*, a bacterium that is found naturally in aquatic environments. The bacterium is motile (can move) and uses a cell structure known as a flagellum to allow it to move through water.

Fig. 4.1 is a drawing of four cells of one form of *V. cholerae*.

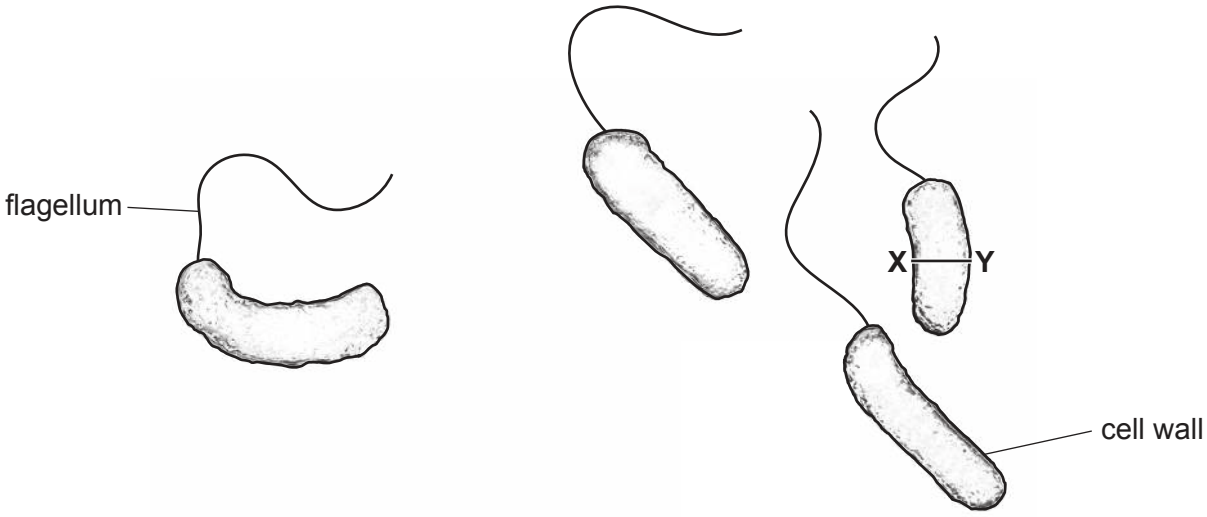

Fig. 4.1

Two main forms of *V. cholerae*, O1 and O139, are able to colonise the small intestine and cause cholera. These two forms are able to produce a toxin, choleragen, which causes the symptoms of diarrhoeal disease. Mutant *V. cholerae* that lack flagella are less able to cause disease.

(a) The magnification of the diagram shown in Fig. 4.1 is ×32 000.

Calculate the actual width **X–Y** in Fig. 4.1 in nanometres (nm) **and** give your answer to the nearest 10 nm.

Complete Fig. 4.2 to show the formula you will use to make your calculation.

actual width	=

Fig. 4.2

answer = ... nm [2]

(b) State the term used to describe disease-causing organisms, such as the bacterium *V. cholerae*.

..... [1]

(c) Outline **one** way in which an uninfected person may become infected by *V. cholerae*.

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..... [1]

(d) Choleragen is produced after *V. cholerae* has penetrated (passed through) the mucus lining and attached to intestinal epithelial cells.

Choleragen is composed of two subunits:
- subunit **A** consists of one polypeptide
- subunit **B** consists of five identical polypeptides
- the polypeptide in subunit **A** is different from the polypeptides in subunit **B**.

Two genes, *ctxA* and *ctxB*, are needed to produce choleragen. Only one strand of the DNA forming gene *ctxA* is involved in the production of subunit **A**. Only one strand of the DNA forming gene *ctxB* is involved in the production of subunit **B**.

Explain why only one strand of the DNA of each gene is involved in the production of the subunits.

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..... [3]

Monoclonal antibodies (mAbs) can be designed to act against components of the cell wall of *V. cholerae*. The cell wall has an outer membrane with lipopolysaccharide (LPS) molecules, shown in Fig. 4.3.

