Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Promotional Examination
Year 5

H2 BIOLOGY

9744/02

Paper 2 Section A Structured Questions

Paper 2 Section B Long Structured and Free-Response Questions

26 September 2023

1 hour 30 minutes

READ THESE INSTRUCTIONS FIRST:

Write your class, index number and name 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.

Sections A and B

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 appropriate units.

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

For Examiner's Use	
Paper 1	
MCQ	**15**
Paper 2	
Section A	
1	**9**
2	**11**
3	**7**
4	**8**
Section B	
1	**15**
2	**15**
Total	**80**

This document consists of **16** printed pages and **2** blank pages.

Section A: Structured Questions

Answer **all** questions.

Question 1

Fig 1 is an electron micrograph of part of a eukaryotic cell.

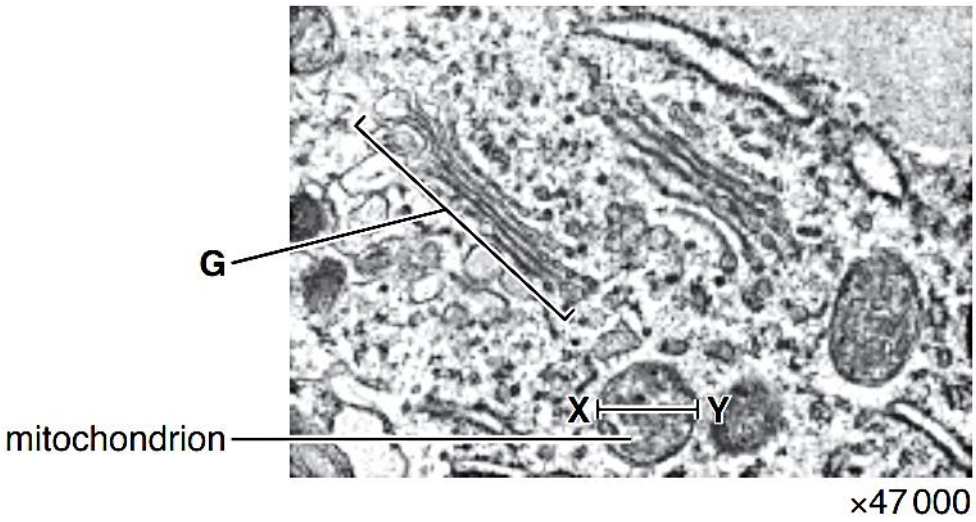

Fig 1

(a) Both the Golgi body and the rough endoplasmic reticulum are part of the network of membranes inside cells.

Outline the structural features shown in Fig 1 that identify G as the Golgi body and not the rough endoplasmic reticulum.

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.....

..... [2]

(b) Calculate the actual diameter, X–Y, of the mitochondrion labelled in Fig 1.

Write down the formula that you will use to make your calculation. Give your answer to the nearest whole nanometre (nm).

formula

Actual diameter = ... nm [2]

(c) Many of the cell structures in Fig 1 are surrounded by membranes.

Membranes are approximately 6 nm to 7 nm wide.

(i) Using your knowledge on fluid mosaic model, describe the structure of membranes. There is space below for a diagram.

[3]

(ii) The inner membrane of the mitochondrial envelope is much less permeable than the outer membrane.

Suggest two ways in which the structure of the inner membrane of the mitochondrion may differ from that of the outer membrane to produce a less permeable inner membrane.

[2]

Total: [9]

Question 2

Fig 2.1 shows a polypeptide molecule during protein synthesis. A molecule of glycine is shown just before it is added to the polypeptide. The product formed is incomplete.

