Antibiotics

Mark Scheme 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Infectious disease
Sub Topic	Antibiotics
Booklet	Theory
Paper Type	Mark Scheme 3

Time Allowed : **76 minutes**

Score : **/ 63**

Percentage : **/100**

Grade Boundaries:

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

1 **(a** cholera and TB ;
ignore *any other underlined diseases* [1]

(b) *must answer in context of antibiotics, not antibodies*
look for bacteria in answer if not clear in mp 1

1 (to ensure) all bacteria are, killed / removed / eliminated / destroyed / AW ;
R virus / bacteria and virus
ignore antigen or pathogen or disease
'all' *may be implied e.g. award if gain mp 2,3,4*
2 (so) no reservoir of infection remains / AW / ora ;
3 (disease) cannot be transmitted / cannot infect others / AW e.g. spread / ora ;
4 no recurrence / disease does not return ; *in context of same person*
5 to reduce chance of / AW, (antibiotic / drug) resistance developing ;
R *idea that human becomes resistant to antibiotics*
6 ref. to mutation in context of resistance ; [max 3]

(c) (i) binds with / fits into / AW, active site ; **R** collides with / reacts with
complementary shape to active site / similar shape to substrate ;
A same shape as substrate / same *or* similar structure as substrate
fewer, enzyme-substrate / E – S, complexes ;
A no ESC in context of one enzyme
A fewer successful collisions between enzyme and substrate
A prevents formation of E – S complexes
reduces rate of / slows (enzyme) reaction ;
A reduced enzyme activity / **A** less product formed [max 3]

(ii) *ideas that*
(humans) do not have the enzyme for cell wall synthesis ;
A penicillin only inhibits bacterial enzymes
penicillin will not inhibit any human enzyme ;
(human cells) do not have cell walls ; [max 1]

(iii) cell wall synthesis will stop / slow / be inhibited ;
A inhibit, murein / peptidoglycan, synthesis
ref. to uptake of water by osmosis ;
cell cannot withstand osmotic stress / cell cannot withstand turgor pressure / lysis / bursting / AW ;
A cell wall weakened
bacteria die / are killed / destroyed ;
stops bacteria dividing / reproducing / 'replicating' ;
AVP ; e.g. detail of action of penicillin (e.g. prevents cross-links forming),
(penicillin) only works on growing cells [max 3]

[Total: 11]

2 **(a** 1. 6 penicillin inhibits, enzyme / peptidase ;
2. blocks / alters shape of, active site ;
3. peptidoglycan chains cannot link up / stops cross-links forming ;
4. (so) cell wall weak(er) ;
5. turgor of cell not resisted (by cell wall) /
idea of inability to withstand increased internal pressure ;
6. cell / wall / bacterium, bursts **;** *ignore 'dies' as in question* [4 max]

(b) 1. mRNA produced by transcription ;
2. *idea of* triplet code ;
3. translated (at ribosome) ;
4. correct ref. to function of tRNA **;** e.g. anticodon / carries amino acid
5. formation of polypeptide ;
6. AVP **;** e.g. ref. tertiary structure / 3D shape / ref. bonds [3 max]

(c) **(i)** *mutant strain 1*
1. very low resistanc **or** affected by low concentration of antibiotic ; **A** less resistant
2. gene (for efflux pump) not properly, expressed / switched on
3. (so) few pumps (produced **or** pumps out less antibiotic ;
A pumps not working well [2 max]

mutant strain 2
4. more / x4, resistan **or** tolerates high concentration of antibiotic ;
5. gene (for efflux pump fully), expressed / switched on
6. (so) many pumps availabl **or** pumps out more antibiotic ; [2 max]

(ii) 1. natural selection **;**
2. antibiotic provides selection pressure
3. mutant **2** has selective advantage ;
4. in presence of >6 **and** <256 $\mu g\,cm^{-3}$ antibiotic ;
5. **R** dies / mutant strain **2** survives ;
6. mutant **2**, reproduces / increases in number ;
7. (so) passes, resistance / mutation, (to offspring) *ignore allele / gene* [4 max]

[Total: 15]

3 **(a** 1 globular ;
2 ref. tertiary structure / 3D shape ;
3 <u>active</u> <u>site</u> (because enzyme) ;
4 outer amino acids with hydrophobic R groups (because in membrane) / AW ; [2 max]

