EUNOIA JUNIOR COLLEGE
JC1 Promotional Examinations 2019
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME								
CIVICS GROUP	1	9	-			REGISTRATION NUMBER		

H2 Biology

9744/02

Paper 2
Structured Questions & Free Response Questions

04 October 2019
2 hours

Candidates are to **answer all questions** in section A in this question booklet.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.

There are **two** sections in Paper 2, section A and B.

Answer **all** questions.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

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.

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
5	
Total	/80

This document consists of **17** printed pages and **1** blank page.

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Section A

Answer **all** the questions in this section.

1 Fig.1.1 is an electron micrograph of an animal cell.

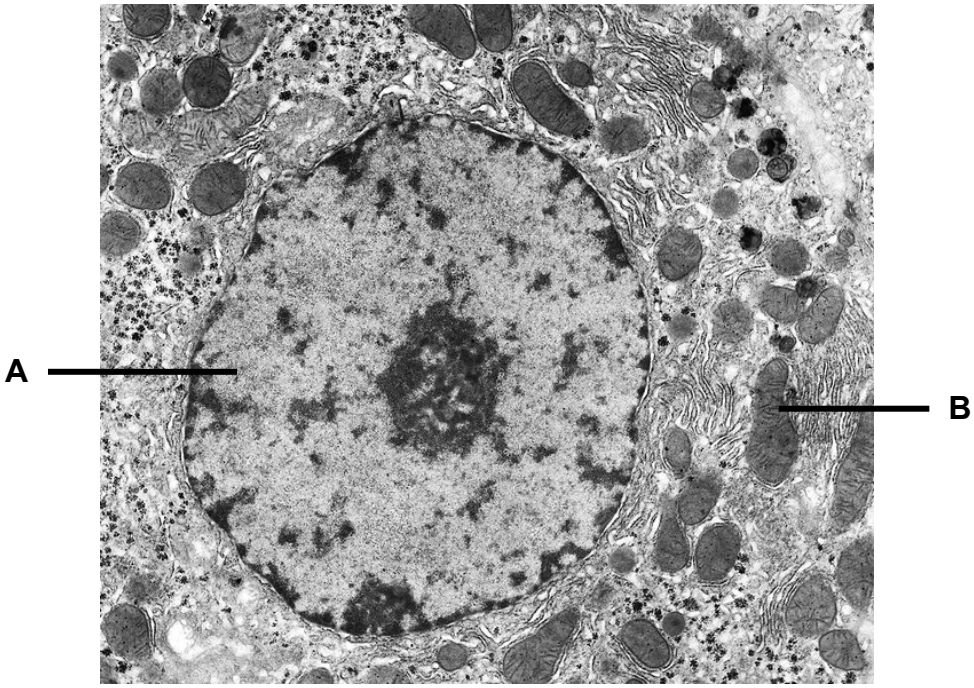

Fig 1.1

(a) **(i)** Identify the organelles **A** and **B** shown in Fig 1.1.

A: _____

B: _____

[2]

(ii) Compare the structures of both organelles.

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Protons are transported across the inner mitochondrial membrane through a transport protein depicted in Fig 1.2. This transport protein also serves as an enzyme that drives the synthesis of ATP from ADP and an inorganic phosphate ion (P_i).

