Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/22**

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

[Turn over

1 The mammalian circulatory system is adapted for the long-distance transport of the respiratory gases, oxygen and carbon dioxide.

The system is described as a closed double circulation.

(a) Name:

- the two different circulations of the double circulatory system of mammals

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  .....

- the main vein returning deoxygenated blood to the heart.

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[3]

(b) In a closed circulation, blood is kept within vessels at all times.

Name the type of blood vessel that connects capillaries and veins.

..... [1]

(c) Fig. 1.1 is a diagram of a section through the heart.

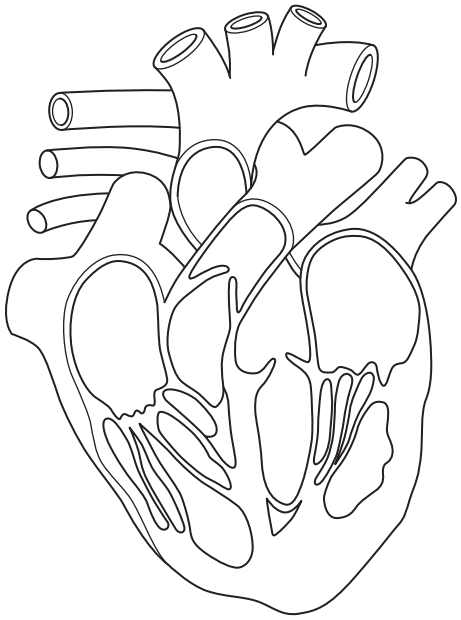

Fig. 1.1

On Fig. 1.1:

- add a label line and the letter **L** to show the artery that takes blood from the heart to the lungs
- add a label line and the letter **R** to show the valve that closes when the right ventricle is in systole. [2]

(d) The entry of carbon dioxide into red blood cells results in the production of hydrogencarbonate ions. This involves the enzyme carbonic anhydrase.

Complete the passage summarising the production of hydrogencarbonate ions by:

- writing the correct biological term in the spaces provided
- writing the molecular formula for **two** of the terms in the spaces in brackets.

Carbonic anhydrase has an overall spherical shape and is known as a ..... protein. The enzyme acts within the cell so can be described as an ..... enzyme. When blood passes into the capillary network through actively respiring tissues, carbon dioxide (CO_2) diffuses into red blood cells and carbonic anhydrase catalyses a reaction where ..... (.....) is combined with CO_2 to form ..... (H_2CO_3), which rapidly forms ..... ions (.....) and hydrogencarbonate ions (HCO_3^-). [5]

[Total: 11]

2 Human cytomegalovirus (HCMV) is a common virus affecting humans. In people with a fully functioning immune system, infection by HCMV usually causes no, or only mild, symptoms.

Fig. 2.1**A** is a diagram of a section through HCMV. In Fig. 2.1**B**, only the outer part of HCMV is sectioned.