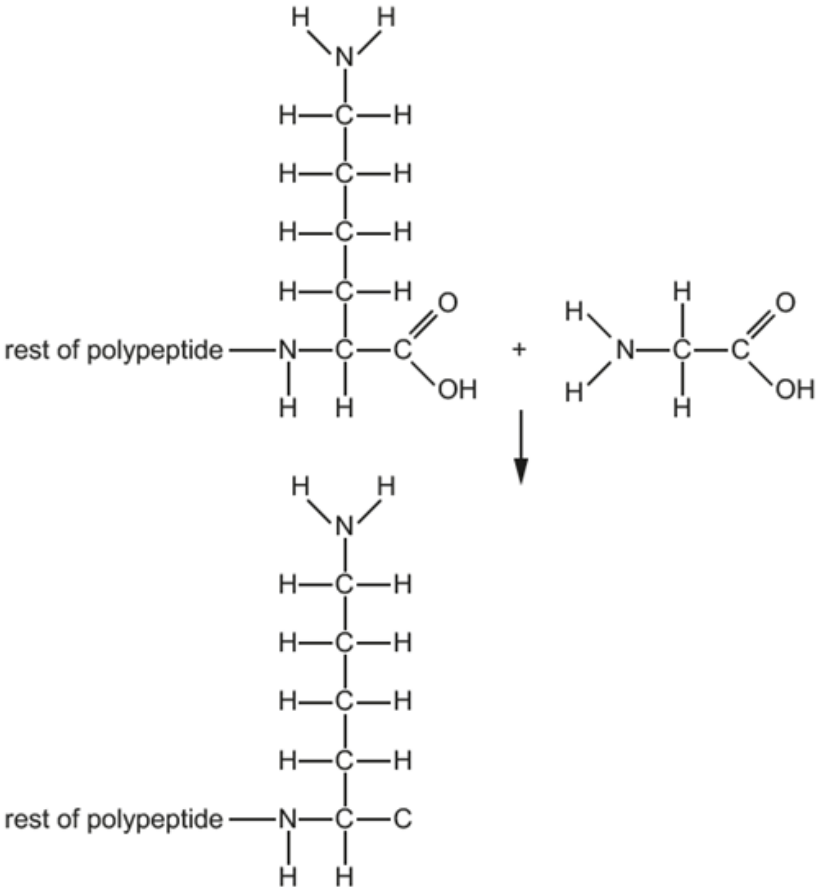

Fig 2.1

(a) **(i)** Complete Fig 2.1 to show how the products are formed. [3]

(ii) Name the enzyme that catalyses the above reaction in cells.

..... [1]

Enzymes can be used to speed up the rate of reaction. When developing an enzyme-catalysed reaction for use in industry, the progress of the reaction is studied.

(b) Outline how, in the production of lactose-free milk, the progress of a lactase-catalysed reaction can be investigated experimentally.

[3]

The feet of elephants are protected by structures under the skin known as cushions, as shown in Fig 2.2.

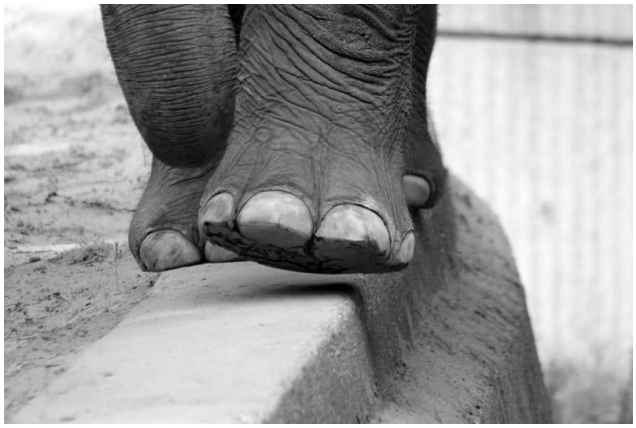

Fig 2.2

The cushions are made up of a large number of cells surrounded by connective tissues containing many fibres of collagen. The fibres help to maintain the structure of the cushions.

The collagen fibres are made of collagen molecules.

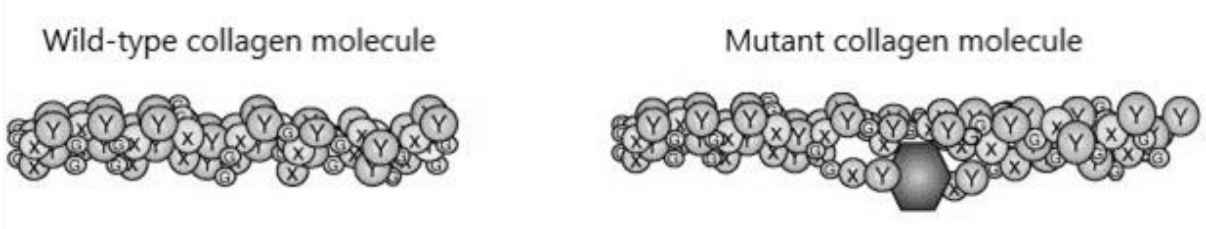

Fig 2.3

Osteogenesis imperfecta (OI), commonly known as "brittle bone disease", is a disorder characterized by bone fragility and abnormalities of connective tissues. Vast majority of affected individuals have mutations in the genes coding the polypeptide chains of collagen, which result in change of amino acid residues.

