VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
2021
HIGHER 2

NAME: ……

CT CLASS: ……..……

BIOLOGY 9744/02

Paper 2 Structured Questions **13/09/2021**

2 hour

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and CT class in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

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

Question	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

This document consists of **22** printed pages.

[Turn over]

Answer **all** questions.

1 Cells in the pancreas secrete enzymes, such as amylase and trypsin, into a duct. The enzymes are packaged in vesicles so that they can be exported from these cells as shown in Fig. 1.1.

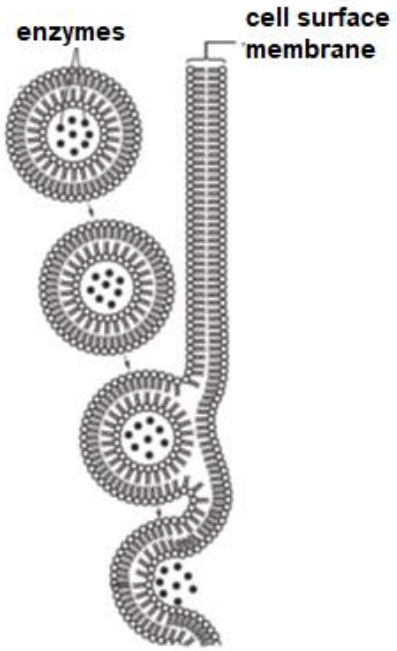

Fig. 1.1

(a) Outline how the enzymes are packaged into vesicles and released to the outside of the cell.

……...

……...

……...

……...

……...

……...

……...

……...

……... [4]

(b) Explain how the structure of the vesicle shown in Fig. 1.1 allows it to serve its function.

……...

……...

……...

……...

……...

……...

…….. [3]

(c) Researchers are interested in using the vesicles to deliver drugs to specific cells.

Suggest and explain one modification to the vesicles to allow them to deliver the drugs to specific cells.

……...

……...

……...

…….. [2]

(d) Describe two differences between the release of enzymes shown in Fig. 1.1 and the release of flu viruses from the host cell.

……...

……...

……...

…….. [2]

[Total: 11]

2 Fig. 2.1 shows the structure of a natural triglyceride.

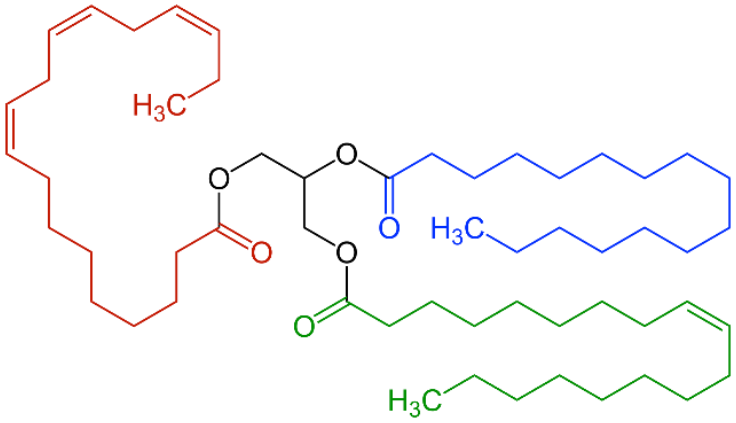

Fig. 2.1

(a) **(i)** On Fig. 2.1, circle and label all the saturated and unsaturated fatty acid chains. [2]

(ii) Explain how the structure and properties of triglyceride is related to its role in living organisms.

……...

……...

……...

……...

……...

……...

……. [3]

(b) Triglycerides, such as the one shown in Fig. 2.1, can be catalysed by lipase. Fig. 2.2 shows the reaction.