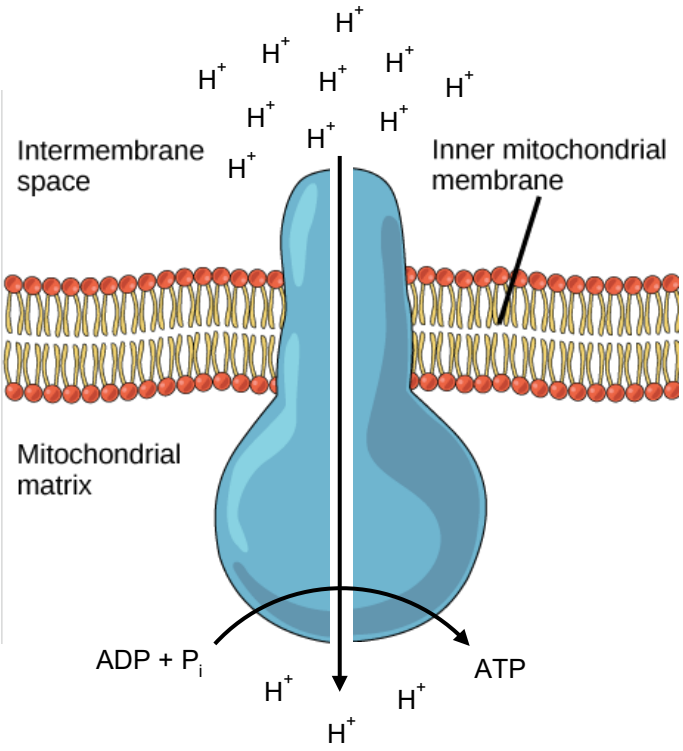

Fig 1.2

(b) Using Fig. 1.2,

(i) identify the type of transport protein.

.....[1]

(ii) state and describe the process by which protons are transported across the inner mitochondrial membrane.

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[Total: 9]

2 Fig 2.1 shows an error occurring during the second meiotic division of primary spermatocytes of an unknown animal.

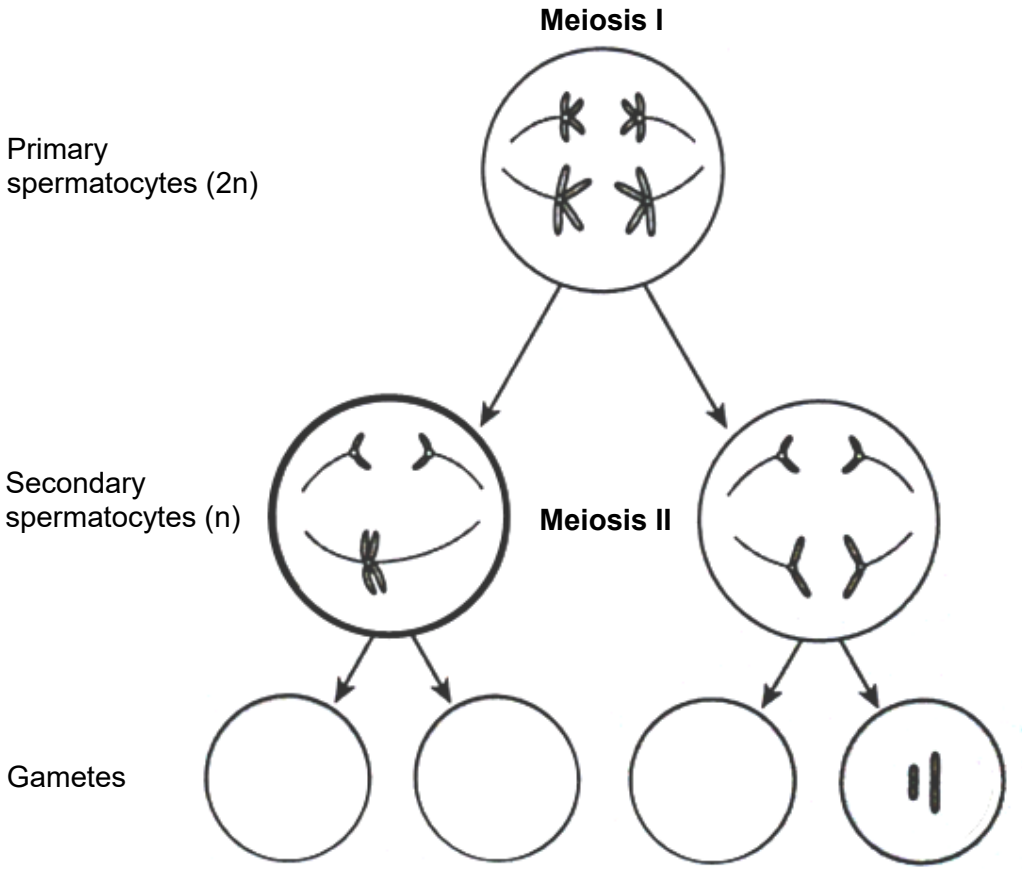

Fig. 2.1

(a) **(i)** Complete Fig 2.1 to show the correct structures and number of chromosomes within the gametes. [1]

(ii) Describe and explain how the error depicted in Fig 2.1 may have occurred.