(c) With reference to Fig 2.3, describe the effect of such change in amino acid to the structure of collagen fibre.

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..... [2]

Collagen is a water-insoluble fibrous protein that can be prone to swelling. Collagen swelling occurs when water fills up the gaps between collagen molecules.

Fig 2.4 shows the effects of pH on the swelling ratio of collagen. Swelling ratio is defined as the percentage increase in the weight of collagen due to water absorption.

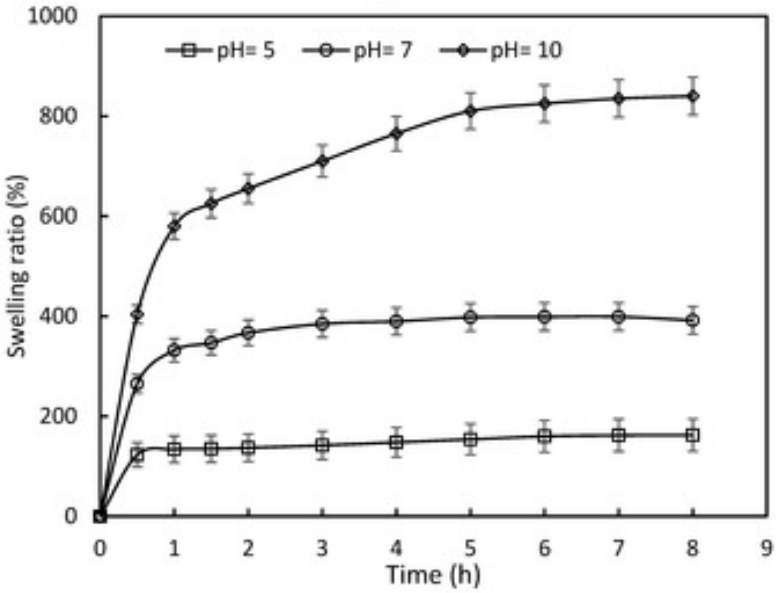

Fig 2.4

(d) With reference to Fig 2.4, describe and explain the effects of pH on collagen when the time is 8h.

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..... [2]

Total: [11]

Question 3

A salamander species, *Notophthalmus viridescens* (newt) has an ability to regenerate its limbs after amputation. The muscle cells of newt can undergo reprogramming and dedifferentiation to return to a less differentiated state. These dedifferentiated cells can proliferate to form a blastema. Cells in the blastema can then differentiate into different cell types to give rise to a newly formed limb.

Fig 3.1 shows a flow chart of the dedifferentiation and differentiation processes after the amputation.

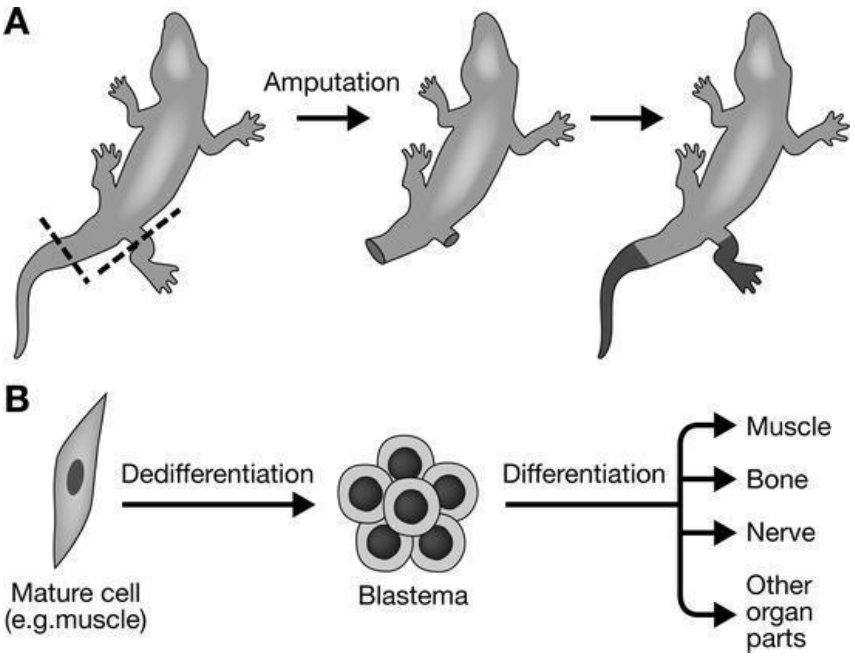

Fig 3.1

(a) Name the nuclear division involved in the formation of blastema shown in Fig 3.1.

