Oxford Cambridge and RSA

GCE

Biology A

H420/02: Biological diversity

Advanced GCE

Mark Scheme for November 2020

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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.

Annotations

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

Marking Annotations

Annotation	Use
BOD	Benefit of Doubt
CON	Contradiction
	Cross
ECF	Error Carried Forward
GM	Given Mark
	Extendable horizontal wavy line (to indicate errors / incorrect science terminology)
I	Ignore
	Large dot (various uses as defined in mark scheme)
	Highlight (various uses as defined in mark scheme)
NBOD	Benefit of the doubt not given
	Tick
^	Omission Mark
BP	Blank Page
L1	Level 1 answer in Level of Response question
L2	Level 2 answer in Level of Response question
L3	Level 3 answer in Level of Response question

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	AO element	Guidance
1			A ✓	1	1.1	
2			D ✓	1	1.1	
3			D ✓	1	2.5	
4			D ✓	1	1.1	
5			B ✓	1	2.3	
6			A ✓	1	1.1	
7			A ✓	1	2.2	
8			A ✓	1	2.1	
9			C ✓	1	2.5	
10			D ✓	1	1.2	
11			D ✓	1	1.2	
12			C ✓	1	1.1	
13			D ✓	1	1.2	
14			C ✓	1	1.2	
15			A ✓	1	2.1	
			Total	15		

Question			Answer	Marks	AO element	Guidance
16	(a)		homeobox ✓ DNA ✓ transcription ✓ plant ✓ kingdoms ✓	5	1.1	
	(b)	(i)	**1** low cost ✓ **2** rapid reproduction (rate) / more generations in a given time ✓ **3** *idea that* fruit fly genetics / development is well understood ✓ **4** simple , genetics / body plan ✓ **5** (many) mutations / structures , observable with , light / low powered , microscope ✓	2 max	3.4	**1 ALLOW** easy to keep **1 IGNORE** small **2 ALLOW** short lifespan / grow quickly
		(ii)	low cost / rapid reproduction (rate) **or** genetics / development , well understood ✓ (more) similar / AW , to humans ✓ i*dea that* can show effects are generalisable to more than one species ✓ *idea that* more than one species is needed to demonstrate conservation of base sequence ✓	2 max	3.4	**ALLOW** easy to keep / short lifespan / grow quickly **IGNORE** small **ALLOW** share more genes with humans **IGNORE** homeobox sequence similar to humans **ALLOW** because they are mammals

Question			Answer	Marks	AO element	Guidance
17	(a)		in , (named) matrix / gel ✓ adsorption / bonding to (named) carrier ✓ membrane separation ✓ cross-linking / covalent bonding ✓	1 max	1.2	**ALLOW** entrapment / encapsulation / inclusion / microcapsulation **ALLOW** carrier bound **ALLOW** attached to partially permeable membrane
	(b)	(i)	**FIRST CHECK ON ANSWER LINE** **If answer = 6.8 +/- 0.8 award 2 marks** 7.5/1.1 = 6.8181· ✓ rounded to 2 s.f. = 6.8 ✓	2	2.4	 **ALLOW** mp 2 for incorrect answer rounded to 2 s.f
		(ii)	smooth curve **AND** goes through or near at least 7 points ✓	1	3.3	 **DO NOT CREDIT** extrapolations
		(iii)	**1** no value between pH5.5 and pH6 measured ✓ **2** peak / optimum , could be anywhere between pH5.5 and pH6 ✓ **3** peak / optimum , for immobilised tannase could be anywhere between pH 5 and pH6.5 ✓ **5** no indication that the experiment has been repeated ✓ **6** AVP ✓	3 max	3.2	**1 ALLOW** without smaller intervals the student cannot be certain **1 ALLOW** examples of untested pH values within this range **2 & 3 DO NOT CREDIT** optimum *is* 5.75 **5 ALLOW** enzyme activity is not stated as a 'mean' **5 IGNORE** not repeated **6 CREDIT** pH scale is , non linear / logarithmic **6 CREDIT** 10 a.u. is V_{max} for this enzyme

