

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 6: MICROBIOLOGY AND PATHOGENS
ACTION OF ANTIBIOTICS

SCORE

/40

PERCENTAGE

%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions and mark schemes in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question or mark scheme material in this pack. Pearson has not endorsed, approved or been involved in the production of it. Pearson, Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson publishes its past papers and mark schemes free of charge. Always check the current specification at [qualifications.pearson.com](https://www.pearson.com/qualifications) before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Bacteria are becoming increasingly resistant to antibiotics.

Controlling the spread of antibiotic resistance is necessary.

Many types of bacteria are resistant to penicillin and tetracycline.

(i) Which row of the table shows the part of a bacterial cell affected by these antibiotics?

(1)

	Penicillin	Tetracycline
☐ A	cell wall	cell wall
☐ B	cell wall	ribosome
☐ C	ribosome	cell wall
☐ D	ribosome	ribosome

(ii) Which row of the table describes the action of penicillin and tetracycline?

(1)

	Penicillin	Tetracycline
☐ A	bactericidal	bactericidal
☐ B	bactericidal	bacteriostatic
☐ C	bacteriostatic	bactericidal
☐ D	bacteriostatic	bacteriostatic

(Total for question = 2 marks)

Q2.

Bacteria are becoming increasingly resistant to antibiotics.

Controlling the spread of antibiotic resistance is necessary.

In an investigation, *E.coli* bacteria were isolated from animals reared for food and from some wild animals.

The mean percentage of the *E.coli* isolated from each type of animal that were resistant to different types of antibiotics was determined.

The table shows the results of this investigation, where n is the number of each type of animal.

Antibiotic	Mean percentage of resistant <i>E.coli</i> isolated from animals reared for food (%)			Mean percentage of resistant <i>E.coli</i> isolated from wild animals (%)	
	Broiler chicken n = 45	Village chicken n = 45	Cattle n = 12	Bat n = 13	Rodent n = 35
Ampicillin	50.00	8.89	8.33	0.00	8.57
Cephalothin	14.29	8.89	8.33	20.00	14.58
Chloramphenicol	46.43	0.00	0.00	0.00	0.00
Neomycin	50.00	2.22	25.00	0.00	5.71
Tetracycline	95.86	55.56	25.00	0.00	2.86

(i) Calculate the ratio of tetracycline-resistant *E.coli* in all the chickens to tetracycline-resistant *E.coli* in cattle.

(2)

Answer

(ii) There was a total of 2×10^8 *E.coli* isolated from cattle and 6×10^9 *E.coli* isolated from rodents.

Calculate how many more *E.coli* are resistant to cephalothin in rodents than in cattle.

(2)

Answer

(iii) Antibiotics can be added to animal feed.

It is thought this use of antibiotics has contributed to the spread of antibiotic resistance.

Evaluate the extent to which the results of this investigation support this idea.

(4)

.....

.....

.....

.....

.....

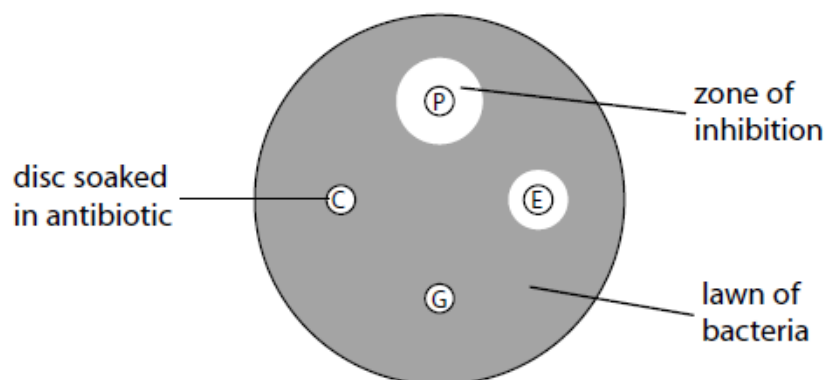
.....

Q3.

The resistance of one type of bacteria to a range of different antibiotics was investigated.

