EUNOIA JUNIOR COLLEGE
JC1 Promotional Examinations 2021
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME								
CIVICS GROUP	**2**	**1**	**-**			REGISTRATION NUMBER		

H2 Biology

9744

Paper 2 Structured & Free Response Questions

05 October 2021

2 hours

Additional Materials: 12-page Answer Booklet.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number 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 paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer **all** questions in the 12-page Answer Booklet.

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 appropriate units.

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	
5	
6	
7	
Section B	
8	
Total	**80**

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

Section A

1 Fats are usually stored as oil in the seeds of the plants and occasionally in the fleshy part of the fruit, as in the olive and the oil palm. The oil is a reserve of high-energy food for use by the germinating seed for growth of the embryo. The sunflower seed is actually the fruit of the sunflower (*Helianthus annuus*) and may contain about 51% oil.

Fig. 1.1 shows a triglyceride molecule found in sunflower oil.

Fig. 1.1

(a) On Fig. 1.1, circle an ester bond. [1]

(b) Sunflower oil can be used to make biodiesel.

During the process, the fatty acids in the triglyceride react with methanol to form fatty acid methyl esters that are liquid products. The other component of the original triglyceride molecule forms another liquid product that is denser than the methyl esters.

Name the component of the molecule seen in Fig. 1.1 that forms this denser liquid.

…… [1]

(c) Table 1.1 shows the melting points of the three different fatty acid methyl esters.

Table 1.1

fatty acid methyl ester	formula	melting point / °C
methyl linoleate	$C_{19}H_{34}O_2$	
methyl linolenate	$C_{19}H_{32}O_2$	- 55.0
methyl oleate	$C_{19}H_{36}O_2$	- 20.0

(i) Complete Table 1.1 with one possible value for the melting point of methyl linoleate. [1]

(ii) Suggest one way the structure of fatty acids found in butter might differ from the fatty acid that forms methyl oleate.

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…… [1]

(d) Living organisms have many uses for triglycerides, one of which is the production of phospholipids.

Describe how the roles of triglycerides and phospholipids differ in cells.

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…… [2]

(e) Explain why phospholipids are able to form bilayers in a cell.

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…… [2]

[Total: 8]

2 Phosphatases are enzymes that catalyse the removal of phosphate groups from organic compounds. A student investigated the effect of substrate concentration on the rate of the reaction catalysed by an acid phosphatase (enzyme **A**). The results are shown in Fig. 2.1.

