GCE

Biology A

H420/01: Biological processes

Advanced GCE

Mark Scheme for Autumn 2021

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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

Question			Answer	Mark	AO element	Guidance
1			C	1	1.1	
2			B	1	1.2	
3			C	1	1.2	
4			A	1	1.1	
5			C	1	2.1	
6			B	1	1.1	
7			B	1	2.6	
8			B	1	2.6	
9			B	1	1.1	
10			C	1	2.1	
11			D	1	1.1	
12			D	1	1.1	
13			B	1	1.1	
14			A	1	2.7	
15			B	1	1.2	

Question			Answer	Mark	AO element	Guidance
16	(a)	(i)	**A** = sinoatrial node / SA node / SAN ✓ **B** = <u>right</u> , atrium / atria ✓ **C** = (inferior) vena cava ✓ **D** = semilunar valve ✓ **E** = bicuspid / (left) atrioventricular / (left) AV , valve ✓	**5**	1.1	**DO NOT ALLOW** sinoarterial **ALLOW** aortic valve **ALLOW** mitral valve **DO NOT ALLOW** tricuspid
16	(a)	(ii)	autonomic ✓	**1**	1.1	**ALLOW** parasympathetic / sympathetic
16	(b)	(i)	I ✓ medulla (oblongata) ✓	**2**	1.1	
16	(b)	(ii)	heart rate controlled by , nervous / autonomic , system / AW ✓ parasympathetic / vagus , nerve reduces heart rate / AW ✓ heart rate reduces by (approximately) 30 bpm ✓	**max 2**	3.1	**ALLOW** heart rate controlled by more than one nerve
16	(b)	(iii)	<u>hypothalamus</u> **AND** <u>pituitary</u> ✓ produce a wide range of hormones / AW ✓ affect other , endocrine / hormone-producing , glands ✓ explanation of symptom caused by injury to G or H from Fig. 16.2 ✓	**max 2**	2.1	**MP1** ignore letters e.g. damage to thermoregulatory centre in , G / hypothalamus , leads to increased sensitivity to cold e.g. damage to , H / pituitary , means reduction in (named) reproductive hormones which leads to menstrual irregularities

16	**(b)**	**(iv)**	damage to other endocrine glands could cause similar symptoms ✓ symptoms (may be) caused by , underlying conditions / other disease / co-morbidity ✓ symptoms (may be) result of epigenetic factors ✓	**max 1**	2.1	**ALLOW** e.g. damage to other organs could cause similar symptoms
16	**(c)**		spinal cord ✓ synapses ✓	**2**	1.1	**DO NOT ALLOW** spine **ALLOW** synaptic junction / synaptic gap

Question			Answer	Mark	AO element	Guidance
17	(a)		**K** = islet of Langerhans ✓ **L** = blood vessel ✓	**2**	2.1	 **ALLOW** arteriole / venule
17	(b)	(i)	beta / β (cells) ✓	**1**	1.1	
17	(b)	(ii)	glucose (concentration) causes release of insulin / AW ✓ change in insulin secretion is high enough to be measured / AW ✓	**2**	3.3 2.3	**IGNORE** synthesis or production of insulin **ALLOW** amount of insulin (secreted by the cells) was high enough to measure
17	(b)	(iii)	(unpaired) t-test ✓ because they are comparing <u>means</u> ✓	**2**	3.3 2.3	**DO NOT ALLOW** paired t-test **IGNORE** reference to tailed **IGNORE** standard deviation **IGNORE** reference to null hypothesis
17	(b)	(iv)	<u>probability</u> is , less than / < , 0.1% / 0.001 ✓ (so) results / differences between means , were due to <u>chance</u> ✓	**2**	2.4 3.1	**ALLOW for 2 marks** e.g. there is less than 1 in 1000 <u>probability</u> that the results are due to <u>chance</u> **OR ora** e.g. there is greater than 99.9% <u>probability</u> that results are not due to <u>chance</u>
17	(b)	(v)	Ca^{2+} / calcium ions , do not enter (cells) ✓ less / no , exocytosis ✓	**2**	2.4	**ALLOW** for **1 max** description of what happens without the inhibitor **ALLOW** less / no , movement of vesicles towards membrane **ALLOW** less / no , vesicles fuse with membrane **DO NOT ALLOW** vesicles not secreted

<table>
<tr><td>17</td><td>(c)*</td><td></td><td colspan="4">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>
<tr><td></td><td></td><td></td><td>Level 3 (5–6 marks)
An evaluation that includes treatments with insulin (past and current) AND includes another treatment (current / potential) e.g. transplant.
Includes advantage and disadvantage statements for insulin and another treatment.

