EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examinations 2023
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME	

CIVICS GROUP	**2**	**2**	-			REGISTRATION NUMBER		

H2 Biology

9744/03

Paper 3 Long Structured and Free-response Questions

19 September 2023

2 hours

Additional Materials: 12-page Answer Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
Write your answers in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue, or correction fluid/tape.

Section A
Answer **all** questions on the **Question Paper**.

Section B
Answer **one** question on the **12-page Answer Booklet** provided**.**

Write your answer to each part of the question on a fresh sheet of paper.

The use of an approved scientific calculator is expected, where appropriate.

The number of marks is given in brackets [ ] at the end of each question or part question.

At the end of the examination, ensure that you submit both the Question Paper and Answer Booklet.

For Examiner's Use	
Section A	
1	
2	
3	
Section B	
4 OR 5	
Total	**75**

This document consists of **12** printed pages.

Section A

Answer **all** questions on the Question Paper.

1 Scientists have produced structures known as virosomes, which are used in certain vaccines. Virosomes do not cause disease. Fig. 1.1 is a diagram of a section through a virosome used in some vaccines to protect against the influenza virus.

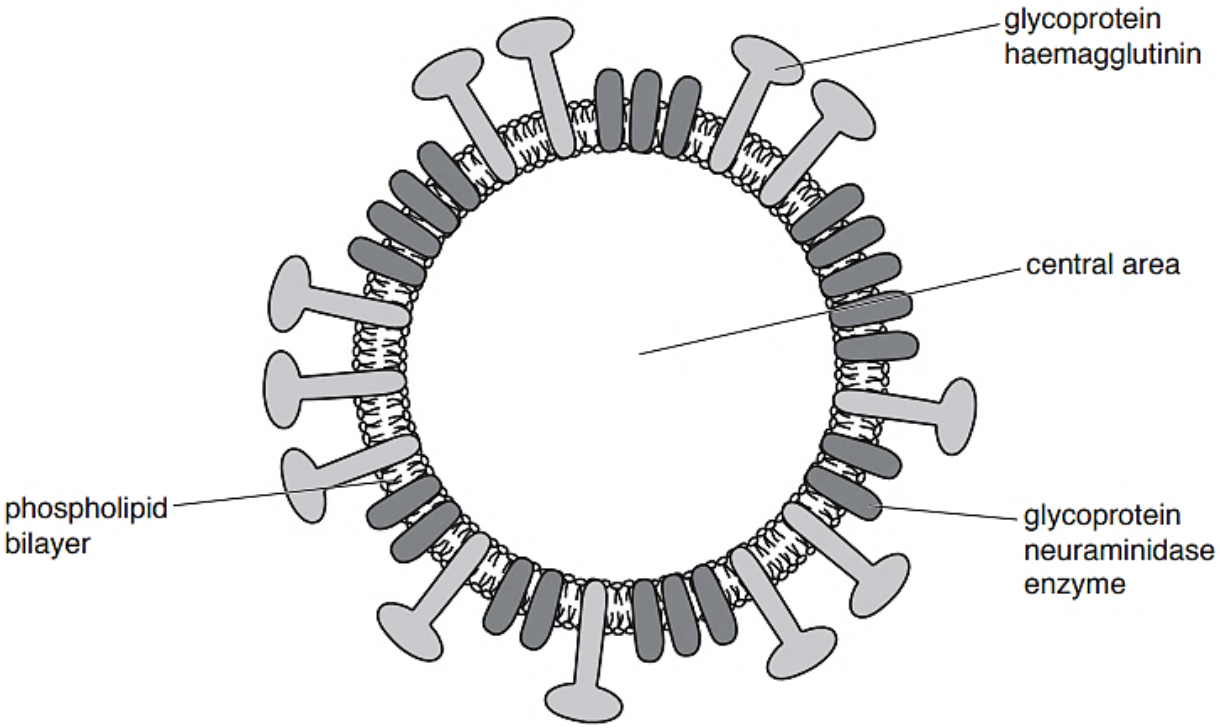

Fig. 1.1

(a) (i) State the structural differences between a virosome and a virus.

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……[2]

(ii) Explain how the structure of the virosome shown in Fig. 1.1 suggests that the central area of the virosome is aqueous.

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……[2]

(b) The glycoproteins haemagglutinin and neuraminidase found in the influenza virus are also found in the virosomes used in a vaccine against the influenza virus.

Briefly explain why haemagglutinin is present in virosomes used in the vaccine for influenza.

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.....[3]

Fig. 1.2 shows the antibody concentration in a patient's serum after he was vaccinated with the virosome.