A lawn of bacteria was prepared by spreading a suspension of the bacteria over the surface of agar. Paper discs that had been soaked previously in different antibiotics were placed on top of the bacteria. The antibiotics were all the same concentration. The culture was incubated for 48 hours.

The diagram below shows the appearance of the culture after incubation.



Key:

C = chloramphenicol

E = erythromycin

G = gentamycin

P = penicillin

Explain why these results indicate that the bacteria must be Gram positive.

.....

.....

.....

.....

.....

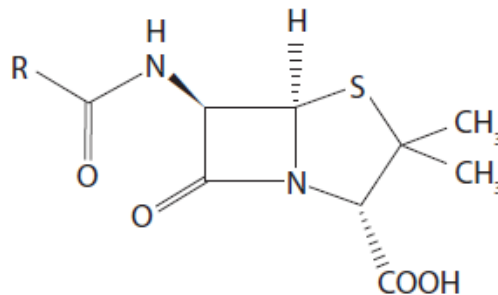
.....

(Total for question = 3 marks)

Q4.

Tetracycline and penicillin are two antibiotics that are commonly used to treat bacterial infections.

The diagram shows the structure of penicillin.



(a) Penicillin acts on bacterial cells by

(1)

- ☐ **A** inhibiting peptidoglycan cross-link formation in the cell wall
- ☐ **B** interfering with t-RNA carrying the amino acid methionine
- ☐ **C** preventing aerobic respiration by blocking the Krebs cycle
- ☐ **D** preventing t-RNA binding to ribosomes during protein synthesis

Q5.

A student read that more than half of raw chickens on sale in supermarkets are contaminated with bacteria from the genus *Campylobacter*.

Some species of *Campylobacter* cause food poisoning in humans.

The student carried out an experiment to test the effectiveness of various antibiotics against *Campylobacter*.

The photograph shows the student's agar plates at the end of the experiment.



The white circles labelled A-H are filter paper discs. These discs were soaked in different antibiotics then placed on the surface of the agar.

One of the antibiotics the student used was penicillin.

Describe the effect of penicillin on bacterial cells.

(3)

.....

.....

.....

.....

.....

.....

Q6.

Describe the action of bactericidal and bacteriostatic antibiotics.

(2)

.....

.....

.....

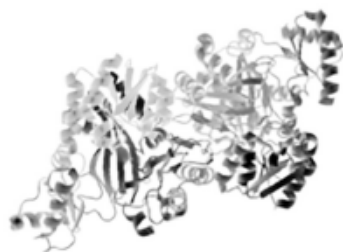
.....

(Total for question = 2 marks)

Q7.

Acetyl CoA is produced in the link reaction when pyruvate is broken down.

The photograph shows a molecule of the enzyme acetyl CoA carboxylase.



This enzyme is involved in the conversion of acetyl CoA into fatty acids.

The enzyme is activated by citrate.

Citrate does not bind at the active site.

Citrate is produced in the Krebs cycle.

The enzyme is inhibited by long chain fatty acyl CoA molecules.

Fatty acyl CoA molecules have a longer carbon chain than acetyl CoA.

The enzyme acetyl CoA carboxylase has a different structure in bacteria.

The enzyme in bacteria is made of several polypeptide subunits whereas in humans, the enzyme is one large polypeptide.

Inhibitors of the bacterial enzyme are being developed to treat bacterial infections.

Explain why inhibitors of the bacterial enzyme may be useful when treating bacterial infections.

(2)

.....

.....

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q8.

Cysteine proteases are enzymes found in fruits such as pineapples.

When a protease enzyme is added to fat-free skimmed milk, the milk turns from cloudy to clear.

Cysteine proteases are also found in the predatory bacterium *Bdellovibrio bacteriovorus* (BvB).

These bacteria are harmless to humans but prey on Gram negative bacteria.

(i) Give two differences between Gram negative and Gram positive bacteria.

(2)

.....

.....

.....

.....

.....

.....

(ii) The cell of the predatory BvB is $1\mu\text{m}$ in length and can swim 100 times its length per second.

Calculate the swimming speed of this bacterial cell in mm s^{-1} .

(2)

Answer

(iii) The BvB bacteria have been described as 'living antibiotics'.

