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General Certificate of Education  
 June 2002  
 Advanced Subsidiary Examination



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

**BYA3**

Monday 27 May 2002 Morning Session

**No additional materials are required.**  
 You may use a calculator.

For Examiner's Use			
Number	Mark	Number	Mark
1			
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Total (Column 1)	→		
Total (Column 2)	→		
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Examiner's Initials			

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.

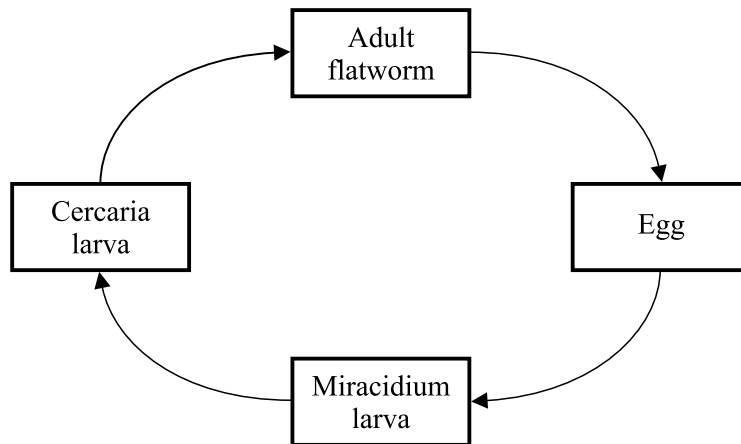
Answer **all** questions in the spaces provided.

1 (a) What is a parasite?

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(1 mark)

(b) Schistosomiasis is a parasitic disease of humans. The diagram shows the main stages of the life cycle of *Schistosoma*, the flatworm responsible for the disease.



Complete the table by naming either the host or place in the environment where the following stages occur in the life cycle of *Schistosoma*.

Stage in life cycle of <i>Schistosoma</i>	Host or place in environment where stage occurs
Adult flatworm releases egg	
Egg hatches to become a miracidium larva	
Miracidium larva becomes a cercaria larva	
Cercaria larva develops into an adult flatworm	

(2 marks)

(c) Explain **three** adaptations shown by *Schistosoma* to its parasitic way of life.

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(3 marks)

2 (a) The table shows the mass of DNA in various cells from the body of a man.

Cell	Mass of DNA / arbitrary units	Number of chromosomes
A	7	
B	14	46
C	28	

(i) Which cell is a mature sperm cell? Explain your answer.

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(1 mark)

(ii) What would be the mass of DNA in a zygote resulting from the fertilisation of an egg cell by this sperm cell? Explain your answer.

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(2 marks)

(b) What is the role of the spindle during the process of mitosis?

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(1 mark)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

3 (a) Describe how Koch's postulates could be used to show that a particular bacterium is responsible for causing a particular disease.

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(4 marks)

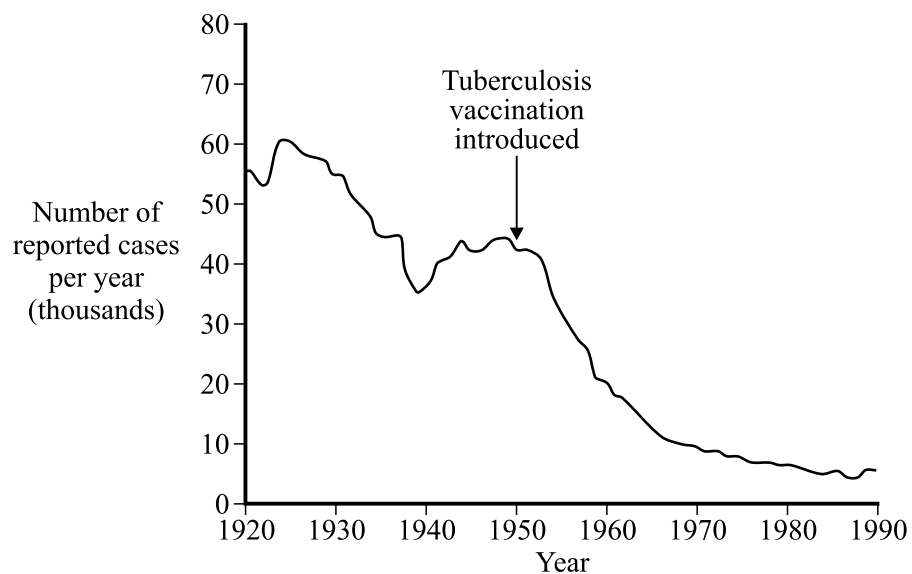
(b) *Mycobacterium tuberculosis* is a bacterium that causes tuberculosis in humans. The gas-exchange system is at high risk from infection by *Mycobacterium tuberculosis*. Suggest why.