Question			Answer	Marks	AO element	Guidance
		(iv)	(immobilised enzymes are) less easily denatured ✓ shape / tertiary structure , supported / AW (by support material) ✓ *idea that* part of enzyme not fully exposed to pH (8) ✓	**2 max**	2.2	**ALLOW ora** for free tannase throughout **ALLOW** does not denature **ALLOW** bonds less easily disrupted
	(c)	(i)	**1** product not contaminated with enzyme ✓ **2** extraction of , product / enzyme , not needed ✓ **3** recycling (of enzyme) ✓ **4** *idea that* process can be run over wider temperature range ✓ **5** (bioreactors) can be run continuously for long periods, so less emptying / cleaning needed ✓	**2 max**	1.2	 **2 ALLOW** reduced downstream processing **3 ALLOW** enzyme can be reused / less enzyme needed **4 ALLOW** e.g. can be run at lower temperatures so less energy cost / can be run at higher temperatures so faster
		(ii)	high(er) , initial / set-up , costs ✓ fewer exposed active sites ✓ *idea that* immobilization method might affect shape of active site ✓ *idea of* leakage ✓	**1 max**	1.2	**ALLOW** immobilization process is expensive **IGNORE** more expensive to buy **ALLOW** active sites and substrates mix more slowly

Question			Answer	Marks	AO element	Guidance
18	(a)	(i)	**FIRST CHECK ON ANSWER LINE** **If answer = 0.41 award 2 marks** 13/32 ✓ correct answer to 2 s.f. ✓	**2**	2.4	*Max 1 if answer given as %*
		(ii)	*supports because…* **1** species B has greater (calculated genetic) polymorphism (than species A) ✓ ora *might not support because…* **2** numbers / polymorphisms , are similar ✓ **3** no statistical test performed ✓ **4** might not have sampled same loci ✓ **5** no indication of (fruit flies) sample size ✓	**3 max**	3.1 3.2	**1 ALLOW** ecf from calculated answer to part (i) **4 IGNORE** different numbers of gene loci studied **5 IGNORE** sample size is small
	(b)	(i)	bar chart drawn **AND** x-axis labelled 'phenotype' **AND** linear y-axis scale labelled 'frequency' ✓ bars correct height and same width ✓ bars fill half the available (vertical) space ✓ bars labelled / key **AND** tongue rolling and non-tongue-rolling bars do not touch ✓	**4**	3.3	**DO NOT CREDIT** stacked bars Y-axis must start at 0 **ALLOW** all 4 bars not touching

Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK ON ANSWER LINE** **If answer = 0.5 or 0.49 or 0.493 or 0.494 award 3 marks** q^2 = 77/248 = 0.31 ✓ q = √ 0.31 = 0.557 ✓ p = 1 – 0.557 = 0.443 $2pq$ = 2 x 0.443 x 0.557 = 0.494 ✓	**3**	2.4	**IGNORE** sig. figs for working marks **If answer incorrect, ALLOW** either half of working equations for 1 mark each up to a maximum of 2. **ALLOW e.g. '**q^2 = 77/248' or '77/248 = 0.31'
		(iii)	(population) not (sufficiently) large ✓ (population) not randomly mating / not subject to selection ✓	**2**	2.3	*Mark the first answer on each prompt line* **ALLOW ora** in context of Hardy-Weinberg assumptions **ALLOW** mutations might occur **IGNORE** immigration / emigration

Question			Answer	Marks	AO element	Guidance
19	(a)	(i)	prophase then metaphase then anaphase then telophase ✓✓	2	1.2	**MAX 1** if interphase or cytokinesis mentioned **ALLOW** 1 mark if phases named correctly but not in correct order
		(ii)	genetically identical offspring ✓ offspring produced , rapidly / in large numbers ✓ (all) offspring will , find conditions favourable / have same adaptations ✓	2 max	2.1	**IGNORE** clones **ALLOW** produces more offspring **ALLOW** finding mate requires , time / energy **ALLOW** population can increase rapidly **IGNORE** 'quicker' without some qualification
	(b)	(i)	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *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):* ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.***			

