

Surname					Other Names				
Centre Number					Candidate Number				
Candidate Signature									

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General Certificate of Education  
 January 2004  
 Advanced Level Examination



**BIOLOGY (SPECIFICATION B)**  
**Unit 7 Section A Microbes and Disease**

**BYB7/A**

Tuesday 27 January 2004 9.00 am to 11.15 am

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

- Section B provided as an insert (enclosed);
- a ruler with millimetre measurements.

You may use a calculator.

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

Time allowed: The total time for Section A and Section B of this paper is 2 hours 15 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 **Section A** in the spaces provided. All working must be shown.
- **Section A** and **Section B** will be marked by different examiners. You must ensure that any supplementary sheets are fastened to the appropriate question paper answer book.
- Do all rough work in this book. Cross through any work you do not want marked.

**Information**

- The maximum mark for **Section A** is 50.
- Mark allocations are shown in brackets.
- You are reminded of the need for clear presentation in your answers. All answers should be in good English and should use accurate scientific terminology.
- You are advised to spend 1 hour on **Section A**.
- You are reminded that **Section A** requires you to use your knowledge of Modules 1-5 as well as Module 7 in answering synoptic questions. These questions are indicated by the letter **S**.

**SECTION A**

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

- 1 An investigation was carried out to determine the effect of concentration of a disinfectant on the growth of the bacterium, *Bacillus subtilis*. The method involved making serial dilutions of a disinfectant solution using sterile water. Six tubes were set up as shown in the table. The tubes were then incubated for 24 hours at 25 °C.

Dilution of disinfectant	10 <sup>-1</sup>	10 <sup>-2</sup>	10 <sup>-3</sup>	10 <sup>-4</sup>	10 <sup>-5</sup>	10 <sup>-6</sup>
Volume of diluted disinfectant/cm <sup>3</sup>	10	10	10	10	10	10
Volume of bacterial culture/cm <sup>3</sup>	1.0	1.0	1.0	1.0	1.0	1.0

- (a) Describe how the 10<sup>-3</sup> dilution would be prepared.

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 .....  
 (1 mark)

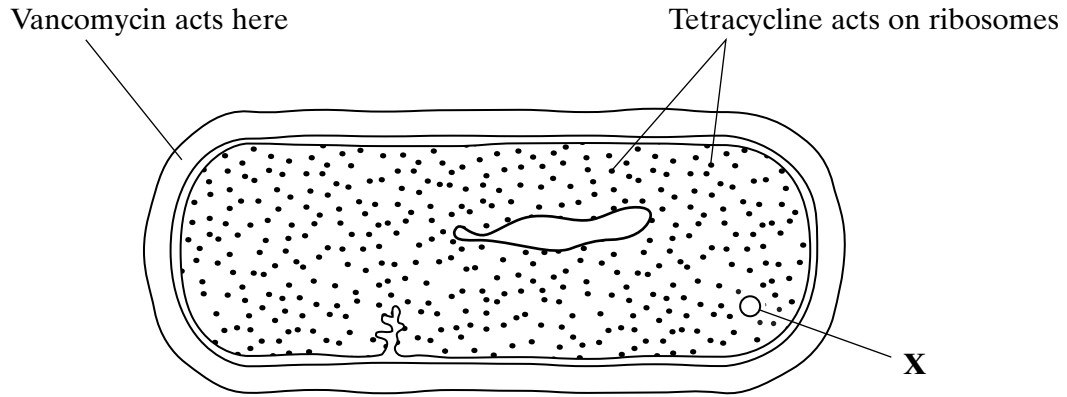
- (b) Give **two** precautions which should be taken for the aseptic transfer of the bacterial culture to the tubes.

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

- (c) The techniques of haemocytometry and dilution plating could be used to determine the number of bacteria per cm<sup>3</sup> in each tube after incubation. Explain why dilution plating would be more useful than haemocytometry in this investigation.

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

2 The diagram shows the structure of a bacterium and the different sites of action of two antibiotics.



(a) Vancomycin is a narrow spectrum antibiotic. What is meant by a *narrow spectrum* antibiotic?

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

(b) Using information in the diagram explain

**S** (i) why vancomycin does **not** affect mammalian cells;

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

(ii) how tetracycline prevents bacterial growth.