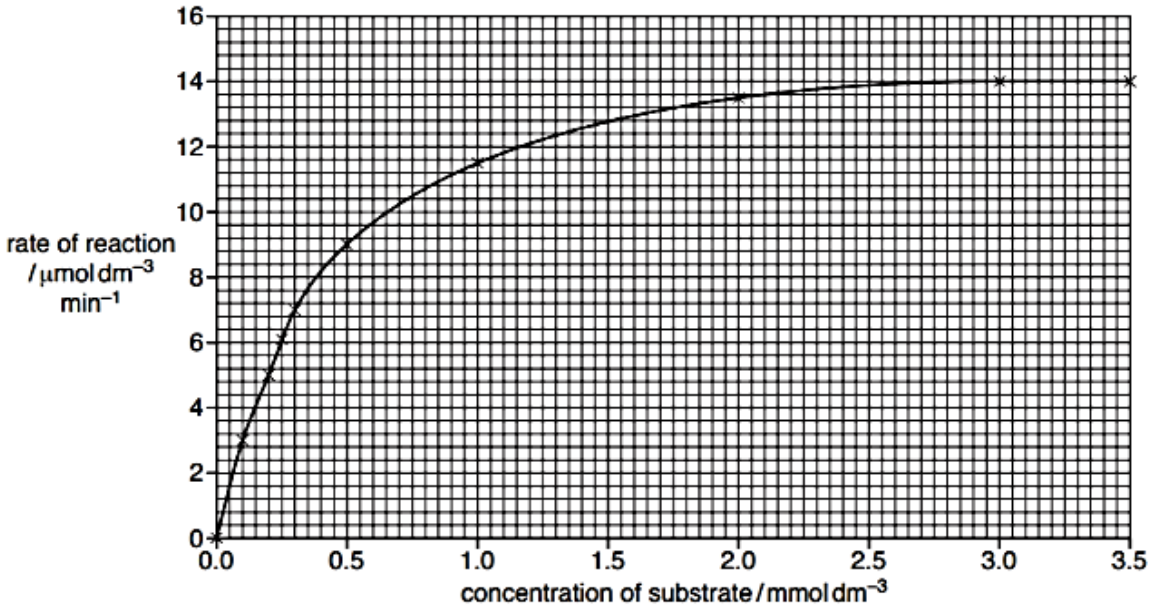

Fig. 2.1

(a) (i) On Fig. 2.1, show how K_m for enzyme A is derived. [1]

(ii) State the K_m value.

…… [1]

(b) The student investigated a different phosphatase enzyme (enzyme **B**) and found the value of K_m to be higher than that of enzyme **A**.

Explain the difference between the values of K_m for these two phosphatase enzymes.

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…… [2]

(c) The student repeated the investigation on enzyme **A** with a competitive inhibitor.

The same concentrations of substrate were used as before, but a competitive inhibitor was added to each reaction mixture.

The same concentration of the inhibitor was used in each reaction mixture.

The student found that V_{max} was the same as before, but K_m was higher.

Explain how the addition of the competitive inhibitor results in the same value for V_{max} but a higher value for K_m.

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..... [4]

[Total: 8]

3 Fig. 3.1 shows a transmission electron micrograph of a replication bubble.

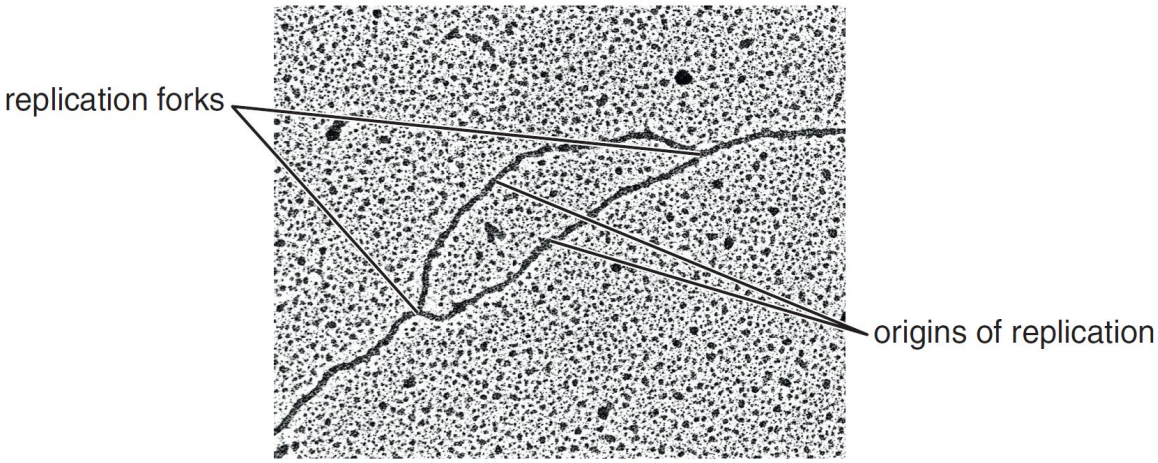

Fig. 3.1

(a) In eukaryotic cells, there are many sites of origin of replication for each DNA molecule.

(i) Explain an advantage of having many sites of origin of replication, rather than only one site.

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..... [1]

(ii) The structure of origins of replication has a higher proportion of A-T base pairs than C-G base pairs. Suggest why this is so.

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..... [2]

(iii) Briefly explain the importance of DNA replication as part of the cell cycle.

