Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

*4506784563*

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

Paper 2 AS Level Structured Questions **February/March 2017**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **15** printed pages and **1** blank page.


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Answer **all** the questions.

**1** A diagram of a chromosome from a dividing cell is shown in Fig. 1.1.



**Fig. 1.1**

**(a)** A dividing cell is at risk of losing genetic material each time DNA replication occurs.

On Fig. 1.1, add a label line and the letter **G** to show the location on the chromosome of an area that helps to prevent the loss of genes. [1]

**(b)** The chromosome shown in Fig. 1.1 consists of one long DNA molecule associated with histone proteins.

Name **one** stage of mitosis in which a chromosome would have the same general structure as the chromosome shown in Fig. 1.1.

..... [1]

**(c)** Name the stage in the mitotic cell cycle during which the cytoplasm and the cell divide to produce two genetically identical daughter cells.

..... [1]

**(d)** The control of the cell cycle can be affected by extracellular chemical messengers that bind to proteins and glycoproteins in the cell surface membrane. The overall mechanism is known as cell signalling.

State the term used to describe the proteins and glycoproteins that function in this way.

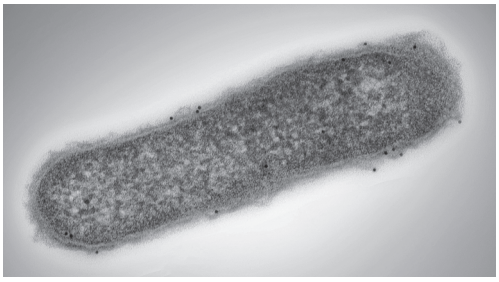
..... [1]

[Total: 4]

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**2** The infectious disease cholera is caused by a bacterium.

**(a)** Fig. 2.1 shows a transmission electron micrograph of this bacterium.



×30 000

**Fig. 2.1**

**(i)** Name the bacterium that causes cholera.

..... [1]

**(ii)** The bacterium in Fig. 2.1 is an example of a prokaryotic cell.

Each of the descriptions **A** to **C** describes a cell structure found in prokaryotic cells **and** in plant cells.

For each of the descriptions **A** to **C**:

- name the cell structure described
- state **one** difference in this structure between a prokaryotic cell and a plant cell.

**A** the site of polypeptide synthesis

*cell structure* .....

*difference* .....

.....

**B** the genetic material of the cell

*cell structure* .....

*difference* .....

.....

**C** the structure that provides a rigid shape to the cell and prevents osmotic lysis

*cell structure* .....

*difference* .....

.....

[6]

**(b)** Cholera is an example of an infectious disease.

Explain what is meant by an infectious disease.

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..... [2]

The symptoms of cholera are caused by choleragen, a toxin released by the bacterium.

Choleragen is a protein made up of six polypeptides:

- a single copy of a polypeptide known as the A subunit that includes an extended alpha helix
- five polypeptides that together make the B subunit.

The B subunit of choleragen binds to a cell surface membrane component, known as GM1, of an intestinal epithelial cell. The complete choleragen protein then enters the cell by endocytosis. Once inside the cell, the A subunit of the protein acts as an enzyme, disrupting the normal functioning of the cell.

**(c)** List the levels of protein structure present in choleragen.

.....

..... [2]

**(d)** Outline the mechanism by which choleragen enters the cell.

You may use the space for annotated diagrams.

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..... [3]

**(e)** Using genetic engineering, it is possible to produce a form of choleragen consisting of only subunit B. This can be combined with inactivated bacterial cells to produce a vaccine against cholera.

**(i)** Suggest why subunit B, rather than subunit A, is used in the vaccine.

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..... [1]

**(ii)** Outline how this vaccine can give protection against cholera.

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..... [5]

[Total: 20]

**3** Catalase is an enzyme that catalyses the breakdown of hydrogen peroxide, a toxic waste product of metabolism.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

Fig. 3.1 shows the results of an investigation into the effect of hydrogen peroxide concentration on the rate of the catalase-controlled reaction, with and without the presence of two different inhibitors.