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(1 mark)

(c) The graph shows information about the number of reported cases of tuberculosis in the UK during the period 1920 to 1990.



- (i) It was not only vaccination that was responsible for the decline in the number of reported cases of tuberculosis. Give **one** piece of evidence from the graph to support this statement.

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(1 mark)

- (ii) Suggest **one** reason, other than vaccination, for the decline in the number of reported cases of tuberculosis during the period shown.

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(1 mark)

- (d) Explain how infection by HIV would increase the risk of a person developing tuberculosis.

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(1 mark)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

4 (a) (i) What is a pathogen?

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.....  
(1 mark)

(ii) What is an *attenuated* microorganism?

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.....  
(1 mark)

(b) Research by the World Health Organisation (WHO) has shown that a population is protected from a pathogenic disease when 95% of children are vaccinated against that disease. Explain why there is a low risk of a disease spreading when vaccination levels reach 95%.

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(2 marks)

(c) The table shows information about vaccination levels against measles in 1997 and 2000.

	Year	
	1997	2000
Percentage of children vaccinated against measles	92	88.4

(i) Explain **one** advantage of recording the percentage of children vaccinated rather than the number of children vaccinated.

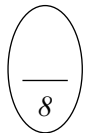
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(1 mark)

(ii) For every 100 000 children born, calculate how many fewer children were vaccinated in the year 2000. Show your working.

Answer.....  
(1 mark)

(d) Give **two** ways in which passive immunity differs from active immunity.

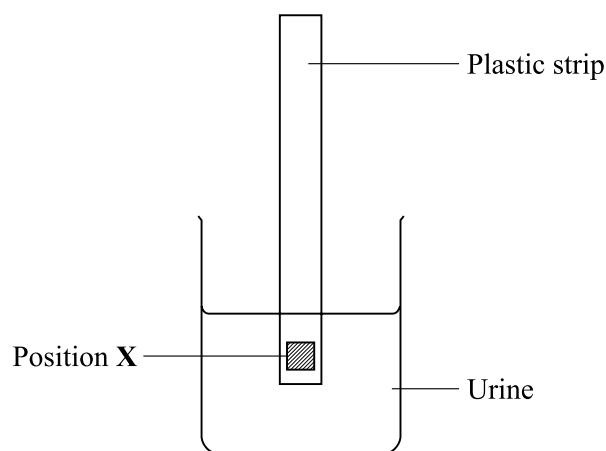
- 1 .....
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- (2 marks)



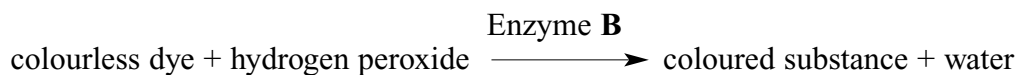
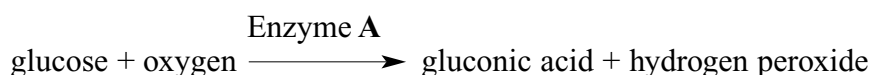
**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

- 5 Enzymes can be used as analytical reagents. The drawing shows a plastic strip dipped into a patient's sample of urine to test for the presence of glucose.



