



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**BIOLOGY (US)**

**0438/41**

Paper 4 Theory (Extended)

**October/November 2016**

MARK SCHEME

Maximum Mark: 80

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**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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**Abbreviations used in the Mark Scheme:**

- ; separates marking points
- / alternatives
- I ignore
- R reject
- A accept (for answers correctly cued by the question, or guidance for examiners)
- AW alternative wording
- AVP any valid point
- ecf credit a correct statement / calculation that follows a previous wrong response
- **ora** or reverse argument
- ( ) the word / phrase in brackets is not required, but sets the context
- underline actual words given must be used by the candidate (or grammatical variants of them)

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
1(a)(i)	(antibiotics) kill / damage / destroy / eliminate, pathogens / bacteria / fungi; Bacteria / fungi / pathogen can cause illness / disease / infections; (antibiotics), prevent growth / reproduction of, bacteria / fungi / pathogen; AVP ref. to how antibiotics kill bacteria; e.g. ref. to cell wall / production of proteins / inhibition metabolism;	<b>2</b>	I virus
1(a)(ii)	<ol style="list-style-type: none"> <li>1 all (bacteria / pathogens) need to be killed / destroyed;</li> <li>2 any remaining (bacteria) will reproduce / multiply;</li> <li>3 illness / disease would continue;</li> <li>4 ref to problem of antibiotic resistance;</li> <li>5 antibiotics no longer effective;</li> <li>6 new antibiotics have to be developed;</li> </ol>	<b>3</b>	<b>A</b> prevents growth    I virus  I any reference to immunity
1(b)	fungus / mould;	<b>1</b>	<b>A</b> <i>Penicillium</i> ( <i>notatum</i> )
1(c)(i)	steam; autoclave / high temperature <u>and</u> high pressure; UV / gamma, radiation / X rays; bleach; AVP; e.g. sterilise nutrients / air supply / items, entering fermenter	<b>2</b>	<b>A</b> any reference to sterilizing substances that are <u>added</u> to the fermenter.

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<b>Question</b>	<b>Answer</b>			<b>Mark</b>	<b>Guidance</b>
1(c)(ii)	letter from Fig. 1.1	name	function	<b>5</b>	one mark for each correct row
	P	water jacket	Maintain / control, temperature;		
	S	paddles / stirrers / mixers / vanes	mixes / stirs / maintains a suspension / stops solids settling / keeps nutrients moving / gives uniform mixture;		
	Q	nutrient inlet	supplies glucose / ammonia / amino acids / nutrients for growth / nutrients for respiration / energy;		
	R	Probe / sensor / data logger	monitors, temperature / pH;		
	U	air supply	supplies oxygen for respiration;		
	T	outlet	allows collection of the liquid containing penicillin after fermentation		

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
1(d)	penicillin is, separated / extracted / filtered / centrifuged / evaporated / purified / crystallised / precipitated / dried / impurities removed;	<b>1</b>	<b>A</b> downstream processing
		<b>Total: 14</b>	

<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
2(a)	group / number, of organisms / AW, from one species; living in same, area / place / environment / time, together;	<b>2</b>	
2(b)	<ul style="list-style-type: none"> <li>1 mode is / majority / most fish are, between 12.1 and 16.0 cm long;</li> <li>2 range / body length, varies up to 24 cm / varies 0 to 24 cm;</li> <li>3 very few fish are less than 4 cm;</li> <li>4 no fish longer than 24 cm;</li> <li>5 normal distribution / bell-shaped curve / similar number of fish longer and shorter than the mean; AW</li> <li>6 Data quote of range with units and thousands of fish;</li> <li>7 AVP ref to actual range may be shorter than 0–24 cm;</li> </ul>	<b>3</b>	<b>A</b> mean
2(c)(i)	4 + 8 + 10 + 6 + 4 + 2 (thousand); = 34 thousand (fish);	<b>2</b>	

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
2(c)(ii)	quotas/licences/permits/limits; fines for overfishing/taxes; only adult fish caught/young fish returned; (laws to) restrict net size; no fishing, zones/seasons; encourage, fish farms/nurseries/hatcheries/captive breeding; international fishing agreements/treaties; reduce, pollution/silting (of rivers)/avoidance of environmental factors detrimental to fish; education; restocking/add more, fish than removed / AW;	<b>4</b>	<b>A</b> 'regulation of fishing'  <b>A</b> 'eutrophication' if linked to the death of fish.
2(d)(i)	genetics/inherited (genes); environmental factors ; any two named environmental factors; (natural) selection;	<b>2</b>	examples of named environmental factors: nutrition / pollution / temperature / predation / disease / fishing
2(d)(ii)	bar chart;	<b>1</b>	
		<b>Total: 14</b>	

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
3(a)(i)	amino acids;	<b>1</b>	
3(a)(ii)	stomach;	<b>1</b>	
3(b)(i)	ref. to surface area; affecting enzyme / enzyme activity; allows comparison; make experiment valid; controlled variable;	<b>2</b>	
3(b)(ii)	water-bath / in a beaker of water / incubator; insulate test-tube; allow solutions to equilibrate to temperature (before experiment); use a thermometer to check the temperature (is constant);	<b>2</b>	
3(c)	(pH) $8 \pm 1$ ;	<b>1</b>	

