GCE

Biology A

H420/01: Biological processes

A Level

Mark Scheme for June 2025

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training: OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor,

which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses

When a multiple choice question has only a single, correct response and a candidate provides two responses, the one inside the box should be marked and any other responses outside the box should be ignored, unless the response inside the box has been crossed out. If no response is inside the box and a single answer is outside this can be marked. If a candidate provides two responses outside the box (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate). When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

7. There is a NR (**No Response**) option. Award NR (No Response):
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
   - OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*

10. For answers marked by levels of response:
Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:
The **higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
The **lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response questions on this paper are **18(b)** and **20(d**

10. **Annotations**

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

Annotation	Meaning
BP	Blank page

11. **Subject Specific Marking Instructions**

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
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

13. **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	C	**1**	1.2	
2	A	**1**	1.1	
3	C	**1**	1.1	
4	A	**1**	1.1	
5	D	**1**	1.2	
6	D	**1**	1.2	
7	B	**1**	2.8	
8	A	**1**	2.8	
9	C	**1**	2.6	
10	D	**1**	2.5	
11	B	**1**	2.7	
12	C	**1**	1.2	
13	A	**1**	1.2	
14	B	**1**	2.3	
15	C	**1**	2.3	

Question			Answer	Marks	AO Element	Guidance
16	(a)	(i)	**A**: thylakoid (membranes) / grana / granum ✓ increased / large, surface area for, light absorption / light dependent reaction **OR** contains (lots of), photosystems / accessory pigments / photosynthetic pigments / ETC / ATP synthase, for, light absorption / light dependent reaction / chemiosmosis ✓ **B**: stroma ✓ contains, (named) enzymes / (named) substrates for, light independent reactions / Calvin cycle **OR** contains, DNA/ ribosomes, for (photosynthetic) protein synthesis ✓	**4**	2.1	**ALLOW** 'LDR' for 'light dependent reaction and 'LIR' for 'light independent reaction' **ECF** If chloroplast component is incorrect but adaptation is correct for A/B, award 1 mark **ECF** (for each adaptation) **ECF** If component A/B wrong way around and adaptation matches **their answer**, award 1 mark ECF (for each adaptation) **IGNORE** ref to, volume/V **ALLOW** photons for 'light' **ALLOW** 'proton pumps' for ETC. **ALLOW** 'stalked particle' for ATP synthase **ALLOW** named stage in the Calvin cycle for 'Calvin cycle'. **IGNORE** (named) light dependent enzymes **IGNORE** (contains) starch/lipid

Question			Answer	Marks	AO Element	Guidance
16	(a)	(ii)	**Similarities- max 1**	2	2.1	read as prose throughout **IGNORE** ref to starch
		1.	(both have) an envelope / double membrane / intermembrane space ✓			**1 ALLOW** 'outer and inner' for 'double'
		2.	(both have) (smaller / 70S) ribosomes / (circular) DNA ✓			
		3.	(both have) ETC (components) / ATP synthase ✓			
			Differences- max 1			**ALLOW ora** for **mp4-6** *e.g. mitochondria do not have photosystems*
		4.	chloroplasts have, photosystems / (named) photosynthetic pigments ✓			
		5.	mitochondria have (membranes folded into) cristae ✓			
		6.	chloroplasts have, thylakoids / granum /grana / lamellae ✓			
		7.	mitochondria have matrix **and** chloroplasts have stroma ✓			

Question			Answer	Marks	AO Element	Guidance
16	(b)	(i)	**Distance travelled = 91 mm, award 1 mark** distance travelled by most soluble = 91 (mm) ✓ **FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.83 award 2 marks** R_f = 91 ÷ 109 ✓ = 0.83 ✓	**3**	2.7	**ALLOW** +/- 0.5mm for each measured distance (soluble pigment and solvent front) **ALLOW** values of 87 **or** 95 **ALLOW 2 marks for** Rf value on answer line matches correct distance travelled answer (refer to table) to 2sf Rf value on answer line correct to 2sf with calculation expressed in cm e.g. *9.1÷ 10.9 = 0.83* incorrect soluble pigment distance measured but subsequent calculation correct with answer to 2sf e.g. *36 ÷ 109 = 0.33* **ALLOW one mark for** incorrect solvent front distance measured but subsequent calculation correct with answer to 2sf e.g. *91 ÷ 111 = 0.82*

