

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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General Certificate of Education  
 January 2005  
 Advanced Subsidiary Examination



**HUMAN BIOLOGY (SPECIFICATION A)**  
**Unit 3 Pathogens and Disease**

**BYA3**

Monday 10 January 2005 Morning Session

**In addition to this paper you will require:**

- a ruler with millimetre measurements.

You may use a calculator.

Time allowed: 1 hour 30 minutes

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

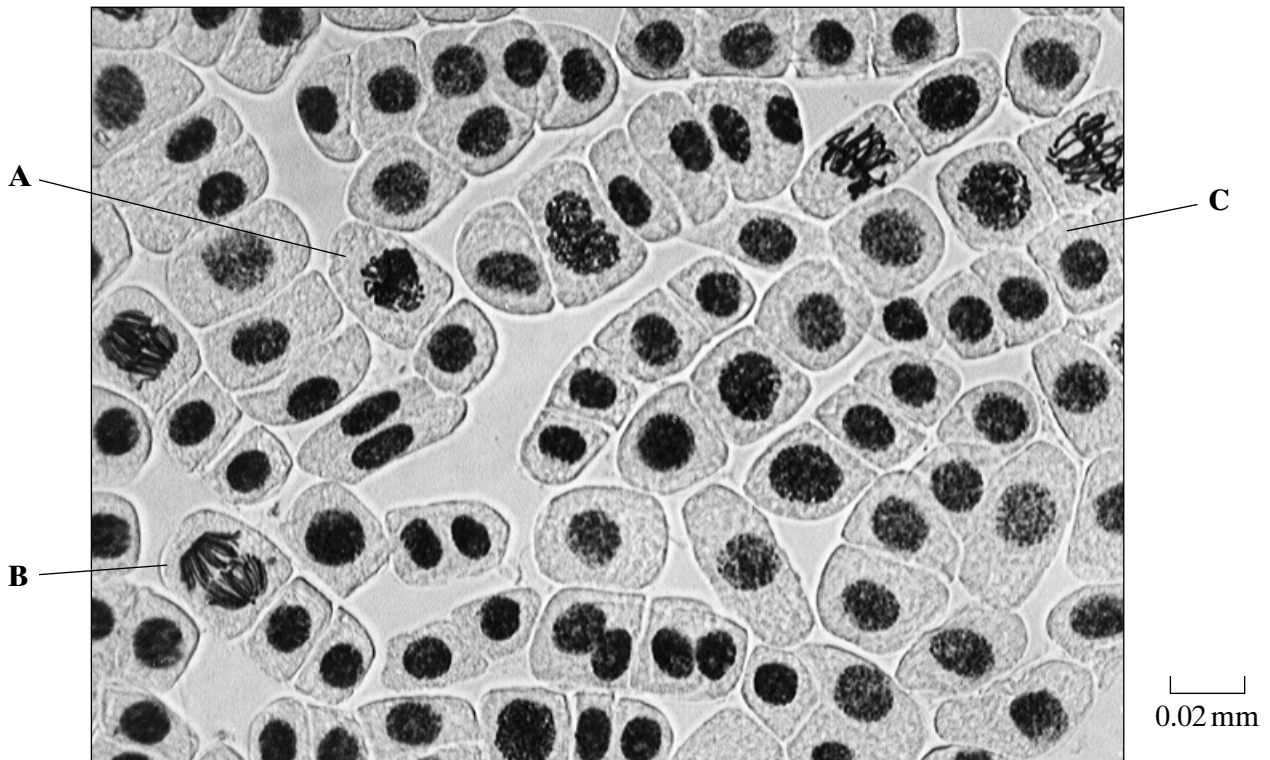
**Information**

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
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4			
5			
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8			
9			
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

- 1 The photograph shows cells from an onion root tip. The root tip has been squashed and stained to show the stages of mitosis.



- (a) (i) At what stage of mitosis is cell **A**?

.....  
(1 mark)

- (ii) What is the evidence that cell **B** is in anaphase?