(b) 1 (penicillin) binds, rarely / briefly, with PBP2a ;
ignore doesn't bind well
2 (so) most PBP2a molecules not blocked ;
3 (so) cell wall / cross links, can still be made (in presence of penicillin) ;
4 penicillin is <u>competitive</u> inhibitor (of PBP) ;
5 (so) reduces PBP enzyme activity ; [3 max]

(c) 1 viruses have no (peptidoglycan) wall ;
2 viruses have no, transpeptidase / glycoprotein peptidase ;
3 viruses, have no cell structure / are not cells ;
4 viruses have no metabolism ; [2 max]

[Total: 7]

4 **(a) (i)** 1 penicillin inhibits, enzyme / peptidase **;**

2 blocks / alters shape of, active site **;**

3 peptidoglycan chains cannot link up / stops cross-links forming **;**

4 cell wall weaker / AW **;**

5 turgor of cell not resisted (by cell wall) / AW **;**

6 cell / wall / bacterium, bursts **;** [3 max]

(ii) *any two from*

1 viruses do not have cell wall **;**

2 viruses do not have cytoplasm **;**

3 viruses do not have peptidoglycan **;**

4 viruses do not have peptidase **;** [2 max]

(b) *without antibiotic*

1 numbers of both wild-type and mutant strains, increase / hardly changes **;**

with antibiotic

2 numbers of both wild-type and mutant strains decrease **;**

3 mutant strains decrease more than wild-type **;** **A** faster
this subsumes marking point 2

4 after 24h, wild-type plateaus and mutant strain continues to decrease **;**

5 ref. comparative figures at any one time **;** *ignore units for bacteria*
blue with blue
red with red
red with blue – with antibiotic [4 max]

(c) **(i)** 1 changes in, base / nucleotide, sequence **;** **A** named change e.g. substitution

2 alters, triplet code / codon **;**

3 enzyme has different, primary structure / amino acid sequence **;**

4 enzyme has different, 3D structure / tertiary structure / active site **;** [2 max]

(ii) *red and blue with antibiotic*

1 wild-type bacteria can produce glucans **or** mutant bacteria produce less glucans **;**

2 glucans bind with antibiotic **;**

3 wild-type more resistant to antibiotic **or** mutant bacteria less resistant to antibiotic **;** [2 max]

(d) 1 antibiotic, is selective agent / provides selective pressure **;**

2 resistant bacteria, survive / reproduce **;**

3 pass allele for resistance to offspring **;**

4 frequency of allele in population increases **;** [3 max]

[Total: 16]

5	**(a)**	**(i)**	condensation ;	[1]
		(ii)	1. autolysi__ ; 2. make holes in cell walls 3. in, growing / developing, bacteria 4. (antibiotic), inhibits / acts on, (another) enzyme 5. so peptidoglycan chains cannot link up / stops cross-links forming 6. cell wall becomes weaker / AW 7. turgor of cell not resisted (by cell wall) / AW 8. cell bursts	[4 max]
		(iii)	(glycoprotein) peptidase ;	[1]
	(b)		viruses have no cell wall ;	[1]
	(c)		*assume gram+ unless otherwise stated*	
		1	(gram+) penicillin can reach, cell wall / peptidoglycan, directly /AW / (gram-) ora ;	
		2	(gram-) outer membrane provides protection (from penicillin) / (gram+) ora ;	
		3	(gram+) more % peptidoglycan in wall (so greater effect from penicillin) / (gram-) ora ;	[2 max]

	(d)		*accept antibiotic for penicillin and bacteria for S. pneumoniae throughout*	
		1	increase in resistance (throughout time period) ;	
		2	paired figs + units ;	
		3	overuse / misuse, of penicillin ;	
		4	some *S. pneumoniae* survive ;	
		5	mutation (in *S. pneumoniae)* ;	
		6	resistance, gene / allele ;	
		7	resistance passed to other bacteria ; e.g. plasmid transfer	
		8	resistant strain, multiplies ; *idea of many produced*	
		9	beta – lactamase produced ;	
		10	breaks down penicillin ;	
			point 7 accept vertical or horizontal transfer *point 8 accept vertical transfer only*	[5 max]
				[Total: 14]