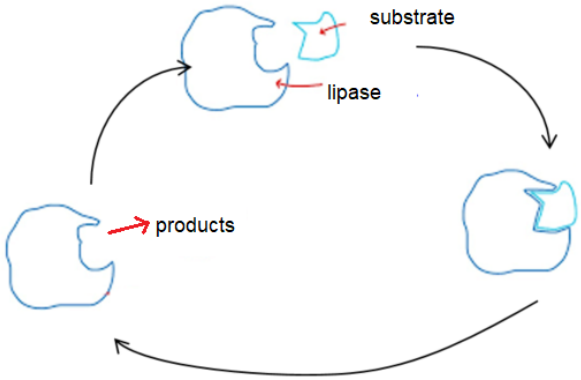

Fig. 2.2

With reference to Fig. 2.2, explain the mode of action of lipase.

……...

……...

……...

……...

……...

……...

……...

……...

…… [4]

[Total: 9]

3 Keratin is one of the most important structural proteins in nature and is widely found in many parts of vertebrates such as the skin, hair, horn and beak.

Fig. 3.1 below shows the organisation of polypeptide chains that make up keratin in the hair.

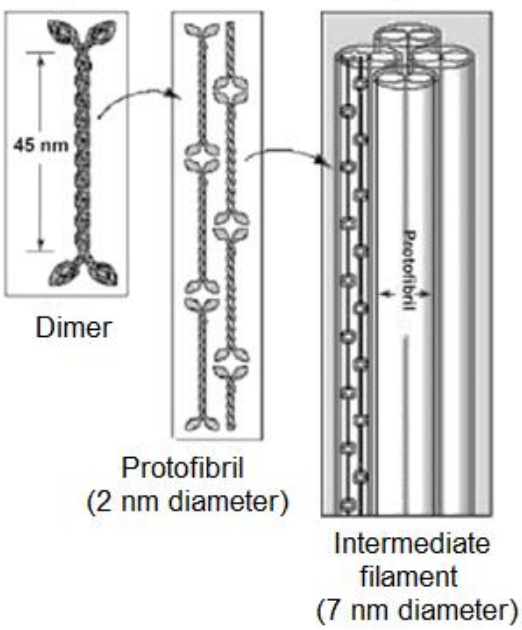

Fig. 3.1

(a) (i) With reference to Fig. 3.1, describe one difference and two similarities between the organisation of polypeptide chains in keratin and collagen.

……

……

……

……

……

……

…… [3]

(ii) Suggest how the structural organisation of keratin enables it to fulfil its function.

……

……

……

…… [2]

Collagen polypeptides consist of approximately 1000 amino acid residues. After their synthesis, collagen polypeptides are secreted out of the cell before assembly.

(b)(i) Explain the significance of the amino acid sequence to the function of collagen.

……...

……...

……...

……...

……...

……...

……...

……...

…….. [4]

(ii) Suggest why assembly of collagen cannot take place in the cytoplasm.

……...

…….. [1]

[Total: 10]

4 Several changes are observed as a cell prepares to undergo mitosis.

To begin mitosis, a complex termed the mitosis-promoting factor, MPF phosphorylates proteins important in prophase. These proteins include:

- lamins, which are fibrous proteins that support the inner nuclear membrane and
- condensins, which are important in the packing of DNA.

Fig. 4.1 shows changes to the nuclear envelope and the genetic material as the cell progresses through the cell cycle.

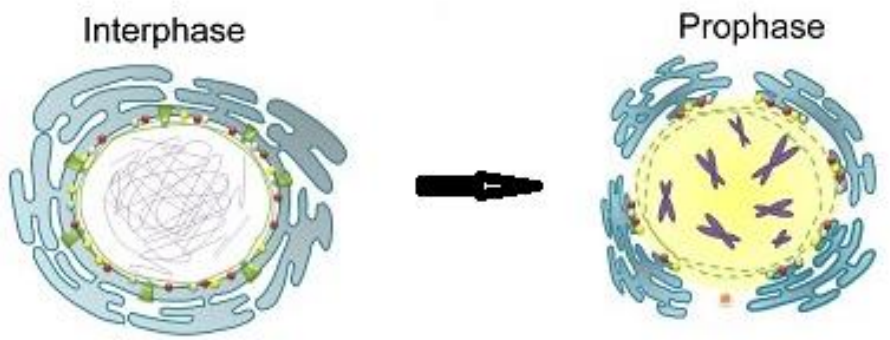

Fig. 4.1

(a) With reference to Fig. 4.1 and your knowledge, suggest how phosphorylation of condensins and lamins prepares the cell for mitosis.

