

EUNOIA JUNIOR COLLEGE JC1 Promotional Examinations 2020 General Certificate of Education Advanced Level Higher 2



H2 Biology

Paper 2 Structured Questions & Free Response Questions

Candidates are to answer questions in **Section A in this question booklet**. Candidates are to answer questions in **Section B in the answer booklet** provided.

Additional Materials: 8-page Answer 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 this paper, Section A and Section B. You are advised to plan your time appropriately to complete both Sections.

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 tape/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			
1			
2			
3			
4			
5			
6			
7			
8			
Total	80		

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

CANDIDATE

CIVICS GROUP

9744/02

02 October 2020 2 hours

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Section A

3

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

- 1 Emperor penguins are the only species of penguin that breed during the Antarctic winter and they may stand still for multiple days to incubate their eggs. In order to survive in freezing temperatures, the feet of emperor penguins contain a high percentage of unsaturated fats.
- (a) Explain the significance of unsaturated fatty acids in cell membranes.

(b) Fig. 1.1 shows the structure of a lipoprotein in the blood of emperor penguins. Lipoproteins transport fats from the liver to other tissues via the bloodstream. The membrane proteins of lipoproteins allow for fats to be deposited to the target tissue.



Fig. 1.1

With reference to Fig 1.1, describe how the structure of lipoproteins allows for fats to be transported from the liver to a specific tissue via the bloodstream.

[3]

(c)	Explain how the structure of haemoglobin allows it to transport oxygen efficiently in red blood cells.

......[3]

[Total: 8 marks]

2 Beta-glucosidase is an enzyme that converts cellobiose to glucose during cellulose hydrolysis. Samples of beta-glucosidase were extracted from two species of bacteria, Agrobacterium tumefaciens (enzyme A) and Thermotoga maritima (enzyme T).

Fig. 2.1 shows the results of an experiment that investigated the effect of temperature between 0° C and 100° C, on the activities of enzyme **A** and enzyme **T**.

L represents the lowest temperature at which activity of each enzyme was detected. H represents the highest temperature at which activity of each enzyme was detected.



Fig. 2.1

(a) With reference to Fig. 2.1, describe the differences in the relative activities of enzymes A and T.

(b)	Explain why an increase in temperature affects the activity of beta-glucosidase.			
	[3]			
(c)	Suggest why enzyme T has a higher optimal temperature as compared to enzyme A .			
	[2]			
	[Total: 8 marks]			

3 Fig. 3.1 shows the gene expression of a ribosomal protein, rS2.





(b)	Fig. 3.2 shows a section of the rS2 DNA template strand.
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[Total: 10 marks]

- 4 Several members of an endangered white rhinoceros species were found to be infertile. Scientists found that their germline cells, which give rise to gametes, were not able to undergo meiosis properly.
- (a) Explain how meiosis gives rise to haploid cells.

(b) During nuclear division, CenH3 is a protein that associates the kinetochore protein complex with centromeric DNA. Scientists observed that infertile white rhinoceroses had a high frequency of mutation in the *CenH3* gene.

Suggest the consequences of this loss-of-function mutation on meiosis.

[3]

(c) To counteract the problem of infertility, scientists attempted to induce the expression of normal *CenH3* gene in white rhinoceroses. However, amplification and overexpression of the *CenH3* gene resulted in prostate cancer.

Explain the effects of two other genes that are overexpressed in the development of cancer.

5 The human *GDAP1* gene codes for the protein GDAP1. Mutations in the coding region of *GDAP1* have been identified as a major cause of a neurodegenerative condition known as Charcot–Marie–Tooth disease (CMT).

It was discovered that the *GDAP1* gene promoter is transcriptionally regulated by YY1.

Fig. 5.1 below shows the 245-bp fragment of the promoter where RNA polymerase binds to initiate transcription after YY1 has bound. The YY1 binding site, -4/+5 region (i.e. nucleotide sequence from -4 to +5) is found within the *GDAP1* promoter.



(a) State the type of transcription factor that YY1 is classified as.

......[1]

(b) In eukaryotes, modification of histones lead to changes in frequencies of gene expression.

Explain how histone acetyltransferase affects the gene expression of GDAP1.

......[3]

(c) Fig. 5.2 shows three deletion constructs which were created at the upstream region of the human GDAP1 gene promoter. The relative transcriptional activities associated with each of the 3 constructs of the promoter were also measured.



6 In bacteria, the production of the amino acid tryptophan is catalysed by five specific enzymes encoded by specific genes *trpE*, *trpD*, *trpC*, *trpB* and *trpA* respectively.

The *trp* operon is transcriptionally regulated by a repressor protein, encoded by the *trpR* gene.

(a) Draw a labelled diagram to show the organisation of the *trp* operon and the regulatory gene associated with it. [2]

(b) Table 6.1 below indicates the activity levels of the functional enzymes **E**, **D**, **C**, **B** and **A** in wild type bacterial cells in the presence and absence of tryptophan (Trp).

Table 6.1				
	activity level of enzymes/units			
enzyme	Trp absent	Trp present		
E	700	0		
D	700	0		
С	700	0		
В	700	0		
Α	700	0		

A group of Eunoians managed to obtain several bacterial mutants. Each mutant is the result of a single base-pair substitution in a single component of the *trp* operon. The activity levels of the functional enzymes **E**, **D**, **C**, **B** and **A** in the bacterial cells having these individual mutations are shown in Table 6.2.

Table 6.2						
	activity level of enzymes/units					
	mutant 1		mutant 2		mutant 3	
enzymes	Trp absent	Trp present	Trp absent	Trp present	Trp absent	Trp present
Е	700	700	700	0	0	0
D	700	700	0	0	0	0
С	700	700	700	0	0	0
В	700	700	700	0	0	0
Α	700	700	700	0	0	0

(i) Using the information provided, state and explain which mutant has a phenotype that is consistent with a loss-of-function mutation in the *trpR* gene.

(ii) The phenotype of mutant 3 is caused by a mutation in the *trpR* gene. Explain how this mutation would affect the structure and function of the repressor protein.

[Total: 8 marks]

7 The rabies virus is classified in the same group as the influenza virus. Fig. 7.1 shows a simplified reproductive cycle of the rabies virus.



(a) Using the information given in Fig. 7.1, explain the role of a named viral enzyme in the rabies reproductive cycle.

[3]

(b) Since late 2019, the rapid spread of the virus, SARS-CoV-2, has caused the Covid-19 global pandemic resulting in more than 900,000 human deaths.

Fig. 7.2 shows conversations between different individuals who have been observing the developments surrounding this pandemic.





(i) Using information from Fig. 7.2, suggest the type of viral evolution that SARS-CoV-2 had undergone to 'jump' to human populations in 2019. Explain your answer.

(ii) Based on your knowledge of viral evolution, comment on the validity of the statement of having 'a more virulent strain of SARS-CoV-2 in 2021' by the concerned citizen.

[Total: 8 marks] [Turn over]

Section B

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

Begin each part question on a fresh page.

6	(a)	Compare the structure and reproductive cycle of HIV and lambda phage.		
	(b)	Explain how DNA-binding proteins control gene expression in prokaryotes.	[8]	