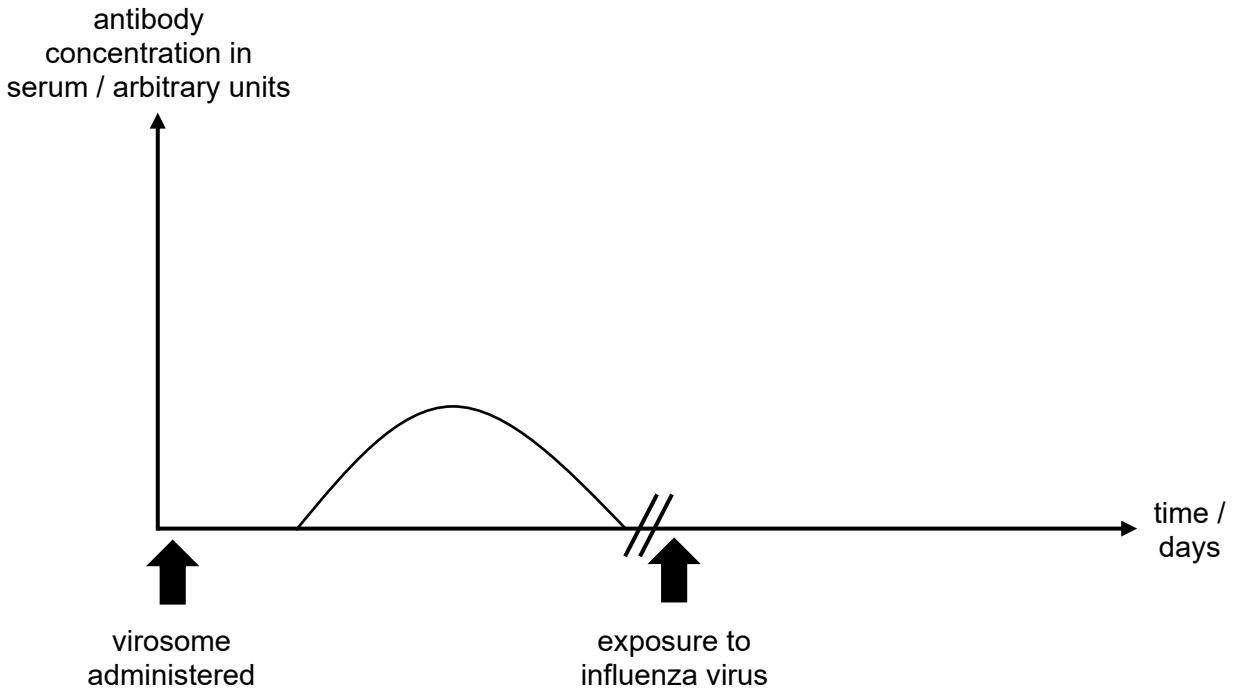

Fig. 1.2

(c) **(i)** On Fig. 1.2, illustrate the antibody concentration in the patient's serum over time, after he was exposed to an influenza virus with the same haemagglutinin and neuraminidase found on the virosome that he was vaccinated with. [1]

(ii) Explain your answer to **(c)(i)**.

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(d) **(i)** The white blood cells that produce antibodies originate from a stem cell.

Identify the stem cells in the body that these white blood cells are derived from.

……[1]

(ii) Describe the differentiation potential of these stem cells.

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……[2]

(e) Due to the emergence of new strains of influenza virus, a new influenza vaccine has to be developed periodically.

Other than mutations, explain how new strains of influenza virus can come about.

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.....[4]

Fig. 1.3 shows a stage of protein synthesis during the reproductive cycle of influenza virus. This takes place in the cytosol of a human cell.

