

WJEC (Wales) Biology A-level
Topic 3.4: Microbiology
Questions by Topic - Mark
Scheme

1.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
(a)	(i)		5.81×10^{-4} or 5.8×10^{-4} = 2 marks (accept any d.ps) If incorrect award 1 mark for 18/3099100 x100 0.00058081 5.80×10^{-4}		2		2	2	
(b)	(i)		Gram – have capsule/lipopolysaccharide (1) Bacillus rod shaped (1)	2			2		
(c)	(i)		172000 = 2 marks Accept standard form If incorrect award 1 mark for 86000×2 86000 (no dilution factor)		2		2	2	
	(ii)	I	there were too many colonies to count/colonies {merged/clumping}			1	1		1
		II	The extra dilution gives additional error/may not have mixed fully/inaccurate representation of whole sample/not valid to count less than 30 colonies/too few to be statistically significant			1	1		1
(d)			azithromycin (no mark for name only) need to use less antibiotic/use of data e.g. Anti A only needs 10% to kill all bacteria. C needs 30% to kill all bacteria(1) so cheaper for government/less likely to lead to antibiotic resistance (1)			2	2		
			Question 1 total	2	4	4	10	4	2

Question				Marking details	Marks Available																									
					AO1	AO2	AO3	Total	Maths	Prac																				
2	(a)	(i)		Any two for 1 mark from Have nucleus (1) membrane-bound organelles/ named example(1) 80S ribosomes (1) DNA associated in chromosomes/linear (1)	1			1																						
		(ii)		Absence of protein/S layer in Gram negative (1) layer of {lipoproteins/lipopolysaccharides} (1)	1	1		2																						
	(b)	(i)		25 (% NaCl)		1		1																						
		(ii)		A <i>Halobacterium salinarum</i> + lives in a marine environment which has high NaCl conc (1) B <i>Staphylococcus aureus</i> + lives on skin which is often high in salt (from sweat) (1) C <i>Escherichia coli</i> + in part of gut with low salt (as most has been absorbed)(1)			3	3																						
		(iii)		Grams staining/ or description of(1) Accept reference to crystal violet only <i>Enterococcus faecalis</i> / Gram positive: purple {spherical/spheres} (1) NOT round/ circle <i>Escherichia coli</i> / Gram negative: red {rods/bacilli/us} (1) both correct colours = 1 mark both correct shapes for 1 mark Accept correct description of penicillin resistance	1	2		3		3																				
	(c)	(i)		<table border="1"><tr><td></td><td></td><td>$x - \bar{x}$</td><td>$(x - \bar{x})^2$</td></tr><tr><td>1</td><td>275</td><td></td><td>324</td></tr><tr><td>2</td><td>293</td><td></td><td>0</td></tr><tr><td>3</td><td>310</td><td></td><td>289</td></tr><tr><td>Mean</td><td>293</td><td></td><td>$\Sigma 613$</td></tr></table> $\Sigma = 613$ (1) Square root of 613/2 Substitution = (1) SD = 17.5 (1) must be to 1dp Correct answer = 3 marks			$x - \bar{x}$	$(x - \bar{x})^2$	1	275		324	2	293		0	3	310		289	Mean	293		$\Sigma 613$		3		3	3	
		$x - \bar{x}$	$(x - \bar{x})^2$																											
1	275		324																											
2	293		0																											
3	310		289																											
Mean	293		$\Sigma 613$																											
		(ii)		Clumping of bacterial/ Overlapping colonies/ Difficult to count large colony numbers Ignore reference to anomalies/ not enough repeats		1		1		1																				
		(iii)		data range is very large/ 10^{-3} is less reliable than 10^{-5} / both unreliable as they have a large SD/ Data is very variable Reject accuracy/ unreliable unqualified		1		1		1																				
		(iv)		$72 \times 4 \times 10^3$ (1) 2 880 000 000 000 (2) $2.9 \times 10^{11}/2.88 \times 10^{11}$ bacteria in 1cm^3 (3) If do not use $\times 4 = 7.2 \times 10^{10} = 1$ mark		3		3	3																					
				Question 2 total	3	12	3	18	6	5																				

3.

