

GCE

Biology A

Unit **H420A/02**: Biological diversity

Advanced GCE

Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.













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Annotations

In mark scheme:

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

In RM Assessor:

Annotation	Meaning
	Correct response
	Incorrect response
	Ignore
	Point already given (i.e. Given Mark)
	Underline (for ambiguous / contradictory wording)
	Omission
	Marking point partially met
	Benefit of doubt
	Benefit of doubt not given
	Contradiction
	Error carried forward
	Blank page

Subject-specific Marking Instructions**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader

Question			Answer	Marks	Guidance
1			C ✓	1	
2			A ✓	1	
3			B ✓	1	
4			C ✓	1	
5			C ✓	1	ALLOW A
6			B ✓	1	
7			A ✓	1	ALLOW B
8			B ✓	1	
9			B ✓	1	
10			B ✓	1	ALLOW C
11			D ✓	1	
12			A ✓	1	
13			B ✓	1	
14			B ✓	1	
15			D ✓	1	
			Total	15	

DO NOT CREDIT ambiguous letters, e.g. B/D hybrids

Question			Answer	Marks	Guidance
16	(a)	(i)	<p>estimate will be inaccurate (because of low numbers) ✓</p> <p>dangerous (for collector or jaguar) ✓</p>	2	<p>IGNORE refs to conspicuousness of tags</p> <p>ALLOW catching one more jaguar will make a big difference to the calculated number</p> <p>ALLOW the technique only works well with large populations</p> <p>IGNORE difficult to catch</p> <p>ALLOW the jaguars might die</p> <p>IGNORE inhumane / cruel / stressful</p>
		(ii)	<p>1 appropriate calculation of , observed / expected , population density ✓</p> <p>2 lower than estimate ✓</p> <p>3 so does not support ✓</p> <p>4 low / unknown , repeatability / reproducibility (of results) ✓</p> <p>5 (some) support because , figure / 3 , is close (enough) to , estimate / 5 ✓</p> <p>6 some individuals not photographed ✓</p> <p>7 <i>idea that</i> if many individuals not trapped population could be higher than estimate ✓</p>	4 max	<p>1 CREDIT e.g.</p> <ul style="list-style-type: none"> • 3.3 / 3 (jaguars per 100 km²) • 13.55 / 13 / 14 (est. pop. in 271 km²) • 0.05 and 0.033 / 0.03 (jaguars per km²) • 20 and 30.1 / 30 (mean area per jaguar) <p>1 IGNORE significant figures</p> <p>2 ALLOW ecf from candidate's calculation</p> <p>3 Must be in context of mp 1 or 2</p> <p>4 ALLOW low reliability</p> <p>4 ALLOW ref. to one-off study / should be repeated</p> <p>4 IGNORE accurate / valid</p> <p>6 ALLOW some not caught by camera</p>

Question	Answer	Marks	Guidance
(iii)	<p><i>human sightings</i> <i>idea of any one of the following</i> misidentification seeing the same individual twice exaggeration / lying poor recollection jaguars likely to be in , places / times , humans are not method unlikely to spot cubs (as still in den) ✓</p> <p><i>footprints</i> <i>idea of any one of the following</i> misidentification might disappear (before recording) multiple prints in same spot makes counting difficult same print might be counted on different occasions many prints made by the same individual hard to distinguish individual jaguars footprints not always left ✓</p>	2	<p>IGNORE hard to spot</p> <p>IGNORE misidentification if given in human sighting</p>
(b)	<p><i>conservation because...</i> there are (local) people there ✓</p> <p><u>sustainable</u> use ✓</p> <p>(area used for) logging / farming / nut production ✓</p> <p>active measures / work , to maintain , biodiversity / habitat / park ✓</p>	3 max	<p>Cannot be implied from another marking point. Look for positive statement, CREDIT if preservation people would not be there</p> <p>CREDIT logging / farming / nut production , not consistent with preservation</p> <p>CREDIT preservation would leave park untouched CREDIT active management NB preservation would leave park untouched by people = mp 4 not mp 1</p>
	Total	11	