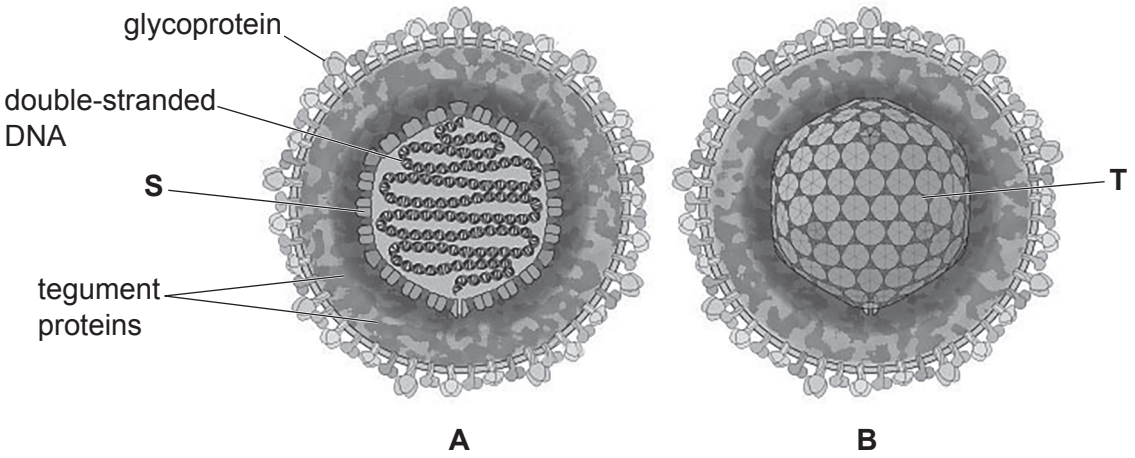

Fig. 2.1

The viral DNA shown in Fig. 2.1 contains genes that code for proteins important in viral replication and viral structure, including viral DNA polymerase and proteins known as tegument proteins.

Viruses can only replicate in host cells as they need to use processes and contents of the host cell. Complete viral particles that are released from the host cell are known as virions.

(a) Structure **S** in Fig. 2.1**A** is a subunit of structure **T** in Fig. 2.1**B**.

Name the chemical compound used to make structure **S and** name structure **T**.

S .....

T .....
[2]

(b) The actual diameter of the HCMV shown in Fig. 2.1 is 0.17 micrometres (μm).

Calculate the actual diameter of the virus in nanometres (nm).

..... [1]

(c) Suggest the role of viral DNA polymerase within the host cell.

..... [1]

(d) The virus in Fig. 2.1 is drawn as a spherical shape. Structure **T** is always the same shape. However, electron micrographs show that HCMV virions are not all the same shape.

Suggest how HCMV virions can be of different shapes.

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..... [2]

(e) With reference to Fig. 2.1**A**, state **one** similarity **and one** difference between the genetic material of HCMV and the genetic material of a typical bacterial cell.

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..... [2]

(f) HCMV is known to infect some types of human cell that carry out the mitotic cell cycle.

Studies have shown that in the presence of one tegument protein, UL69, the cell cycle stops in the G1 stage.

Outline the effects the presence of UL69 will have on the normal activity of the mitotic cell cycle.

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..... [3]

(g) After a person has been infected with HCMV, the virus remains in a dormant state in the body for life.

If the virus becomes active again (reactivates), the virus will only cause serious illness if the person has a weak immune system at that time.

Explain why the response to reactivation of HCMV is more likely to cause serious illness in a person who has a weak immune system.

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..... [4]

[Total: 15]

3 *Plasmodium falciparum* is one species of *Plasmodium* that causes the life-threatening disease malaria. With early diagnosis and the correct drug treatment, the pathogen can be eliminated from the body, particularly if the disease is not severe.

(a) Name the type of pathogen that causes malaria.

..... [1]

(b) To help prevent the development and spread of drug resistance in *Plasmodium*, the World Health Organization (WHO) recommends using a treatment known as artemisinin-based combination therapy (ACT).

ACT involves two different types of drug:

- a fast-acting drug derived from a compound known as artemisinin, which causes a rapid decrease in the number of *P. falciparum*
- one or more longer-acting, non-artemisinin, drugs that eliminate any remaining pathogens.

(i) Suggest why using ACT with the two different types of drug is more effective in preventing the development of drug resistance in *Plasmodium* than a treatment using only one type of drug.

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..... [2]

(ii) In some areas, partial artemisinin resistance has developed. This means ACT takes a longer time for the pathogen to be eliminated from the body.

Explain why there is an increased risk of transmission of the pathogen to other people if a person is receiving ACT and the pathogen has partial artemisinin resistance.

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..... [2]

(c) ACT can act on the stage of the life cycle of *P. falciparum* that occurs within red blood cells. The cells of *P. falciparum* in this stage are known as trophozoites.

Fig. 3.1 is a photomicrograph of a blood smear (thin layer of cells). Some of the red blood cells contain trophozoites.

