Q1. (a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adults and 66% of healthy infants.

(i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

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(2)

(ii) Suggest why older people are more likely to be affected by *C. difficile*.

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(1)

(b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

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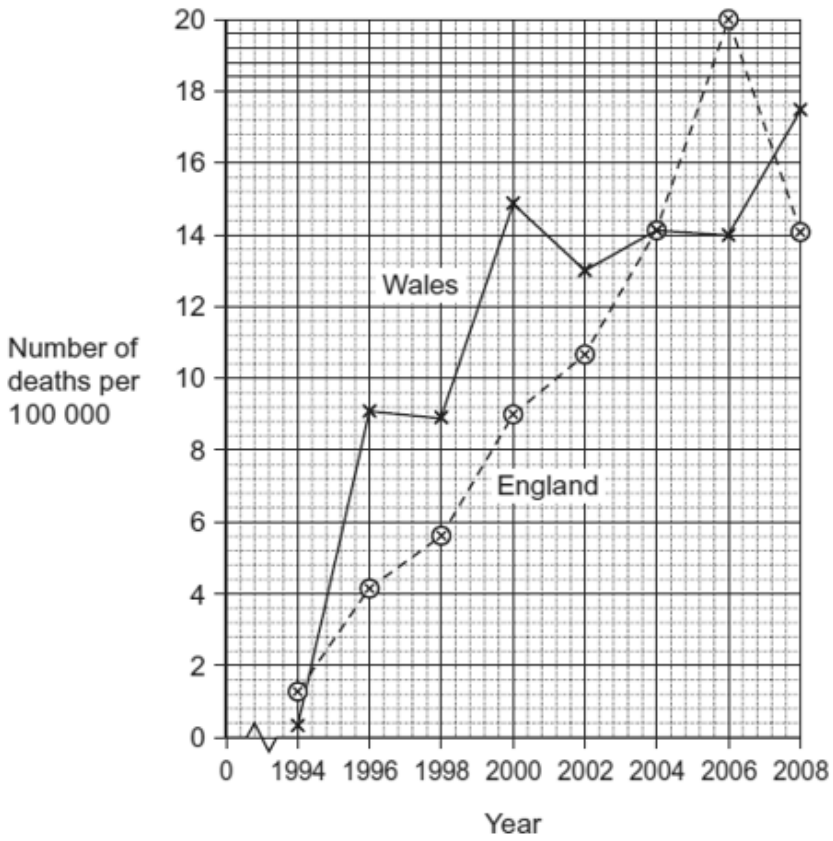
(2)

(c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this bacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 caused by MRSA.



(i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

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(1)

(ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

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(1)

(iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

Answer .....

(2)

(d) Describe how gene transmission and selection have increased the difficulty of treating bacterial infections with antibiotics.

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(Extra space) .....

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(6)
(Total 15 marks)

Q2. Penicillin was first used to treat infections in the 1940s.

(a) Describe how penicillin prevents the growth of bacteria.

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(1)

(b) The bacterium *Staphylococcus aureus* is a common cause of life-threatening infections. By the 1960s it had already become resistant to the antibiotic penicillin.

(i) Describe **one** mechanism of resistance to penicillin.

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(1)

S (ii) Explain how *S. aureus* evolved resistance to penicillin.

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(3)

(c) If a patient fails to respond to treatment with penicillin, another antibiotic, called vancomycin, may be used. In 2002 a patient was found to be infected with a strain of *S. aureus* containing a gene that made it resistant to vancomycin. The same gene was found to be very common in bacteria of the species *Enterococcus faecalis* from the gut of the patient. Suggest how some of the *S. aureus* bacteria came to contain the vancomycin-resistance gene.

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(2)
(Total 7 marks)

Q3. 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)

(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)

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

1 .....

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2 .....

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(2)

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

Antibiotic .....

Explanation .....

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(2)
(Total 7 marks)

Q4. (a) Give **two** factors, other than cost, that should be considered when selecting an antibiotic to treat a bacterial disease.

1 .....

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2 .....

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(2)

S (b) The table describes the effects of two antibiotics on bacteria.

Antibiotic	Effect
Tetracycline	prevents tRNA binding
Chloramphenicol	prevents peptide bonds forming

(i) Explain how each of these antibiotics slows down the rate of growth of bacteria.

Tetracycline .....

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Chloramphenicol .....

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(4)

(ii) Suggest why tetracycline has no effect on human cells.

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(1)

(Total 7 marks)

Q5. In a hospital laboratory, a sterile Petri dish of nutrient agar was inoculated with bacteria from a patient with a throat infection. Four discs, each of which had been soaked in a different antibiotic, were placed on top of the bacteria. The dish was incubated at 37 °C. **Figure 1** shows the appearance of the dish after incubation.

