

Antibiotics

Question Paper 2

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Infectious disease
Sub Topic	Antibiotics
Booklet	Theory
Paper Type	Question Paper 2

Time Allowed : 68 minutes

Score : / 56

Percentage : /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

- 1 The sensitivity of bacteria to antibiotics can be tested using the disc diffusion method. An inoculum of the bacteria is spread onto agar culture plates and then filter paper discs impregnated with antibiotic are pressed onto the surface of the agar. The plates are incubated. Bacteria grow as a 'lawn' across the agar, but a circular zone (the zone of inhibition) appears around any disc where bacterial growth is inhibited.

Two species of bacteria, **A** and **B**, were grown on separate culture plates in the presence of three types of filter paper disc:

- 1 – no antibiotic (control)
- 2 – penicillin V, a natural penicillin
- 3 – carboxypenicillin, a synthetic penicillin.

The appearance of the incubated plates is shown in Fig. 3.1.

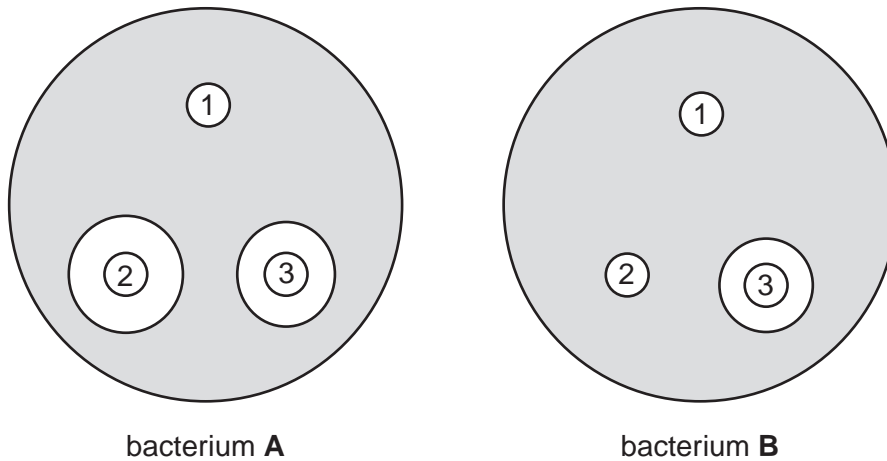


Fig. 3.1

- (a) With reference to Fig. 3.1, explain the effect of penicillin V on bacterium **A**.

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Bacteria **A** and **B** have different outer layers, as shown in Fig. 3.2.