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

(c) Explain how the structure labelled **X** gives a bacterium resistance to an antibiotic.

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

Turn over ▶

- 3 Microorganisms can be placed into one of four groups according to the temperature range in which they grow. The table shows these four groups of microorganisms.

Group of microorganisms	Temperature range for growth/°C
Psychrophile	-10 to 10
Mesophile	10 to 45
Thermophile	40 to 70
Hyperthermophile	above 70

- (a) In which group of microorganisms would *Escherichia coli* be placed?

.....  
(1 mark)

- (b) Hyperthermophiles are found near hot springs in deep water. The water from these springs does not contain organic substances. Suggest the source of energy used by these microorganisms to synthesise their organic compounds.

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

- (c) Immobilised enzymes from thermophilic bacteria are used in some industrial processes.

- (i) Give **two** methods of immobilising enzymes.

1 .....

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2 .....

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(2 marks)

**S** (ii) Explain the advantage of using enzymes from thermophilic bacteria in some industrial processes rather than enzymes from mesophilic bacteria.

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*(3 marks)*

$\frac{\quad}{7}$

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** 

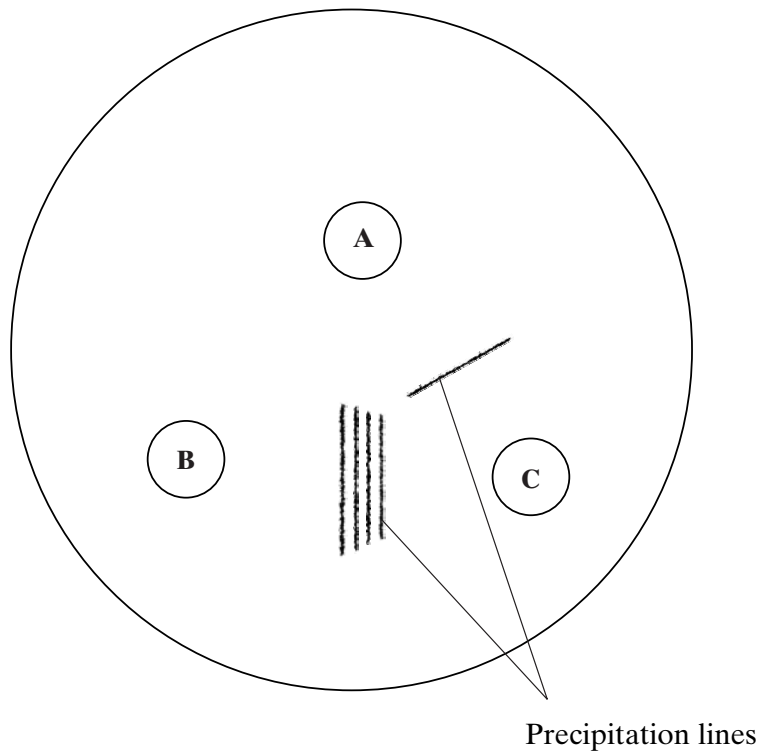
4 Wells **A**, **B** and **C** were cut into an agar plate and the following substances were put in them.

Well **A** – antigens from one strain of the influenza virus

Well **B** – a ‘cocktail’ vaccine containing antigens from several strains of influenza virus

Well **C** – blood plasma from a human volunteer

After ten hours, precipitation lines were observed in the agar. Precipitation lines appear where there is agglutination. The diagram shows where these lines occurred.



(a) Describe how the precipitation line between wells **A** and **C** was formed.

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(2 marks)

(b) Explain what the precipitation lines suggest about the volunteer's plasma.