[1]

(b) The cells in the blastema are genetically identical and have low or no expression of the myosin heavy chain (MYC) protein. However, the muscle cells have a high level of expression of the MYC protein.

Describe how the expression of the *MYC* gene in the muscle cells may be controlled at the translational level.

[2]

Scientists compared the species richness (number of unique species), the average body size in centimetres (cm) and the average genome size in picograms (pg) of different families of organisms. The results are shown in Fig 3.2.

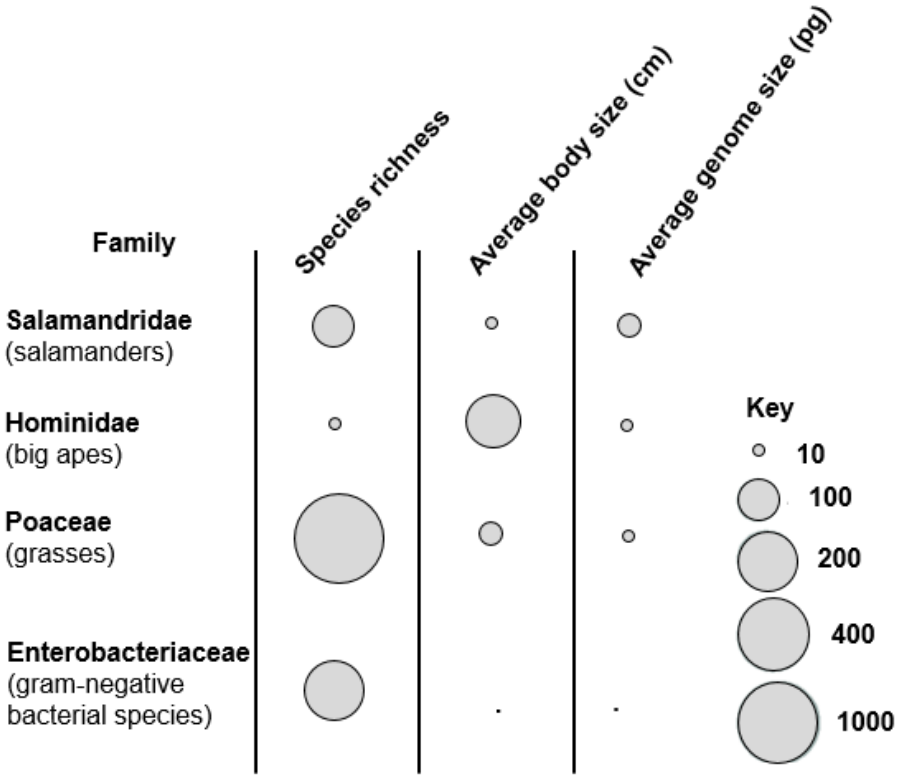

Fig 3.2

(c) **(i)** Comment on the relationship between the average body size and average genome size shown in Fig 3.2.

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..... [2]

(ii) Suggest possible reasons for the difference in the average genome size between salamanders and the Enterobacteriaceae bacterial species.

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.....

..... [2]

Total: [7]

Question 4

A group of researchers created a DNA construct, fusing elements of the *Trp* operon to the *Lac* operon. The DNA construct was then transformed into *E. coli* that lack the *Lac* and *Trp* operon.

Fig 4 illustrates the fusion between the two operons.