Question			Answer	Marks	Guidance																				
17	(a)	(i)	YR, Yr, yR, yr ✓	1	ALLOW ry, Ry, RY, rY																				
		(ii)	<i>genotypes</i> YyRr, Yyrr, yyRr, yyrr ✓ <i>phenotypes</i> yellow round, yellow wrinkled, green round, green wrinkled ✓	2	ALLOW YRyr , Yryr, yRyr, yryr phenotypes must correspond to correct genotype DO NOT CREDIT if no or incorrect genotypes are given																				
	(b)	(i)	8.73 or 8.8 ✓✓✓ <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>O</th> <th>E</th> <th colspan="2">(O-E)²/E</th> </tr> </thead> <tbody> <tr> <td>58</td> <td>63</td> <td>0.40</td> <td>25/63</td> </tr> <tr> <td>31</td> <td>21</td> <td>4.76</td> <td>100/21</td> </tr> <tr> <td>21</td> <td>21</td> <td>0</td> <td>0</td> </tr> <tr> <td>2</td> <td>7</td> <td>3.57</td> <td>25/7</td> </tr> </tbody> </table>	O	E	(O-E) ² /E		58	63	0.40	25/63	31	21	4.76	100/21	21	21	0	0	2	7	3.57	25/7	3	ALLOW correct answers up to 4 s.f. ALLOW 2 marks any answer between 8.73 and 8.8 <i>If answer is incorrect</i> ALLOW 1 mark for correct expected numbers: 63, 21, 21, 7 ALLOW 1 mark for correctly calculated (O-E) ² /E numbers: 0.40, 4.76, 0, 3.57 OR ALLOW 2 marks for 636 to 638 (ECF from incorrect expected numbers – 9, 3, 3, 1)
O	E	(O-E) ² /E																							
58	63	0.40	25/63																						
31	21	4.76	100/21																						
21	21	0	0																						
2	7	3.57	25/7																						

		<p>(ii)</p> <p><i>supports because...</i></p> <p>1 (critical / table , value =) 7.82 ✓</p> <p>2 <u>difference</u> is <u>significant</u> as (X^2) , higher than , 7.82 / critical value ✓</p> <p>3 (less than) 5% / 1 in 20 , probability / chance , that difference is due to chance ✓ ora</p> <p>4 X^2 / calculated value is , smaller than , 9.35 / value at $p=0.025$ ✓</p> <p>5 greater than , 2.5% / 1 in 40 , probability that difference is due to chance ✓ ora</p>	3 max		<p>ALLOW correct interpretation of significance of incorrect X^2 value in part (i) If candidate has miscalculated degrees of freedom CREDIT only mps 2 and 3 IGNORE reject null hypothesis</p> <p>1 ALLOW 7.82 highlighted in table</p> <p>2 ALLOW difference is not significant as (selected number) less than (selected) critical value</p> <p>3 ALLOW > 5% chance that difference is due to chance (if consistent with candidate's X^2 and critical value)</p> <p>4 ACCEPT X^2 / calculated value is , close to critical value / 7.82 / value at $p=0.05$ 4 ACCEPT X^2 / calculated value , < , 11.34 / value at $p=0.01$</p> <p>5 ACCEPT > 1% probability that difference is due to chance</p>
		<p>(iii)</p> <p>1 (autosomal) <u>linkage</u> ✓</p> <p>2 (both) genes / alleles , occur on same , chromosome / autosome / chromatid ✓</p> <p>3 no independent assortment ✓</p> <p>4 (so) <u>alleles</u> , inherited together / end up in same <u>gamete</u> ✓</p> <p>5 (unless) crossing over occurs / chiasma forms between gene loci ✓</p>	3 max		<p>1 IGNORE sex linkage / mutations 1 ALLOW <i>idea of</i> lethal genes 1 ALLOW genetic drift if number of individuals is small (in suggestion or explanation)</p> <p>5 ALLOW if the genes are close together there is less chance of crossing over</p>