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.....  
(1 mark)

- (iii) Cell **C** is in interphase. Give **two** processes which occur during interphase that enable cell division to occur.

1 .....

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2 .....

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(2 marks)

- (b) Explain how you would calculate the magnification of the photograph.

.....  
 .....

(1 mark)

- (c) The number of cells at each stage of mitosis was counted. The results are shown in the table.

Stage of mitosis	Number of cells
Interphase	123
Prophase	32
Metaphase	12
Anaphase	6
Telophase	27

One complete cell cycle takes 24 hours. The number of cells at each stage is proportional to the time spent at that stage. Calculate the length of time spent in metaphase. Show your working.

Answer ..... hours.  
(2 marks)

7

**TURN OVER FOR THE NEXT QUESTION**

Turn over 

2 Scientists are working to produce a genetically modified bacterium to treat patients suffering from a disease of the digestive system. They plan to collect mRNA from human cells. This will be used to produce the DNA of the gene for the protein interleukin. They will then transfer this human gene into the bacterium *Lactococcus*. The scientists intend patients to swallow the genetically modified bacteria. These bacteria will release interleukin inside the digestive system to treat the disease.

- (a) (i) Name the type of enzyme which will be used to produce the DNA from the mRNA.

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(1 mark)

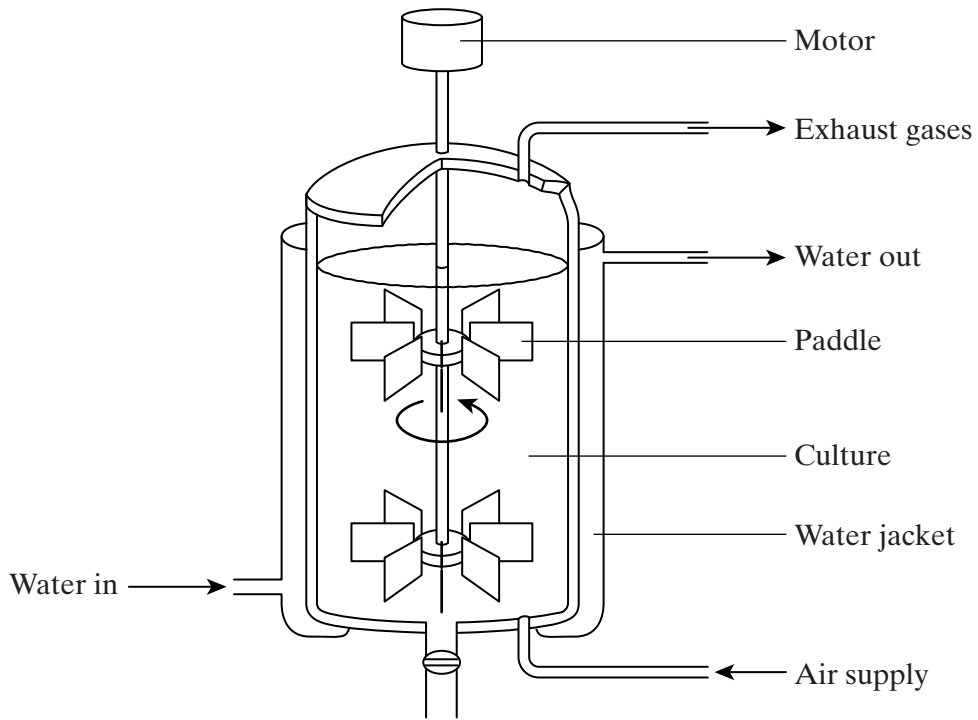
- (ii) It is easier to obtain the interleukin gene from mRNA rather than directly from the DNA removed from human cells. Explain why.

.....  
.....  
(1 mark)

- (b) The scientists propose to put the gene directly into the DNA of *Lactococcus*. Describe the role of the enzyme ligase in this process.

.....  
.....  
(1 mark)

- (c) The diagram shows a fermenter used to grow large numbers of genetically-modified bacteria.



