Civics Group	Index Number	Name (use BLOCK LETTERS)	H2

ST. ANDREW'S JUNIOR COLLEGE
2024 JC2 PRELIMINARY EXAMINATIONS

H2 BIOLOGY **9744/03**

Paper 3 Booklet B

Wednesday 11th September 2024 2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
Write your answers in the spaces provided on the question paper.

All working for numerical answers must be shown.

Conceptual error (C)	Data Quoting (D)	Expression (E)	Misreading the question (Q)

For Examiners' Use	
2	/7
3	/13
4 or 5	/25
Total	**/45**

This document (Booklet B) consists of **14** printed pages.

[Turn over]

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

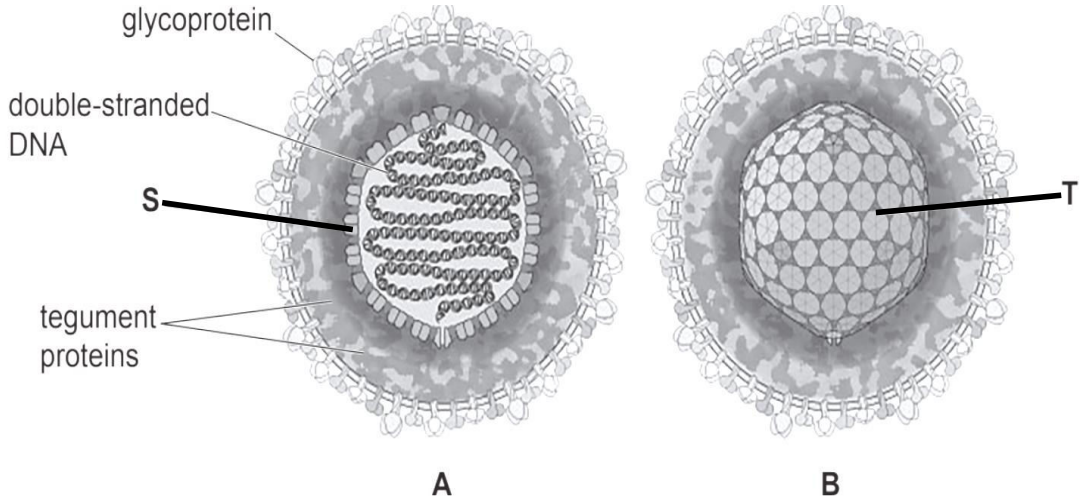

Fig. 2.1

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. 2.1A is a subunit of structure **T** in Fig. 2.1B.

Name the biological molecule used to make structure **S**.

..... [1]

(b) 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 why HCMV virions can appear in different shapes.

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(c) With reference to Fig. 2.1A, 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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(d) Suggest the role of viral DNA polymerase within the host cell.

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Fig. 2.2 shows the reproductive cycle of HCMV.