	(c)	(i)	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>In summary: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a ‘best-fit’ approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i></p> <ul style="list-style-type: none"> ○ award the higher mark where the Communication Statement has been met. ○ award the lower mark where aspects of the Communication Statement have been missed. <p>• The science content determines the level. • The Communication Statement determines the mark within a level.</p>			
			<p>Level 3 (5–6 marks) A reference to the nature of the genetic code AND an outline of how alleles are transcribed and translated AND a detailed explanation of why the y allele results in a different primary structure.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) An outline of some key aspects of transcription and translation AND an explanation of why a change in the sequence of bases in a gene causes a change in the primary structure of the polypeptide it codes for.</p> <p>OR A detailed explanation of why a change in the sequence of bases in a gene causes a change in the primary structure of the polypeptide it codes for.</p> <p><i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.</i></p>	6		<p>Indicative scientific points may include:</p> <p>Genetic code (G)</p> <ul style="list-style-type: none"> • DNA base sequence codes for amino acid sequence • reference to mRNA base sequence • triplet code / 3 bases = 1 amino acid • degenerate code • substitution could result in same amino acid <p>Transcription (C)</p> <ul style="list-style-type: none"> • transcription then translation • complementary base pairing • synthesis of mRNA strand • role of RNA polymerase <p>Translation (L)</p> <ul style="list-style-type: none"> • mRNA binds to ribosome • tRNA binds to mRNA • tRNA brings specific amino acid • mRNA translated into polypeptide <p>Effect of y allele (M)</p>

		<p>Level 1 (1–2 marks) A reference to the mechanism of protein synthesis AND reference to the effects of a mutation or the nature of the genetic code. OR A description of some aspects of the mechanism of protein synthesis. OR A description of the nature of the genetic code or the effects of mutation.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>			<ul style="list-style-type: none"> • substitution / frame-shift • different base sequence of DNA • different mRNA codon • different tRNA anticodon • tRNA brings different amino acid • different sequence of amino acids • amino acid sequence is primary structure
	(c)	(ii)	(active) enzyme / protein / product , will still be synthesized even if you only have one Y allele ✓	1	CREDIT you need 2 y alleles to prevent the (functional) enzyme being synthesized
			Total	19	

Question		Answer	Marks	Guidance	
18	(a)	<p>production / AW of , <u>callose</u> ✓</p> <p>release / production , of (named / toxic) chemical ✓</p> <p>leaf drop / abscission ✓</p> <p>necrosis ✓</p>	2 max	<p>IGNORE cell signalling</p> <p>ALLOW formation of tylose</p> <p>ALLOW production of chemical to prevent spread</p> <p>ALLOW production of lignin</p> <p>IGNORE insecticide / antibacterial / pheromones</p> <p>IGNORE contain chemicals</p> <p>CREDIT (rapid) death of , plant / tissue (to limit spread)</p> <p>IGNORE death unqualified</p>	
	(b)	(i)	reduced / no , genetic variation ✓	2 max	<p>ALLOW genetically identical / same genetics</p> <p>ALLOW same / similar , alleles</p> <p>IGNORE same / similar , genes</p> <p>ALLOW makes it valid</p>
		(ii)	<p><i>procedure</i></p> <p>tissue culture / micropropagation ✓</p> <p><i>asepsis important because</i></p> <p>reduces , microorganisms / contamination ✓</p>	2	<p>IGNORE cuttings / vegetative propagation</p> <p>ALLOW clear description</p> <p>ALLOW without asepsis microbes might grow</p> <p>ALLOW reduces competition for , space / nutrients / resources</p> <p>IGNORE infection / pathogens</p>

		(iii) clone C = 952 ± 2 ✓✓✓	3	<p>ALLOW 2 marks for any answer between 915 and 990</p> <p><i>If answer is incorrect</i> ALLOW 1 mark for 700 (area of triangle) and ALLOW 1 mark for 252 (area of rectangle)</p>
		(iv) 0.76(16) ✓	1	<p>ALLOW 76(.2)% / 76/100 / 19/25 / 7.6×10^{-1} ALLOW ECF for answer to part (iii) $\div 1250$ ALLOW e.g. 0.564 / 56% (if answer to (iii) is 700)</p>
		(v) (shows) total / cumulative , infection over time (of study) ✓ <i>idea that</i> on different days the level of infection could be different ✓ any reference Fig.18 to support ✓	2 max	<p>ALLOW descriptive or numeric reference</p>
		(vi) light <u>intensity</u> ✓ light duration ✓ soil (named) mineral (content) ✓ soil , water / moisture (content) ✓ soil type ✓ soil pH ✓ humidity ✓ air pollution ✓	2 max	<p>Mark the first 2 answers with exception of ignored answers below. IGNORE temperature / wind speed / rainfall</p> <p>ALLOW day length IGNORE light exposure</p> <p>IGNORE nutrients / ions / solutes / nitrogen</p> <p>IGNORE water availability</p> <p>IGNORE carbon dioxide</p>
		Total	14	