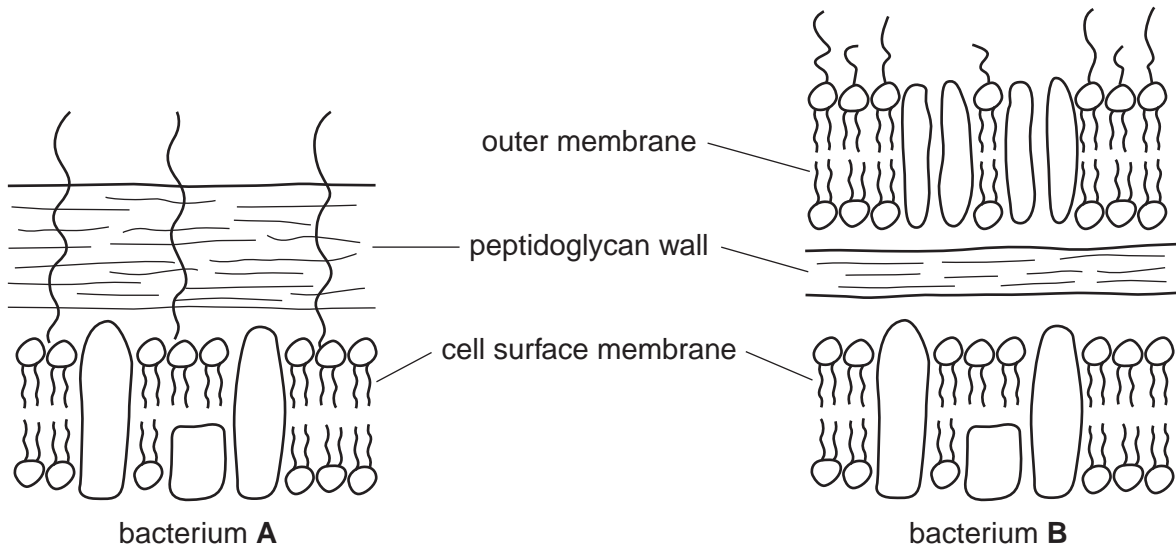


Fig. 3.2

(b) With reference to Fig. 3.1 and Fig. 3.2

(i) describe how the outer layers of bacterium **B** differ from those of bacterium **A**

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(ii) explain the different effects of penicillin V on bacteria **A** and **B**

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(iii) suggest how the synthetic penicillin, carboxypenicillin, is able to affect the growth of bacterium **B**.

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(c) Distinguish between batch culture and continuous culture of microorganisms.

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(d) Explain why batch culture rather than continuous culture is used in the production of penicillin.

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[Total: 15]

2 (a) Fig. 4.1 shows a section through a maize fruit.

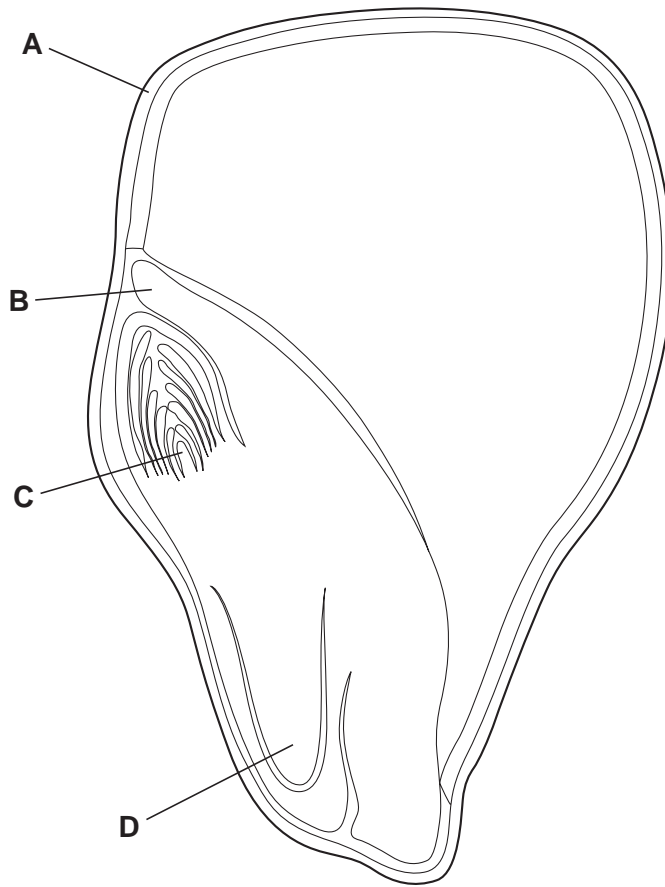


Fig. 4.1

(i) Name the parts labelled A to D.

A

B

C

D [2]

(ii) Describe the function of the endosperm.

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(b) The corn earworm, is the larva of a moth *Helicoverpa zea*, that is a serious pest of maize. Insecticides containing pyrethrum have long been used to control this insect. These act by irreversibly inhibiting the enzyme acetylcholinesterase, which normally catalyses the hydrolysis of acetylcholine.

(i) Describe how an insecticide could irreversibly inhibit acetylcholinesterase.

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(ii) Suggest the effects on synapses of this irreversible inhibition of acetylcholinesterase.

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(c) Some populations of *H. zea* have developed resistance to pyrethrum. This occurs as the result of a point mutation of the acetylcholinesterase gene. Many different such mutations have been identified in different populations.

Explain how a point mutation in the acetylcholinesterase gene could confer resistance to pyrethrum.