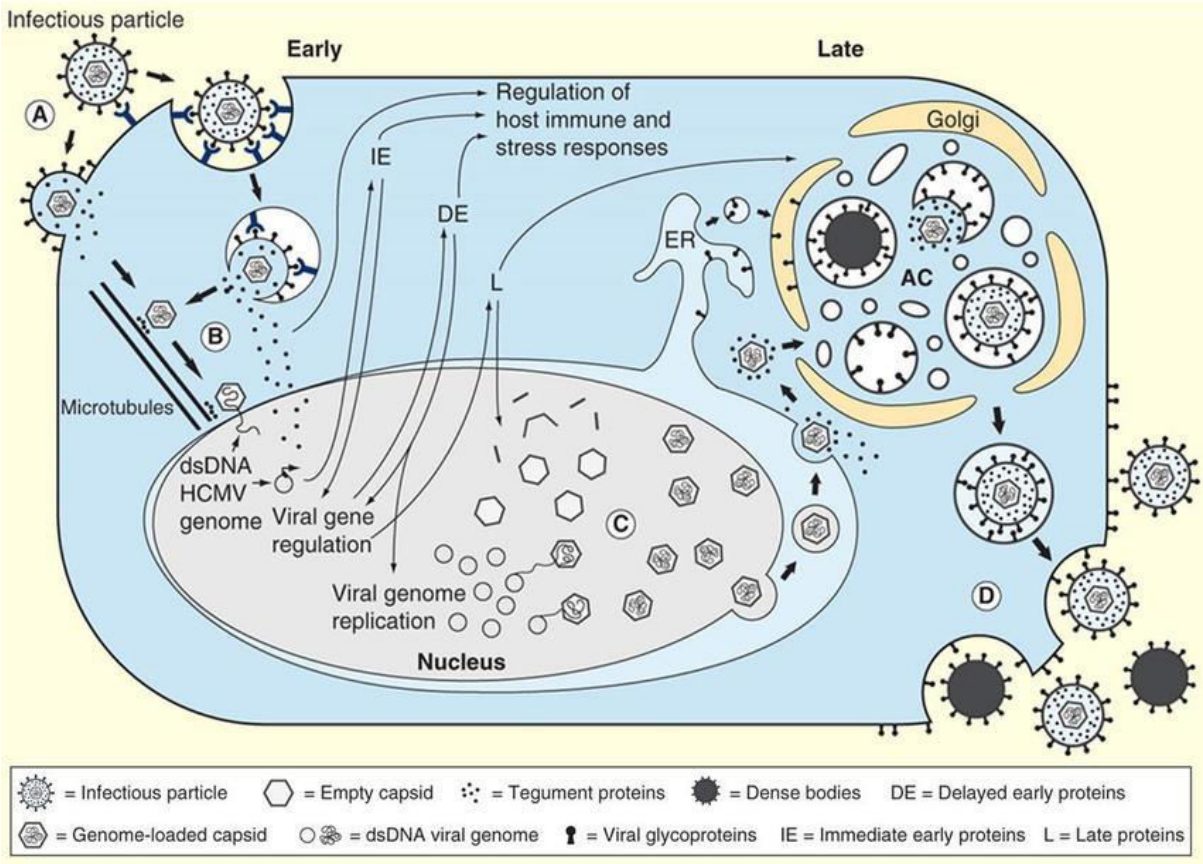

Fig. 2.2

(e) With reference to Fig. 2.2, briefly describe how HCMV enters the cell.

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[Total: 7]

QUESTION 3

Malaria is a serious and often fatal disease that is transmitted by the mosquito *Anopheles gambiae*. One method of reducing the incidence of malaria is to control the numbers of these mosquitoes. In mosquitoes, as in humans, males have an X chromosome and a Y chromosome, while females have two X chromosomes.

Researchers investigated the possibility of producing genetically modified (GM) fertile male mosquitoes in which most of the sperm contained a Y chromosome and not an X chromosome. They predicted that introducing these males into a population of *A. gambiae* could greatly reduce the number of females in each generation and therefore reduce the numbers of eggs laid.

In order to produce the GM males, the researchers inserted the gene coding for a restriction endonuclease called I-PpoI. This restriction endonuclease was known to destroy the X chromosome of *A. gambiae*.

(a) The researchers found that I-PpoI destroyed the X chromosome during meiosis in the GM male mosquitoes. This prevented these males from producing sperm containing an X chromosome. However, I-PpoI was still active in zygotes produced by the fusion of female gametes with sperm containing a Y chromosome. Explain why this meant that the GM males produced no offspring at all.

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(b) The researchers modified the gene for I-PpoI, so that it produced a version of I-PpoI that was active only during meiosis in the males, and was not active in the zygote. They then tested the effect of introducing these GM males into a mosquito population.

• Several cages were set up. 50 adult male mosquitoes and 50 adult female mosquitoes without the I-PpoI gene were placed in each cage.

• 150 adult GM males were introduced into each cage. In half of the cages (A), these GM males had the normal gene for I-PpoI. In the rest of the cages (B), the GM males had the modified gene for I-PpoI.

• The mean number of adult female offspring per cage was determined over the next six generations.

Fig. 3.1 shows the results.