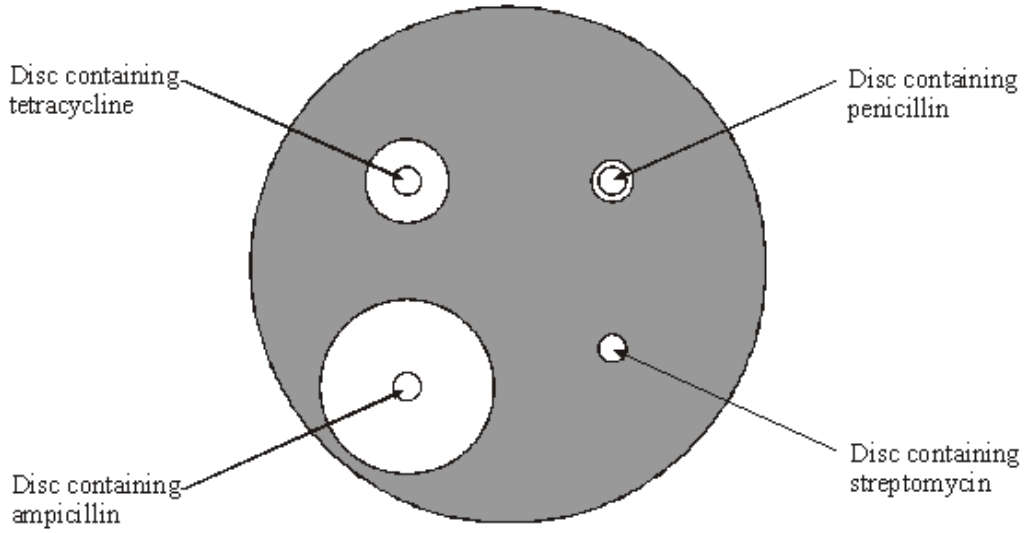

Figure 1

(a) Explain why there are clear zones around some of the discs containing antibiotic.

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(2)

(b) It was suggested that ampicillin might be the best antibiotic to treat the patient's throat infection. Give the evidence from the laboratory test to support this suggestion.

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(1)

(c) Tetracycline binds to bacterial ribosomes. This is shown in **Figure 2**.

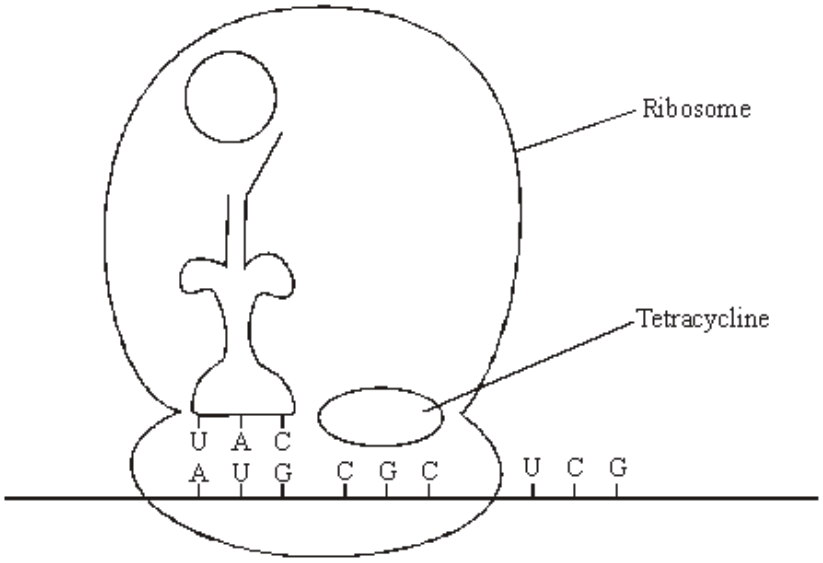

Figure 2

Tetracycline prevents bacterial growth by preventing protein synthesis. Give **two** other ways in which antibiotics can prevent bacterial growth.

1 .....

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2 .....

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(2)
(Total 5 marks)

Q6. Penicillins are antibiotics. Some bacteria produce an enzyme that breaks down one sort of penicillin.

(a) The gene that codes for this enzyme may be passed from one species of bacteria to another species. Describe how.

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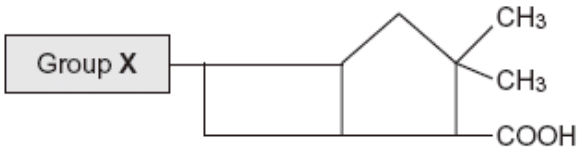
(2)

(b) There are different sorts of penicillin. All of these have the same basic chemical structure shown in the diagram but group **X** is different.