……...

……...

……...

…….. [2]

(b) Outline briefly the role of the microtubules in the formation of clones in mitosis.

……...

……...

……...

……...

……...

……...

…….. [3]

Pancreatic cancer is an almost universally lethal disease. It is predominantly a disease of the elderly, with men and women having an approximately equal risk.

Many genes are involved in the development of pancreatic cancer. Table 4.1 shows four of these genes,

Genes	Genetic changes observed
P	Homozygous deletion
Q	Hypermethylation of the gene promoter
R	Substitution in codon 12
S	Amplification of gene

Table 4.1

(c) Using the data in Table 4.1, identify an oncogene and a mutated tumor suppressor gene. Explain your answer.

(i) oncogene

……...

……...

……...

…….. [2]

(ii) mutated tumor suppressor gene

……...

……...

……...

…….. [2]

[Total: 9]

5 Huntington's disease is a rare neurodegenerative disease. It is caused by mutation in the Huntingtin (HTT) gene located on human chromosome 4. The mutation involves an increase in the number of repeats of three nucleotide bases (CAG) in the first exon of the HTT gene. These repeats code for the amino acid glutamine. The CAG triplet is normally repeated about 20 times, but an approximate doubling in the number of repeats to 40 or more results in the expression of the disease.

(a) Explain the effect of the abnormal increase in CAG repeats on HTT protein structure and function.

……...

……...

……...

……...

……...

……...

…….. [3]

It was observed that the presence of multiple copies of CAG affect splicing of exon 1 and exon 2 of the HTT gene.

(b) Describe how splicing occurs in cells with normal HTT gene.

……...

……...

……...

……...

……...

……...

…….. [3]

(c) A major difficulty in finding treatment for Huntington's disease has been a limited understanding of how the mutant HTT protein cause the death of nerve cells.

An investigation by a group of researchers showed that blocking the synthesis of the mutant HTT protein resulted in an increase in ribosome movement and protein synthesis.

Based on the information given, suggest how the mutant HTT protein can bring about the death of nerve cells.

……...

……...

……...

…….. [2]

[Total:8]

6 In bacteria, there are two main types of operons: inducible and repressible operons.

(a) Using a specific example, explain what is meant by a repressible operon.

……...

……...

……...

……...

……...

……...

…….. [3]

In a study, *Escherichia coli* cells were genetically engineered such that they contain two operons which can be induced or repressed rapidly and reversibly by the same DNA-binding protein EL222. This protein is sensitive to blue light. Transformed cells were exposed to blue light repeatedly in OFF–ON–OFF–ON cycle for every 2 hour over a period of 8 hour. The responses by the two operons are shown in Fig. 6.1.