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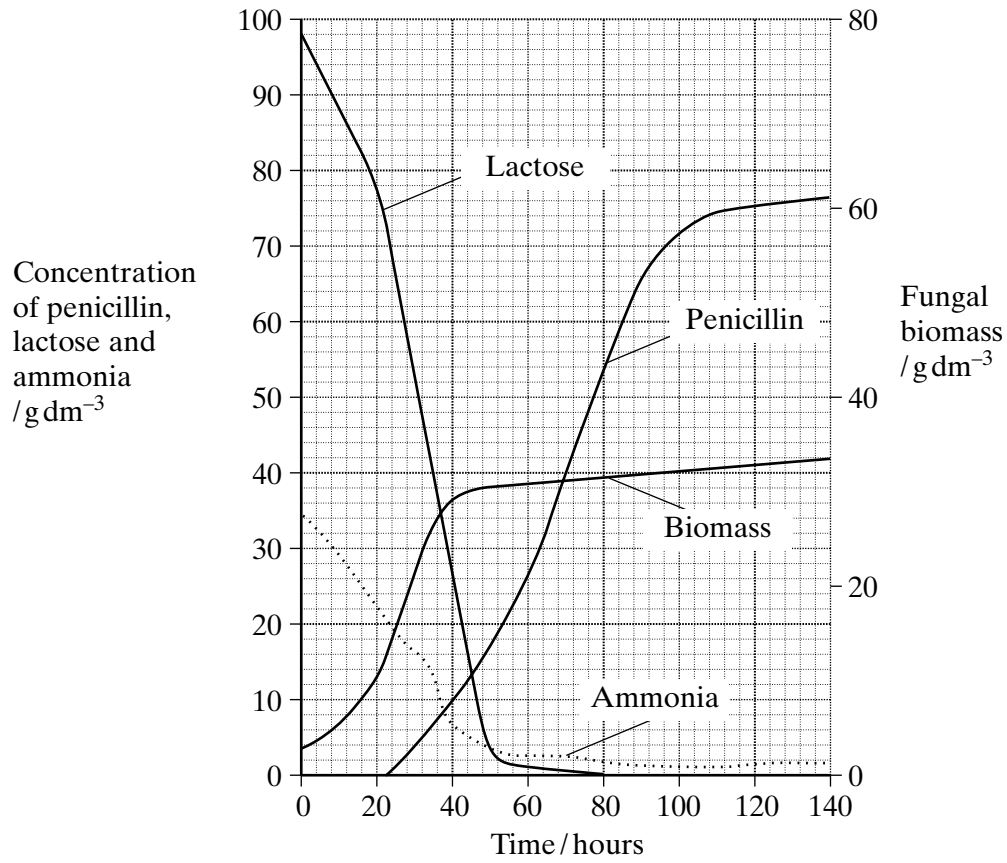
(2 marks)

$\frac{\quad}{4}$

**TURN OVER FOR THE NEXT QUESTION**

Turn over 

5 The fungus *Penicillium chrysogenum* is grown in a fermenter to produce penicillin. The graph shows some of the changes which occur during this process.



(a) Explain why

(i) the concentration of ammonia decreases;

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

S (ii) without a water jacket, the temperature in the fermenter would rise.

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



(b) Use the graph to calculate the maximum rate of penicillin production per hour. Show your working.

Answer .....  $\text{g dm}^{-3} \text{h}^{-1}$   
(2 marks)

(c) Explain why penicillin is usually produced commercially using a batch process, rather than by a continuous process.

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(2 marks)

**S** (d) Explain how X-rays might produce strains of *Penicillium chrysogenum* which give greater yields of penicillin.

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(2 marks)

8

Turn over 

**6** Cholera is a water-borne disease caused by the intestinal pathogen, *Vibrio cholerae*. The pathogen produces an exotoxin which acts specifically on the epithelial cells of the small intestine causing changes in membrane permeability. Individuals with cholera suffer from severe diarrhoea which may result in death.

(a) Suggest **two** precautions which could be used to prevent the transmission of cholera.

1 .....

2 .....

(1 mark)

(b) Explain how the effects of diarrhoea on the body can be treated.

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(2 marks)

(c) (i) What is an exotoxin?

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.....

(1 mark)

**S** (ii) Suggest why the cholera exotoxin is specific to the epithelial cells of the small intestine.

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.....  
.....

(2 marks)

S (d) The cholera exotoxin affects the movement of ions through the intestinal wall. It causes the loss of chloride ions from the blood into the lumen of the small intestine. This prevents the movement of sodium ions from the lumen of the small intestine into the blood.

(i) Describe how sodium ions normally enter the blood from the cells of the intestinal wall against a concentration gradient.

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(2 marks)

(ii) Use the information provided to explain why individuals with cholera have diarrhoea.