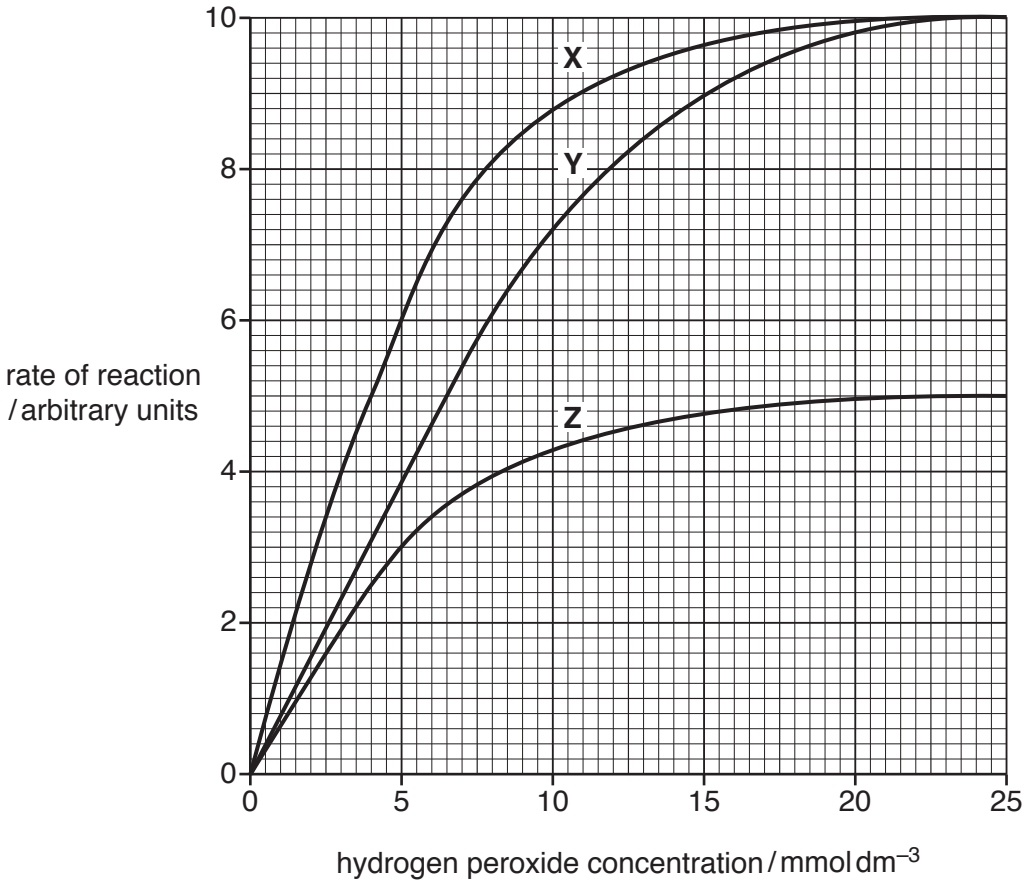



**Fig. 3.1**

**(a)** The inhibitors used in the investigation have different modes of action.

Identify which of curves **X**, **Y** and **Z** are the results for:

- the reaction with the non-competitive inhibitor
- the reaction with the competitive inhibitor
- the reaction without any inhibitor.

*non-competitive inhibitor* .....

*competitive inhibitor* .....

*without any inhibitor* .....

[1]

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**(b)** With reference to Fig. 3.1, compare the maximum rate of reaction, $V_{max}$, and the Michaelis-Menten constant, $K_m$, for curves **X**, **Y** and **Z**.

$V_{max}$ .....

.....

.....

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$K_m$ .....

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[4]

Hydrogen peroxide has a harmful effect on cells. One effect is to damage DNA.

**(c)** Describe the structure of DNA.

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..... [4]

**(d)** The cell has mechanisms to repair the damage to DNA caused by hydrogen peroxide. Errors in repair may cause a change to the structure of DNA.

Studies have investigated possible risks associated with foods and drinks that contain hydrogen peroxide. This is because the compound can be considered a mutagen. Mutagens cause mutations.

Explain why hydrogen peroxide can be considered a mutagen.

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..... [2]

[Total: 11]

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**Question 4 starts on page 10**

**4** The transport systems of plants and mammals both function to transport substances to and from cells.

**(a)** Table 4.1 contains descriptions concerning the mammalian circulatory system and the structure of the heart.

Complete Table 4.1 by writing down the term that matches each description.