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO Element</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>incorrect soluble pigment distance measured and incorrect solvent front distance measured but subsequent calculation correct with answer to 2sf

e.g. 73 ÷ 114 = 0.64

answer not to 2sf but calculation shows correct distances measured for both soluble pigment and solvent front.

e.g. 87 ÷ 109 = 0.798

<table>
<tr><th>Pigment</th><th>Solvent front</th><th>Rf</th></tr>
<tr><td>86.5</td><td>108.5</td><td>0.80</td></tr>
<tr><td>86.5</td><td>109 / 109.5</td><td>0.79</td></tr>
<tr><td>87.0</td><td>108.5 / 109</td><td>0.80</td></tr>
<tr><td>87.0</td><td>109.5</td><td>0.79</td></tr>
<tr><td>87.5</td><td>108.5</td><td>0.81</td></tr>
<tr><td>87.5</td><td>109 / 109.5</td><td>0.80</td></tr>
<tr><td>90.5</td><td>108.5 / 109 / 109.5</td><td>0.83</td></tr>
<tr><td>91.0</td><td>108.5</td><td>0.84</td></tr>
<tr><td>91.0</td><td>109 / 109.5</td><td>0.83</td></tr>
<tr><td>91.5</td><td>108.5 / 109 / 109.5</td><td>0.84</td></tr>
<tr><td>94.5</td><td>108.5 / 109</td><td>0.87</td></tr>
<tr><td>94.5</td><td>109.5</td><td>0.86</td></tr>
<tr><td>95.0</td><td>108.5</td><td>0.88</td></tr>
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</table>
</td></tr>
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Question			Answer	Marks	AO Element	Guidance
16	(b)	(ii)		max 2	3.3	**ALLOW** dots for spots
		1.	allow/ leave, (existing) spot/ extract (at origin), to dry ✓			
		2.	(once dry) add, another spot / more extract, to, X / origin / original spot ✓			**2 ALLOW** 'pigment**s**' for 'spots' **2 ALLOW** origin line for 'origin'
		3.	evaporate (some) solvent from (original) extract ✓			
16	(b)	(iii)		max 1	3.3	
		1.	allow the ,TLC to run for longer / solvent to travel further ✓			**1 ALLOW '**chromatography paper' for 'TLC' **1 ALLOW** use a longer TLC, plate / paper
		2.	mark the, solvent front/ pigments/spots, immediately (after removing from solvent) ✓			
		3.	measure front and back of spot and divide by 2 (to get more accurate centre measurement) ✓			
		4.	repeat and calculate mean ✓			
16	(b)	(iv)	data book used a different , solvent / (TLC) plate / temperature ✓	max 1	3.1	
			extract was prepared from different, plant /chloroplasts✓			

Question			Answer	Marks	AO Element	Guidance
16	(b)	(v)	run known pigments, on same TLC/ using same set up / with same solvent / at same time ✓ compare to position of known pigments **OR** compare colour to, known pigments / colour chart ✓	**2**	3.3	**ALLOW** 'same conditions' for 'same set up' **IGNORE** ref to colorimeter **ALLOW** colour in, data, book/base for 'colour chart'
17	(a)	(i)	phosphorylation ✓	**1**	2.5	**DO NOT ALLOW** 'substrate level' phosphorylation
17	(a)	(ii)		**max 3**	2.5	*must refer to active site at least once for mp2 and 3* **ALLOW** PFK for 'enzyme' throughout **IGNORE** 'fit' for 'bind' once then **ECF**
		1.	(PEP) binds to, the allosteric site / the enzyme away from the active site ✓			
		2.	(so) changes the, tertiary structure / shape, of the, enzyme / active site ✓			**2 DO NOT ALLOW** (enzyme) denatures
		3.	substrate / fructose phosphate , cannot bind / is not complementary to, active site ✓			**3 ALLOW** less/no, enzyme- substrate complexes form **3 ALLOW** less substrate/fructose phosphate can bind
		4.	reversible because, PEP/inhibitor, forms, temporary / (named) weak, bonds ✓			**4 DO NOT ALLOW** covalent bonds **4 ALLOW** 'not permanently bound' for 'temporary bonds'