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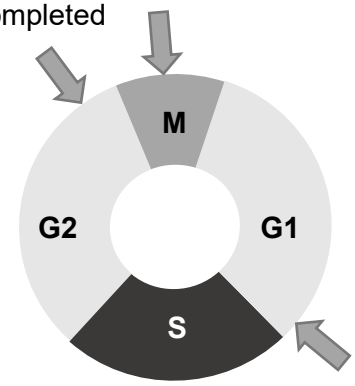
Testis cells undergo several rounds of mitosis to differentiate into primary spermatocytes.

Fig 2.2 shows the different phases of the cell cycle. Arrows indicate checkpoints of the cell cycle, and brief descriptions of the G1 and G2 checkpoint criteria are given. The M checkpoint occurs during metaphase of mitosis.

G2 checkpoint:
- DNA replication is completed
- cell size is adequate



G1 checkpoint:
- cell size is adequate
- sufficient nutrients and growth factors
- absence of DNA damage

Fig. 2.2

(b) (i) State the criteria for the cell to pass the M checkpoint.

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.....[1]

(ii) With reference to Fig 2.2, describe how the dysregulation of cell cycle checkpoints could lead to cancer.

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(c) Research has shown that colchicine exerts its effect by binding to tubulin molecules and preventing polymerisation of microtubules. As such, colchicine has been identified as a potential chemotherapeutic drug.

(i) Explain how colchicine may be used in the treatment of cancer.

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(ii) Suggest an undesirable side effect of using colchicine in cancer treatment.

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[Total: 12]

3 Semi-conservative DNA replication results in the formation of genetically identical DNA molecules. Fig. 3.1 shows a replication fork involved in DNA replication.

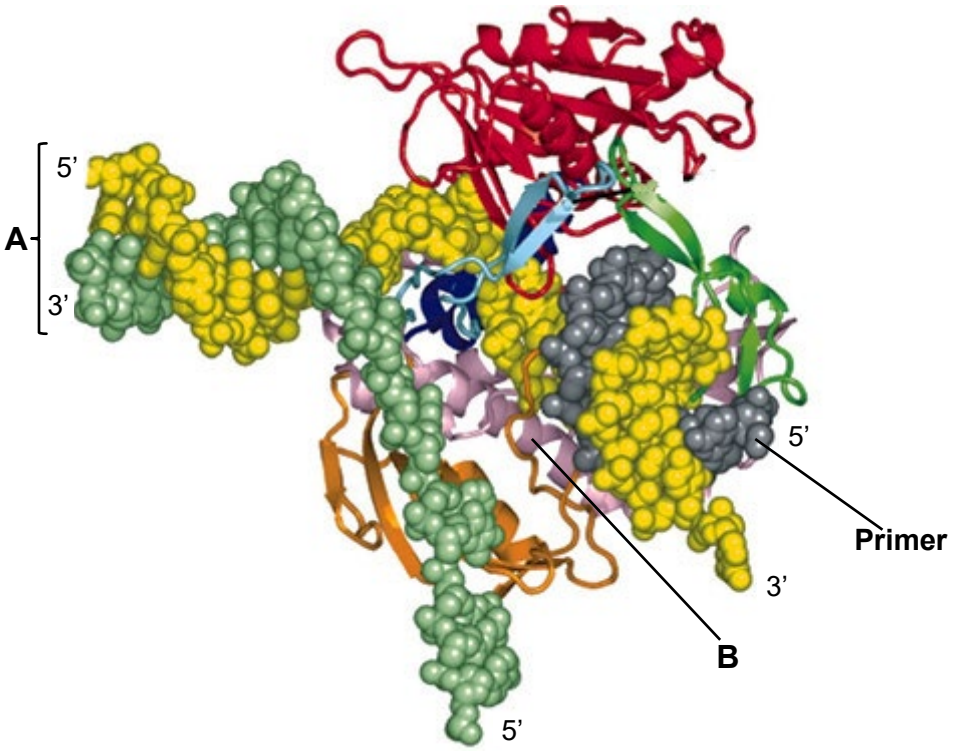

Fig. 3.1

(a) Describe two structural differences between helices A and B.

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……[2]

(b) Explain why DNA replication is described as "semi-conservative".