A bacterial infection that cannot be treated with one sort of penicillin can be treated with a different sort. Use your knowledge of enzyme action to explain why the different sort of penicillin is effective in treating the infection.

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(3)

(c) Farmers often keep large numbers of cattle together. Farmers used to give cattle food which had antibiotics added to it.

(i) Suggest how adding antibiotics to the food of the cattle increased profit for the farmers.

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(2)

(ii) Adding antibiotics to the food of cattle is now banned in many countries. Use your knowledge of selection to explain why adding antibiotics was banned.

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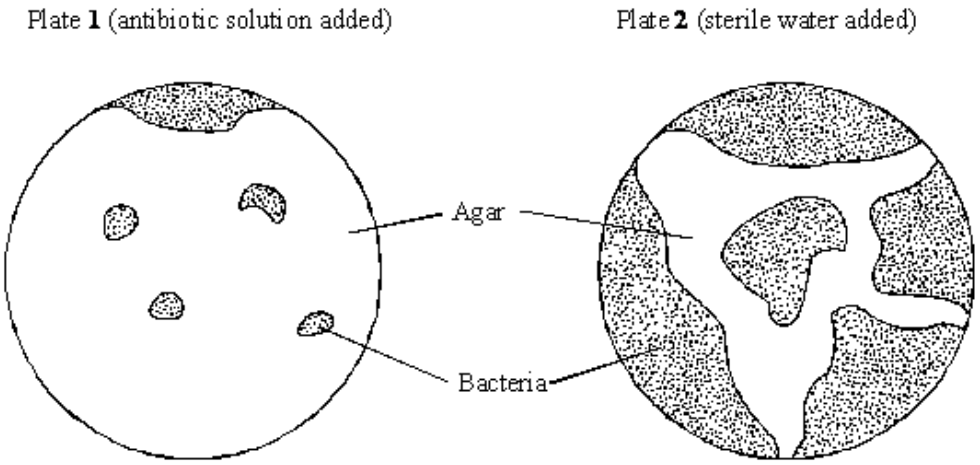
(2)

(Total 9 marks)

Q7. (a) In an investigation, two sterile agar plates were inoculated with bacteria from the same culture. Then, using a syringe, 2 cm^3 of an antibiotic solution were added to plate **1** and 2 cm^3 of sterile water were added to plate **2**. The diagram shows the plates after 24 hours.



(i) At the start of the investigation, the agar was sterilised. Explain why.

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(1)

(ii) The water was added to plate **2** as a control. Explain why this control was necessary.

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(1)

(b) Give **two** ways in which antibiotics kill bacteria or prevent them from multiplying.

1 .....

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2 .....

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(2)

(c) Explain why some bacteria were able to grow on plate **1**.

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(1)

(Total 5 marks)

Q8. (a) The number of patients infected with the bacterium MRSA has increased in some hospitals. Scientists have suggested ways to reduce the transmission of MRSA in hospitals. Suggest **two** ways to reduce the transmission of MRSA in hospitals.

1 .....

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2 .....

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(2)

(b) The minimum inhibitory concentration (MIC) is the lowest concentration of a substance that prevents the growth of a microorganism.

When antibiotics are prescribed for treating patients, higher doses than the MIC are recommended. Suggest **two** reasons why.

1 .....

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2 .....

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(2)

Scientists tested a new group of drugs for their effectiveness against four species of bacteria. The scientists used MICs to compare the effectiveness of four drugs. The results are shown in the table.

	Minimum inhibitory concentration / µg cm^{-3}			
Drug	*Escherichia coli*	*Staphylococcus aureus*	*Enterococcus faecalis*	*Pseudomonas aeruginosa*
P	0.39	0.049	0.049	3.13
Q	1.54	0.049	0.195	3.13
R	0.39	0.049	0.195	1.56
S	1.56	0.098	0.390	12.50

(c) Which of the four drugs is

(i) most effective against *Enterococcus faecalis*?

(1)

(ii) least effective against all the species of bacteria used?

(1)

(d) The effectiveness of these drugs was tested in double-blind trials using human volunteers. In a double-blind trial neither the volunteers nor the scientists know which treatment a particular volunteer is receiving.

(i) Suggest **two** ways in which a double-blind trial improves reliability.

1 .....

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2 .....