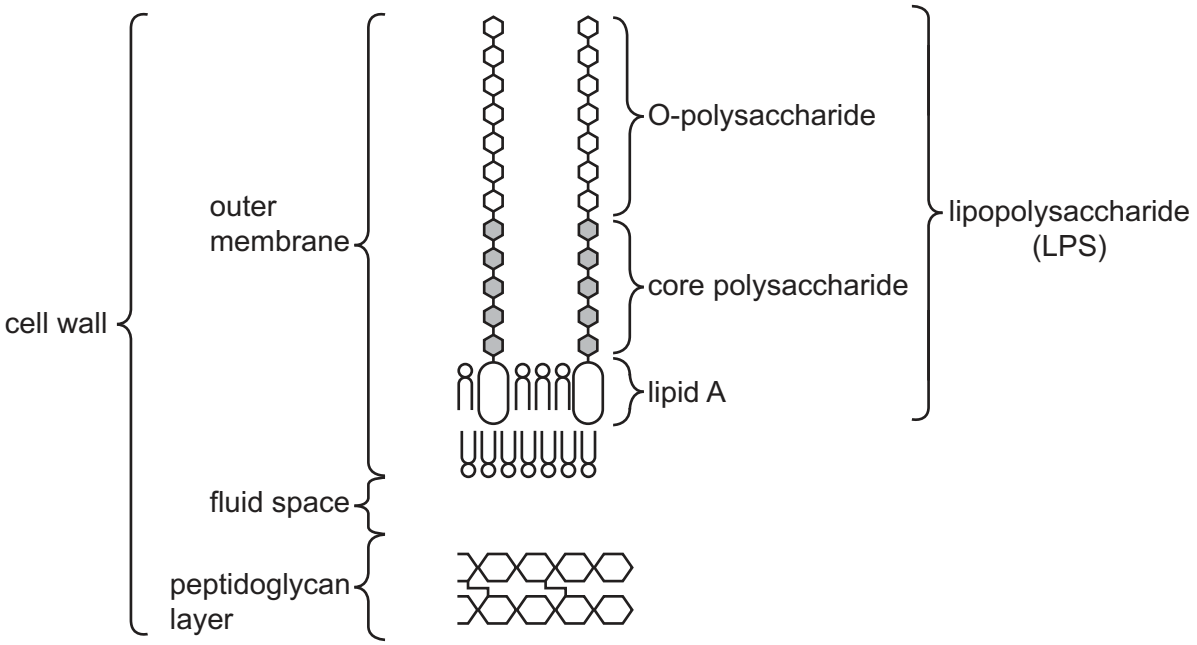

Fig. 4.3

The core polysaccharide and the lipid A components of the LPS molecules are the same in *V. cholerae* O1 and *V. cholerae* O139. However they have different O-polysaccharides.

There are also different types of *V. cholerae* O1 and these have different O-polysaccharides.

(e) Laboratory tests were carried out using two different monoclonal antibodies that had been designed and produced to act against the LPS of bacterial cultures of *V. cholerae* O1:

- mAb 2D6 acts against the O-polysaccharide
- mAb ZAC-3 acts against the core polysaccharide and lipid A components.

(i) Explain why the mAb ZAC-3 produced against the core polysaccharide and lipid A components will not act against the O-polysaccharide of the LPS molecules.

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..... [2]

(ii) The results of the tests showed that both mAbs were effective in causing agglutination (clumping) of bacteria and in preventing their motility. This suggests they may be useful for preventing cholera and for treating the disease.

Discuss whether mAb 2D6 and mAb ZAC-3 may be useful for preventing cholera **and** for treating the disease.

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..... [4]

[Total: 13]

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.

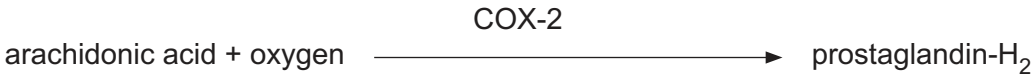

Fig. 5.1

(a) The enzymes involved in the COX pathway are located in the membrane of rough endoplasmic reticulum.

Suggest the advantages to the cell of enzyme pathways being located in cell membranes, rather than in the cytosol of the cell (fluid portion of cytoplasm).

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..... [2]

(b) During an inflammatory response, compounds produced by the COX pathway cause an increased sensitivity to pain.

Some anti-inflammatory drugs are reversible competitive inhibitors of COX-2.

Fig. 5.2 shows how increasing arachidonic acid concentration affects COX-2 activity.