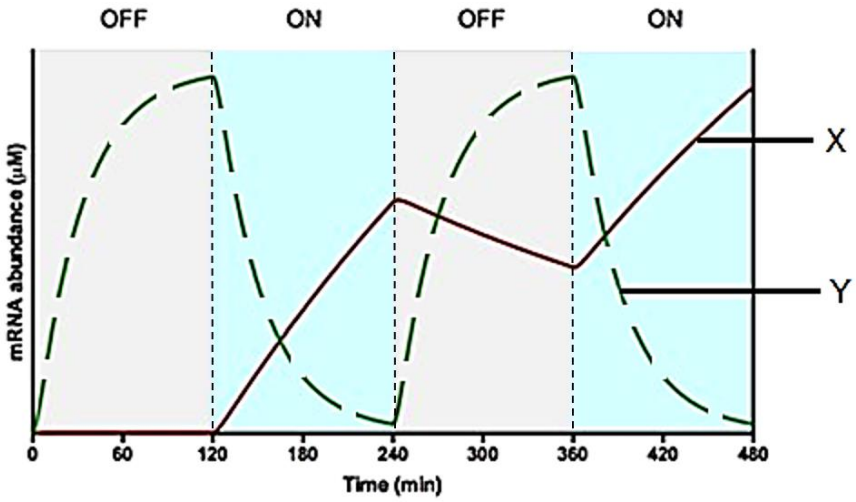

Fig. 6.1

(b) With reference to Fig. 6.1,

(i) identify the graph that shows the light-inducible system. Explain your answer.

……...

……...

……...

…….. [2]

(ii) suggest how it is possible for DNA-binding protein EL222 to regulate the gene expression of two different operons.

……...

……...

……...

……...

……...

……...

…….. [3]

(c) Eukaryotes are structurally different from prokaryotes and can exhibit differences in their control of gene expression.

Explain the significance of two such differences that occurs in the cytoplasm of the eukaryotic cell.

……...

……...

……...

……...

……...

……...

……...

……...

…….. [4]

[Total: 12]

7 Scientists isolated two sections of DNA in cats that were thought to correspond with the allele for full colour (R) and the allele for pointed (r).

Sequencing these two DNA sections showed that the DNA sequence for full colour, R, had a restriction site for the restriction enzyme *Hpa*II. This restriction site did not occur in the DNA sequence r because of a difference in one single nucleotide.

The scientists then carried out an analysis of three generations of cats. Each cat was assessed for three features:

- coat pattern, full colour or pointed
- the presence or absence of the *HpaII* restriction site
- the pair of alleles present at a variable marker locus thought to lie close to the R/r locus. The marker locus (gene) has seven different alleles designated as 1, 2, 3, 4, 5, 6 and 7.

Fig. 7.1 shows the relationships of these cats and the results of the assessment

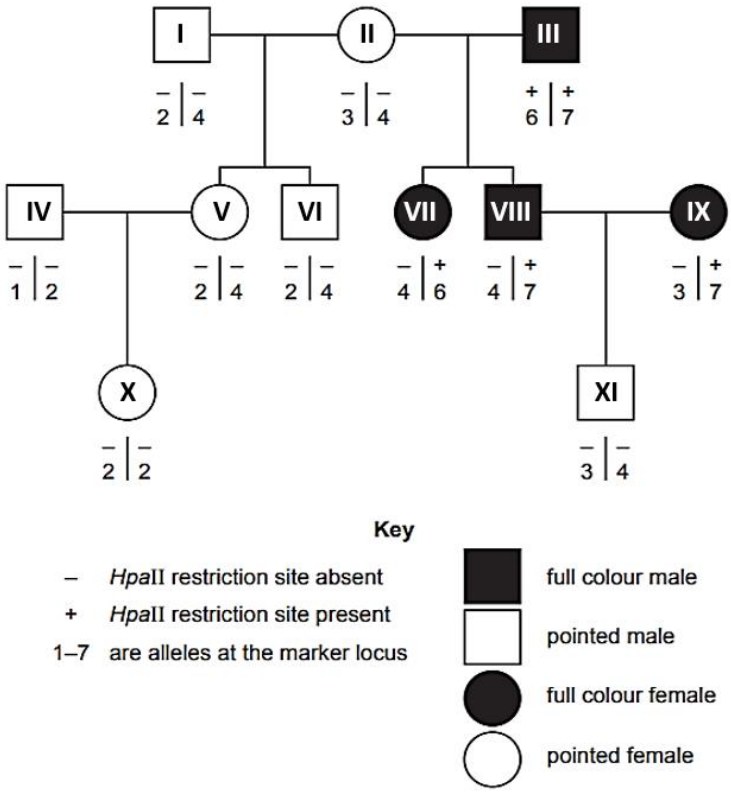

Fig. 7.1

(a) Suggest how phenotype for pointed coats arises in cats.