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..... [1]

(b) The amino acid sequence of haemoglobin in **person A** has been determined. The first five amino acids of this sequence are shown in Table 3.1.

Table 3.2 shows the genetic code (mRNA codons).

A student was asked to use Table 3.2 to work out an mRNA nucleotide sequence that would correspond to the first five amino acids of haemoglobin. The student's sequence is shown in Table 3.1.

Table 3.1

amino acid sequence	met	tyr	glu	pro	lys
student's nucleotide sequence	AUG	UAU	GAC	CCU	UGU
correct = ✓ incorrect = ×					

Table 3.2

2nd base in codon

1st base in codon	U	C	A	G	3rd base in codon
U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G
C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

(i) Complete Table 3.1 using a ✓ or a × to indicate whether the student has used Table 3.2 correctly to identify the codons for each amino acid in the nucleotide sequence. [1]

(ii) Discuss, with reasons, how an mRNA sequence in **person A** may not be the same as the mRNA sequence for those five amino acids present in another person?

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..... [3]

[Total: 8]

4 Fig. 4.1 shows an electron micrograph of actively dividing onion cells undergoing various stages in the cell cycle.

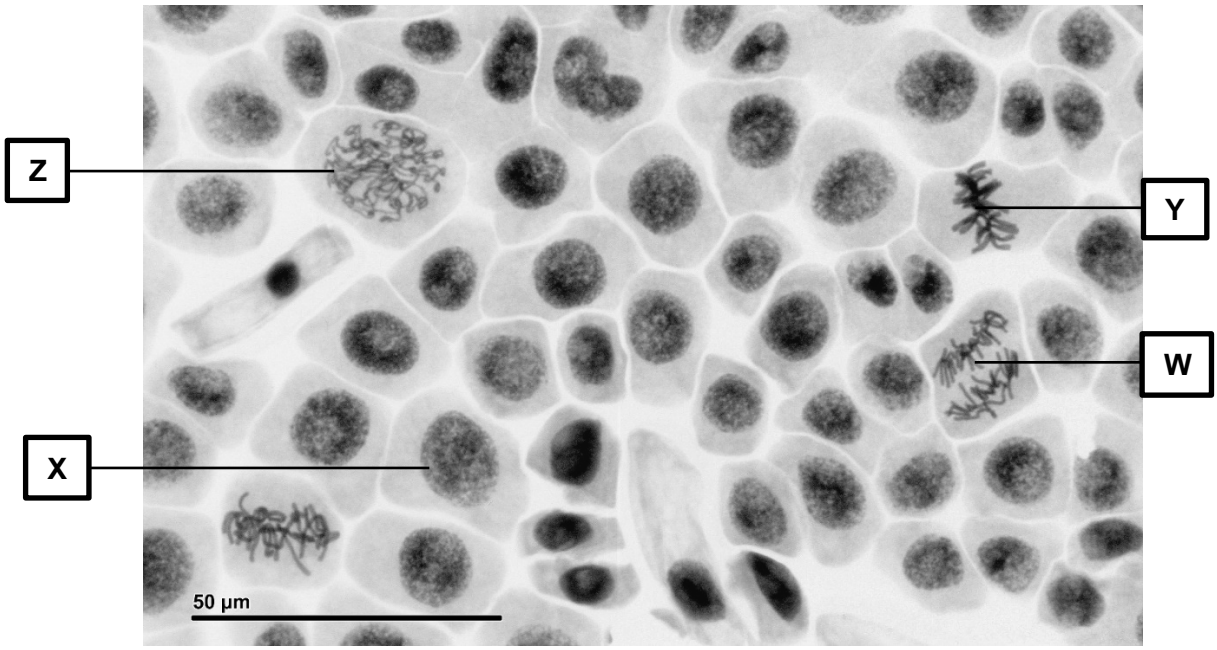

Fig. 4.1

(a) With reference to Fig. 4.1,

(i) state the order in which these stages (W, X, Y, Z) occur during the cell cycle.

…… [1]

(ii) outline the events occurring in stage Z.