Question

Marking details

Marks
Available

(a)	(i)	Obligate aerobe	{microorganisms/bacteria} that {grow/divide/ metabolise} in the presence of <u>oxygen</u> ;	1
	(ii)	Obligate anaerobe	{microorganisms/bacteria} that will only {grow/divide/metabolise} in the absence of <u>oxygen</u> ;	1
	(iii)	Facultative anaerobe	{microorganism/bacteria} that can {grow/divide/ metabolise} with or without <u>oxygen</u> ;	1

- (b) Gram +ve PURPLE Gram –ve RED/PINK
(**both** colours correct for one mark);
Gram positive retain the {(crystal) violet/ purple} stain
because of their {thick/peptidoglycan/murein} cell wall;
Gram negative do not retain the stain because of their
{thinner cell wall/ less peptidoglycan/ less
murein/lipopolysaccharide layer};
Gram positive retain crystal violet because they have a
thicker cell wall than the gram negative = 2 marks

- (c) **Both for one mark**

Cocci sphere/ spherical
Bacilli Rod; Accept cylinder

Question 3 Total

[7]

4.	Question	Marking details	Marks Available
1	(a)	There more {microorganisms/ bacterial/ fungi} in indoor air than outdoor air samples;	1
	(b)	(Different) pH; (Different) C {source/ concentration}; (Different) N {source/ concentration}; (Different) growth factors: {Different/ different concentration} Vitamins/minerals; NOT nutrients	max 2
		Any 4 1 mark per pair	
	Question 1 total		[3]

5.	Question			Marking details	Marks Available
1	(a)			colony;	1
	(b)			living;	1
	(c)			Gram positive;	1
	(d)			spirillum;	1
				Question 1 total	[4]

6.	Question	Marking details	Marks Available
	(a)	Gram positive: purple/ violet NOT crystal violet Gram negative: red / pink [both needed for 1 mark];	1
	(b)	<u>Gram +ve:</u> (thick) {murein / peptidoglycan} cell wall (only)/ no lipopolysaccharide layer; {retains/ binds/ absorbs} crystal violet stain / purple colour;	3

{retains/ binds/ absorbs} crystal violet stain / purple colour,		max 2 if only
<u>Gram –ve:</u>		discuss one
{lipoprotein / lipopolysaccharide}{ layer / wall} (external to murein cell wall);		type of
Does not retain {crystal violet stain / purple colour};		bacteria
Stains {red/pink} with {counter stain / safranin / carbol fuchsin};		
(c)	(i) Ignore references to Gram +ve / Gram –ve.	
A	bacillus/ bacilli; NOT rod	1
B	spirillum/ spirilli; NOT spiral	1
C	coccus/ cocci; NOT round / staphylococcus	1
	(ii) (lipoprotein / lipopolysaccharide layer)	
	protects against (some) {antibiotics} / penicillin / antibodies} /	1
	makes them less susceptible to attack by lysozyme/	
	(lipid component) acts as an (endo)toxin;	
(d)	(i) <i>Plate U</i> - enough colonies for reliable results/	
	- colonies easily countable;	
	NOT the right number/ we can see them	
	<i>Plate R/S</i> - cannot distinguish individual colonies;	max 2
	<i>Plate T</i> - too many colonies to count reliably;	
	<i>Plate V</i> - not enough colonies for reliable estimate	
	(ii) 69 colonies x 10 000 (dilution factor) x 2 (or 1/0.5);	
		2
	1 380 000/ 1.38 x 10 ⁶ colonies per cm ³ ;	
	(iii) does not include {dead / non-viable bacteria}/	
	cannot be sure that {each colony has grown from a single	1
	bacterium/ colonies are not clumped}/ ORA;	
	(iv) need to count pathogenic bacteria / pathogenic bacteria more	
	likely to grow at temperature close to body temperature/	
	want bacteria to grow quickly to identify to treat infection as	
	quickly as possible;	1
	NOT want to grow them as quickly as possible without	
	qualification	

Question 6 total

[14]