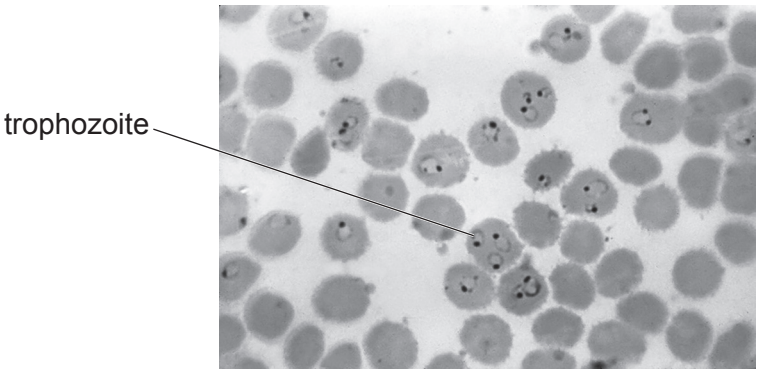

Fig. 3.1

PfK13 is a protein that has an important role in the development of the trophozoite stage of *P. falciparum*. The gene *kelch13* codes for PfK13.

Two different mutations of *kelch13*, known as F446I and C580Y, were investigated to see if they were associated with partial artemisinin resistance. Details of these mutations are summarised in Table 3.1.

Table 3.1

name of mutation	change in DNA		change in protein PfK13	
	nucleotide present in *kelch13*	**nucleotide present after mutation**	**amino acid before mutation**	**amino acid after mutation**
F446I	thymine (T)	adenine (A)	phenylalanine (phe)	isoleucine (ile)
C580Y	guanine (G)	adenine (A)	cysteine (cys)	tyrosine (tyr)

(i) Using gene *kelch13* and mutation F446I as examples, explain the difference between a gene and a gene mutation.

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..... [3]

(ii) In the investigation, the survival rate of trophozoites within red blood cells was determined for two different concentrations of an artemisinin-based drug known as DHA.

Two different strains, **A** and **B**, of *P. falciparum* were tested. Three different cultures of each strain were involved:

- no mutation in *kelch13* (control)
- *kelch13* F446I mutation
- *kelch13* C580Y mutation.

Table 3.2 shows the six different cultures tested and the trophozoite survival rate for each culture.

Table 3.2

culture number	culture details	mean percentage survival rate of trophozoite	
		DHA concentration 20 nmol dm^{-3}	DHA concentration 700 nmol dm^{-3}
1	strain **A** no mutation	3.15	0.00
2	strain **A**, F446I mutation	26.00	0.73
3	strain **A**, C580Y mutation	33.08	0.91
4	strain **B** no mutation	2.86	0.00
5	strain **B**, F446I mutation	13.50	0.53
6	strain **B**, C580Y mutation	17.50	0.63

State the main conclusions that can be drawn from the results shown in Table 3.2.

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..... [3]

[Total: 11]

4 The airways of the gas exchange system are lined with epithelium. Gradual changes in the structural features of this epithelium occur as the airways branch and become increasingly narrow.

(a) Table 4.1 shows the changes that occur in the number of goblet cells in the epithelium of the different structures of the gas exchange system.

Table 4.1

gas exchange structure	number of goblet cells in epithelium
trachea	many
bronchi	many
larger bronchioles	very few
smaller bronchioles	none
alveoli	none

Goblet cells produce mucus, which is important in maintaining the health of the airways.

The smallest bronchioles closest to the alveoli are known as respiratory bronchioles.

Suggest **and** explain why respiratory bronchioles do not have any goblet cells.

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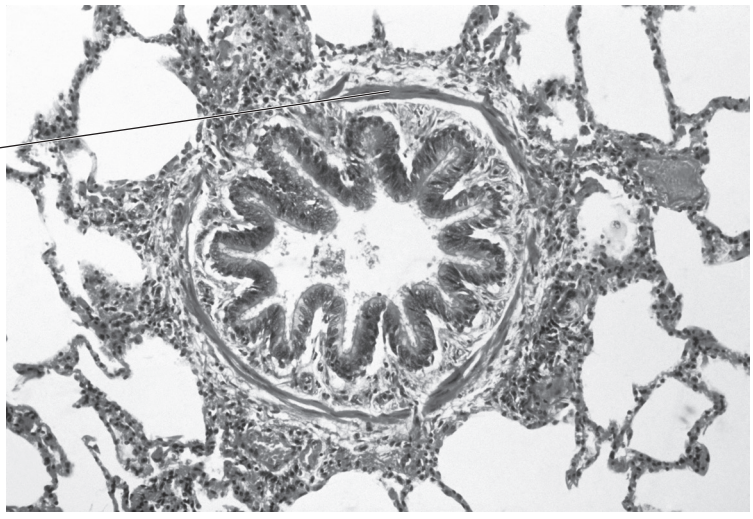
..... [2]

