Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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General Certificate of Education
January 2006
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

HUMAN BIOLOGY (SPECIFICATION A) **BYA3**
Unit 3 Pathogens and Disease

Tuesday 10 January 2006 9.00 am to 10.30 am

For this paper you must have:
- 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.
- Answer the questions in the spaces provided.
- 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.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.
- Use accurate scientific terminology in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		9	
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 (a) In which phase of the cell cycle does DNA replication take place?

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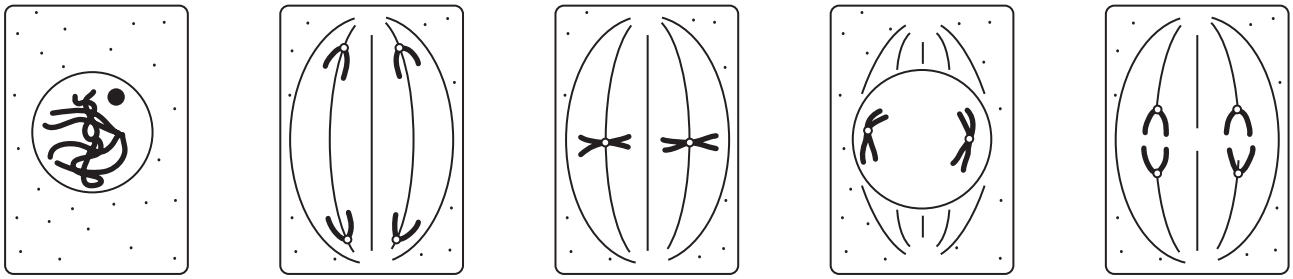
(1 mark)

(b) The diagrams show five stages of mitosis.



List the stages **A** to **E** in the correct sequence, beginning with the earliest stage.

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(1 mark)

(c) Describe the role of the spindle during mitosis.

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(2 marks)

(d) Meiosis also occurs during the life cycle of organisms. What is the importance of meiosis?

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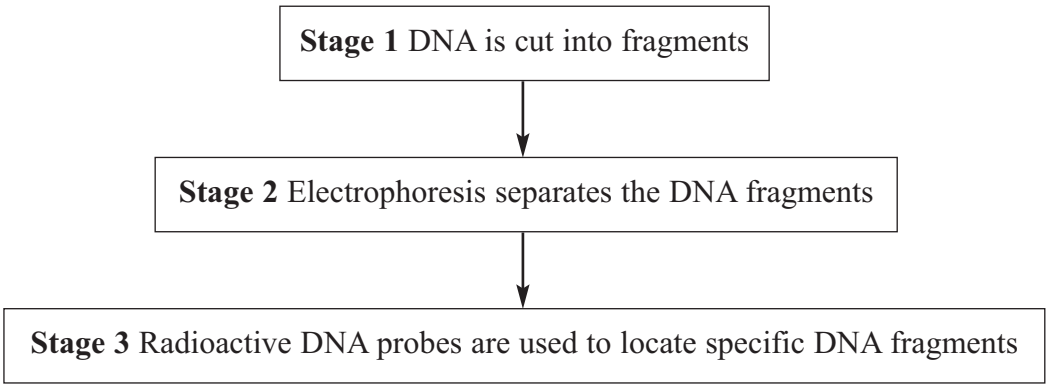
(2 marks)

6

2 DNA probes may be used to identify the presence of specific genes associated with human diseases. The flow chart summarises the way in which they are used.



(a) Name the enzyme used in **Stage 1**.

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(1 mark)

(b) Explain how electrophoresis separates the fragments of DNA in **Stage 2**.

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(2 marks)

(c) (i) What is a *DNA probe*?

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(2 marks)

(ii) Explain why *radioactive* DNA probes are used to locate specific DNA fragments.

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(2 marks)

7

3 *Schistosoma* is a parasite which lives in veins in the human abdomen.

(a) Give **one** adaptation of *Schistosoma* which

(i) ensures it stays in place in the veins;

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(1 mark)

(ii) Explain why *Schistosoma* is not destroyed by the immune system of the human host.

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(2 marks)

(b) *Schistosoma* has a very high rate of reproduction. Explain the advantage of this to *Schistosoma*.

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(1 mark)

(c) Anaemia is a condition in which the blood does not have enough red blood cells. A study was carried out on a group of schoolchildren in part of Africa. Samples of urine were tested to see if they contained *Schistosoma* eggs. Their blood was also tested to see if they had anaemia. The results of the investigation are given in the table.

Number of *Schistosoma* eggs per 10 cm^3 urine	**Percentage of children with moderate anaemia**	**Percentage of children with severe anaemia**
0	46.2	7.5
1 – 250	59.9	11.2
251 – 500	73.2	15.9
Over 501	75.0	16.4

(i) Describe the effect of *Schistosoma* infection on the incidence of anaemia.