Explain why the BvB bacteria might be useful in the future for treating bacterial infections.

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q9.

Antibiotics have been developed to control bacterial infections.

(a) Name **one** bacterium which causes symptoms of infection by producing exotoxins.

(1)

.....

.....

(b) Explain how an antibiotic has a bacteriostatic effect on bacteria.

(2)

.....

.....

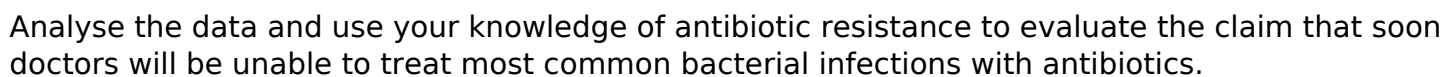
.....

.....

*(c) Bacterial resistance to common antibiotics is an increasingly serious problem facing doctors treating a wide range of infections.

The graph below shows the percentage of resistant bacteria in patients being treated with antibiotics for *Streptococcus pneumoniae* infections.

Group C had been previously treated with the named antibiotic.

[illegible]

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 12 marks)

Q10.

Antibiotics are widely used to treat infections.

Some antibiotics are bactericidal.

State what is meant by the term bactericidal.

(1)

.....

.....

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is B <i>A is incorrect because tetracycline targets the ribosomes</i> <i>C is incorrect because tetracycline targets the ribosomes and penicillin targets the cell wall</i> <i>D is incorrect because penicillin targets the cell wall</i>		(1)
(ii)	The only correct answer is B <i>A is incorrect because tetracycline is bacteriostatic</i> <i>C is incorrect because tetracycline is bacteriostatic and penicillin is bactericidal</i> <i>D is incorrect because penicillin is bactericidal</i>		(1)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	- number of chicken and cattle with resistant <i>E.coli</i> (1) - ratio given (1) OR - mean percentage of resistant bacteria in chickens calculated (1) - ratio given (1)	Example of calculation: $(43 + 25) = 68$ chickens and 3 cattle $22.67 : 1 / 22.7 : 1 / 23 : 1 / 1 : 0.04$ $(95.86 + 55.56) \div 2 = 75.71$ $(75.71 : 25.00 =) 3.03 : 1 / 3 : 1$ ACCEPT $1 : 0.33 / 1 : 0.3 / 1 : 1$ NB correct answer with no working gains two marks $\{6.06 : 1 / 6.1 : 1 / 6 : 1 / 1 : 0.17 / 1 : 0.2\} = 1$ mark	(2)

Question Number		Additional Guidance	Mark
(ii)	- mean number of resistant bacteria for cattle or rodents calculated (1) - answer (1)	Example of calculation: 8.33% of $2 \times 10^8 = 16.66 \times 10^6$ OR 14.58 % of $6 \times 10^9 = 87.48 \times 10^7$ 53 / 52.5 / 52.51 (times more) 8.6×10^8 / 8.58×10^8 / 858 140 000 etc (more bacteria) correct answer with no working gains two marks	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to four of the following: (idea supported because) overall there are more resistant bacteria in the animals reared for food (1) (idea not entirely supported because) the bacteria in wild animals are more resistant to cephalothin (1) - the number of animals in each group is very small (1) - the number of different types of {animal / antibiotic} is limited (so data may not be representative) (1) - no standard deviations shown so spread of data is unknown (1)	ACCEPT other quoted data to illustrate exception ACCEPT validity of data	(4)

Q3.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: - there is a zone of inhibition around the penicillin disc / because penicillin only affects Gram positive bacteria (1) Plus two from the following points: - because it has a thick cell wall (1) - because penicillin interferes with formation of cross links (1) - during synthesis of new cell wall (1) - this results in bacteria being susceptible to osmotic shock (1)		(3)

Q4.

Question Number	Answer	Additional guidance	Mark
	A (inhibiting peptidoglycan cross-link formation in the cell wall)		(1)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following: • inhibits formation of (new) crosslinks in peptidoglycan in cell wall (1) • causing lysis of cell due to osmotic pressure (1) • therefore penicillin is bactericidal (1)		(3)

Q6.