……...

……...

……...

…….. [2]

(b) Explain using evidence from Fig. 7.1,

(i) the mode of inheritance for coat pattern in cats.

……...

……...

……...

……...

……...

……...

…….. [3]

(ii) why the “variable marker locus is thought to lie close to the R/r locus”.

……...

……...

……...

…….. [2]

(c) Describe how one could determine the genotype of a cat showing the full colour phenotype.

……...

……...

……...

…….. [2]

[Total: 9]

8 Scientists investigated the effects of temperature on the rate of photosynthesis in creeping azalea at three different light intensities. The effect of temperature on the rate of respiration was also monitored. The results of the investigation are shown in Fig 8.1.

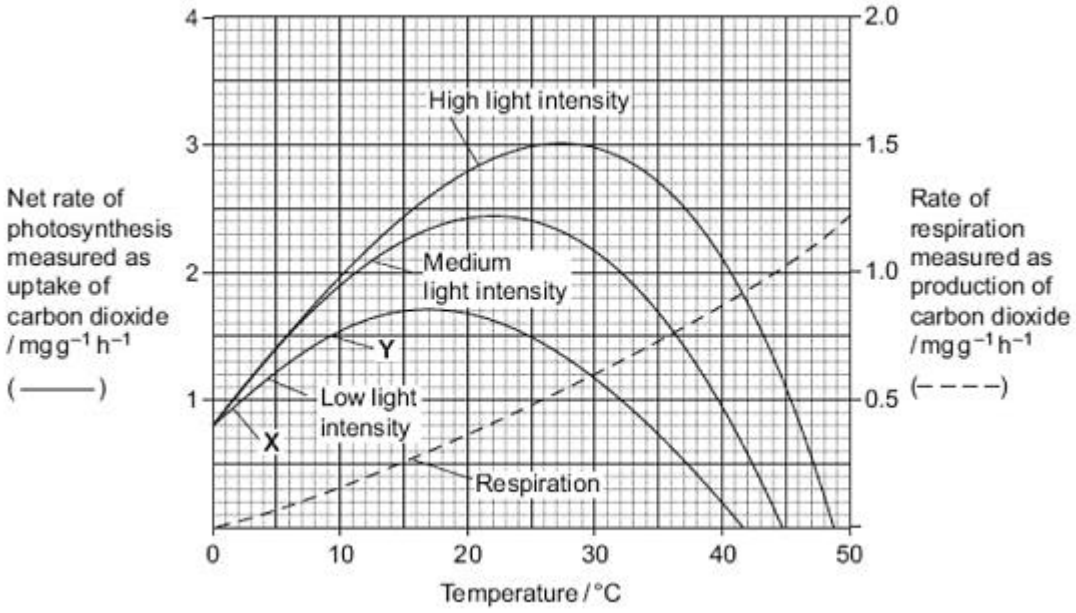

Fig. 8.1

(a) Using information from Fig 8.1, identify, with reasons, the factors that limit the rate of photosynthesis between X and Y.

……...

……...

……...

……...

……...

……...

…….. [3]

Different responses were shown by the plants in terms of their photosynthetic rate and respiration rate.

(b) Suggest an explanation for this difference.

……...

……...

……...

……...

……...

……...

…….. [3]

(c) NAD and NADP are coenzymes involved in respiration and photosynthesis respectively.

Compare the roles of NAD and NADP.

……...

……...

……...

……...

……...

……...

…….. [3]

(d) Starch synthesised by the plants are made up of amylose and amylopectin.

In the space below, draw a representative section of amylopectin. Label the bonds clearly.

[3]

[Total: 12]

9 Galapagos tortoises (*Chelonoidis spp*) can be found on many of the islands that made up Galapagos Islands. Originally 14 different species were identified based on the islands on which they lived and their similarity in their carapace (shell) shape.

In 2015, researchers carried out investigations to determine if two isolated tortoise populations (A and B) found on one of the islands belong to the same species.