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- (d) • A group of corn earworms was collected from a field where the farmer had reported resistance to insecticides containing pyrethrum.
- Another group was collected from a field where the insects showed no resistance (were susceptible).
- Some individuals from these two groups were crossed with each other to form a hybrid group.

Insects from each of the three groups were then exposed to a range of concentrations of pyrethrum. The percentage of the insects that were dead after 24 hours was recorded. The results are shown in Table 4.1.

Table 4.1

dose of insecticide/ µg per group	% mortality of insects after 24 hours		
	resistant group	hybrid group	susceptible group
0	0	0	
0.1	0	0	50
0.5	0	23	63
1.5	7	45	94
2.5	12	50	100
5.0	42	89	100
10.0	80	1	100
30.0	100		100

- (i) With reference to Table 4.1, compare the effect of the insecticide on the resistant group and on the hybrid group.

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- (ii) Assuming that resistance is conferred by a single point mutation in the gene for acetylcholinesterase, suggest an explanation for the overall differences between all **three** groups of insects in Table 4.1.

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[Total: 17]

3 The fungus *Penicillium chrysogenum* is grown in fermenters on an industrial scale to produce penicillin, using a batch culture system.

(a) Explain why batch culture, rather than continuous culture, is used for the production of penicillin.

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(b) Temperature and pH are normally controlled in the fermenter. Temperature is kept constant, while pH is held at a value of 5.5 for the first stage of the fermentation and then raised to 6.8 and kept constant for the remainder of the fermentation period.

Fig. 5.1 shows how the pH and the concentration of penicillin in the culture change over time, when the pH is controlled and when the pH is not controlled.

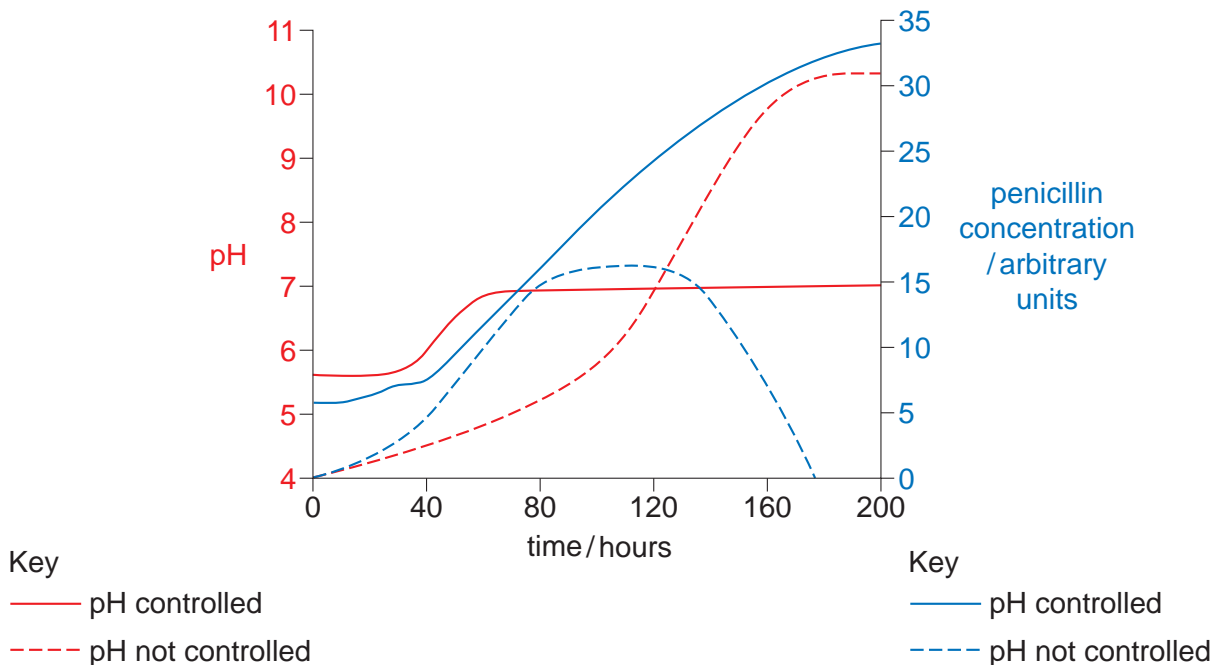


Fig. 5.1

With reference to Fig. 5.1, describe and explain the differences in the concentration of penicillin in the culture when the pH is controlled and when the pH is not controlled.