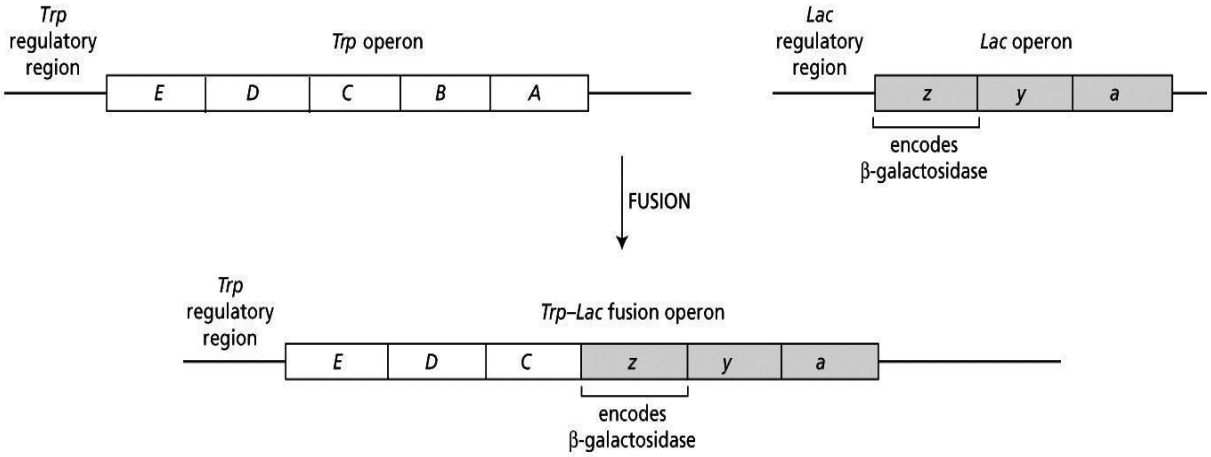

Fig 4

(a) Describe how the DNA construct containing the *Trp-Lac* fusion operon can be taken into the *E. coli* cell by transformation.

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..... [2]

Following transformation, the bacteria containing the DNA construct were grown in a medium containing lactose until the cell density reached $2x10^6$ cell/ml. The cells were washed, and 1 ml was transferred to a medium containing lactose and tryptophan. Samples of the bacteria cell were removed at 0 minutes and 60 minutes and the mRNA levels of specific structural genes were measured.

The results are shown below:

Table 4

Gene	Specific mRNA level/arbitrary units	
	0 minutes	**60 minutes**
LacZ	2000	20
LacY	2000	20
LacA	2000	20
TrpE	2000	20
TrpD	2000	20
TrpC	2000	20

(b) (i) Describe and explain the difference in mRNA levels at 0 and 60 minutes.

[4]

(ii) Explain why there is no difference between the specific mRNA levels of the *Trp* and *Lac* genes at 0 minutes.

[2]

Total: [8]

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Name:		Index Number:		Class:	

Section B: Long Structured and Free-Response Questions

Answer **all** questions.

Question 1

In the bacterium *Thermus thermophilus*, a sequence of DNA contains two overlapping genes, rnpA and rpmH, which code for RNase P and a ribosomal protein respectively.

Fig 1.1 shows the first 30 bases in the DNA sequence. Following process X, a different strand of nucleic acid is formed, and it contains the translation start sites for RNase P and the ribosomal protein.

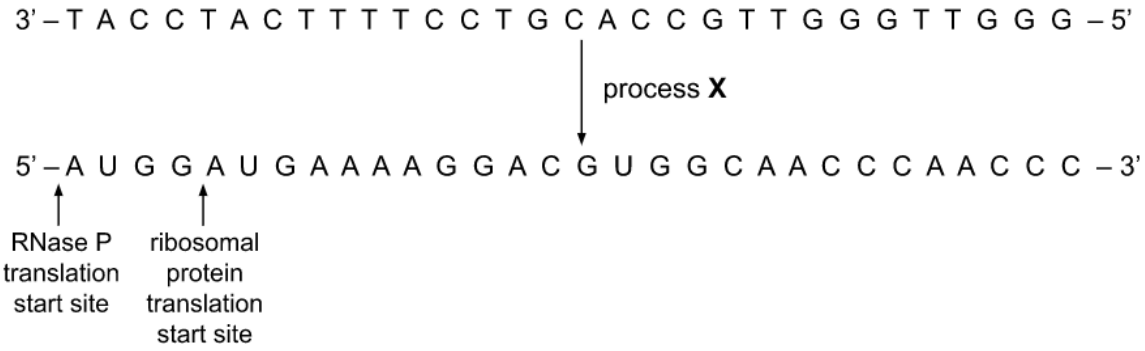

Fig 1.1

(a) **(i)** Briefly describe process **X**.

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..... [3]

(ii) Explain why the product of process **X** can code for two different polypeptides.

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..... [2]

In eukaryotic cells, the *FECH* gene codes for ferrochetalase, which is the final enzyme in the metabolic pathway of haem synthesis.

A study done in zebrafish found that a mutation in the *FECH* gene resulted in a disease phenotype known as dracula. The disease is characterised by lysis of red blood cells upon exposure to light.

Fig 1.2 shows a segment of the *FECH* template DNA sequence in normal and dracula zebrafish.