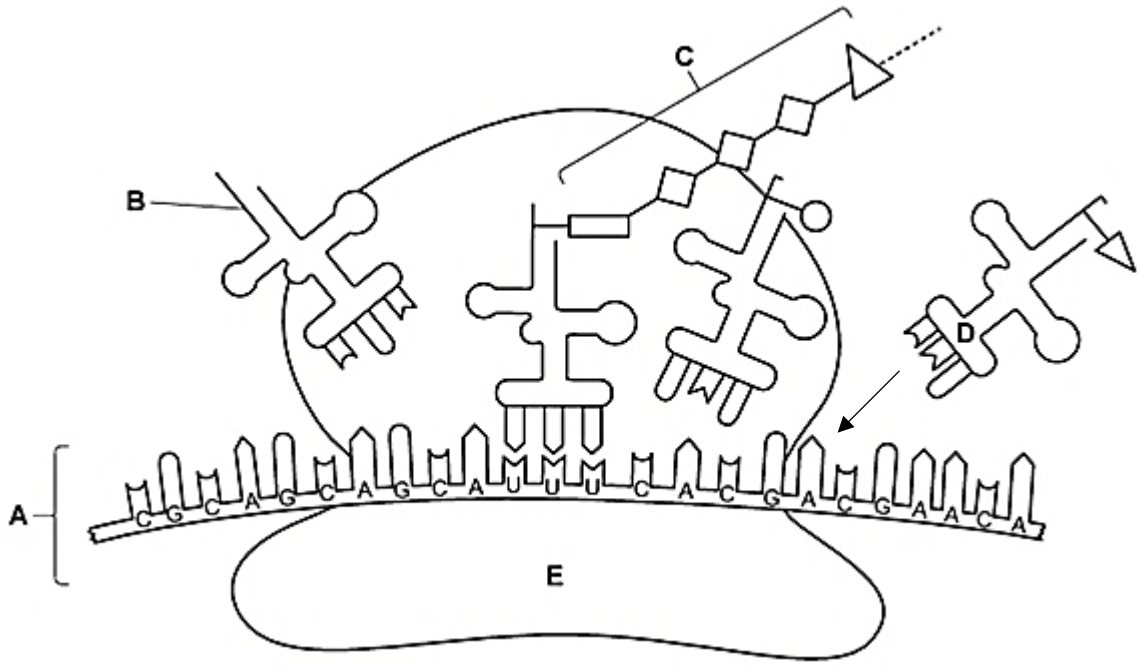

Fig. 1.3

(f) **(i)** Name the stage of protein synthesis shown in Fig. 1.3.

……[1]

(ii) State the base sequence of the anticodon on structure **D**.

……[1]

(iii) Explain the roles of structure **A** in the reproductive cycle of influenza virus.

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……[3]

(iv) After the synthesis of structure **C** is completed, it will fold into a viral protein.

Suggest if this viral protein is likely to be haemagglutinin or RNA-dependent RNA polymerase. Explain your answer.

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(g) In a human cell, proteins can undergo post-translational modifications.

Explain the significance of such modifications.

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.....[2]

(h) Unlike eukaryotic cells, prokaryotic cells lack membrane bound organelles.

Explain how this difference in structure results in a difference in protein synthesis between eukaryotic and prokaryotic cells.

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[Total: 30]

2 There are over 200 species of catfish. All catfish evolved from a common ancestor.

Fig. 2.1 shows how some species of catfish are classified. This phylogenetic tree is based on the evolutionary links between these species.

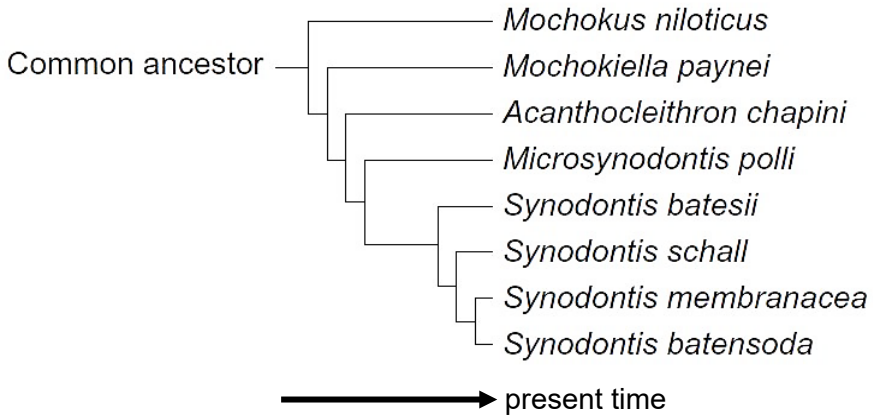

Fig. 2.1

(a) (i) A student who saw the phylogenetic tree in Fig. 2.1 wrote the following statement: "*Synodontis batensoda* was descended from *Mochokus niloticus*".

Evaluate the validity of this statement.

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(ii) The phylogenetic tree shown can be a useful aid in determining a phylogenetic species.

Define the phylogenetic species concept.

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……[1]

(iii) State **two** pieces of evidence that can be used in determining the phylogenetic history of a species.

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……[1]

(iv) Suggest one advantage of using phylogenetic species concept for classification over another named species concept.

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……[1]

Regressive evolution is a change in a population over time that involves the **loss** of certain phenotypic characteristics. It is thought to be caused by either genetic drift or natural selection.

An example of regressive evolution is the loss of eyes in one form of the Mexican cavefish, *Astyanax mexicanus*. These eyeless cavefish live in caves that are in total darkness.

There are three theories to explain how the loss of eyes in the cavefish has occurred.

Theory A
There is no advantage to having eyes in a cave that is in total darkness, where energy sources are scarce. Having eyes is a disadvantage as there may be an energy cost.