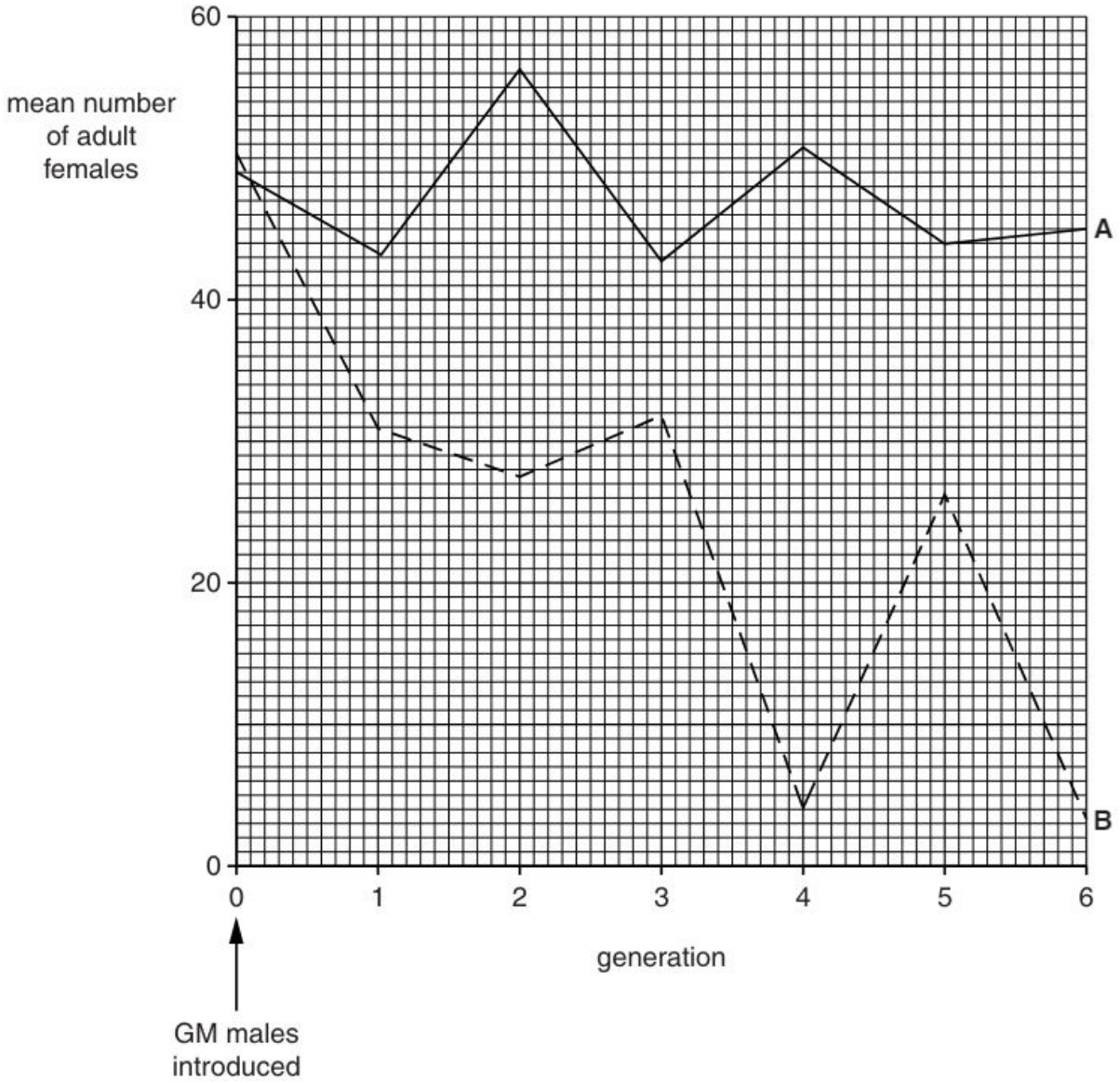

Fig. 3.1

(i) Describe and suggest explanations for the differences between the mean numbers of adult females in the two sets of cages during the experiment.

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(ii) Suggest possible difficulties that might arise if the technique of releasing GM male mosquitoes with the modified I-PpoI gene were used to try to control populations of *A. gambiae* that occur naturally in the wild.

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Malaria vaccines stimulate an immune response with the production of antibodies.

(d)(i) Elaborate on how malaria vaccines result in the activation of naïve CD4 T cells.

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(ii) Describe how the antibodies can reduce the spread of the malarial pathogen through the bloodstream.

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[Total: 13]

Essay

Answer **one** question only in this section.

Write your answers on the lined paper provided at the end of this question paper. Indicate the choice of question clearly on your answer.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections (a), (b) etc., as indicated in the question.

4 **(a)** Biochemical modifications to chromatin structure alters the structural organization of chromatin packing of a cell's DNA into a form that helps to regulate gene expression. Describe how chemical modifications to the chromatin structure regulate gene expression. [15]

(b) Evolution by natural selection over time reduces variation in a population. Compare evolution by natural selection between asexually reproducing populations and sexually reproducing populations. [10]

5 **(a)** In nature, many mechanisms preserve and restore variation in a population. Describe the various mechanisms that help to preserve variation in a population. [15]

(b) In cells, cycles play important roles in many biological processes. Explain the significance of cycles. [10]

[Total: 25]

Response to Essay:

-End of Paper-