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..... [3]

(b) An experiment was carried out to investigate the effect of p53 on cell cycle in human liver cells. Two types of cell populations were used in the investigation, one with intact *p53* gene and the other with mutated *p53* gene. Both cell populations were subjected to gamma radiation which is a DNA damaging agent. Mitotic index of the cells were then measured and the results are shown in Fig. 4.2.

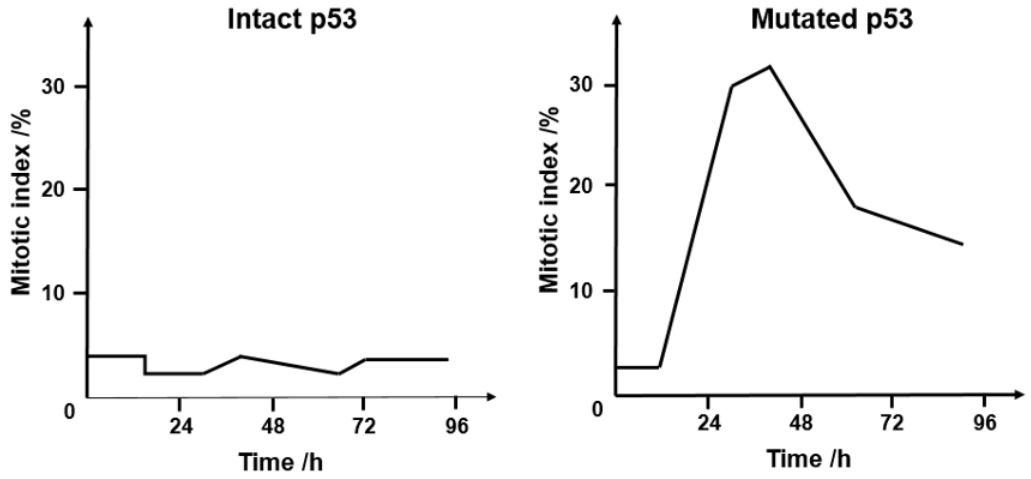

Fig. 4.2

Mitotic index reflects the number of cells in a population that are dividing. It is calculated by counting the number of cells with condensed chromosomes and dividing it by the total number of cells observed.

(i) Suggest why the condensed chromosomes are used to calculate mitotic index.

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..... [1]

(ii) With reference to Fig. 4.2, explain the difference between the two sets of results obtained.

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..... [3]

[Total: 8]

5 T cells (a type of white blood cell) synthesize a specific type of cell surface proteins known as CD proteins, which are inserted into the cell surface membrane.

Fig. 5.1 shows the stages involved in the synthesis of a CD protein in a T cell.