Theory B
A mutation has occurred in a single gene. This mutation has two effects:

- a lack of eye development
- an increase in the number of chemoreceptors on the skin, for better detection of molecules released by other organisms in the surrounding.

Theory C
Various mutations occurred in the genes responsible for eye development over a period of time. Randomly, these mutations increased in frequency in small isolated populations. Eventually this produced a population of eyeless cavefish.

(b) State and explain which of the above theories are based on natural selection as the cause of loss of eyes.

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[Total: 10]

3 The interpupillary distance (IPD) is the distance in millimetres between the centres of the pupils of the eyes. Fig. 3.1 shows how IPD is measured.

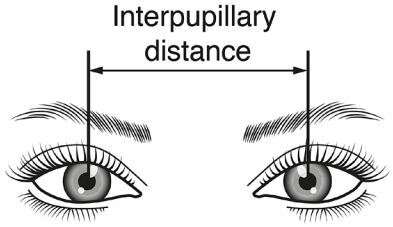

Fig. 3.1

IPD is one example of a characteristic of human facial structure that shows variation.

Fig. 3.2 shows the pattern of variation in IPD in a large sample of adults.

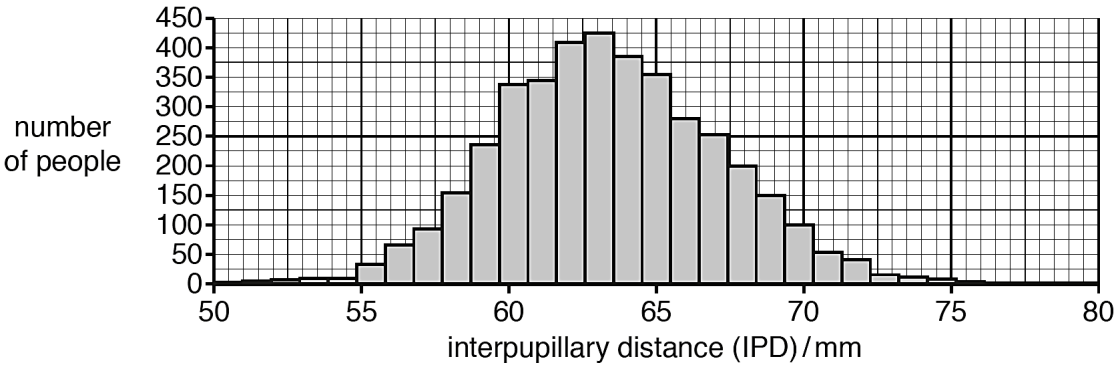

Fig. 3.2

(a) **(i)** Name the type of variation shown in Fig. 3.2. Explain your answer.

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……[2]

(ii) Explain **two** factors that contribute to variation in IPD in humans.

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(b) Individuals with an IPD of 70 mm or more have a mutation in the *PAX3* gene that results in less PAX3 protein being made.

The normal role of the PAX3 protein is to increase the expression of many other genes involved in embryonic development. These genes affect a range of phenotypic features such as facial structure, hearing, and eye colour.

(i) Identify which type of specific transcription factor the PAX3 protein functions as.

……...[1]

(ii) Describe how the PAX3 protein controls the expression of other genes.

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……...[3]

The chimpanzee, *Pan troglodytes*, has DNA that is 98.5% similar to humans, including possession of the *PAX3* gene. Investigations show that chimpanzees express higher levels of the PAX3 protein during embryonic development than humans.

Fig. 3.3 shows a chimpanzee, *Pan troglodytes*.

Fig. 3.3

(iii) Suggest how knowledge of the *PAX3* gene helps scientists explain how humans and chimpanzees are very different in facial structure, even though they have very similar DNA.

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……[2]

[Total: 10]

Section B

Answer **one** question in this section.

Write your answers on the 12-page Answer Booklet provided.

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 parts **(a)** and **(b)**, as indicated in the question.

4 **(a)** Compare evolution by natural selection in asexually reproducing populations with evolution by natural selection in sexually reproducing populations. [10]

(b) Substances move in and out of cells via several ways.

Explain the significance of named transport processes to the functions of blood cells. [15]

[Total: 25]

5 **(a)** In 1665, Robert Hooke discovered cells using one of the first microscopes ever invented. Subsequently, the biologists Matthias Schleiden and Theodor Schwann summarised a large number of observations by themselves and others.

Their conclusions have come to be known as the cell theory, and forms the foundation for understanding the reproduction and growth of all organisms.

Using knowledge of the cell theory as well as named examples and/or processes, describe the universal features of cells. Discuss ways to test the cell theory as well as how viruses challenge the cell theory. [10]

(b) Explain the significance of specificity during transcription and translation in eukaryotic organisms. [15]

[Total: 25]