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
3(d)	enzymes are protein; enzymes can be reused / are unchanged in the reaction; enzymes are specific; (enzymes are) catalysts / speeds up reaction; lowers the energy needed for the reaction; successful collisions / enzyme-substrate complex / ESC; active site; (enzyme and substrate) fit together; complementary shape; (digestive enzymes perform) chemical digestion / hydrolysis / catabolic reactions; break down, large / insoluble, molecules into, small / soluble, molecules; amylase converts starch to sugars / maltose; lipase converts lipid / fats, to fatty acids and glycerol; maltase converts maltose to simple sugars / glucose; ref to pH; ref to denaturation;	<b>6</b>	
		<b>Total: 13</b>	

<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
4(a)(i)	pancreas;	<b>1</b>	
4(a)(ii)	recognize a specific, pathogen / antigen; lock on antigens / antibody-antigen complex; agglutination / clumping; destruction by, phagocytes / white blood cells / lymphocytes; AVP; e.g. neutralise / inhibit toxins;	<b>2</b>	<b>A</b> bacteria / fungus / virus / parasite



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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
4(b)(i)	lack of sun(light) / dark skin AW; lack of fish (oils) / egg (yolk) / liver; unbalanced diet; kidney / liver / digestive, disease;	<b>1</b>	
4(b)(ii)	muscle cramps; soft / bent, bones / rickets; stunted growth; prone to infections; fatigue; reduced ability to absorb calcium (ions);	<b>2</b>	
4(c)	lack of vitamin D leads to more cases of type 1 diabetes in mice / ora; there is no difference in cases / same number of cases (wrt normal mice) until after 50 days; at 100 days there are more cases (in vitamin D mice); (vitamin D mice) levels off before normal mice / levels off after 150 days; comparative data use ;e.g. 20% more cases at day 200 or at 250 days normal mice is 46% , deficient mice is 65%;	<b>3</b>	

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
4(d)	frequent urination; thirst / AW; hunger; fatigue; weight loss; itchy skin; wounds heal slowly / more susceptible to infection; blurred vision / AW; vomiting; glucose in urine; high blood, glucose/sugar;	<b>4</b>	<b>A</b> nausea <b>A</b> hyperglycaemia.
4(e)	insulin; by injection / insulin pump; regular blood sugar tests; regular meals; AVP; exercise / restrict carbohydrate content of diet	<b>3</b>	
		<b>Total: 16</b>	

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Question	Answer	Mark	Guidance
5(a)	root hair (cells); long and thin; thin cell wall; large surface area; for absorption; (water by) osmosis ; (ion / nutrients by) active transport; against the concentration gradient; protein (pumps) in membrane; require energy / ATP; ref. to many mitochondria;	5	
5(b)(i)	(positive) gravitropism;	1	<b>A</b> geotropism <b>R</b> negative gravitropism
5(b)(ii)	auxin;	1	

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
5(b)(iii)	<p>in space / AW; because no gravity;</p> <p>in a clinostat / AW; gravity constantly changing / AW;</p> <p>remove root tip; no auxin source;</p> <p>lateral roots; searching for, water / nutrients / hydrotropic;</p> <p>light source below, plant / root; roots grow away from light / negatively phototropic;</p> <p>anaerobic mud / mangrove swamp / pneumatophores; need oxygen (for respiration); ORA</p> <p>roots attaching plant to solid objects for support eg walls / other host plants; material is too hard for root to grow through (takes line of least resistance);</p> <p>AVP; e.g. epiphytes / parasitic plants</p>	<b>2</b>	paired marking points
		<b>Total: 9</b>	

Question	Answer	Mark	Guidance
6(a)(i)	T, C, A, G;	2	all correct = 2 marks 2 or 3 correct = 1 mark
6(a)(ii)	double helix;	1	
6(b)	<i>species C with species D: 4;</i> <i>species G with species H: 3;</i>	2	
6(c)	species <b>A</b> and species <b>D</b>	1	
6(d)		3	4 correct = 3 marks 2 or 3 correct = 2 marks 1 correct = 1 marks
6(e)(i)	<u>genetic engineering</u> ;	1	

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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Guidance</b>
6(e)(ii)	<p>drought / salt / pollution / metal / frost / stress / cold, resistant; increased, yield / productivity; extend range where crops can be grown;</p> <p>herbicide resistance; increased yield / productivity;</p> <p>pesticide resistance; increased yield / productivity;</p> <p>crop plants produce own insecticides; less insecticide used; increased yield;</p> <p>vitamin / nutrient, enrichment / <math>\beta</math> carotene (Golden rice); increased nutritional value;</p> <p>pathogen resistant / Bt; increased productivity / less pesticide use;</p> <p>antigens / vaccines / pharmaceuticals; e.g. insulin cheap production of medicines;</p> <p>flavour / texture / ripening; Improved customer satisfaction / shelf life;</p>	<b>4</b>	<p>linked marking points 2+2</p> <p><b>R</b> bacteria (as not a crop plant)</p> <p><b>A</b> 'more profit' once.</p>
		<b>Total: 14</b>	