**Table 4.1**

| description | term |
|---|---|
| a transport system where blood is enclosed in blood vessels and passes through the heart twice in one complete circuit of the body | |
| blood vessel, with a lumen of approximately 7 μm in diameter, that supplies substances to cells | |
| the blood vessel that carries oxygenated blood from the lungs to the heart | |
| the chamber of the heart that receives deoxygenated blood from the body | |
| the structure dividing the heart into the left and right sides | |

[5]

**(b)** Water is the main component of the fluids associated with transport in mammals and plants.

**(i)** One property of water is its ability to act as a solvent.

Suggest why this property is important in the mammalian transport system.

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..... [2]

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**(ii)** The transport of water in plants depends on the ability of water molecules to form hydrogen bonds.

Explain how hydrogen bonding is involved with the movement of water in the xylem.

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..... [3]

[Total: 10]

5 **(a)** Smooth muscle and cartilage are two of the tissues found in the walls of structures of the gas exchange system of mammals.

Complete Fig. 5.1 to show the distribution of these tissues in the gas exchange system of mammals.

Choose from the four structures listed below.

**alveolus** **trachea** **bronchus** **bronchiole**

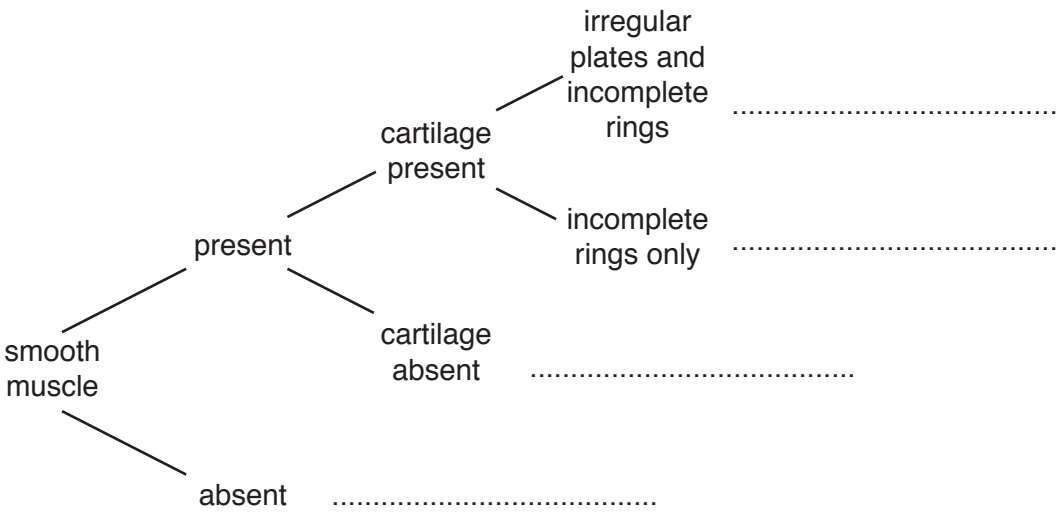



**Fig. 5.1**

[3]

Tobacco smoke is known to be one of the causes of lung cancer and chronic obstructive pulmonary disease (COPD).

**(b)** Outline how tobacco smoke may cause lung cancer.

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..... [2]

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**(c)** Fig. 5.2 shows a section through the wall of one part of the gas exchange system in a person with COPD.

The tissue in the section of the wall labelled **X** is the result of changes to the original healthy tissue lining the lumen of the gas exchange system. The tissue shown is **not** scar tissue and is **not** a tumour.