			Level 3 (5–6 marks) Explains in detail how sexual reproduction leads to genetic variation with reference to more than one stage of meiosis and with reference to *Hydra*. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Explains in some detail how sexual reproduction leads to genetic variation with reference to more than one stage of meiosis OR with reference to *Hydra* and one stage of meiosis. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Mentions more than one reason why sexual reproduction leads to genetic variation. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** *No response or no response worthy of credit.*	**6**	1.1, 1.2 2.5	**Indicative points include** *AO1.1 Demonstrate knowledge and understanding of scientific ideas* • genetic variation is the variety of alleles • offspring have alleles from more than one parent • random fertilisation • meiosis produces genetically unique gametes *AO1.2 Demonstrate knowledge and understanding of scientific processes* • crossing over in prophase 1 • alleles swapped between non-sister chromatids • base sequence of chromosomes altered • independent assortment / random segregation • in metaphase 1 • also relevant in metaphase 2 if crossing over has occurred *AO2.5 Apply knowledge and understanding of scientific processes in a theoretical context when handling qualitative data* • the sperm from one *Hydra* can fertilise an egg from any other individual Hydra • the two *Hydra* can have different alleles	1.1 1.2 2.5

						• sperm carried in water • might travel large distances • to unrelated *Hydra* •	
Question			**Answer**	**Marks**	**AO element**	**Guidance**	
		(ii)	(some offspring) might survive unfavourable conditions ✓ (some) offspring have useful alleles ✓ (named) unfavourable conditions mean (all) offspring might die (if asexual) ✓	**1 max**	2.1	**IGNORE** eggs can lie dormant as stated in question **IGNORE** less susceptible to unfavourable conditions	
	(c)	**(i)**	224 ✓	**1**	2.2	*haploid number = 28* *x 2 for diploid number = 56* *x 2 after DNA replication = 112* *x 2 strands per molecule = 224*	
		(ii)	a cross drawn anywhere between sporophyte and spores ✓	**1**	2.5		
		(iii)	many mitochondria ✓ to supply , energy / ATP , for movement ✓ **OR** enzymes / acrosome ✓ (enzymes) to , penetrate / AW , egg ✓	**2**	2.1	*Mark the first suggestion given but ignore partially achieved marking points* **DO NOT CREDIT** make energy **ALLOW** to digest outer layer / break through membrane **DO NOT CREDIT** break down egg cell wall	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>20</td><td>(a)</td><td>(i)</td><td>A = combustion ✓

F = respiration ✓</td><td>2</td><td>1.2</td><td>ALLOW burning

IGNORE aerobic / anaerobic</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>more combustion / less photosynthesis ✓</td><td>1</td><td>2.6</td><td>ALLOW more burning (of fuel)</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td><table><tr><th>Glucose</th><th>Starch</th></tr><tr><td>monomer</td><td>polymer</td></tr><tr><td>monosaccharide</td><td>polysaccharide</td></tr><tr><td>no glycosidic bonds</td><td>glycosidic bonds</td></tr><tr><td>$C_6H_{12}O_6$ / more H and O</td><td>$C_6H_{10}O_5$ / less H and O</td></tr></table>✓ ✓ ✓ ✓</td><td>max 3</td><td>2.1
2.2</td><td>Mark the first 3 responses
ALLOW two responses in the same box if they are on the same horizontal level

ALLOW glycosidic links
IGNORE 1-6 glycosidic bonds

IGNORE branched</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>S / sulfur ✓</td><td>1</td><td>1.1</td><td>ALLOW sulphur</td></tr>
<tr><td></td><td>(c)</td><td colspan="5">Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.

In summary:
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):
○ award the higher mark where the Communication Statement has been met.
○ award the lower mark where aspects of the Communication Statement have been missed.

• The science content determines the level.
• The Communication Statement determines the mark within a level.</td></tr>
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Question		Answer	Marks	AO element	Guidance

		Level 3 (5–6 marks)
		Describes in detail the main similarities between the carbon and nitrogen cycles.
		
		There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.
		
		Level 2 (3–4 marks)
		Describes some of the key similarities between the carbon and nitrogen cycles, at least one similarity is discussed in detail.
		
		There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.
		
		Level 1 (1–2 marks)
		Mentions some similarities between the carbon and nitrogen cycles.
		
		The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.
		