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 evaluation that includes treatment with insulin (past or current) AND includes another treatment (current / potential) e.g. transplant.
Includes advantage and disadvantage statements for either insulin or another treatment.

There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.

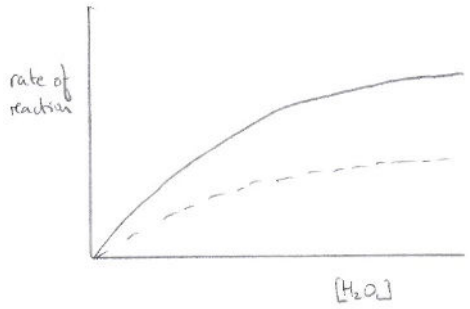
Level 1 (1–2 marks)
Description of any treatment for Type I diabetes.
Includes an advantage OR disadvantage statement.

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</td><td>6</td><td>1.1
3.2</td><td>Indicative scientific points include:
Insulin treatments:
past
• from animal pancreas e.g. pig
current
• from e.g. GM / recombinant bacteria / humulin
Other current / potential treatments:
• transplant of pancreas / islets
• transplant of (pancreatic) stem cells
• immunotherapies / gene therapy

Advantages /disadvantages should be linked to treatment being discussed
Advantages of insulin
animal-derived insulin
• tried and tested method
• early treatment kept people alive
‘human’ insulin
• high purity
• less risk of allergic reaction
• lower production cost
• overcomes religious / ethical issues of animal products
• use of smart pens / pumps
• detail of pump use e.g. monitored by apps

Disadvantages of insulin</td></tr>
</table>

			0 marks *No response or no response worthy of credit.*			*animal-derived insulin* • needs to be purified • risk of allergic reaction • high production cost • religious / ethical issues of animal products *'human' insulin* • people persuaded to change from previous insulin regime e.g. animal insulin • some may not understand technology of injection routine • side effects of pumps e.g. hard lumps forming under skin **Advantages of other treatments** *e.g. transplants* • less / no need for insulin injections • more physiological control of blood glucose compared with injection • reduce risk of 'hypos' • improved quality of life • stem cells turned into functioning β-cells *e.g. immunotherapies* • 'reprogrammes' immune system • prevents / stops damage to β-cells **Disadvantages of other treatments:** *e.g. transplants* • requirement for immunosuppression • availability of donor tissue • ethical issues associated with stem cells • risk of cancer with stem cells • not suitable for certain people e.g. those with poor kidney function • may still need low dose of insulin • initial high costs *e.g. immunotherapies* • still in early stages • need clinical trials

Question			Answer	Mark	AO element	Guidance
18	(a)	(i)	**N** = central vein / intralobular blood vessel ✓ **O** = hepatocyte / liver cell ✓	**2**	2.1 2.1	**ALLOW** branch of hepatic vein
18	(a)	(ii)	thin / flat , cells ✓ short diffusion distance ✓ **OR** fenestrated / AW ✓ increases permeability ✓	**max 2**	2.1	**DO NOT ALLOW** thin cell wall
18	(b)		prosthetic group ✓ induced fit ✓ non-competitive inhibition ✓	**3**	2.1	
18	(c)		 ✓	**1**	2.2	**ALLOW** any curve that starts at origin and stays below the curve given in Fig. 18.2. **DO NOT ALLOW** negative gradients