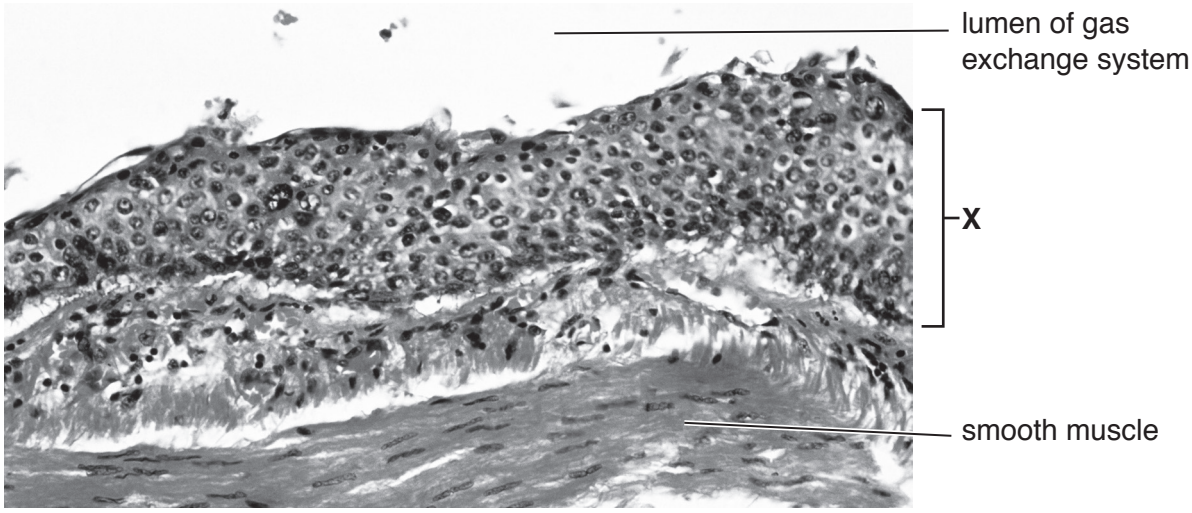



**Fig. 5.2**

The area labelled **X** on Fig. 5.2 is different in appearance to the original healthy tissue in the same part of the gas exchange system.

Describe these differences.

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..... [3]

[Total: 8]

**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.

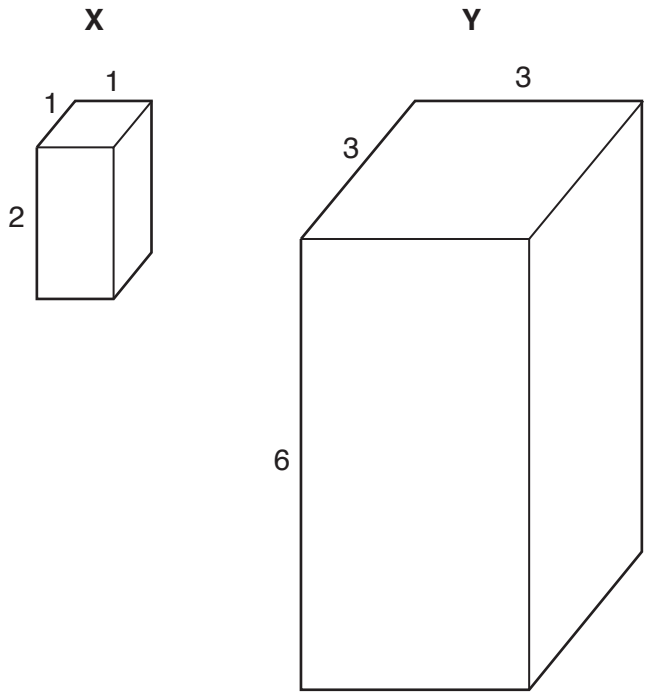



**Fig. 6.1**

**(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]

**(b)** An experiment was carried out by the student to investigate the ability of reducing sugars to diffuse through Visking tubing. Fig. 6.2 shows the apparatus used.

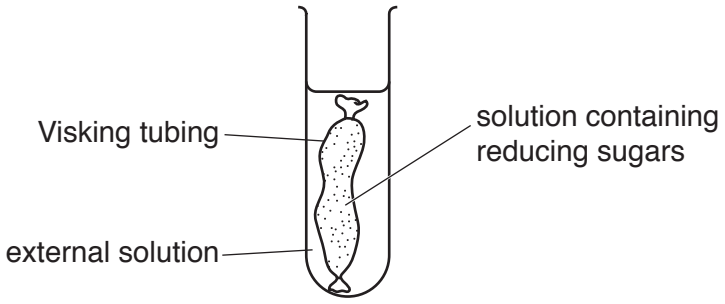



**Fig. 6.2**

At the start of the experiment, the external solution did not contain any reducing sugars.

At intervals, the student tested for the presence of reducing sugars, both within the Visking tubing and in the external solution.

Name the reagent that is used to test for the presence of reducing sugars.

..... [1]

[Total: 7]

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