The test involves two enzymes which catalyse the following reactions:



- (a) (i) Which of the substances in the equations are located at position X on the plastic strip?

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(1 mark)

- (ii) Name

Enzyme A .....

Enzyme B .....

(2 marks)

- (iii) Explain the need for two different enzymes in this test.

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(1 mark)



(b) In this test, no colour change was observed at the end of the plastic strip. What does this suggest about the person from whom the sample was obtained?

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(1 mark)

(c) Glucose is a reducing sugar which can also be detected by a biochemical test such as the Benedict's test. Suggest an advantage of using the enzyme-based method for determining the concentration of glucose in a sample of urine.

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(1 mark)

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**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

6 Atherosclerosis can result from plaque formation in the lining of an artery. Plaque contains fatty substances, cholesterol, blood platelets, fibrin, calcium ions and cellular debris. These materials attach to a roughened part of the lining of an artery. Turbulence in the blood and high blood pressure are thought to cause the roughening of the lining. Over time, the amount of plaque increases and the lumen of the artery gets narrower.

(a) Suggest why plaque does not usually form in a vein.

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*(1 mark)*

(b) Fibrin is not normally present in the blood. Describe the sequence of events that leads to the presence of fibrin in the plaque.

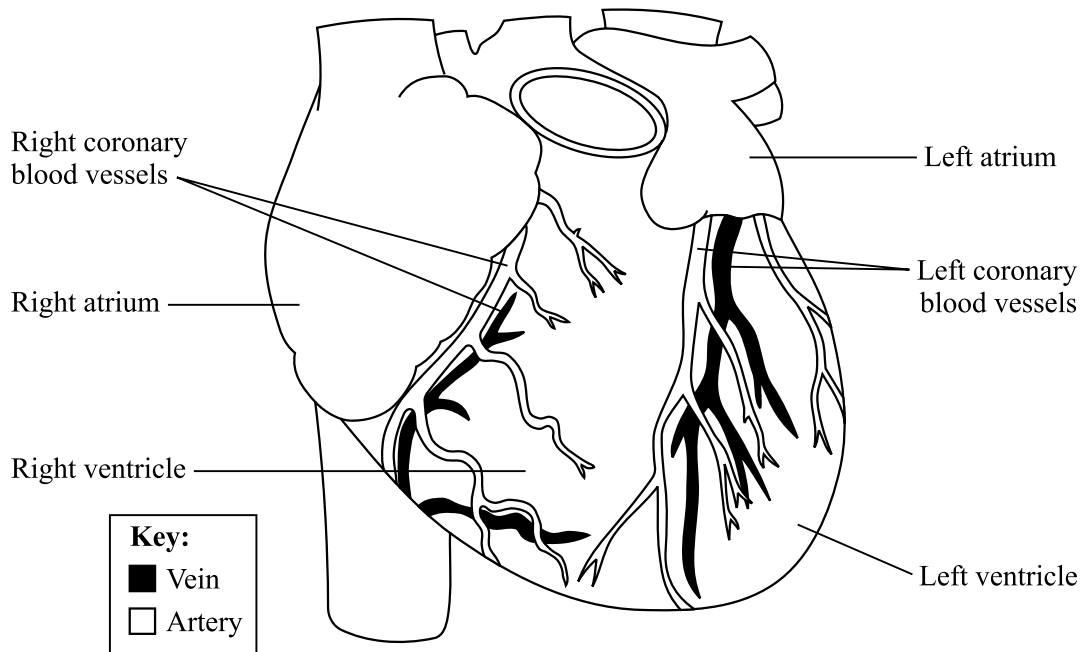
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*(4 marks)*

- (c) (i) Plaque is most likely to form where one artery branches to become two arteries. Suggest why.

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(1 mark)

- (ii) The drawing shows a human heart. Use the information given in this question to show **one** place where plaque is most likely to form. Mark the position on the drawing with an arrow.



