10. Infectious Diseases

10.2 Antibiotics

Paper 2

Question Paper

1 Lysozyme is an antibacterial enzyme that was discovered in 1921 by Alexander Fleming, the scientist who discovered penicillin.

Lysozyme catalyses the hydrolysis of glycosidic bonds present in peptidoglycan molecules to form smaller products, NAG (N-acetylglucosamine) and NAM (N-acetylmuramic acid).

(b) Lysozyme and penicillin can be described as antibacterial agents.

Compare lysozyme **and** penicillin to show the similarities **and** differences between these two antibacterial agents.

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2 The diseases myasthenia gravis (MG) and HIV/AIDS both involve disorders of the immune system.

(c) Many people who are living with HIV (infected with HIV) develop tuberculosis (TB). If a person does not have any symptoms of TB, one preventive measure is to prescribe antibiotics. This reduces the overall number of cases of TB and deaths from TB.

State the **disadvantage** of prescribing antibiotics as a preventive measure against TB.

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3 Cholera is an infectious disease caused by the bacterial pathogen *Vibrio cholerae*.

(d) The World Health Organization states that most cases of cholera can be treated with oral rehydration therapy. To reduce the risk of antibiotic resistance developing, antibiotics are only recommended for the most serious cases.

Discuss the consequences of the development of antibiotic resistance in *V. cholerae*.

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4 **(b)** The endocardium is a thin layer of tissue lining the chambers of the heart. A serious condition called endocarditis results if bacteria infect this tissue.

Endocarditis is treated with a combination of antibiotics. This increases the effectiveness of the treatment and reduces the risk of antibiotic resistance in bacteria.

Table 3.1 shows the action of two antibiotics used together to treat endocarditis.

Table 3.1

antibiotic used in treatment	action of antibiotic
gentamicin	binds permanently to the bacterial ribosomes
penicillin G	inhibits an enzyme involved in cell wall synthesis

(i) With reference to Table 3.1, explain why treating endocarditis with a combination of gentamicin and penicillin G reduces the risk of developing antibiotic resistance.

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(ii) Describe how the bacteria that cause endocarditis could become resistant to gentamicin.

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5 The treatment for people with active tuberculosis (TB) lasts six months and involves a combination of antibiotics. This is usually very effective if the person has a susceptible (non-resistant) strain of *Mycobacterium tuberculosis*, the causative organism of TB.

Table 2.1 summarises one recommended treatment strategy that involves a combination of antibiotics.

Table 2.1

antibiotic	length of treatment	mode of action of antibiotic
rifampicin (R)	6 months	enters bacterial cells and inhibits protein synthesis
isoniazid (H)	6 months	prevents the synthesis of cell wall components known as mycolic acids
ethambutol (E)	first two months	prevents mycolic acids from being added to the cell wall
pyrazinamide (Z)	first two months	prevents the synthesis of fatty acids

(a) Susceptible strains of *M. tuberculosis* will be killed using any one of the antibiotics listed in Table 2.1. However, combination treatment is preferred as it is one method that can be used to reduce the impact to society of antibiotic resistance.

With reference to Table 2.1, explain how combination treatment for TB can help to reduce the impact of antibiotic resistance compared to single antibiotic treatment.

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6 Fig. 2.1 is a transmission electron micrograph showing the bacterial pathogen that causes tuberculosis (TB).



Fig. 2.1

Some bacteria have developed resistance to rifampicin. However, they are still susceptible to the other antibiotics that can be used to treat TB.

Multi-drug resistant bacteria have developed resistance to at least two drugs, including rifampicin.

WHO collects data from all countries on the number of cases of TB caused by rifampicin-resistant bacteria (RR-TB) and multi-drug resistant bacteria (MDR-TB).

Fig. 2.2 shows the reported number of cases of TB between 2009 and 2013.

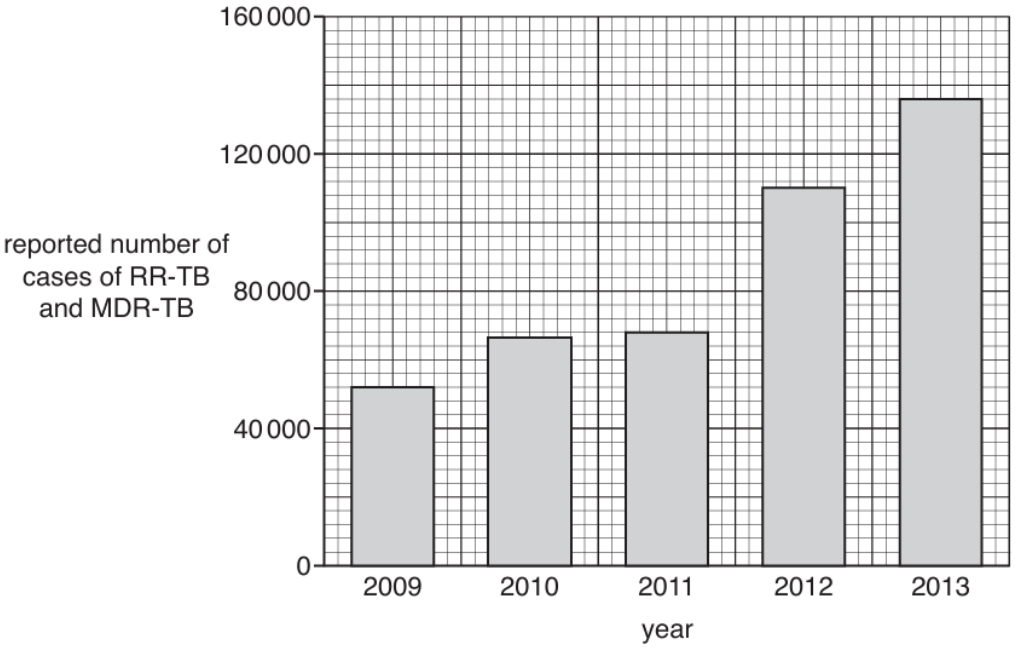


Fig. 2.2

(ii) Describe the trend shown by the data in Fig. 2.2.