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(c) **(i)** Describe how a primer strand is synthesized.

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(ii) With reference to Fig. 3.1, explain if the primer is priming the synthesis of the leading strand or lagging strand

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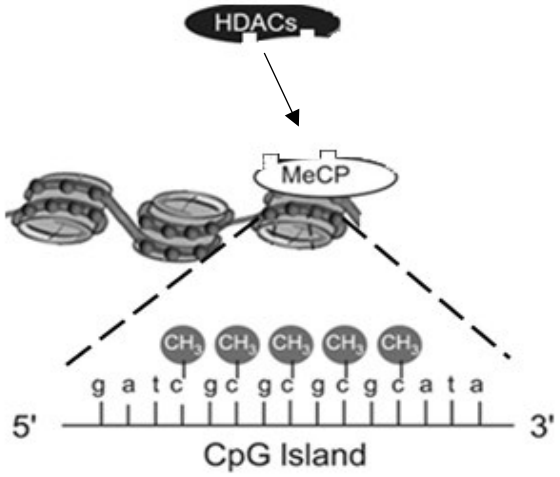
CpG islands are regions of DNA where a cytosine nucleotide is followed by a guanine nucleotide in the linear 5' to 3' sequence. CpG islands are typically 300 to 3000 base pairs in length. These CpG islands have been found to be in or near approximately 40% of promoters of mammalian genes and can be methylated.



HDAC: Histone Deacetylase
MeCP: Methyl-CpG-binding protein

Fig. 3.2

(d) With reference to Fig. 3.2, explain the significance of the presence of CpG islands in regulating gene transcription.

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The gene encoding insulin receptor is located on chromosome 19 and contains 22 exons.

There are two forms of the insulin receptor (IR) that differ by 12 amino acids. These two forms of the receptor are:

- IR-A, which binds insulin and insulin-like growth factor 2, and is expressed in the brain and ovary.
- IR-B, which binds only insulin, and is expressed in the skeletal muscle and liver.

Fig. 3.3 illustrates the pre-mRNA sequence and the mRNA sequences for the two forms of IR. The numbered boxes represent exons and the introns can be found between the exons in the *IR* pre-mRNA.

IR pre-mRNA:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

IR-A mRNA:

1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	20	21	22

IR-B mRNA:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Fig. 3.3

(e) **(i)** Explain how *IR-A* mRNA and *IR-B* mRNA are derived from *IR* pre-mRNA.

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(ii) Explain how *IR-A* and *IR-B* mRNA results in gene products with different specificity.

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Prokaryotes and eukaryotes and exhibit differences in their control of gene expression.

Fig. 3.4 shows the *arg* operon found in *Escherichia coli*. In the absence of arginine, the operon is in the active state. In the presence of arginine, the expression of the structural genes decreases.