Question			Answer	Mark	AO element	Guidance
19	(a)	(i)	nicotinamide adenine dinucleotide phosphate / NADP ✓	1	1.1	**ALLOW** $NADP^+$ **DO NOT ALLOW** NADPH / reduced NADP
19	(a)	(ii)	(final) electron acceptor ✓ replaces , NADP / the usual electron acceptor ✓ allows photolysis to continue ✓	Max 2	2.3	**ALLOW** proton / hydrogen (ion) acceptor
19	(a)	(iii)	***Tube A***: photosystems / components , are not in , stroma / supernatant / liquid ✓ ***Tube B***: proteins / enzymes / (intact) membranes , are needed ✓ ***Tubes C & D***: light is required (for electron transport / reduction of DCPIP) ✓ ***Tube E***: DCPIP does not spontaneously , decolourise / reduce / AW ✓	4	3.2	**ALLOW** stage only takes place in chloroplasts / thylakoids / thylakoid membranes **ALLOW** stage does not take place in the stroma **ALLOW** photosystems are contained in , thylakoids / thylakoid membranes / pellet / sediment **ALLOW** ATP synthase needed **ALLOW** reactions stop when , enzymes denatured / membranes disrupted

19	(a)	(iv)	(buffer) maintains optimum pH **OR** enzymes / proteins , have an optimum pH ✓ (no sucrose) no need to prevent damage to chloroplasts / AW **OR** damage to chloroplasts increases access of DCPIP to (reaction) components ✓	**max 2**	2.7 3.4	**1 max for buffer and 1 max for sucrose** **ALLOW** if pH changes , proteins / enzymes , denature
19	(a)	(v)	**I1** use ice-cold solutions ✓ **E1** prevents damage to components / reduces rate of enzyme reactions ✓ **I2** centrifuge at different speeds ✓ **E2** to obtain different fractions / AW **OR** to obtain a pellet containing mainly chloroplasts / AW ✓ **I3** use , a heat shield / water bath ✓ **E3** so that temperature (of all tubes) is , not a variable / controlled / kept constant ✓ **I4** use same , light source / distance from light source , for illuminated tubes ✓ **E4** so that light , intensity / wavelength , is , not a variable / controlled / kept constant (for those tubes) ✓	**max 4**	3.3	**1 mark** for each improvement (**I**) and **1 mark** for correct explanation (**E**). *Explanation must correspond to improvement* **I1 ALLOW** keep , extract / AW , cold **E2 ALLOW** to remove , cell debris / nuclei / membranes

19	**(b)**	**(i)**	respiration produces , carbon dioxide / CO_2 , that is used in photosynthesis ✓ photosynthesis produces , oxygen / O_2 , that is used in respiration ✓ dead leaves / decomposition , replaces (named) nutrients ✓	**max 1**	2.5 2.5 2.5	
19	**(b)**	**(ii)**	because they are xerophytes ✓ because the conditions are too , moist / wet ✓	**max 1**	2.1 2.1	**ALLOW** suited to / live in , dry environments **IGNORE** hot environment

Question			Answer	Mark	AO element	Guidance
20	(a)		**P1** do not allow air to enter , cut end / shoot ✓ **E1** prevent airlock / ensures continuous column of water ✓ **OR** **P2** keep named abiotic factor constant / AW ✓ **E2** affects , rate of transpiration / evaporation of water ✓ **OR** **P3** keep screw clip closed ✓ **E3** prevents entry of water whilst measuring / AW ✓	**max 2**	1.2	1 mark for precaution and 1 mark for **corresponding** explanation **P1 ALLOW** method that prevents entry of air, e.g. cutting / assembling under water **P1 IGNORE** do not introduce air bubbles into the capillary tube. **P2** e.g. temperature / humidity
20	(b)	(i)	**FIRST CHECK ON ANSWER LINE** **If answer = 2.3 award 2 marks** SD = 2.30217 ✓ Correct answer to 2 s.f. ✓	**2**	2.8	**ALLOW** for 1 mark 2.30
20	(b)	(ii)	data for 'fan off' are , more spread out about the mean / less precise ✓	**1**	3.2	**ALLOW** data were less repeatable **ALLOW ora** for 'fan on'
20	(c)	(i)	flatten / AW , leaves (on to graph paper) ✓ account for / AW , partially covered squares ✓ double leaf area to give total of both surfaces / AW ✓	**max 2**	2.6	**ALLOW** e.g. only count squares more than 50% covered