- (i) The air supplied to the fermenter is passed through filters to remove very small particles. Suggest an explanation for removing these particles.

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(2 marks)

- (ii) Suggest **one** function of the water jacket shown.

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(1 mark)

3 A gene was broken into fragments using enzyme **Z**. The mixture of fragments produced was then separated by electrophoresis.

(a) What type of enzyme is enzyme **Z**?

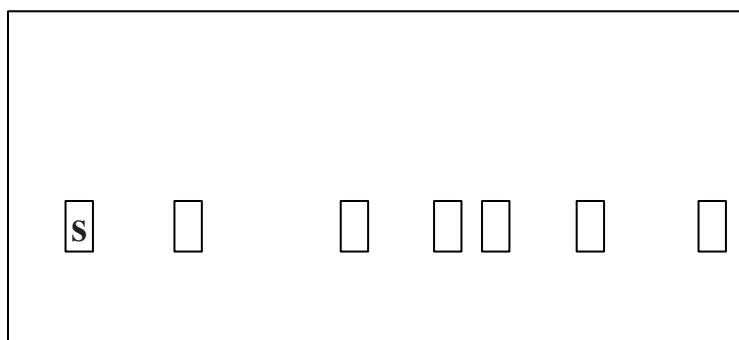
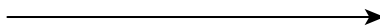
.....  
(1 mark)

The table shows the number of base pairs present in the fragments.

Fragment	Number of base pairs ( $\times 10^3$ )
1	4.65
2	5.72
3	10.71
4	2.39
5	5.35
6	7.53

The diagram shows the electrophoresis gel used. The mixture of fragments was placed at the start point marked **S** and the process started. The boxes indicate the positions reached by the different fragments.

Direction of movement of fragments



(b) Explain why base pairs are a suitable way of measuring the length of a piece of DNA.

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.....  
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(2 marks)

- (c) (i) Write **6** above the appropriate box on the diagram to show the position you would expect fragment **6** to have reached.

(1 mark)

- (ii) Explain how you arrived at your answer.

.....  
.....

(1 mark)

- (d) Enzyme **Z** recognises a particular sequence of bases in the gene. How many times does this sequence appear in the DNA of this gene?

.....

(1 mark)

6

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

4 *Schistosoma* is a parasite of humans. Its life cycle includes a secondary host.

(a) (i) Name the secondary host.

.....  
(1 mark)

(ii) Describe how the parasite is transmitted from a human to its secondary host.

.....  
.....  
(1 mark)

(iii) Rice is grown in water in paddy fields. Explain why workers in paddy fields are especially likely to be infected by *Schistosoma*.

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(2 marks)