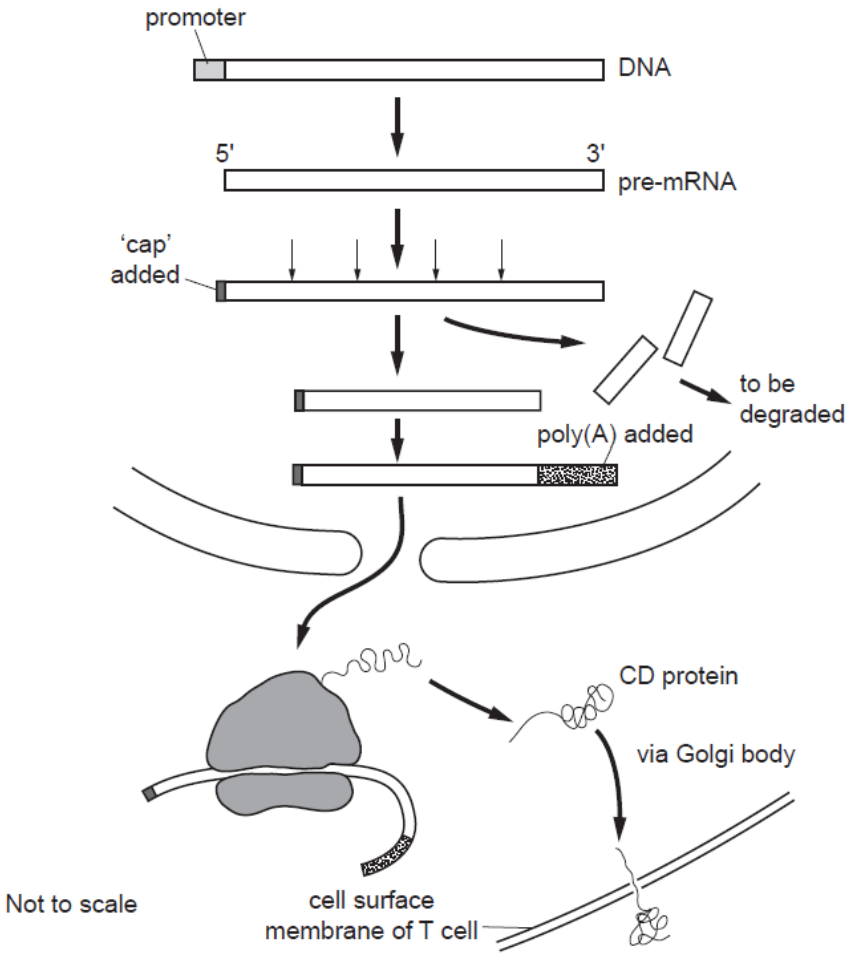

Fig. 5.1

(a) Explain the function of the promoter region of the DNA.

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..... [3]

(b) Explain why the cuts made in pre-mRNA are necessary for the T cell to produce a functional CD protein.

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..... [3]

(c) Explain the functions of the poly(A) region attached to the mRNA.

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..... [2]

(d) A misfolded CD protein can be tagged by a type of molecule and subsequently degraded.

(i) Identify the type of molecule that can be tagged on a misfolded CD protein.

..... [1]

(ii) Describe how the tagged CD protein is degraded.

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..... [1]

[Total: 10]

6 HIV is a retrovirus, which has RNA as its genetic material.

(a) Outline the role of gp120 in HIV.

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..... [1]

(b) Outline the role of reverse transcriptase in HIV.

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..... [2]

(c) HIV can remain in a dormant state within infected immune system cells for many years. A person diagnosed as HIV-positive (HIV+) has the virus but does not have symptoms of HIV/AIDS.

The chances of an HIV+ person developing HIV/AIDS can be greatly reduced with a drug treatment programme known as anti-retroviral therapy (ART).

In 2010, the World Health Organization (WHO) published recommendations for the treatment of pregnant women living with HIV. This includes both HIV+ women and women who have developed HIV/AIDS.

The publication recommended that **all** pregnant and breastfeeding women living with HIV should be provided with ART.

Fig. 6.1 shows the number of pregnant women living with HIV, and the number of these receiving ART, between 2005 and 2013, in low and middle income countries.