Question			Answer	Marks	AO Element	Guidance
17	(a)	(iii)	*cannot competitively inhibit because*	max 2	2.5	
		1.	ATP does not have a similar shape to, substrate / fructose phosphate ✓			**1 ALLOW** 'ATP has different shape' for 'ATP does not have a similar shape' **1 ALLOW** 'structure' for 'shape'
		2.	ATP is not complementary (in shape) to active site (where fructose phosphate enters) ✓			**2 IGNORE** ATP does not enter the active site
		3.	ATP cannot compete with itself for the active site ✓			
		4.	ATP needed to add phosphate to fructose phosphate (for glycolysis to continue / fructose bisphosphate formation) ✓			**4 ALLOW** ATP has to be hydrolysed for PFK to function **4 ALLOW** ATP and fructose phosphate both enter active site to transfer phosphate from one to the other
17	(a)	(iv)	end-product (inhibition) ✓	1	1.2	
17	(a)	(v)		max 2	3.1	*must refer to rate (of glycolysis) at least once for mp1 and 2*
		1.	(when ATP) inhibits PFK (glycolysis) rate, decreases/ stops✓			**1 ALLOW** high rate returns to normal when PFK is inhibited
		2.	(with) AMP binds to PFK and (glycolysis) rate increases ✓			**2 ALLOW** 'stops the inhibition of / activates' for 'binds to' **2 ALLOW** low rate returns to normal when AMP binds to PFK
		3.	PFK activity / rate of glycolysis, is determined by ATP:AMP ✓			**3 ALLOW** 'relative concentration/ proportions, of ATP and AMP' for 'ATP:AMP'

Question			Answer	Marks	AO Element	Guidance
17	(b)		non-reversible ✓	1	1.1	**ALLOW** irreversible **IGNORE** permanent
17	(c)	(i)	(oxidative) decarboxylation ✓	1	1.2	
17	(c)	(ii)	link (reaction) ✓ Krebs (cycle) ✓	2	1.2	**ALLOW** any order
17	(c)	(iii)	*Oxidation occurs in glycolysis when* Dehydrogenation / removal of H (from TP) ✓ H goes to, NAD / coenzyme / H acceptor ✓	2	1.2	**ALLOW '**$H^+ + e^-$' for 'H' **IGNORE** triose bisphosphate **ALLOW** to reduce, NAD/ coenzyme **ALLOW** NAD($^+$) ⟶ NADH **Max 1** if H^+ / e-, only stated ***Award 2 marks for***: **e.g**. • *a hydrogen is removed to form NADH* • *NAD accepts hydrogen from TP*

Question			Answer	Marks	AO Element	Guidance
18	(a)	1.	water, is absorbed by seed/ activates embryo ✓	max 4	1.2	**1 IGNORE** GA causes water uptake
		2.	(embryo releases), gibberellin / GA ✓			**2 DO NOT ALLOW** gibberellin and ABA (causing germination)
		3.	production / gene expression, of digestive enzymes ✓			**3&4 ALLOW** named enzymes e.g. lipase/ amylase/ protease/ maltase **3 ALLOW** 'gene activation' for 'gene expression' **3 IGNORE** (named) enzymes, activated / released
		4.	enzymes , digest / break down , (named) food / energy, stores ✓			
		5.	product / glucose, used, in respiration / to produce ATP ✓			**5 DO NOT ALLOW** ref to, photosynthesis/ plant respiring
		6.	abscisic acid / ABA , inhibits germination / causes dormancy ✓			**6 ALLOW** cytokinins / ethene, promote germination **6 ALLOW** ABA is antagonistic to gibberellins

Question			Answer	Marks	AO Element	Guidance
18	(b)*		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** An appropriate null hypothesis **AND** interpretation of the *t*-test **AND** a detailed discussion of points not supporting the conclusion. *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)** An appropriate null hypothesis **AND** some interpretation of the *t*-test **OR** An appropriate null hypothesis **AND** a discussion of points not supporting the conclusion **OR** Some interpretation of the t-test **AND** a discussion of points not supporting the conclusion. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	**6**	2.4 3.2 3.4	**Comms**: line of reasoning based on • **stated** critical values that are **correct** • differences between means not in context of correlation/relationship. **Indicative scientific points could include:** *Null / H_0 hypothesis* • there is no (significant) difference between (mean, internode / stem) lengths • there is no (significant) increase in stem length compared to control. • Application of gibberellin has no effect on stem length. *Interpretation of t-test / supporting conclusion* • *t* > critical value • reject null hypothesis **OR** there is a significant, difference/ increase in, internode/stem, length • <5% / <1% , probability **the differences** are due to chance