Question		Answer	Marks	Guidance	
19	(a)	<p><i>chimpanzee has (relatively)</i> smaller / shorter / thinner , thumb ✓ longer / narrower , palm ✓ thicker fingers ✓ wider wrists ✓</p>	2 max	<p>ACCEPT ora for human IGNORE size IGNORE creases</p> <p>IGNORE longer fingers</p> <p>IGNORE less space between fingers</p>	
	(b)	(i)	0.177 ± 0.004 ✓✓	2	<p>Max 1 if answer not given to 3 s.f. ALLOW 1 mark for a number between 5.2 and 5.3 ÷ 30</p>
		(ii)	<p><i>time since divergence</i> 5.25 ± 0.25 million years ✓</p> <p><i>range</i> 4.2 ± 0.2 to 6.3 ± 0.3 (million years) ✓</p>	2	<p>Unit is required for mark</p> <p>ACCEPT 2.1 ± 0.1 (million years)</p>

	(iii)	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p><i>In summary:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a ‘best-fit’ approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i></p> <ul style="list-style-type: none"> ○ <i>award the higher mark where the Communication Statement has been met.</i> ○ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> <p>• The science content determines the level. • The Communication Statement determines the mark within a level.</p>		
		<p>Level 3 (5–6 marks) A supported reason for AND a supported reason against reclassification AND discussion of the basis of the classification system.</p> <p><i>There is a well-developed line of reasoning, which is clear and logically structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) A supported reason for OR against reclassification AND a reference to how organisms are classified. OR A reference to some evidence that supports AND does not support reclassification AND a reference to how organisms are classified.</p> <p><i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.</i></p>	6	<p>Indicative scientific points may include:</p> <p>valid (V) because <i>the indicative point may be subsumed within reference to a supporting figure</i></p> <ul style="list-style-type: none"> • recent divergence <ul style="list-style-type: none"> ○ <i>figs to support from Fig 19.3</i> • occupy same branch on phylogenetic tree <ul style="list-style-type: none"> ○ <i>as seen in Fig 19.1</i> <p>invalid (I) because <i>the indicative point may be subsumed within reference to a supporting figure</i></p> <ul style="list-style-type: none"> • divergence less recent than chimpanzee and bonobo <ul style="list-style-type: none"> ○ <i>figs to support from Fig 19.3</i>

		<p>Level 1 (1–2 marks) A supported reason for OR against reclassification. OR A reference to some evidence that supports OR does not support reclassification AND a reference to how organisms are classified.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>			<ul style="list-style-type: none"> ○ as seen in Fig 19.1 • different anatomy ○ as seen in Fig 19.2 <p>principles of classification (P) <i>may be implied during discussion of V and I points</i></p> <ul style="list-style-type: none"> • phylogeny is basis of classification • species that , diverged recently / share similar base sequence , occupy same group • original classification based on comparative anatomy • recognition that biochemistry is more accurate than comparative anatomy • scientific knowledge develops over time • change justified by new molecular evidence
		<p>(iv) no / little , because , homeobox genes / they , are highly conserved (within animal kingdom) ✓ (only) that humans and chimpanzees , belong to the same kingdom / are animals ✓</p>	1 max		
		Total	13		