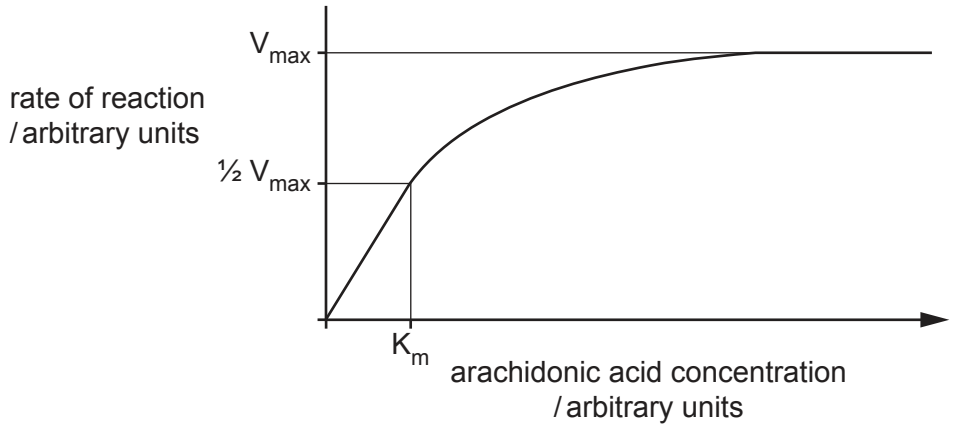

Fig. 5.2

(i) Sketch on Fig. 5.2 the curve obtained if an anti-inflammatory drug, which is a **competitive** inhibitor, is present with arachidonic acid. [1]

(ii) Complete the statements to show whether the maximum rate of reaction (V_{max}) and the Michaelis-Menten constant (K_m) of COX-2 **increases**, **decreases**, or **stays the same** in the presence of a competitive inhibitor.

In the presence of a competitive inhibitor:

V_{max} of COX-2 .....

K_m of COX-2 ..... . [2]

(c) COX-2 is composed of two identical polypeptides. The enzyme is produced when a gene, *PTGS2*, located on chromosome 1, is switched on and transcription begins.

(i) Using gene *PTGS2* and enzyme COX-2 as examples, explain what is meant by a gene.

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..... [2]

(ii) Some mutations in *PTGS2* lead to an increased rate of transcription. These mutations have been linked to an increased risk of certain types of cancer.

Suggest why mutations in *PTGS2* may increase the risk of cancer.

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..... [2]

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

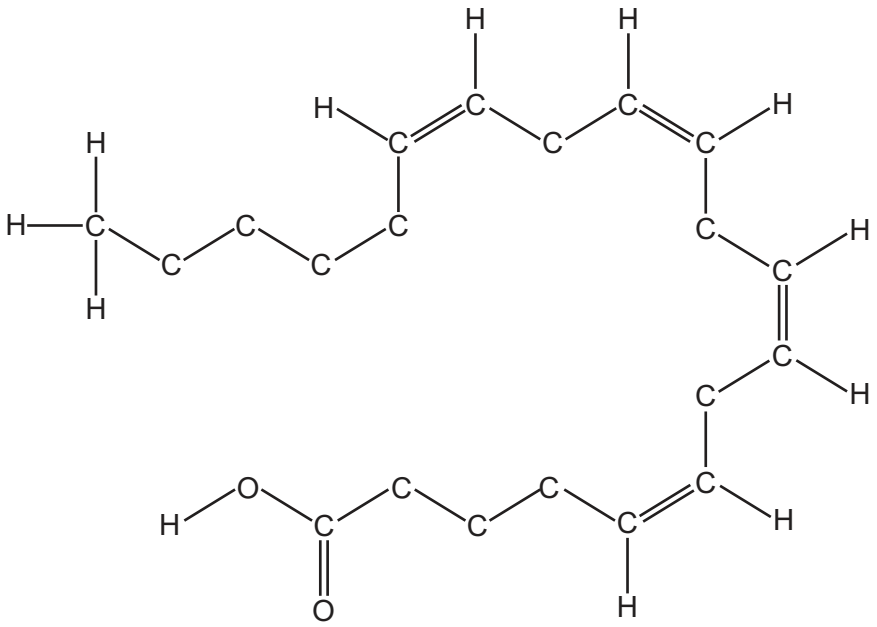

Fig. 5.3

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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..... [3]

[Total: 12]

6 The sinoatrial node, atrioventricular node and the Purkyne tissue have important roles in the cardiac cycle.

(a) State the precise location in the heart of the sinoatrial node.

..... [1]

(b) State the part of the cardiac cycle that is directly initiated by the wave of excitation sent out by the sinoatrial node.

..... [1]

(c) Part of the control of the cardiac cycle involves the contraction of the ventricle walls after the walls of the atria have finished contracting.

Outline how this control is achieved.

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..... [2]

(d) Name the valves of the heart that **open** soon after the Purkyne tissue has received an impulse from the atrioventricular node.

..... [1]

[Total: 5]

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