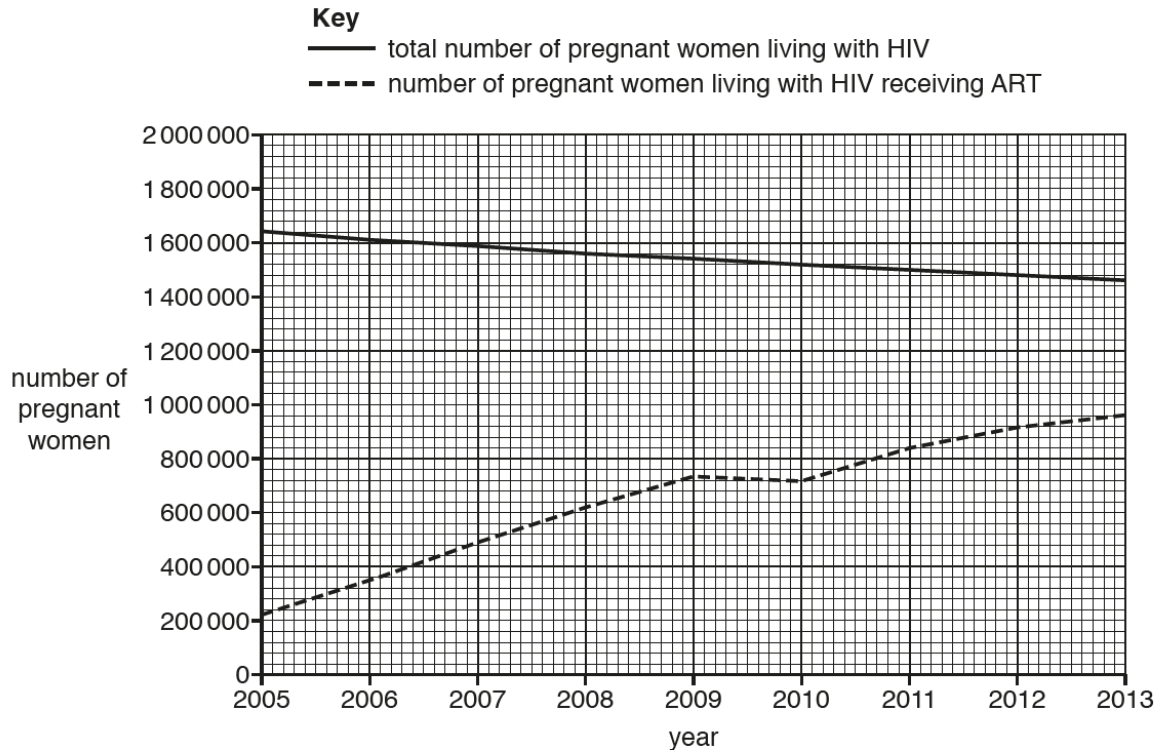

Fig. 6.1

(i) From the data in Fig. 6.1, it can be calculated that 13% of pregnant women living with HIV received ART in 2005.

Calculate the percentage of pregnant women living with HIV that received ART in 2013.

answer = ... % [2]

(ii) Suggest and explain the importance of providing ART to all pregnant and breastfeeding women living with HIV.

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..... [3]

(c) The existence of viruses, including HIV, continues to challenge the cell theory. Suggest reasons why this is so.

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..... [2]

[Total: 10]

7 The *lac* operon is a section of DNA present in the genome of the bacterium, *Escherichia coli* (*E. coli*). The structural genes of the *lac* operon are only fully expressed when the bacteria are exposed to high lactose concentrations.

Fig. 7.1 is a diagram showing the lac operon and a nearby region of the *E. coli* genome.

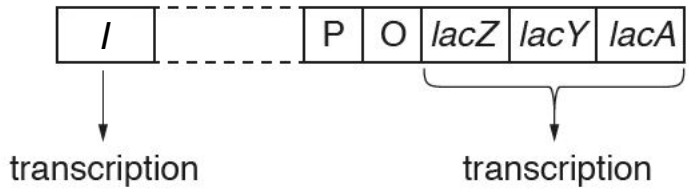

Fig. 7.1

(a) (i) Fig. 7.1 shows how the *lac* operon consists of structural genes and regulatory sequences.

Complete Table 7.1 to name each structural gene and its product. [2]

Table 7.1

structural gene	name of gene product

(ii) Gene *I* is transcribed all the time to produce its protein. This is constitutive expression.

Suggest why gene *I* shows constitutive expression.

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..... [1]

(iii) Describe the effect of the product of gene *I* on the *lac* operon.

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..... [2]

(b) If *E. coli* is placed into a nutrient medium containing lactose, *lac* operon is induced.

Explain why.

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..... [3]

[Total: 8]

Section B

Answer **all** questions in the 12-page Answer Booklet.

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.

8 **(a)** Describe the functions of structural and regulatory genes in **eukaryotic** genome. [10]

(b) Discuss how microscopes are used in the study of biology. [10]

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