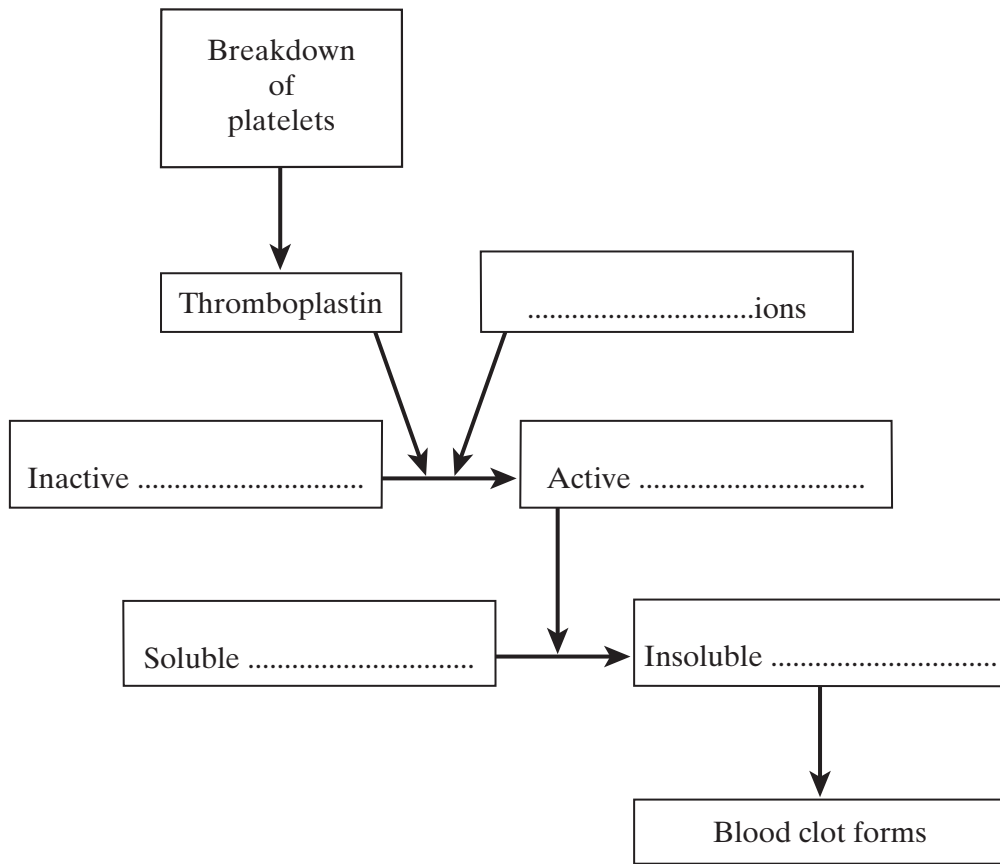
(b) Both *Schistosoma* and the malarial parasite spend one stage of their lives in humans. Complete the table to show **two** ways in which the life cycle of *Schistosoma* is different from that of the malarial parasite.

	<i>Schistosoma</i> parasite	Malarial parasite
Way in which the parasite enters the human body		
Part of the human body where the parasite is mainly found		

(2 marks)



- 5 (a) The diagram shows the main stages in the formation of a blood clot at a wound. Complete the boxes to show the names of the substances involved.



(3 marks)

- (b) (i) Bacteria entered a wound. Name the proteins produced by B-lymphocytes in response to these bacteria.

.....  
(1 mark)

- (ii) A second infection by the same species of bacterium took place later. The response to the second infection was faster than the response to the first infection. Explain why the response to the second infection was faster.

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(2 marks)

Turn over ►

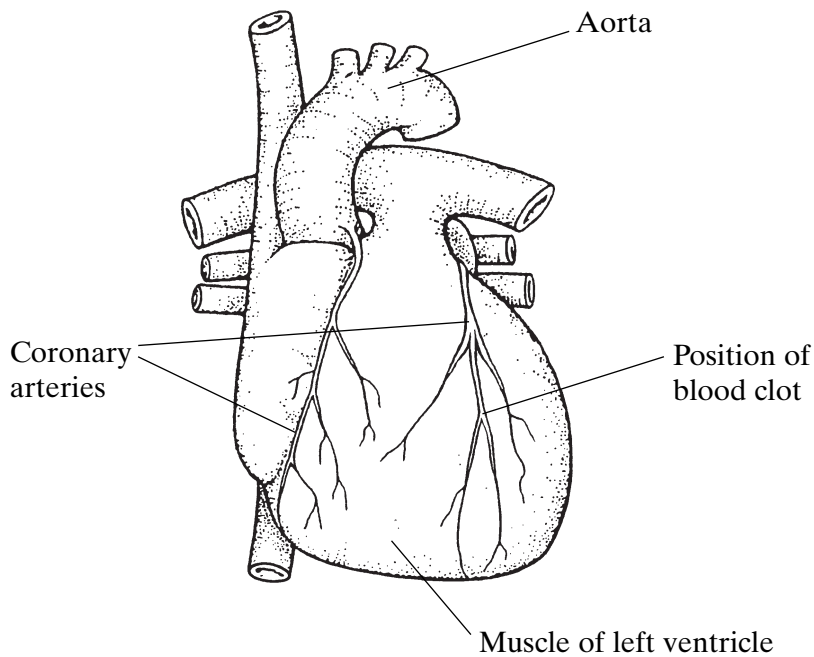
6 (a) (i) Explain the meaning of the term *atheroma*.