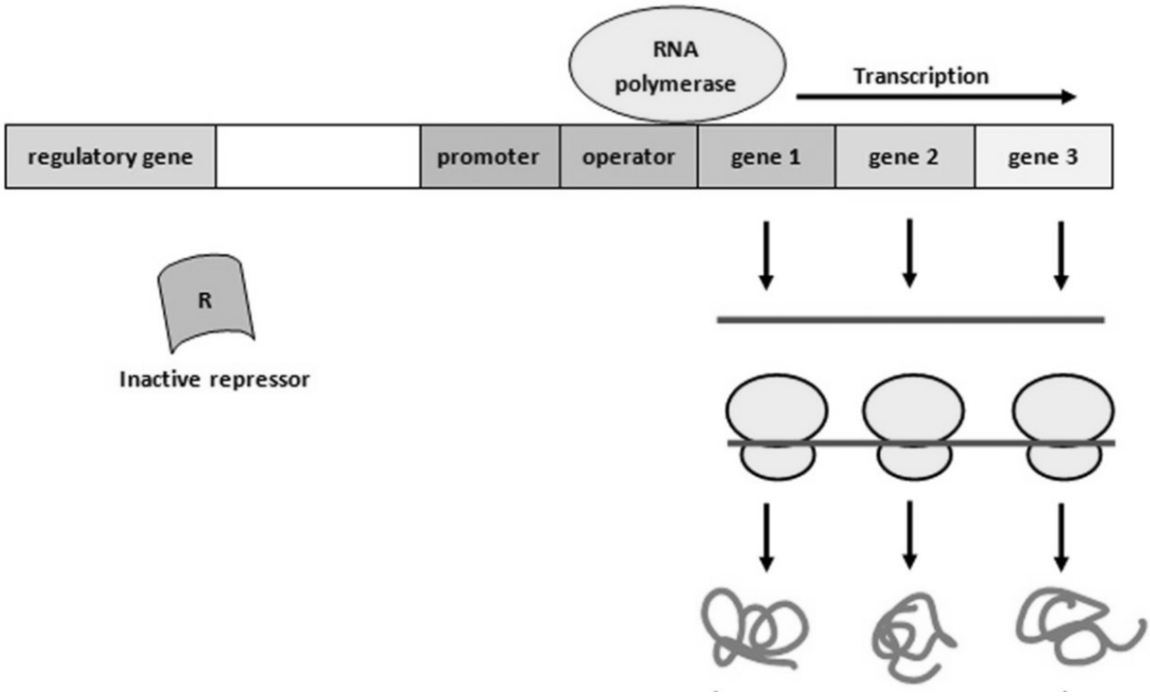

Fig 3.4

(f) **(i)** State which type of operon is the *arg* operon.

.....[1]

(ii) Describe how the *arg* operon is turned off.

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Besides regulating gene expression through operons, bacteria have other means to enhance their adaptability to the changing environment through gene transfer.

Fig. 3.5 shows one way in which bacteria can acquire new genetic material.

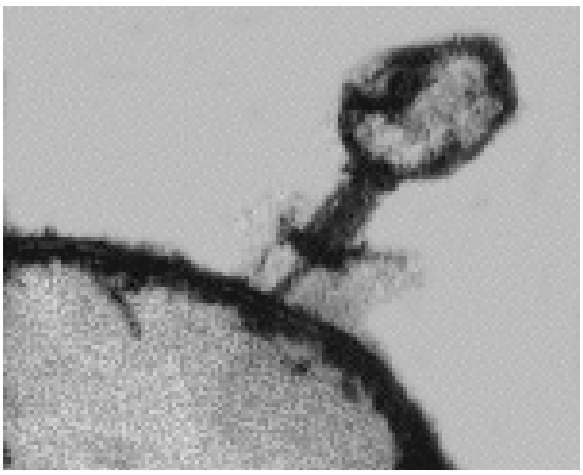

Fig. 3.5

(g) With reference to Fig. 3.5, describe the process which can allow a population of bacteria to acquire an advantageous allele.

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Fig. 3.6 shows a classic experiment used to show that physical contact between bacterial cell is necessary for a mode of horizontal gene transfer to occur.

In the experiment, the researchers placed 2 different strains of bacteria in the U-tube, with a filter separating the two strains. Strain A is able to synthesise 3 essential amino acids (thr^+ leu^+ thi^+) but is unable to synthesise 2 other essential amino acids (met^- bio^-). Strain B is able to synthesise 2 essential amino acids (met^+ bio^+), but is unable to synthesise three others (thr^- leu^- thi^-). Minimum medium was also used in the experiment and only bacteria able to synthesise all 5 essential amino acids are able to grow on it.