Question			Answer	Marks	AO Element	Guidance
			Level 1 (1–2 marks) An appropriate null hypothesis **OR** some interpretation of the *t*-test **OR** some points not supporting the conclusion. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*			*Points not supporting conclusion* • The sample size is small • There is no information about/ should make sure that, seedlings grown in same (named) environment • There is no information about/ should make sure that, seedlings similar • There is no information about/ should make sure that, gibberellin is same • There is no information about/ should make sure that, control group given water (instead of GA) • Endogenous gibberellin may have interfered • Internode length of 5^{th} & 6^{th} pairs may not be representative of stem length • The standard deviations are (relatively) large (either generally or GA higher than control group)

Question			Answer		Marks	AO Element	Guidance
18	(c)		1	the chemical reduced gibberellin <u>concentration</u> ✓	max 3	3.2	**IGNORE** ref to other uses of GA **1 ALLOW** GA, gibberellic acid **1 ALLOW** chemical causes zero gibberellin concentration
			2	(plants) shorter / reduced stem size so, do not fall over / stay upright ✓			**2 ALLOW** 'less' for 'do not' **2 ALLOW** 'stems are not elongated' for 'shorter' **2 IGNORE** 'smaller' for 'shorter'
			3	plants are less damaged / more can be harvested (to increase yield). ✓			**3 ALLOW** 'more viable/ lost less' for 'less damaged'
			4	plants use less (named) resources for growth of stem so can increase yield ✓			**4 ALLOW** protein/lipid/glucose/carbohydrate/energy for 'resources'
19	(a)	(i)			max 2	3.3	**mark as prose** **DO NOT ALLOW** CO_2 concentration, light intensity, pH **1 IGNORE** amount of beads **1 ALLOW** algae for 'beads'
			1.	number/ size / volume / mass, of beads ✓			
			2.	species/ type / age, of algae ✓			
			3.	wavelength of light ✓			
			4.	temperature ✓			
			5.	concentration / volume , of <u>indicator</u> ✓			

Question			Answer	Marks	AO Element	Guidance
19	(a)	(ii)	relative intensity = $\underline{7.11 \times 10^{-6}}$ ✓ mean = ((77 + 80 + 82 + 78) ÷ 4) = $\underline{79.3}$ ✓	2	2.4	**ALLOW** values written in table in standard form **IGNORE** units
19	(a)	(iii)	use a colorimeter ✓ measure the time taken to reach an absorbance value ✓ **OR** Use a pH probe ✓ Measure the time taken to reach a set pH ✓	2	3.3	**DO NOT ALLOW** calorimeter **ALLOW** '% transmission' for 'absorbance' **ALLOW** measure the absorbance after a set time **ALLOW** measure the pH after a set time
19	(b)	(i) **1.** **2.** **3**	different / changing / increasing, CO_2 concentrations ✓ (adding CO_2) initially, changes/ effects, the colour of the indicator ✓ CO_2 concentrations cannot be both an independent and dependent variable ✓	max 2	3.2	**IGNORE** hydrogen carbonate in context of releasing / source of, CO_2 **2 ALLOW** (at high concentrations of CO_2) colour will remain, yellow/red/orange (for long time) **2 ALLOW** (at low concentrations of CO_2) colour could be purple at the start (of experiment) **3 ALLOW** changes/ results /colour, due to (added) CO_2 and not (only) photosynthesis

Question			Answer	Marks	AO Element	Guidance
19	(b)	(ii)	measure <u>oxygen</u> production / use an <u>oxygen</u> sensor ✓ gas/ oxygen, produced/ collected, in, stated/ set, time = rate (of, oxygen production / photosynthesis) ✓ **OR** measure time taken for DCPIP to, decolourise / change colour✓ 1/time = rate (of photosynthesis) ✓	**2**	3.3	**ALLOW** count the <u>oxygen</u> bubbles/ use gas syringe to measure volume of <u>oxygen</u> / measure length of <u>oxygen</u> bubble **DO NOT ALLOW** names of apparatus that does not match a method for measuring oxygen production in photosynthesis. **ALLOW** O_2 for 'oxygen' **DO NOT ALLOW** CO_2 for gas **ALLOW** measure time taken to produce set volume of oxygen = rate
19	(c)	(i) **1** **2**	(rate) plateau shows light intensity is no longer limiting ✓ higher rate, with increasing CO_2/ when CO_2 goes from 0.1% to 0.2% (at same temperature)✓ **ora**	**2**	2.2 3.2	**1 IGNORE** CO_2/ temperature, is limiting the rate **1 ALLOW** (rate) remains constant / levels off, for 'plateaus' **1 ALLOW** graph/line, plateaus