Table 9.1 shows the average measurements of skull size taken from both populations. The measurements were taken at six different positions on the skull. For comparisons, measurements were also taken from three other species of tortoises living in other Galapagos islands.

Measurement position	Average skull measurement/ mm				
	Population A	Population B	*Chelonoidis chathamensis*	*Chelonoidis ephippium*	*Chelonoidis vicina*
1	98	118	80	74	86
2	37	40	27	25	28
3	18	21	14	12	16
4	23	26	18	17	21
5	9	10	7	6	8
6	17	19	14	13	16

Table 9.1

(a) Based on the data provided in Table 9.1, explain why skull size can be used to support the hypothesis that Population A and Population B belong to different species.

……...

……...

……...

…….. [2]

Researchers also compared the sequences of the control regions in the mitochondria DNA as well as the nuclear DNA microsatellites. Both sequences are non-coding.

Table 9.2 shows the differences in the sequence in these regions measured as percentage of sequence divergence between Populations A and B as well and some of the groups of tortoises shown in Table 9.1.

Groups/ Species	Sequence divergences/ %			
	Population A	Population B	*Chelonoidis chathamensis*	*Chelonoidis vicina*
Population A	-			
Population B	4.5	-		
Chelonoidis chathamensis	4.8	1.4	-	
Chelonoidis vicina	2.8	4.7	4.8	-

Table 9.2

(b) (i) State and explain how you would expect the data in Table 9.2 to differ if Population A and B belongs to the same species.

……...

……...

……...

…….. [2]

(ii) Explain why information about the sequence divergence provides more information about evolutionary relationship than skull size.

……...

……...

……...

……...

……...

……...

…….. [3]

The generation time of a species is the mean (average) time from one generation (parents) to the next generation (offspring). For example, the generation time for humans is about 25 years.

Fig. 9.1 shows a graph of the relationship between the rate of evolution and the generation time for a wide range of different species.

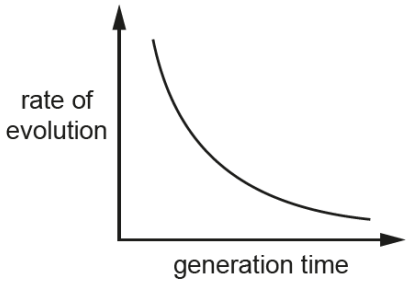

Fig 9.1

(c) Suggest an explanation for the relationship shown.

……...

……...

……...

…….. [2]

[Total: 9]

10 Fig. 10.1 shows a process that occurs naturally in a somatic cell.

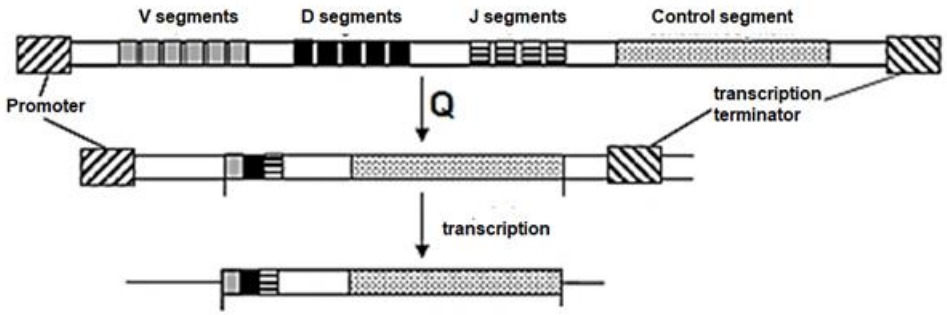

Fig. 10.1

(a) State precisely the type of cell and where it is located in the human body.

…….. [1]

(b) Explain why Process Q is essential to maintaining the health of an individual.

……...

……...

……...

……...

……...

……...

…….. [3]

(c) Besides the location, describe two differences between process Q and class switching.

……...

……...

……...

…….. [2]

[Total: 6]