20	**(c)**	**(ii)**	**FIRST CHECK ON ANSWER LINE** **If answer = 4.9 x 10^{-2} award 2 marks** 30 mm^3 min^{-1} = 1 800 mm^3 hr^{-1} = 1.8 cm^3 hr^{-1} ✓ 1.8 ÷ 37 = 0.0486 = 4.9 x 10^{-2} cm^3 hr^{-1} cm^{-2} ✓	**2**	 2.6 2.6	**Must** be **2SF** and **standard form** for 2 marks If answer is incorrect **ALLOW** for 1 mark 0.049 / 0.0486
20	**(d)**		(produced) in , meristems / cambium ✓ (by) differentiation (from stem cells) ✓	**2**	1.2	 **ALLOW** specialised **IGNORE** mitosis

Question			Answer	Mark	AO element	Guidance
20	(e)*		***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) A description that includes mass flow **and** phloem loading **and** unloading. *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 includes mass flow **and** phloem loading **or** unloading. *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)** A description that includes either mass flow **or** phloem loading **or** unloading. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks**	**6**	1.1	*Indicative scientific points may include* **Phloem loading** • Glucose is converted to an assimilate / sucrose in photosynthesising cells • Apoplast route • Active process • Proton pump in companion cells • H^+ concentration gradient • Co-transport of H^+ and sucrose into companion cell • Structural adaptations of companion cells, e.g. many mitochondria, increase surface area of cell surface membranes • Passive loading via symplast route • Role of plasmodesmata • entry of sucrose / solutes decreases water potential of phloem / sieve elements • water enters phloem from surrounding cells / xylem • results in higher hydrostatic pressure **Mass flow** • Bulk transport of sucrose caused by pressure difference • Entry / exit of water / solutes affects hydrostatic pressure • Movement from source to sink • e.g. leaf is source

			No response or no response worthy of credit.			• e.g. root is sink • Role of hydrostatic pressure gradient from source to sink • High hydrostatic pressure in source phloem explains rapid transport over long distance **Phloem unloading** • Diffusion of sucrose from phloem to surrounding cells • Sucrose converted back to glucose • Glucose used for respiration • Converted to starch for storage • Concentration gradient of sucrose maintained between phloem and cells • Occurs wherever cells need glucose / sucrose • Loss of sucrose / solutes increases water potential of phloem • water leaves phloem to surrounding cells / xylem • results in lower hydrostatic pressure

Question			Answer	Mark	AO element	Guidance
21	(a)	(i)	(water potential) decreases / more negative ✓	1	1.1	
21	(a)	(ii)	large plasma proteins cannot , pass out through capillary wall / leave the blood , but other solutes can ✓ imbalance of large plasma proteins between blood and tissue fluid results in oncotic pressure ✓	2	2.1	
21	(b)	(i)	Jv = (4.5 – 0.15) – 0.75 (4.2 – 0.03) = 1.22 (kPa) ✓ out of capillary / outward ✓	2	2.2	**ALLOW** 1.2 / 1.2225 / 1.223 **ALLOW** into tissue fluid
21	(b)	(ii)	reduction in albumin concentration reduces (capillary) oncotic pressure ✓ (so) increase the net driving force ✓	2	2.2	
21	(b)	(iii)	***student is correct because...*** net driving force , is higher / has increased ✓ (so) more tissue fluid formed ✓ ***student is incorrect because....*** kidney damage could lead to more loss of water (in urine) ✓ no information about , hydrostatic pressure / tissue oncotic pressure , in patients ✓ single patient could respond atypically ✓ (inflammation leading to) reduction in value of reflectance factor could increase , albumin / protein , in tissue fluid ✓	max 4	3.1	 **ALLOW** less , fluid / water , returned to blood **ALLOW** reduction in σ could increase oncotic pressure in tissue fluid

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>21</td><td>(c)</td><td></td><td>
<table>
<tr><th>Statement</th><th>True</th><th>False</th></tr>
<tr><td>Lymph is similar in composition to tissue fluid but has more oxygen.</td><td></td><td>✓</td></tr>
<tr><td>Tissue fluid does not contain lymphocytes because they are too large to pass through capillary wall.</td><td></td><td>✓</td></tr>
<tr><td>Lymph contains more protein than tissue fluid because of antibody production by plasma cells.</td><td>✓</td><td></td></tr>
</table>
3 correct ✓✓
2 correct ✓</td><td>2</td><td>1.1</td><td>IGNORE crosses</td></tr>
</table>

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