Question			Answer	Marks	Guidance												
20	(a)	(i)	two , 6-membered rings / hexoses ✓ (1-4) glycosidic bond ✓ two CH ₂ OH (groups) ✓ rings contain one , oxygen atom / O ✓	2 max	IGNORE 6-carbon ring ALLOW two 5C-rings IGNORE molecule IGNORE oxygen / O , molecule												
		(ii)	<table border="1"> <thead> <tr> <th>lactose</th> <th>maltose</th> <th></th> </tr> </thead> <tbody> <tr> <td>(contains) beta / β-glucose</td> <td>(contains) alpha / α-glucose</td> <td>✓</td> </tr> <tr> <td>β-glycosidic bond</td> <td>α-glycosidic bond</td> <td>✓</td> </tr> <tr> <td>sugars in opposing orientation / flipped / AW</td> <td>both (monomers) in same direction / AW</td> <td>✓</td> </tr> </tbody> </table>	lactose	maltose		(contains) beta / β-glucose	(contains) alpha / α-glucose	✓	β-glycosidic bond	α-glycosidic bond	✓	sugars in opposing orientation / flipped / AW	both (monomers) in same direction / AW	✓	3	IGNORE description of structural difference between glucose and galactose IGNORE refs to inversion of, e.g. CH ₂ OH
lactose	maltose																
(contains) beta / β-glucose	(contains) alpha / α-glucose	✓															
β-glycosidic bond	α-glycosidic bond	✓															
sugars in opposing orientation / flipped / AW	both (monomers) in same direction / AW	✓															
	(b)	(i)	bonds contain energy ✓ (bonds) can be broken by (respiratory) enzymes ✓ soluble so , can move (within cell) ✓ H / OH , (groups) can form H bonds with water / allow solubility ✓ AVP ✓	3 max	CREDIT used in glycolysis / converted to pyruvate / phosphorylated / (easily) converted to glucose												

Question		Answer	Marks	Guidance
	(ii)	<p>(too) big ✓</p> <p>unable to pass between phospholipids ✓</p> <p>OR</p> <p>no / small , concentration gradient ✓</p> <p>needs , carrier protein / pump ✓</p>	2	<p>IGNORE charged / polar</p> <p>CREDIT needs , channel / (lactose) permease</p> <p>IGNORE phospholipid bilayer</p> <p>DO NOT CREDIT channel</p> <p>ALLOW needs <u>active</u> transport protein</p>
	(iii)	<p>(mammal diet high in milk, so) high lactose concentration ✓</p> <p>(structural) gene for protein channel / lactose permease gene / lac Y , is , transcribed / expressed / switched on ✓</p> <p>(protein is) lactose permease ✓</p>	2 max	<p>ORA for older mammals</p> <p>ALLOW lactose is present</p> <p>ALLOW description of lactose causing repressor protein to leave operator</p> <p>ALLOW <i>lac</i> operon is switched on</p>
	(c)	<p>1 <u>zero</u> the colorimeter / set to <u>zero</u> ✓</p> <p>2 using <u>blank</u> ✓</p> <p>3 use red filter ✓</p> <p>4 use known concentrations (of lactose) ✓</p> <p>5 (produce) serial / series , dilutions ✓</p> <p>6 construct calibration curve ✓</p>	4 max	<p>ALLOW calibrate to zero</p> <p>3 ALLOW red light / orange filter</p> <p>4 ALLOW a list of stated concentrations</p> <p>5 ALLOW clear description</p> <p>6 ALLOW plot concentration against , transmission / absorbance</p>

Question			Answer	Marks	Guidance
			7 test <u>unknown</u> sample (using the same method) ✓ 8 use / read from , graph / calibration curve , to determine (unknown) concentration ✓		8 Cannot be assumed from mp 6
			Total	16	

Question			Answer	Marks	Guidance
21	(a)		restriction , enzyme / endonuclease ✓ same ✓ complementary ✓	3 max	ALLOW restriction (endonuclease) IGNORE sticky ends
	(b)		the gene / the DNA fragment , inserted into plasmid ✓ <u>complementary</u> bases (pair / anneal) ✓ formation of hydrogen bonds ✓ formation of phosphodiester bonds ✓ using (DNA) ligase ✓	3 max	ALLOW the bit of DNA combines with ring of bacterial DNA ALLOW <u>complementary</u> sticky ends DO NOT CREDIT in context of making hydrogen bonds
	(c)		use of <u>marker</u> (gene) ✓ (genes for) fluorescence / colour change ✓ (examine fluorescence under) UV , light / radiation ✓ antibiotic resistance (gene) ✓ (then) grow on agar containing antibiotic ✓	3 max	IGNORE replica plating ALLOW (gene for) glowing ALLOW use GFP ALLOW test for survival in antibiotic

Question		Answer	Marks	Guidance
	(d)	make , single stranded DNA / cDNA / complementary DNA ✓ using , reverse transcriptase / reverse transcription ✓ make double-stranded DNA using DNA polymerase ✓	2 max	IGNORE mRNA ALLOW make copy DNA
	(e)	(increase in antibiotic) <u>resistance</u> ✓	1	DO NOT CREDIT immune
Total			12	

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