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(iii) Explain how resistance to drugs such as rifampicin develops.

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7 Countries that have a high number of cases of malaria also have problems with diseases caused by bacteria. This means that many people in these countries are prescribed antibiotics, such as penicillin, for the treatment of bacterial infections.

(a) Outline how penicillin acts on bacterial cells.

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8 Bacteria may be classified according to differences in cell wall structure. The differences are shown by using the Gram stain.

- A Gram-positive bacterium has a cell wall mainly composed of a thick layer of peptidoglycan (murein).
- A Gram-negative bacterium has a more complex cell wall. This wall is composed of a much thinner layer of peptidoglycan and an outer layer known as the outer membrane.

Escherichia coli is a Gram-negative bacterium.

Fig. 3.1 is a diagram through the cell surface membrane **and** the cell wall of *E. coli*.

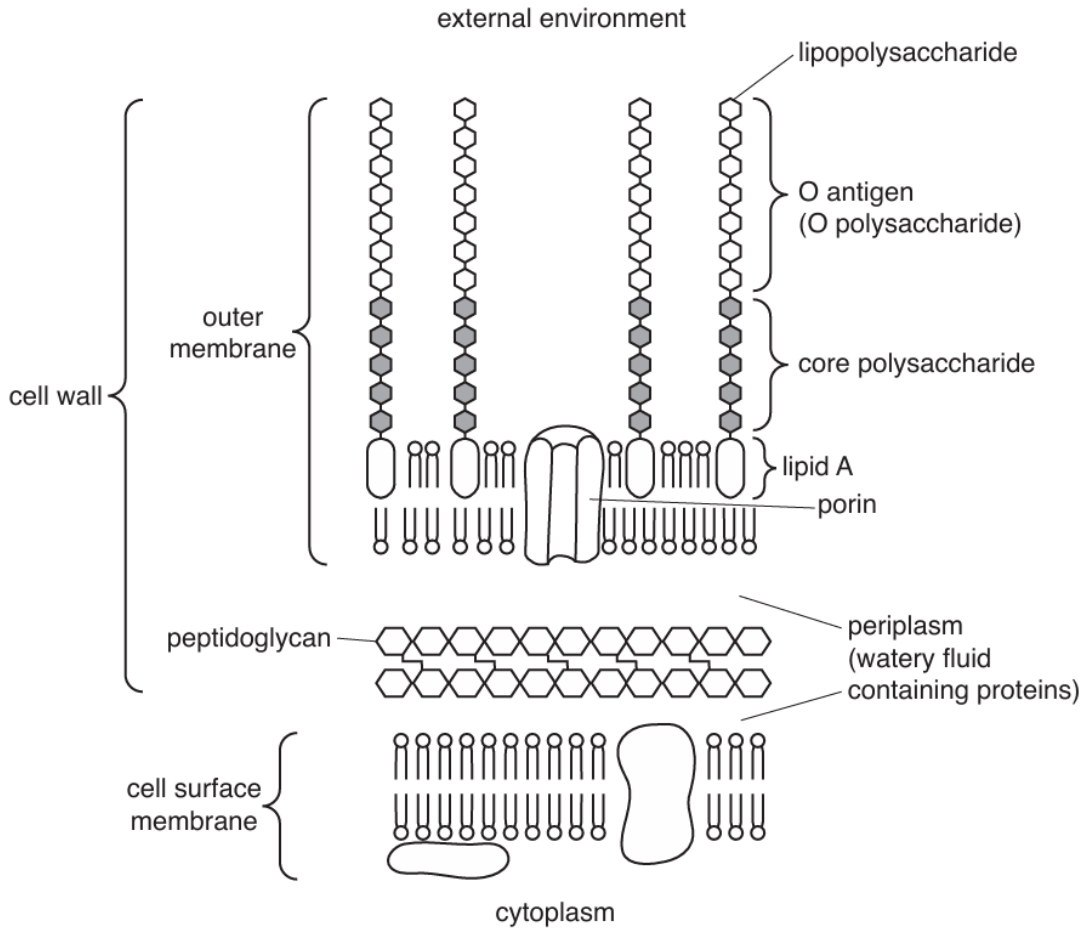


Fig. 3.1

(a) The antibiotic penicillin kills bacteria by causing them to lyse (burst). It is more effective in treating diseases caused by Gram-positive bacteria than diseases caused by Gram-negative bacteria.

Outline how penicillin acts on bacteria **and** use Fig. 3.1 to suggest why penicillin has little or no effect at treating diseases caused by Gram-negative bacteria, such as some strains of *E. coli*.

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