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO Element</th><th>Guidance</th></tr>
<tr><td>19</td><td>(c)</td><td>(ii)</td><td></td><td>max 2</td><td>2.8</td><td></td></tr>
<tr><td></td><td></td><td>1.</td><td>doubling CO_2 concentration doubles rate ✓</td><td></td><td></td><td>ALLOW 0.2% CO_2 was 2x higher than 0.1% (at 20’C)</td></tr>
<tr><td></td><td></td><td>2.</td><td>calculation
(Q_{10}) rate at 30ºC ÷ rate at 20ºC
OR
Rate when CO_2 is 0.2% ÷ rate when CO_2 is 0.1% ✓</td><td></td><td></td><td>ALLOW e.g Q_{10} = 27/18 = 1.5</td></tr>
<tr><td></td><td></td><td>3.</td><td>a 10°C increase in temperature, does not double the rate/ the rate is less than doubled ✓</td><td></td><td></td><td></td></tr>
</table>

Temp	CO_2 0.1	CO_2 0.2	Rel increase
20	8.5 (8.6/ 8.7)	18	X 2.1
30	14 (13.8 / 13.9)	27	X 1.9 (x 2.0)

CO_2	Temperature 20	Temperature 30	Q_{10}
0.1	8.5 (8.6/ 8.7)	14 (13.8 / 13.9)	X 1.6
0.2	18	27	X 1.5

<table>
<tr>
<td>20</td>
<td>(a)</td>
<td></td>
<td>
<table>
<tr><th>Description</th><th>Blood vessel type</th></tr>
<tr><td>This blood vessel type transports deoxygenated blood to the lungs.</td><td>F ✓</td></tr>
<tr><td>This blood vessel type is the site of exchange of gases and nutrients.</td><td>H ✓</td></tr>
<tr><td>This blood vessel type is involved in regulation of blood flow near the surface of the skin.</td><td>G ✓</td></tr>
</table>
</td>
<td>3</td>
<td>1.1</td>
<td>DO NOT ALLOW additional answer for each blood vessel type</td>
</tr>
<tr>
<td>20</td>
<td>(b)</td>
<td>1.

2.

3</td>
<td>no backflow because

short distance (from lungs to heart) / short (length of) vein ✓

flow is not against <u>gravity</u> ✓

pressure, high / is not low (compared to other veins)✓</td>
<td>1</td>
<td>2.1</td>
<td>2 ALLOW flow is with <u>gravity</u></td>
</tr>
<tr>
<td>20</td>
<td>(c)</td>
<td></td>
<td>J = sino-atrial node / SAN ✓

K = atrio-ventricular node / AVN / AV node ✓

L = septum ✓

M = purkyne , fibres / tissue ✓</td>
<td>4</td>
<td>2.1</td>
<td>ALLOW L = bundle of His

ALLOW M = Purkinje fibres</td>
</tr>
</table>

20	**(d)***		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** A comprehensive description that covers the initiation and coordination of heartbeat including myogenic activity **AND** relates the electrical changes in the heart to components of the ECG trace. *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)** A description that covers the initiation and coordination of heartbeat which may include myogenic activity **AND** relates the electrical changes in the heart to a component of the ECG trace. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** An outline description that covers the initiation and coordination of heartbeat **OR** includes myogenic activity **OR** relates the electrical changes in the heart to a component of the ECG trace. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	1.1 2.1	**Comms:** sequence of events is correct i.e. • SAN before AVN, • ECG in correct order (P before QRS/ QRS before T) **Indicative scientific points could include:** **<u>Myogenic activity</u>** • Cardiac/heart, muscle, initiates its own contraction (from rest)/ is myogenic • SAN, is pacemaker/ sets up regular beat • No CNS input required (at rest) **<u>Initiation & Coordination</u>** • SAN causes, wave of excitation / depolarisation / impulse • (waves/ impulse) across atria walls • (so) atria contract • Pause / delay, at AVN • (pause) to allow atria to empty/ so atria contract before the ventricles • Transmission along bundle of His to Purkyne fibres • Purkyne fibres conduct impulse through wall of ventricles • Contraction occurs from apex • ventricles contract at the same time **<u>Correlation with ECG trace</u>** • P wave represents, atrial depolarisation / atrial systole / atria contracting • QRS complex represents ventricular, depolarisation / ventricular systole / ventricles contracting • T wave shows (ventricular)**,** repolarisation / recovery/ diastole / relaxation