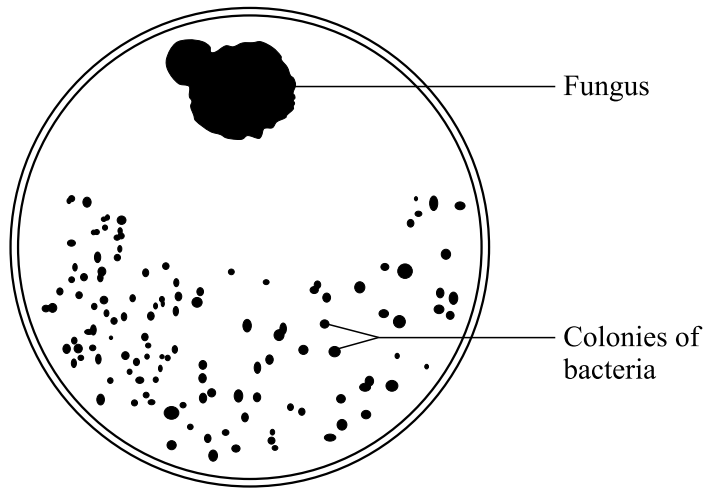
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**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

7 In 1928, Alexander Fleming discovered that one of his agar plates, containing a culture of the bacterium *Staphylococcus aureus*, was contaminated by the fungus *Penicillium*. The drawing shows the appearance of this agar plate.



(a) Explain why no colonies of bacteria grew near the fungus.

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(2 marks)

(b) The bacterium, *Staphylococcus aureus*, is commonly used for experimental work. Suggest why supplies of bacteria are usually kept refrigerated until they are required.

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(2 marks)

(c) Chloramphenicol is a substance that prevents the attachment of tRNA to a ribosome. Explain why bacterial cells treated with chloramphenicol cannot synthesise proteins.

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(2 marks)

**8** Scientists believe that the tendency to develop cancer can be inherited. It is thought that some people possess cancer-causing genes. These genes only become functional when activated by an environmental factor. The functional genes then cause the production of abnormal cells. The abnormal cells multiply and spread, causing cancer.

(a) Explain why medical screening of people for the presence of these cancer-causing genes is recommended.

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*(2 marks)*

(b) Cells also contain suppressor genes, which code for proteins that control cell division and growth. Describe what is meant by a mutation, and explain how a mutation in a suppressor gene might lead to the development of a malignant tumour.

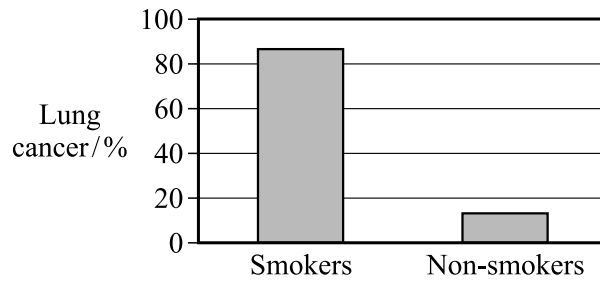
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*(6 marks)*

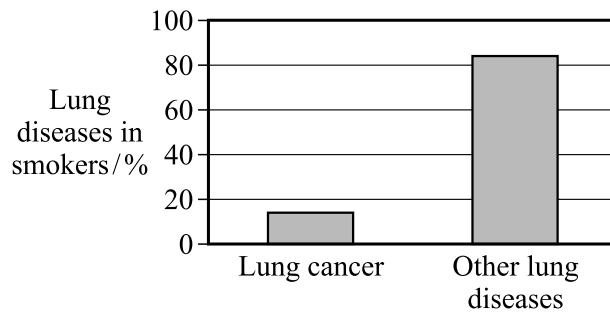
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**Turn over ►**

(c) **Figure 1** and **Figure 2** show information from one study of lung cancer and lung diseases in adults of all ages in the UK.