(b) Fig. 4.1 is a photomicrograph of a section through a bronchiole, which is surrounded by alveoli.



magnification ×40

Fig. 4.1

(i) There are structural differences between the epithelium of the bronchiole and the epithelium of an alveolus.

Describe the differences between the epithelium of bronchioles and the epithelium of alveoli, **other than** differences in the number of goblet cells.

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..... [3]

(ii) Tissue **X**, shown in Fig. 4.1, is located in the wall of the bronchiole.

Name tissue **X and** outline the function of tissue **X** in the bronchiole.

tissue **X** = ...

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..... [3]

[Total: 8]

5 Fibroblasts are one of the cell types of connective tissue. The cells synthesise and secrete collagen, which forms part of the supporting external cellular environment, known as the extracellular matrix.

(a) Fig. 5.1 shows the primary structure of a section of a polypeptide chain of collagen.

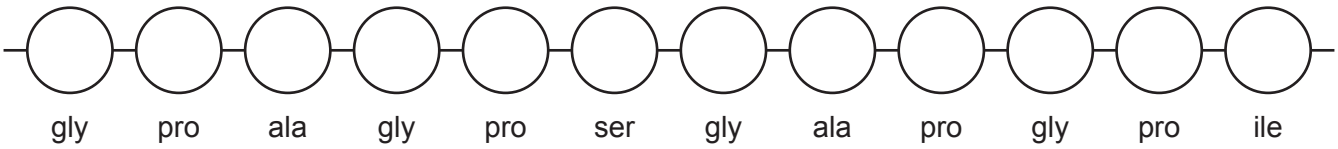

Fig. 5.1

Explain how the primary structure shown in Fig. 5.1 indicates that the structure of the polypeptide is suited to be a component of a collagen molecule.

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..... [3]

(b) After final processing in the Golgi body, collagen is released to the outer surface of the cell by exocytosis.

Complete the passage to describe the process of exocytosis.

After final processing in the Golgi body,
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..... [3]

(c) Hydrolytic enzymes, known as collagenases, are secreted by cells in an inactive form.

Cells also secrete inhibitors of collagenases. The activity of the enzymes and inhibitors is regulated so that the development and maintenance of the extracellular matrix is controlled.

(i) State **and** explain what the outcome will be for the composition of the extracellular matrix if collagenase inhibitor activity is needed.

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..... [2]

(ii) Synthetic inhibitors have been trialled as potential treatment for diseases caused by a lack of regulation of collagenase activity.

Research involves investigating the mechanism of action of an inhibitor.

State the effect that a **non-competitive** inhibitor will have on the maximum rate of reaction, V_{max}, and the Michaelis–Menten constant, K_m, of collagenase.

V_{max} .....

K_m .....
[2]

[Total: 10]

6 Xylem and phloem are the transport tissues of plants. Both tissues have more than one cell type.

The conducting cells of xylem contain xylem sap and those of phloem contain phloem sap. The composition of xylem sap differs from the composition of phloem sap.

(a) The main component of xylem sap and phloem sap is water.

Explain why water is the main component of xylem sap and phloem sap.

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..... [2]

(b) Three types of cell associated with the translocation of sucrose are:

- companion cell
- mesophyll cell
- phloem sieve tube element.

A, **B** and **C** are three events that occur at the source. Each event refers to '**the cell**' but does not name the type of cell concerned.

A Sucrose moves through plasmodesmata into **the cell**.
B Hydrogen ions are transported out of **the cell**.
C Sucrose moves into **the cell** through cotransporter proteins.

Complete Table 6.1 by matching the event with a correct cell type.

Each cell type may be identified once, more than once, or not at all.

Table 6.1

event	cell type
A	
B	
C	

[3]

[Total: 5]

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