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(2 marks)

10

**TURN OVER FOR THE NEXT QUESTION**

7 (a) Give **two** ways in which HIV may be transmitted, other than by sexual contact.

1 .....

2 .....

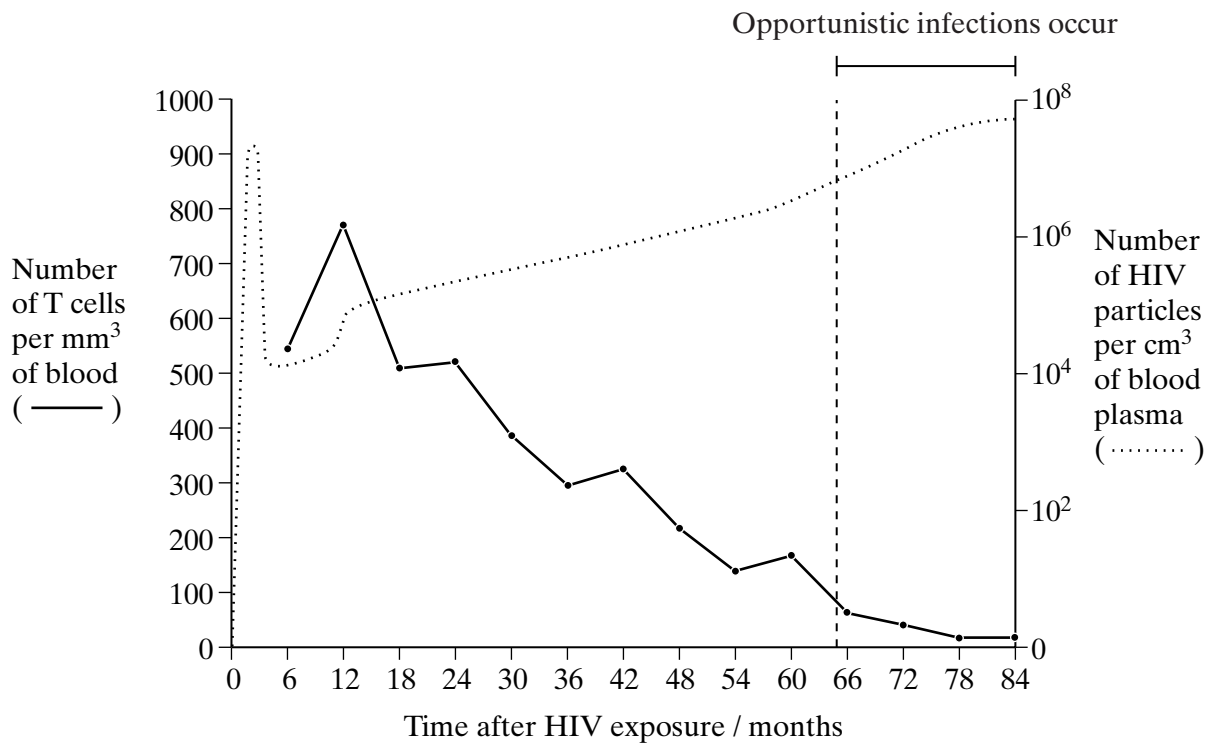
(1 mark)

(b) Explain how the envelope of HIV helps the virus to infect a cell.

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 .....  
 .....

(2 marks)

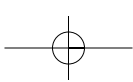
The graph shows some of the changes in the blood of an AIDS patient after infection with HIV.



(c) Explain the decrease in the number of HIV particles in the blood plasma shortly after infection.

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 .....

(1 mark)



(d) Use the information in the graph to explain why AIDS patients are likely to suffer from opportunistic infections.

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.....  
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(2 marks)

S (e) One anti-HIV drug is AZT which has a similar structure to the nucleotide containing thymine. AZT lacks the OH group required for it to join with another nucleotide.

Explain how this drug prevents an increase in the number of HIV particles in the blood plasma.

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(3 marks)

S (f) HIV contains the enzyme reverse transcriptase. Genetic engineers have used this enzyme and mRNA to produce a gene for human insulin. Describe how this gene could be produced.

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.....

(2 marks)

**END OF SECTION A**

**SECTION B IS PROVIDED AS AN INSERT**