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(2)

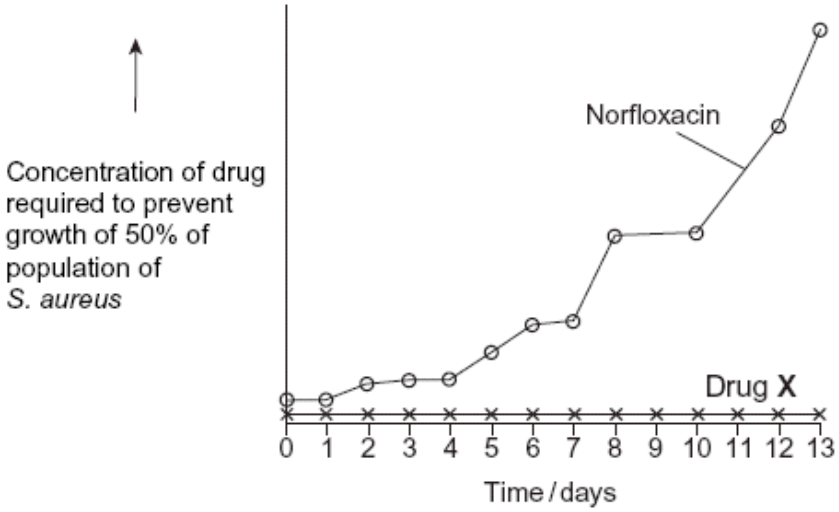
(ii) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1 .....

2 .....

(2)

(e) Scientists investigated resistance of the bacterium, *S. aureus* to the antibiotic Norfloxacin. They grew the bacteria in a medium containing a low concentration of Norfloxacin. The concentration of Norfloxacin that they added killed some of the bacteria. It did not kill all of them. Every 24 hours, they removed a sample of the bacteria from the culture. They tested the sample to find the concentration of Norfloxacin that prevented the growth of 50 % of the bacteria in the sample.
The scientists then used the same method to investigate the resistance of *S. aureus* to a new drug, drug **X**. The results of both investigations are shown in the graph.



(i) Describe the results obtained with Norfloxacin.

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(1)

(ii) Use your knowledge of resistance to explain the results obtained with Norfloxacin and drug **X**.

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(4)
(Total 15 marks)

Q9. (a) Give **one** way in which a DNA molecule in a prokaryote, such as a bacterium, is different from a DNA molecule in a eukaryote.

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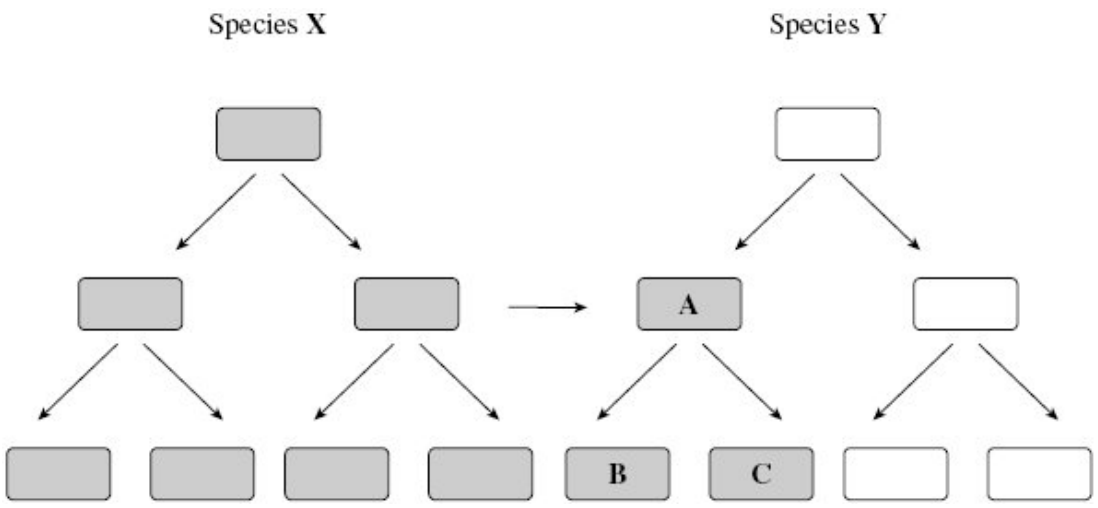
(1)

Species **X** and **Y** are bacteria. The diagram shows gene transfer between bacteria in these two species. The bacteria that are shaded are resistant to the antibiotic penicillin.



(b) (i) Use the diagram to explain why bacterium **A** is resistant to penicillin.

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(3)

(ii) Use the diagram to explain why bacteria **B** and **C** are resistant to penicillin.

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(2)

(c) A person is infected with bacteria of species **Y**. Some of these bacteria are resistant to penicillin. A doctor gives the person a course of penicillin.

What would happen to the proportion of species **Y** bacteria that are resistant to penicillin? Explain your answer.

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(2)
(Total 8 marks)

Q10. Antibiotics are used in the treatment of bacterial infections. They affect a range of processes in bacteria.

(a) Describe **three** ways in which antibiotics may act on bacteria.

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(3)

(b) Bacteriostatic antibiotics do not kill bacteria but allow patients to recover from a bacterial infection. Explain why they allow patients to recover.

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(2)
(Total 5 marks)