	VICTORIA JUNIOR COLLEGE
\mathscr{Y}	JC 2 PRELIMINARY EXAMINATION 2017

NAME :	
CT CLASS:	

H2 BIOLOGY

Paper 2 Structured Questions

9744/2

2 hours

READ THESE INSTRUCTIONS FIRST

Write your Name and CT Class on the cover page of this paper.

Write in dark blue or blue pen.

You may use a soft pencil for any diagrams or graphs.

Do not use any staples, paper clips, highlighters, glue or correction fluid.

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

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

You may lose marks if you do not show your working or if you do not use the appropriate units.

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

For Examiner's Use	
1	
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Total	

This document consists of 19 printed pages, including cover page

1 Fig.1 shows an electron micrograph of an organelle. There are two distinct groups of vesicles (Boxes B and C) associated with this organelle.



Fig. 1 Source:https://ib-biology2010-12.wikispaces.com/Cell+Images

(a) (i) Identify Organelle A.

Support your answer with one observable feature, other than vesicles, shown in Fig 1.

Organelle A:



(ii) Describe the differences in the role of the vesicles in Boxes B and C.

[4] _____ In Angelman syndrome, a severe and rare neurodevelopmental disorder, it has been reported that the lack of ubiquitin protein ligase E3A (UBE3A) expression leads to a disruption of structure and function of Organelle A. (b) Suggest how the lack of UBE3A expression can lead to a disruption in the structure and function of Organelle A. _____

[3]

(c) State two characteristics, one in structure and one in chemical property that you would expect to see in ubiquitin protein ligase.

[2]

[Total:11]

2 An experiment to determine the effect of Compound K, a metabolite derived from ginseng, on the expression of a gene (*RUNX3*) was carried out using a culture of human colorectal cancer cells. *RUNX3* gene codes for a transcription factor.

Cells were treated with Compound K for 72 hours. Samples of cells were removed at specific time intervals. These cells were then lysed and the mRNA and proteins analysed.

Fig 2 shows the changes in the HDAC (Histone Deacetylase) mRNA and HDAC protein over the 72 hour period. The thickness of the band is an indication of the concentration of the mRNA and proteins.



Fig 2

(a) Explain the similarity in the pattern seen in both HDAC mRNA and HDAC protein.



[3]

(ii) Suggest one way how your answer in (i) can affect the cell.

	[3]
(c)	With reference to the data shown in Fig 2, suggest how Chemical K can bring about the change in the HDAC mRNA and protein.
	[2]
(d)	Suggest why HDAC mRNA instead of the HDAC gene was analysed in this experiment.
	[2]

[Total:12]

3 Diauxic growth is a two-phase growth response observed in a culture of bacteria of *E. coli.* This phenomenon (Fig. 3) was discovered by Jacob and Monod who were awarded the Nobel prize for their ground breaking study of how gene expression is regulated in prokaryotic organisms. They studied how glucose and lactose impact the growth of *E. coli.* Substrates X and Y are the two different sugars that are introduced to the bacteria culture medium at the same time, to serve as carbon sources.



Fig. 3 *Note: Optical density, measured in a spectrophotometer, is used as a measure of the concentration of bacteria in a suspension.

(a) (i) Identify substrates X and Y. X:



(ii) Using your knowledge of gene expression in bacteria, explain how Fig. 3 supported their conclusion that the *Lac* operon is under dual control.

	[4]
(b)	On Fig. 3, draw separate graphs to show the change in the concentration of the two substrates over time. Label your graphs clearly. [2]
(c)	Eukaryotes are structurally different from prokaryotes and hence exhibit differences in their control of gene expression.
1.	Explain two such differences.
2.	
	[4]
	[Total:12]

- 4 Wild-types freshwater snails, *Physa heterostropha* have pigmented shells. When two pure-breeding albino snails were crossed and their F1 selfed, the F2 generation consists of 48 pigmented snails and 35 albino snails.
 - (a) What do you understand by the term pure-breeding?

[1]

(b) Using appropriate symbols, draw a genetic diagram to explain the results obtained.

Symbols:

[1]

5 Cells X and Y are two types of cells taken from a healthy individual and cultured in media that is similar to the actual conditions in the body.