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(c) Explain why penicillin affects bacteria but not viruses.

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- 4 (a) Three different strains, **A**, **B** and **C**, of a species of bacterium were grown on nutrient agar in a divided petri dish until they formed ‘lawns’ covering the agar.

Three discs of filter paper were soaked in a solution of a penicillin antibiotic and one disc placed in contact with each of the bacterial strains for 10 minutes.

After 24 hours, zones of clearance, indicating bacterial cell death, were seen in the ‘lawns’ of strains **A** and **B**.

The appearance of the petri dish 24 hours after addition of antibiotic is shown in Fig. 3.1.

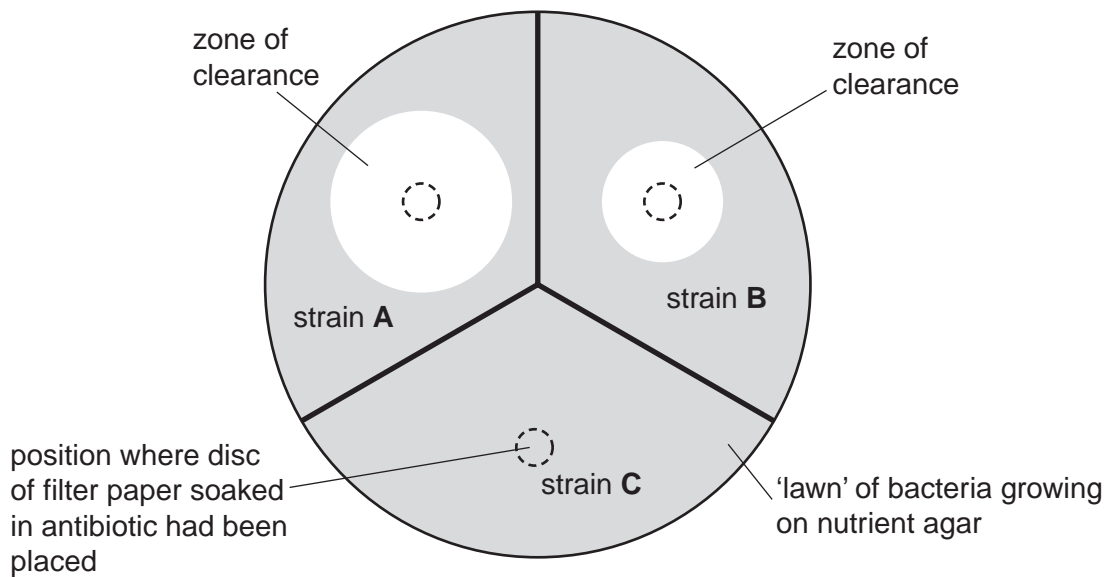


Fig. 3.1

- (i) The effectiveness of the antibiotic is proportional to the area of the zone of clearance.

Measure the diameters (**d**) of each of the zones of clearance of bacterial strains **A** and **B** and record them to the nearest mm in Table 3.1.

Using πr^2 , calculate the **area** in mm^2 of the zone of clearance for each strain of bacterium and record them in Table 3.1.

Calculate the ratio of the **area** for strain **A** to the **area** for strain **B** and record the ratio in Table 3.1.

Table 3.1

bacterial strain	A	B
diameter (d) of zone of clearance / mm
area of the zone of clearance / mm^2
area for strain A : area for strain B	

(ii) Explain the different effects of the antibiotic on bacterial strains **A**, **B** and **C**.

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(iii) Describe the role of natural selection in the spread of bacterial strains, such as **A** and **B**, when an antibiotic is used.

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(b) The β -lactam antibiotics, such as penicillin, are similar shaped molecules to the substrate of a bacterial enzyme, transpeptidase.

Explain the mode of action of β -lactam antibiotics on susceptible bacteria.

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