20	**(e)**	**(i)**	abnormality: bradycardia reason: because the, T wave and (next) P wave are far apart (than normal) ✓	**1**	2.1	**both needed for mark** **DO NOT ALLOW** brachycardia **ALLOW** because heart, rate/ beat, is slow (than normal) **ALLOW** distance between successive QRS complexes, is greater than normal / are further apart
20	**(e)**	**(ii)**	abnormality: ectopic heartbeat reason: because the distance between the 4th and 5th beats is less than normal ✓ **OR** abnormality: (atrial) fibrillation reason: no (distinct) P wave ✓	**1**	2.1	**both needed for mark** **ALLOW** because 5th heartbeat is early **ALLOW** one heart beat is (too) early

21	**(a)**	**(i)** **1.** **2.** **3.** **4.** **5.**	gill filaments / lamellae , provide large / increases, surface area ✓ thin walls (of lamellae / capillaries) provide short diffusion distance ✓ extensive blood supply for increased (rate of), gas exchange / diffusion ✓ counter-current flow maintains (concentration) gradient ✓ gill filament tips, overlap / interlock, so more time for gaseous exchange ✓	**max 3**	1.1	**read as prose** **1 ALLOW** gill plates **1 ALLOW SA:V** for 'surface area' **2 ALLOW** 'only one cell thick' for 'thin walls' **4 ALLOW** 'counter-current, exchange/system' for 'counter-current flow' **4 ALLOW** description for 'counter current' *e.g. water and blood flow in different directions*
21	**(a)**	**(ii)** **1.** **2.** **3.**	(Insect) tracheoles / trachea(e), for gas exchange / supplies oxygen / supplies gases (directly) ✓ circulatory system/ haemolymph, does not transport oxygen / separate from oxygen transport ✓ small size / short distances , in insects means a high (blood), flow rate/ pressure, is not needed ✓	**3**	1.1	**1 ALLOW** takes air (straight) to the tissues **1 ALLOW** tracheal fluid for 'trachea' **2 ALLOW** insect circulatory system transports, **only** nutrients **3 IGNORE** ref to SA:V **3 IGNORE** (insect) low metabolic rate

21	**(a)**	**(iii)** **1.** **2.** **3.** **4.**	large, distances/mass, require, fast blood flow / high pressure ✓ **ora** whales have double circulatory system / sharks have single circulatory system ✓ double circulatory system allows , high**er** pressure / fast**er** flow ✓ **ora** whales obtain oxygen from air which has, higher concentration / partial pressure ✓	**2**	2.1	**ALLOW** mammals for whales and fish for sharks throughout **ALLOW** 'they' for mammals **1 IGNORE** 'maintains' for 'high' **2 ALLOW** description of double / single circulatory systems **2 DO NOT ALLOW** open circulatory system **4 ALLOW** sharks obtain oxygen from water which has, a lower concentration/ partial pressure

21	**(b)**	**1.**	soluble globular protein ✓	**max 4**	1.1 2.1	**1 ALLOW** hydrophilic R groups on outside so soluble
		2.	Fe^{2+} / haem, able to bind to O_2 ✓			**2 IGNORE** haem/haemoglobin, has a high affinity for O_2 **2 ALLOW** iron ion **2 IGNORE** Fe^{3+} **2 IGNORE** Fe / iron unqualified
		3.	4 polypeptides / (1) haemoglobin, allows binding of 4 O_2✓			**3 ALLOW ‘**carries’ for ‘binding’ **3 ALLOW** ‘subunit / haem’ for ‘polypeptide’ **3 ALLOW ‘**8 oxygen atoms’ for ‘4 oxygen molecules’
		4.	cooperative binding / positive cooperativity✓			**4 ALLOW** description of cooperative binding e.g. *once one oxygen molecule has bound to haemoglobin the tertiary structure changes so easier for other oxygen molecules to bind*
		5.	allows saturation at, high pO2/ lungs **and** release at, low pO2 / tissues ✓			**5 ALLOW** ‘loading/ associate’ for ‘saturation’ and ‘unloading/ dissociate’ for ‘release’ ***e.g.*** *haemoglobin has 4 haem groups each of which can bind with an oxygen molecule = 2 marks (mp2 & 3)*

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