.....  
.....  
(1 mark)

(ii) Explain why atheroma may lead to a blood clot.

.....  
.....  
.....  
.....  
(2 marks)

(b) The diagram shows an external view of the heart. The position of a blood clot is marked.



(i) On the diagram, shade the area of the heart muscle which is likely to die as a result of the blood clot. (1 mark)

(ii) Explain why this area of the heart muscle is likely to die.

.....  
.....  
(1 mark)

(c) High blood pressure is a risk factor associated with damage to the circulatory system. Suggest **two** ways in which prolonged high blood pressure may affect the arteries.

1 .....

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2 .....

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(2 marks)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over** 

7 Some strains of the bacterium that causes gonorrhoea are resistant to antibiotics. This makes the disease difficult to treat. One way of testing the effectiveness of antibiotics is to use discs of paper soaked in antibiotic. These are placed in the centre of an agar plate covered by bacteria. A clear zone forms around the disc if the antibiotic is effective.

The table shows some results of an investigation into the effect of four different antibiotics on gonorrhoea bacteria.

Antibiotic	Diameter of clear zone/ mm	Minimum diameter of clear zone if antibiotic is effective/mm
A	47	52
B	30	28
C	22	40
D	33	34

(a) Give **two** reasons why it would be important to use sterile techniques during this investigation.

1 .....

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2 .....

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(2 marks)

(b) (i) The antibiotic reached the bacteria by diffusion. Suggest why an effective antibiotic may produce only a small clear zone.

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(1 mark)

(ii) Give **two** ways in which an antibiotic could prevent bacteria from dividing.

1 .....

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2 .....

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(2 marks)

- (iii) Which antibiotic used in the investigation would be most useful for treating gonorrhoea? Explain your answer.

Antibiotic .....

Explanation .....

.....

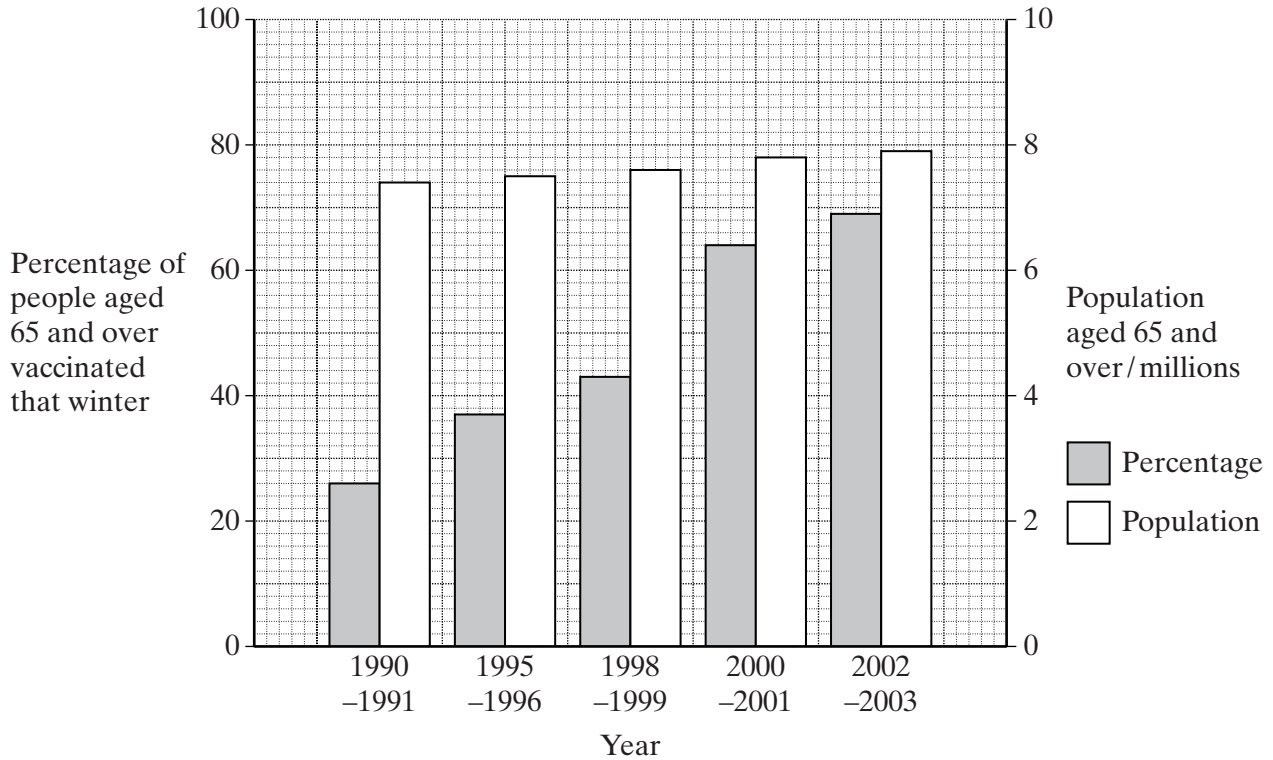
(2 marks)