Table 1 shows the genetic code.

normal

27	28	29	30	31	32	33
CAC	GTG	GAC	A**G**T	GGA	CTC	ATC

dracula

27	28	29	30	31	32	33
CAC	GTG	GAC	A**T**T	GGA	CTC	ATC

Fig 1.2

Table 1

	U		**C**		**A**		**G**		
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	**U**
	UUC		UCC		UAC		UGC		**C**
	UUA	Leu	UCA		UAA	STOP	UGA	STOP	**A**
	UUG		UCG		UAG	STOP	UGG	Trp	**G**
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	**U**
	CUC		CCC		CAC		CGC		**C**
	CUA		CCA		CAA	Gln	CGA		**A**
	CUG		CCG		CAG		CGG		**G**
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	**U**
	AUC		ACC		AAC		AGC		**C**
	AUA		ACA		AAA	Lys	AGA	Arg	**A**
	AUG	Met	ACG		AAG		AGG		**G**
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	**U**
	GUC		GCC		GAC		GGC		**C**
	GUA		GCA		GAA	Glu	GGA		**A**
	GUG		GCG		GAG		GGG		**G**

(b) Using Fig 1.2 and Table 1,

(i) state the amino acid sequence for this segment of the normal polypeptide (starting from the C-terminus to the N-Terminus),

.....[1]

(ii) describe and explain how this mutation in the *FECH* gene results in non-functional ferrochetalase.

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.....[3]

(c) Fig 1.3 is a photomicrograph of root tip cells at different stages in the cell cycle.

A cell in interphase is labelled.

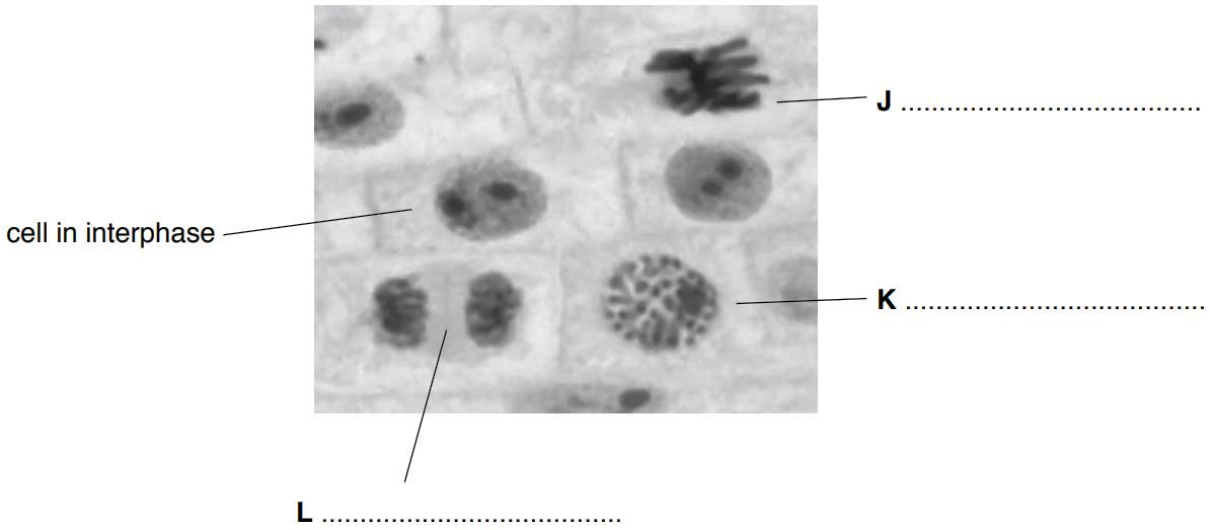

Fig 1.3

(i) Complete Fig 1.3 by naming the stages of mitosis shown in cells **J**, **K** and **L**. [3]

(ii) State one feature of the cell, labelled as cell in interphase in Fig 1.3, that shows that this cell is not in early interphase.

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..... [1]

(iii) Describe the stage of mitosis shown in cell **J**.

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..... [2]

Total: [15]

Write your answers in the Answer Booklet provided.
Your answers should be illustrated by large, clearly labelled diagrams, wherever appropriate.

Your answer must be in continuous prose, where appropriate.

2 The body's immune response to the influenza virus can lead to damage of the collagen matrix in the affected tissues, leading to possible tissue remodelling and other related physiological effects.

Compare the structures of collagen fibril and influenza genome and describe how new strains of influenza virus might arise.

Total: [15]

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