**Figure 1 – Proportion of lung cancer sufferers who are smokers or non-smokers.**



**Figure 2 – Proportion of types of lung disease in smokers who are suffering from lung disease.**

(i) Give **three** conclusions that can be drawn from the results of this study.

- 1 .....
- .....
- 2 .....
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- 3 .....
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*(3 marks)*

(ii) Suggest **two** reasons why conclusions, made only on the basis of these data, may not be reliable.

- 1 .....
- .....
- 2 .....
- .....

*(2 marks)*

(d) Some scientists believe that heart disease is also the result of the activation of genes by environmental factors. One research study, to try and identify the genes responsible, was carried out on the people living on a remote island. Suggest why a remote island is more suitable for genetic research than an area like the UK.

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*(2 marks)*

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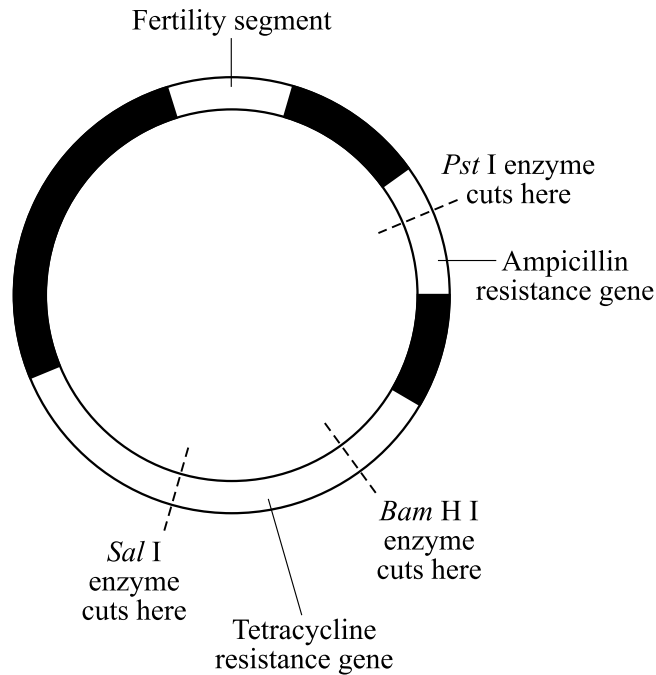
**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

9 Read the following passage.

Recombinant DNA technology uses restriction enzymes to cut plasmid DNA at specific places. A gene from a different organism is located and then inserted in the plasmid. The plasmid is replaced in a bacterium which is then allowed to multiply. Plasmids may also contain marker genes. These make it possible to identify and isolate bacterial cells that contain the plasmid with the relevant gene.

A plasmid from the bacterium *Escherichia coli* is often used as a vector in recombinant DNA technology. The diagram shows the structure of this plasmid. It also shows the sites where the plasmid can be cut by different restriction enzymes.



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

- (a) Explain why the plasmid is described as a *vector* (line 6).

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(1 mark)



(b) A DNA fragment, containing the gene for insulin, was inserted into this plasmid. To isolate bacteria that contained this recombinant plasmid, the bacteria were added to a culture medium containing the antibiotic ampicillin. Bacteria which contained the recombinant plasmid had lost resistance to ampicillin.

(i) Use the diagram to identify the restriction enzyme which had been used to insert the DNA fragment into the plasmid.

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(1 mark)

(ii) Explain why resistance to ampicillin had been lost.

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(2 marks)

(iii) Describe how a DNA probe could be used to confirm that the insulin gene was present in the DNA fragment.

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(3 marks)

(c) Before a plasmid is used in recombinant DNA technology, the fertility segment is removed. This piece of DNA controls the process of conjugation in which different bacteria can link and pass DNA from one cell to the other. Explain why it is necessary to remove the fertility segment.

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(2 marks)

**QUESTION 9 CONTINUES ON THE NEXT PAGE**

**Turn over ►**

(d) Describe the process of DNA replication.

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*(6 marks)*

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**END OF QUESTIONS**

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