7

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ▶

- 8 People considered ‘at risk’ are offered a vaccination against influenza each year. The bar chart shows the number of people in the UK population aged 65 and over and the percentage of those who were vaccinated against influenza each winter.



- (a) Suggest **one** reason to explain the change in the percentage of people aged 65 and over being vaccinated.

.....  
 .....

(1 mark)

- (b) (i) Calculate the change in the total number of people aged 65 and over being vaccinated between 1990/91 and 2000/01. Show your working.

Answer .....

(2 marks)

(ii) A student suggested that some people aged 65 and over were being vaccinated every year. Explain how the information in the bar chart supports this suggestion.

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(2 marks)

(iii) Suggest why it is advisable for people to be vaccinated against influenza every year.

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(2 marks)

(c) An influenza virus consists of a protein coat surrounding nucleic acid. The influenza vaccine consists only of the protein coat of the virus. Explain how the influenza vaccine produces immunity in the body.

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(2 marks)

**QUESTION 8 CONTINUES ON THE NEXT PAGE**

**Turn over** ►

(d) Describe how the human immunodeficiency virus (HIV) enters the body and causes disease.

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(6 marks)

15



**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

9 Read the following passage.

The sequence of bases in a molecule of DNA codes for proteins. Different sequences of bases code for different proteins. The genetic code, however, is degenerate. Although the base sequence AGT codes for serine, other sequences may also code for this same amino acid. There are four base sequences which code for the amino acid glycine. These are CCA, CCC, CCG and CCT. There are also four base sequences coding for the amino acid proline. These are GGA, GGC, GGG and GGT.

Pieces of DNA which have a sequence where the same base is repeated many times are called “slippery”. When “slippery” DNA is copied during replication, errors may occur in copying. Individual bases may be copied more than once. This may give rise to differences in the protein which is produced by the piece of DNA containing the errors.

Use information in the passage and your own knowledge to answer the following questions.

(a) Different sequences of bases code for different proteins (lines 1 – 2). Explain how.

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(2 marks)

(b) The base sequence AGT codes for serine (lines 2–3). Give the mRNA codon transcribed from this base sequence.

.....

(2 marks)

(c) Glycine-proline-proline is a series of amino acids found in a particular protein. Give the sequence of DNA bases for these three amino acids which contains the longest “slippery” sequence.

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(2 marks)

(d) (i) Explain how copying bases more than once may give rise to a difference in the protein (lines 9 – 10).

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(2 marks)

(ii) At what stage in the cell cycle would these errors in copying DNA bases occur?

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(1 mark)

(e) Starting with mRNA in the nucleus of a cell, describe how a molecule of protein is synthesised.

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(6 marks)

**END OF QUESTIONS**

**THERE ARE NO QUESTIONS PRINTED ON THIS PAGE**