		0 marks
		No response or no response worthy of credit.
			6	2.5	**Indicative points include**
					
					AO2.5 Apply knowledge and understanding of scientific processes in a theoretical context when handling qualitative data
					
					• inorganic gases
					  ○ CO_2 and N_2
					• in atmosphere
					
					• elements fixed to organic compounds
					  ○ C and N both form proteins / nucleic acids
					• incorporated into plants (producers) then animals (consumers)
					• animals obtain element by feeding on plants
					
					• decomposing microorganisms
					• break down organic macromolecules in living things
					• release inorganic molecules
					  ○ carbon dioxide and ammonium ions
					
					• microorganisms return element to atmosphere
					  ○ CO_2 released during decomposition
					  ○ N_2 released by denitrifying bacteria

Question			Answer	Marks	AO element	Guidance
21	(a)	(i)	**FIRST CHECK ON ANSWER LINE** **If answer 91 ± 1 or 90.7 ± 1 (%) award 2 marks** 215 000 – 20 000 = 195 000 195 000/215 000 = 0.907 ✓ x 100 = 90.7 ✓	**2**	2.8	*Max 1 if answer not given to 2 or 3 s.f.* *If answer incorrect …* **ALLOW** 195 000/215 000 **or** 0.907 for 1 mark
		(ii)	*idea of* changes over time ✓ figs with units to illustrate population change ✓	**2**	2.8	**ALLOW** calculated change / ref to answer to part (i)
		(iii)	**1** no data shown for , winter months / Dec / Jan / Feb ✓ **2** no data shown about temperature or light ✓ **3** *idea of* fluctuations / dips during summer months ✓ **4** another , biotic / abiotic , factor could be causing the increase ✓	**3 max**	3.2	**4 ALLOW** e.g. increased nutrient availability / reduction in predators / increased CO_2 / qualified reference to pollution **4 ALLOW** correlation does not imply causal link
	(b)	(i)	**1** protoctista ✓ **2** nucleus / (named) membrane-bound organelles , so <u>eukaryot</u>ic / not <u>prokaryot</u>ic ✓ **3** unicellular so not plant(ae) ✓ **4** cell wall / chloroplast / starch grains, so not animal(ia) ✓ **5** cellulose cell wall / chloroplast , so not fungi ✓	**4 max**	3.1 3.2	**1 ALLOW** protista **2 IGNORE** eukarya **2 IGNORE** peptidoglycan **4 IGNORE** autotrophic

Question			Answer	Marks	AO element	Guidance
						5 ALLOW cell wall not chitin so not fungi **5 IGNORE** autotrophic
		(ii)	(nucleic acid) base sequence / amino acid sequence ✓ genes / DNA / RNA / cytochrome C ✓	**1**	2.1	**ALLOW** genetic material **IGNORE** chromosomes / RNA polymerase / ribosomes **DO NOT CREDIT** haemoglobin

Question			Answer	Marks	AO element	Guidance
22	**(a)**	**(i)**	C and F and I and J ✓	**1**	1.2	**ALLOW** the correct terms written instead of letters
		(ii)	I and J ✓	**1**	1.1	**ALLOW** the correct terms written instead of letters
		(iii)	A and E and G and H ✓	**1**	1.2	**ALLOW** the correct terms written instead of letters
		(iv)	F ✓ one / few , types of cell performing a function ✓	**2**	2.1 1.1	**ALLOW** mucous membrane **IGNORE J** **ALLOW** examples of cells involved if one or few types is implied **ALLOW** similar cells doing the same job
	(b)		*cytokines* attract / AW , (named) phagocytes ✓	**2**	1.2	**IGNORE** increase phagocytosis without reference to movement

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<tr><td></td><td></td><td></td><td>opsonins
bind to / AW , pathogens / foreign cells / antigens , and increase phagocytosis / recognition by phagocytes ✓</td><td></td><td></td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td><table><tr><th>type of immunity</th><th></th></tr><tr><td>natural and active</td><td></td></tr><tr><td>natural and passive</td><td></td></tr><tr><td>artificial and active</td><td></td></tr><tr><td>artificial and passive</td><td>✓</td></tr></table></td><td>1</td><td>2.5</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>injected ✓

(patient) is not producing , antibodies / memory cells / immune response ✓</td><td>2</td><td>1.1</td><td>IGNORE natural / artificial / active / passive
IGNORE ‘antibodies are given’, as this is in the question</td></tr>
</table>

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