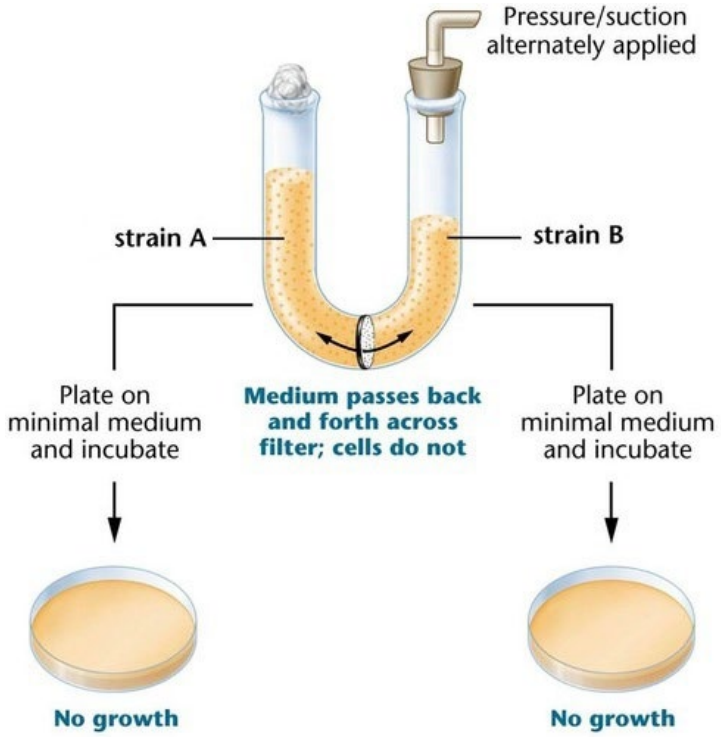

Fig. 3.6

(h) A student tried to replicate the experiment but did not get the result shown in Fig. 3.6. Instead, he observed a few bacterial colonies which are hybrids of strains A and B. He later realized that he accidentally forgot to add in DNase in the U-tube before carrying out the experiment.

Explain how the lack of DNase in the experiment resulted in the growth of hybrid bacterial colonies.

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[Total: 29]

4 Bacteriophages play an important role in regulating microbial ecology of many ecosystems because of their impact on bacteria.

Fig. 4.1 shows an electron micrograph of some bacteriophages.

Fig 4.1

(a) **(i)** Identify the reproductive cycle shown in Fig. 4.1.

.....[1]

(ii) Describe how newly synthesised phages are released from the bacterium.

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Animal viruses, such as the influenza virus, undergo a different method of release as shown in Fig 4.2.

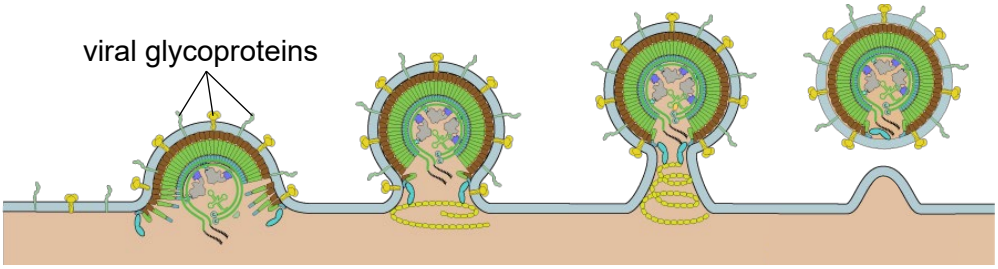

Fig 4.2

(b) Describe how viral glycoproteins become embedded in the viral envelope.

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Different strains of influenza virus have different glycoproteins in their envelope. Over time, these may result in different flu epidemics, as shown in Fig 4.3.

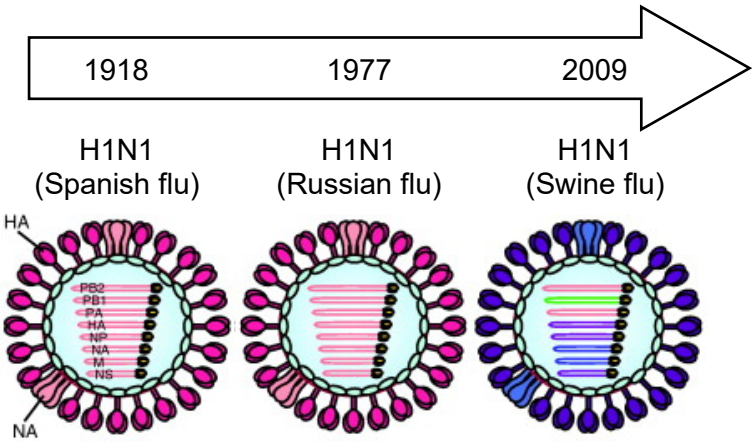

Fig 4.3

(c) Explain how different strains of H1N1 influenza virus may arise.

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[Total: 10]

Section B

Answer **all** the questions in this section.

5 (a) Polymers perform a variety of functions in living organisms.

Using named examples, relate the structure of polymers to their importance to cells. [11]

(b) Distinguish the structures and reproductive cycles of HIV and influenza virus. [9]

[Total: 20]

- End of Paper -