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(1 mark)

(ii) Describe **two** ways in which *Schistosoma* may cause anaemia.

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(2 marks)

7

4 (a) What is vaccination?

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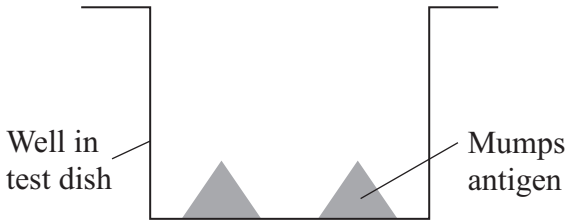
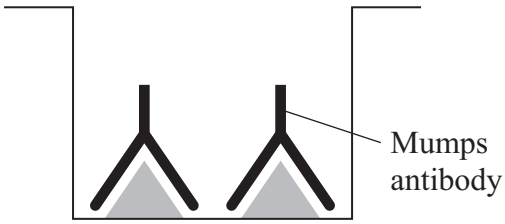
(2 marks)

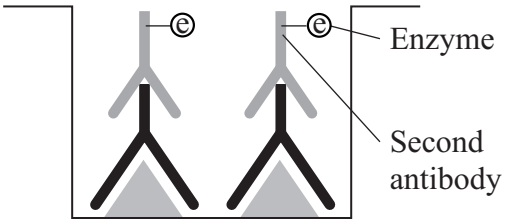
(b) A test has been developed to find out whether a person has antibodies against the mumps virus. The test is shown in the diagram.



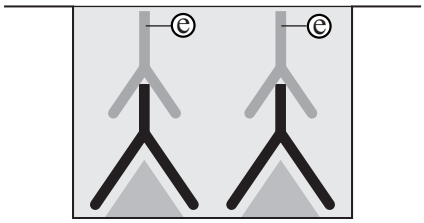
Step 1
Mumps antigen is attached to a well in a test dish.



Step 2
A sample of blood plasma is added to the well. If mumps antibodies are present, they bind to the mumps antigen.



Step 3
The well is washed. Then a second antibody with an enzyme attached is added. This binds specifically to the mumps antibody.



Step 4
The well is washed again. A solution is added which changes colour if the enzyme is present. A colour change shows that the person has mumps antibodies.

(i) Explain why this test will detect mumps antibodies, but not other antibodies in the blood.

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(1 mark)

(ii) Explain why it is important to wash the well at the start of **Step 4**.

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(2 marks)

(iii) Explain why there will be no colour change if mumps antibodies are not present in the blood.

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(2 marks)

7

Turn over for the next question

5 The table shows the sequence of bases on part of the coding strand of DNA.

Base sequence on coding strand of DNA	**C**	**G**	**T**	**T**	**A**	**C**
Base sequence of mRNA						

(a) Complete the table to show the base sequence of the mRNA transcribed from this DNA strand.

(2 marks)

(b) A piece of mRNA is 660 nucleotides long but the DNA coding strand from which it was transcribed was 870 nucleotides long.

(i) Explain this difference in the number of nucleotides.

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(1 mark)

(ii) What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer.

Number of amino acids .....

Explanation .....

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(2 marks)

(c) Complete the table to give **two** differences between the structure of mRNA and the structure of tRNA.

mRNA	**tRNA**

(2 marks)

7

6 Concerns have been expressed that doctors' clothing might transmit bacteria from one patient to another. An investigation in a hospital showed that 50% of the ties worn by doctors had pathogenic bacteria on them. However, only 10% of the ties worn by a control group of security personnel at the hospital had pathogenic bacteria on them.

(a) Describe how you could use an agar plate to investigate whether a tie has bacteria on it.

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(4 marks)

(b) Suggest why ties worn by the security personnel at the hospital were chosen as the control.

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(2 marks)

6

There are no questions printed on this page

7 The box jellyfish produces a poison (venom) which enters the blood when a person is stung. A person who has been stung can be treated with an injection of antivenom. This antivenom is produced by injecting small amounts of venom from box jellyfish into sheep, then extracting antibodies from the sheeps' blood. These antibodies are then injected into the person who has been stung.

(a) If a sheep is injected with the box jellyfish venom on more than one occasion a higher yield of antivenom is obtained. Explain why.

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(2 marks)

(b) Injecting antivenom does not give a person lasting protection against the venom of box jellyfish. Explain why.

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(2 marks)

(c) Suggest **one** possible problem in injecting people with antivenom made in this way.

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(1 mark)

5

8 Read the following passage.

The idea that bacteria could be used as a cancer treatment originated over 100 years ago. A doctor noticed that some cancer patients with bacterial infections showed signs of recovery from the cancer. Attempts to use the bacteria as a treatment were disappointing, however. Experiments showed that the bacteria made an impressive onslaught on tumours, but a ring of cancerous tissue around the edge usually survived.