Question Number	Acceptable Answer	Additional guidance	Mark
	A description that makes reference to the following: • bactericidal kills by affecting structure of the cell membrane/cell wall (1) • bacteriostatic prevents reproduction by affecting DNA replication (1)		(2)

Q7.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: - an inhibitor of the bacterial enzyme may not affect the human one (1) - description of effect of treatment eg fatty acids not made so {less respiration / bacteria die} (1) - so that there will be fewer side effects if used as a treatment for infections (1)	Allow enzymes are specific Allow is an effective antibiotic	(2)

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to two of the following: - Gram positive bacteria have more peptidoglycan than Gram negative bacteria (1) - Gram positive stains {purple / blue} (with Gram stain), but Gram negative do not stain {purple / blue} (with Gram stain) (1) - Gram positive contains {teichoic acid / lots of murein} but Gram negative do not (1) - Gram positive have no {periplasmic space / outer membrane} but Gram negative do (1)	Allow Gram positive have a thicker cell wall than Gram negative Allow Gram positive stains {purple / blue} (with Gram stain), but Gram negative stain red (with Gram stain) Allow Gram positive have low {lipid / phospholipid} content but Gram negative have high {lipid / phospholipid} content	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • conversion of micrometres to mm (1) • calculation of speed (1)	Example calculation $1\mu\text{m} = 0.001\text{ mm}$ $0.001 \times 100 = 0.1\text{ (mm s}^{-1}\text{)}$ Correct answer with no working gains full marks	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: • BvB can kill gram negative bacteria (1) • without side effects for humans (1) • therefore could be useful when treating resistant bacterial infections (1)	Allow bacteria cannot become resistant to BvB	(2)

Q9.

Question Number	Correct Answer	Additional guidance	Mark
(a)	<i>Staphylococcus</i> spp.		(1)

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following: • the number of living bacteria does not increase (1) • because cell division is prevented (1)	Accept more sophisticated answers that give details of how cell division is prevented	(2)

Question Number	Indicative content	
*(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Candidates are expected to reach a decision/conclusion on whether the development of bacterial resistance is so serious and rapid that antibiotics will become ineffective in the treatment of the majority of bacterial infections. • Prior use of antibiotics increases the percentage of resistant bacteria, supported by quantitative data • Prior use of the named antibiotic has the greatest effect, supported by quantitative data • Increasing use of antibiotics increases selection pressures so more resistant strains • Shows understanding that resistance mechanisms are inherited by sexual means and lateral gene transfer, e.g. via plasmids and this means they can spread rapidly and in some cases across species • Bacteria have high reproduction rates and mutations more likely within a short time • Understands current methods used to limit increase in resistant strains such as strict controls on antibiotic prescribing, problems of ensuring patients complete course of treatment when symptoms disappear, limit use of antibiotics in animal husbandry etc. • Comments on difficulties of developing new drugs • Methods of preventing spread of resistant strains especially hospital infection • Movement of humans means that transfer of resistant strains will spread to	
Level	Mark	Descriptor
	0	No rewardable material
Level 1	1-3	Provides little or no reference to a range of scientific ideas, processes, techniques and procedures. Scientific argument may be attempted, but fails to link biological concepts and/or ideas in order to support decision/conclusion. Limited attempt to address the question.
Level 2	4-6	Scientific reasoning occasionally supported through the linkage of a range of scientific ideas, processes, techniques and procedures. Scientific argument is partially developed. Attempts to synthesise and integrate relevant knowledge with linkages to biological concepts and/or ideas, leading to a notional scientific argument or decision/conclusion based on evidence.
Level 3	7-9	Scientific reasoning supported throughout by sustained linkage of a range of scientific ideas, processes, techniques or procedures. Scientific argument is well developed and logical. Demonstrating throughout the skills of synthesising and integrating relevant knowledge with consistent linkages to biological concepts and/or ideas, leading to nuanced and balanced scientific argument or decision/conclusion based on evidence.

Q10.

Question Number	Answer	Additional Guidance	Mark
	{kills / destroys} bacteria	Do not accept causes lysis / affects cell wall synthesis	(1)