7.	(a) (i)	rod shaped;	1
	(ii)	retains (red) counter stain/stains red/pink in Gram test/do not retain crystal violet; because of complex nature of cell wall/reference to lipopolysaccharide/does not contain as much murein/peptidoglycan.	1 1
	(iii)	grow best with oxygen; (not: prefer/like oxygen) but can grow with or without oxygen (not: ref. aerobic/anaerobic)	1 1
	(b) (i)	viable only counts living cells/cells which are reproducing/total count includes living and dead cells	1
	(ii)	9 cm ³ of sterile distilled water in each tube; (not: tap water) 1 cm ³ of sample transferred to tube 1; mixed well or ref. 1 cm ³ transferred next tube in sequence; any reference to aseptic technique. (Any 3) (labelled diagram=2max e.g. 9cm ³ sterile distilled water + 1 cm ³ sample)	3
	(iii)	4	1
	(iv)	take/prepare 4 sterile nutrient agar plates; (idea of each dilution on a different plate needed) transfer 0.5 cm ³ /other specified volume of each to a separate plate; (allow: 0.1-1 cm ³) spread with sterile spreader; incubate plates at suitable temp./25°C; (allow: 25-40°C) count colonies; 1 colony=1 cell. (any 4 in correct sequence)	4
			Total 14 marks

8. (a) (i) spherical / round / circular [**not:** oval] [1]
- (ii) Contains peptidoglycan / murein / glycoprotein
Do not have (or little) outer layer with lipopolysaccharide /
lipoprotein [Reference to dye retention = 0] [1]
- (iii) Grow better in the presence of oxygen but can survive in its absence. [1]
- (b) (i) each cell produces one colony [1]
- (ii) underestimate / doesn't allow for clumping [1]
- (c) includes dead bacteria [1]
- (d) serial dilution [1]

[Total 8 marks]

Question			Marking details	Marks Available
	(a)		A Obligate aerobe B Facultative anaerobe C Obligate anaerobe All 3 correct for 2 marks 2 correct for 1 mark 0/1 correct = 0 marks Question 3 Total	2 [2]

10.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
(a)			A <i>Staphylococcus</i> (1) B <i>Lactobacillus</i> (1) C <i>Neisseria</i> (1) D <i>E. coli</i> (1)			4	4		4
(b)			D value = 13 minutes = 3 marks If incorrect award 2 marks for Two correct readings from two consecutive whole numbers e.g. 36-23 If incorrect award 1 mark for Two lines shown on graph between two consecutive whole numbers		3		3	3	
(c)			Any four (× 1) from: A. 10×/100× series of dilutions/1+9/0.1+9.9cm ³ (1) B. Volume 1cm ³ (or less) plated onto each plate (1) C. Incubated at 25-37°C for 24-48 hours (1) D. Number of colonies counted (1) E. Use of dilution factor and calculation of numbers of bacteria (per cm ³ in original sample)/ or description of (1) F. Repeat (×3) and calculate a mean (1)	4			4		
(d)			A. Increased kinetic energy + {breaks hydrogen bonds/ denatures protein} (1) B. Holding together the specific (3-D) shape/ shape of active site changes (1) C. Protein can no longer carry out function/ enzyme- substrate complexes {can no longer form/ reduced} (1)	3			3		
			Question¹⁰ total	7	3	4	14	3	4

11.

Question			Marking Details	Marks Available					
				AO1	AO2	AO3	TOTAL	Maths	Prac
(a)			Accept any answer in the range 613 000 - 624 000 = 3 marks Accept in standard form If incorrect award 2 marks for either $100/(0.09 \times 0.09) \times 3.14 (\pi) \times 156$ $100/0.025(43) \times 156$ If incorrect award 1 mark for area calculation $0.09 \times 0.09 \times 3.14 (\pi)$		3		3	3	
(b)	i		Serial dilution description (of tenfold/ hundredfold) e.g. 1 cm ³ of sample and 9 cm ³ of {water/ growth medium} mixed (gives 10 ⁻¹) (1) or equivalent (does not have to give 10 ⁻⁵) Water/ saline/ equipment must be sterile / reference to aseptic technique(1) Repeated four more times/ method to achieve a 10 ⁻⁵ dilution (1) Accept annotated diagram	3			3		3
	ii		Plate 5 (1) (Plate 1/2/3/4)- cannot distinguish individual colonies/ too many colonies to count accurately /merged colonies (might provide underestimate) (1) (Plate 6) has too few colonies to provide an accurate estimate (closer to the true value)/ too few to be statistically significant (1) Penalise bacteria once only			3	3		3
	iii		37°C is body temperature which is optimum for these bacteria/ 37°C grows the bacteria found in the patient / 37°C grows the bacteria found in the patient <u>faster</u> (1)		1		1		1
	iv		Thick {murein/peptidoglycan} layer (1) No lipopolysaccharide layer (1)	2			2		
			QUESTION¹¹TOTAL	5	4	3	12	3	7