Bacteria are once again being used in the war on cancer. Scientists have genetically engineered a harmless strain of *Clostridium* to carry the gene for an enzyme. This enzyme converts a harmless "prodrug" into an active drug which acts as a powerful toxin. In people, this strain of *Clostridium* will only grow in tumours. Scientists hope that when they inject the prodrug into a cancer patient's blood, the bacteria will convert it into an active drug. This will destroy tumours from the inside, leaving healthy tissues unharmed.

The idea of converting a harmless prodrug into an active drug that only kills cancer cells is not new. Apart from the use of genetically modified *Clostridium*, other methods have been tried. One of these involved attaching an enzyme to an antibody that binds only to cancer cells. This enzyme then activates the drug. Unfortunately, different types of cancer require different antibodies, making the treatment expensive to develop. Scientists hope their bacterial approach will offer a way of delivering the enzymes to any cancer cell.

(a) Describe how scientists could genetically engineer *Clostridium* bacteria to produce the enzyme which activates the prodrug. (lines 7-8)

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(6 marks)

(b) Explain why it is important to destroy all the cancer cells in a tumour.

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(2 marks)

(c) Explain how the use of antibodies (lines 16-17) results in a drug only killing cancer cells.

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(3 marks)

(d) Cancer drugs usually interfere with DNA replication. Use this information to explain why the cancer drugs are administered as prodrugs and not the active form.

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(4 marks)

15

9 (a) Describe how atheroma is caused and how it may result in a myocardial infarction.

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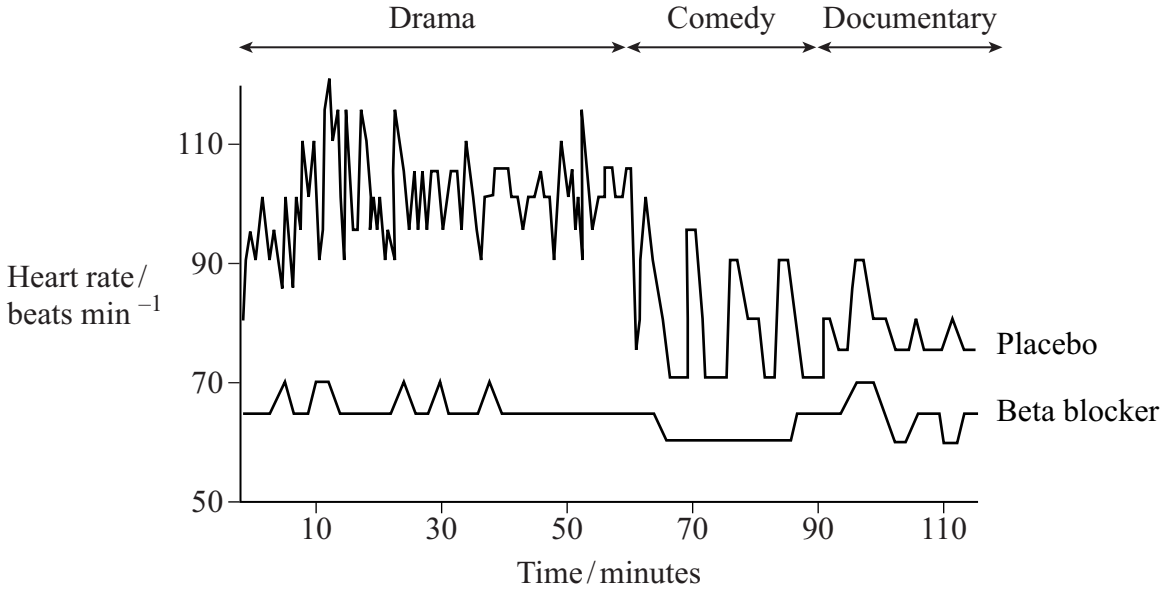
(6 marks)

(b) The graph shows the heart rates of two men with hypertension. They were watching television. One of the men had taken a beta blocker and the other had taken a placebo (dummy pill).



(i) Use the graph to describe the effects of the beta blocker on heart rate.

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(2 marks)

(ii) Explain how a beta blocker reduces hypertension.

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(3 marks)

(iii) In this investigation, it was important that neither man knew which type of pill he had taken. Suggest why.

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(1 mark)

Question 9 continues on the next page

(c) The table shows the results of an investigation into the effects of prescribing beta blockers to patients who had suffered a myocardial infarction.

Patient age at time of myocardial infarction / years	Under 60	60 – 69
Percentage reduction in mortality within the next 2 years compared with groups who had taken a placebo	19	33

(i) Give **one** conclusion which may be drawn from these data.

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(1 mark)

(ii) Explain how the percentage reduction in mortality would have been calculated.

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(2 marks)

15

END OF QUESTIONS