Fig. 5 illustrates the change in the telomere lengths of these cells with increasing rounds of cell division. M1 represents the Hayflick limit where cells will leave the cell cycle (replicative senescence) while M2, termed crisis, is characterised by widespread cell death, although some cells that survive M2 will be able to continue dividing.



(a) (i) Account for the decrease in the telomere length of Cell Y.

[4]

(ii) Explain why there is a limit to the number of times Cell Y can divide. [2] (b) Outline how Cell X is able to maintain its telomere length. [3] (c) With reference to Fig 5, explain how the change in telomere length resulted in Cell Y* after M2. [2] Describe the importance of centromeres in cell division. (d) _____ [2]

6 Metformin has been used for the treatment of Type II diabetes where the skeletal muscles are resistant to insulin stimulation. It is transported into the cell by specific protein carrier.

Fig 6 shows how metformin influence the cellular activity involved in the signal transduction pathway. AMPK is a kinase that is involved in energy sensing and is activated by AMP(adenosine monophosphate) which is the one of the products of ATP hydrolysis.



Fig 6

source: http://www.nature.com/nrendo/journal/v8/n8/fig_tab/nrendo.2012.106_F1.html?foxtrotcallback=true

(a) Explain how metformin can be used to decrease the blood glucose level in patients with Type II diabetes.



(b) Akt is known to stimulate other cellular responses in the insulin signaling pathway. Suggest how activation of Akt can lead to different cellular responses.



7 The Hawaiian Islands are some of the most isolated islands in the world. It is made up islands that are formed at different times. The first birds to have flown to these islands probably arrived millions of years ago from East Asia.

Fig. 7 shows the fossils of two extinct species of Hawaiian waterfowl found on two different islands. The giant Hawaiian goose was a flightless bird whereas the nene could fly.

Until recently, the evolutionary relationships among Hawaiian waterfowl are known only from bone structures. Fig. 7A shows the skulls and mandibles while Fig. 7B shows the wing and leg bones of the giant Hawaiian goose and nene.



Fig. 7A. Skulls and mandibles of (a) giant Hawaiian goose and (b) nene.



(Source: <u>https://www.researchgate.net/figure/11540628_fig2_Fig-3-Left-ulna-and-tibiotarsus-a-B-canadensis-maxima-USNM-555497-b-giant</u>)

(a) With reference to Fig7A and 7B, discuss whether these fossils can be used to support Darwin's theory of evolution.

[3]

(b) Using your knowledge of anatomical homology, explain how these differences came about.



(c) Explain why molecular data is able to overcome the limitations of this fossil study.

[4]

(d) Based on the fossils, state one species concept that can be used to determine whether the Hawaiian goose and nene belong to the same species.

[1]

[Total:13]

- 8 The immune response consists of innate and adaptive responses.
 - (a) What is the importance of the innate immune response?

[3]

Fig 8 shows the changes to the variable regions of B cell receptors over time. CDR1-3 are specific regions in the variable regions that are important for the attachment of antigen. Changes in the base sequence are indicated by the darkened vertical lines.



http://slideplayer.com/slide/7421892/

(b) Explain the significance of these changes over time.

	<u>-</u>	
	<u>-</u>	
['	4]	
(c) State how a B cell is able to produce two types of B cell receptor (Ig M and Ig D) at		
Same time. [1]	

[Total:8]

9 In Rio de Janeiro, Brazil, dengue epidemics first appeared during the 1980s, according to city authorities. In 2002, the city reported 145,779 cases, in 2008 there were 120,917 cases, and by June 2012 there were over 68,000 cases.



(a) (i) Describe the pattern of resurgence of dengue shown in Fig.9.

[2] (ii) Suggest three possible ways in which climate change can result in the pattern described in part (i). (b) Adhering to all WHO recommendations, Singapore has dramatically reduced the percentage of households with *Aedes* mosquitoes since the inception of its vector control programme in 1996. However, the incidence of dengue fever has recently increased.

Suggest why the vector control programme might not have worked as initially intended.

[2]

(c) To suppress the wild *Aedes aegypti* mosquito population responsible for dengue outbreaks in Singapore, British company Oxitec has created special genetically modified (GM) mosquitoes of the same species which have a self-limiting gene that kills off their larvae. They have achieved success with such GM mosquitoes released into the wild.

(i) Describe two advantages of this strategy.

(ii) Discuss the possible impact of these advantages on the natural ecosystem.

[2]

[Total: 11]

[2]