Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCE
In Biology Spec B (9BI03) Paper 03
General and Practical Principles in Biology

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- In questions marked with an **asterisk** (*), marks will be awarded for the ability to structure answers logically showing how the points are related or follow on from each other where appropriate.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Question Number	Answer	Additional Guidance	Mark
1(a)	use ratio of 8:2 of sucrose and water	**ACCEPT** other correct ratios	**(1)**

Question Number	Answer	Mark
1(b)	An answer that makes reference to the following: • x axis labelled 'sucrose concentration / mol dm^{-3}' **and** y axis labelled 'percentage change in mass' / 'change in mass (%)' (1) • trend shows top left to bottom right, crossing x axis / crossing 0% (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(c)	An answer that makes reference to three of the following: • control temperature because affects {diffusion / osmosis / molecular movement / membrane permeability} (1) • submerge cubes in sucrose solution so all surfaces in contact (1) • use smaller intervals of sucrose concentration (between 0.2 and 0.4) (1) • blot cubes before weighing to remove surface solution / blot cubes dry to remove excess solution (1) • repeat to identify {anomalies / variability / SD} / because result in table could be {anomalous} (1)	**ACCEPT** dry but not if linked to dry mass **DO NOT ACCEPT** to calculate mean	**(3)**

Question Number	Answer	Mark
2 (a)(i)	(350 + 490 + 270 + 40 =) 1146 to 1150	**(1)**

Question Number	Answer	Additional Guidance	Mark
2 (a)(ii)	An explanation that makes reference to four of the following: • {blood / plasma} concentration {low / decreased / dilute / high(er) water potential / hypotonic} (1) • detected by {osmoreceptors / hypothalamus} (1) • therefore {no/less} ADH released by pituitary (1) • collecting duct is less permeable / impermeable (1) • therefore less/no {reabsorption} of water (1)	**DO NOT ACCEPT** higher concentration of water **ACCEPT** baroreceptors **ACCEPT** fewer aquaporins	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(b)	line or bars at 100 cm^3 or below for total duration		**(1)**

Question Number	Answer	Mark
3 (a)	A description that makes reference to three of the following: • pollen grains put in {water / sugar / sucrose / mineral ions / glycerol} solution (1) • use of a (microscope) slide / cavity slide / use a coverslip (1) • use low power lens first / use increasing magnification (1)	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(b)	• conversion of 6 mm / 0.6 cm into µm (1) • division by 30 (1)	Example of calculation 6 mm = 6000 µm 6000 ÷ 30 = 200 Correct answer gains full marks, with no working shown **ACCEPT** one mark in working ÷ 30	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)(i)	An explanation that makes reference to the following: • shows variation from the mean / shows range of results from mean / spread of data around the mean / shows reproducibility / shows repeatability (1) • therefore gives an indication of significant difference / overlap gives indication of significant difference (1)	**ACCEPT** average	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)(ii)	• divide number germinating by total number (1) • use graph to determine time (1)	<u>Example of calculation</u> 4 ÷ 11 = 36.36 / 36 / 36.4 36.36 is 16 to 18 minutes **ACCEPT** one mark for 12 to 14 if 3 ÷ 11 seen in working	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	absorption spectrum shows absorption of light of different wavelengths and action spectrum shows rate of photosynthesis at each wavelength	**ACCEPT** absorption spectrum involves wavelengths only and action spectrum involves photosynthesis / oxygen production only	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	spectra are similar / spectra overlap / peaks and troughs follow similar pattern	**ACCEPT** similar peak at blue / similar peak at red / similar trough at green	**(1)**

Question Number	Answer	Mark
4(b)(i)	An answer that makes reference to the following: • decreases chlorophyll **and** carotenoid / plant pigment (synthesis) (1) • chlorophyll a (synthesis) is less than chlorophyll b (synthesis) / chlorophyll a more inhibited / chlorophyll b less inhibited (1) • carotenoid (synthesis) is less than chlorophyll (synthesis) / carotenoid more inhibited than chlorophyll / chlorophyll less inhibited than carotenoid (1) • SD show difference is significant (1)	**(3)**

Question Number	Answer	Mark
4(b)(ii)	An answer that makes reference to five of the following: • grown in darkness for a week so leaves big enough to obtain discs / so leaves contain {less / no pigment} (1) • discs same {diameter / leaves / leaf age} because affects pigment {amount / content / concentration} (1) • 25 discs used so that sufficient pigment obtained / calculate SD (1) • {control / 0.0} solution allows comparison (1) • same temperature as it affects enzymes (1) • same light {wavelength / source / intensity} as light affects synthesis of pigments (1) • 48 hours allows time for pigment synthesis (1)	**(5)**

Question Number	Answer	Mark
5(a)	An explanation that makes reference to three of the following: • catalase / enzyme {denatured / change to tertiary structure} (1) • because {hydrogen / ionic / disulfide} bonds are broken (1) • {shape} of active site changed (1) • therefore no longer {binds / fits / attaches} to {substrate / hydrogen peroxide} / no enzyme substrate complexes (1)	**(3)**

Question Number	Answer	Mark
5(b)	An explanation that makes reference to the following: • it is the initial rate of reaction (1) • substrate / hydrogen peroxide is in excess / not limiting / substrate / hydrogen peroxide decreases / becomes limiting (1)	**(2)**

Question Number	Answer	Mark
5(c)	An answer that makes reference to four of the following: • use liver with same surface area to volume ratio (1) • control temperature (1) • control {volume / concentration} of hydrogen peroxide (1) • replace bung quickly (1) • use gas syringe to collect oxygen (1)	**(4)**

Question Number	Answer	Additional Guidance	Mark
6(a)	organisms that interbreed to produce fertile offspring	**ACCEPT** mate / reproduce	(1)

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	An answer that makes reference to two of the following: **One from similarities:** • neither found 34 to 35 m from high water line (1) • both found between 85 to 86 m and 116 m (1) **One from differences:** • marram grass found closer to high water line / elder is not found close to high water line / marram grass not found further inland / elder is found further inland (1) • range for marram grass is less than for elder / range for elder is greater than for marram grass / marram range is 80/81 m and elder range is 85 m (1) • maximum percentage cover of marram is greater than elder / marram maximum is 40% and elder maximum is 30% (1)	**DO NOT ACCEPT** description of data	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	An explanation that makes reference to the following: • use of {transect / tape measure / line} (1) • place {quadrats} at stated intervals (1) • method of how percentage cover measured (1)	**Eg:** number of squares occupied / point frame	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(c)	A description that makes reference to the following: • sample at intervals along transect / sample from same place in quadrat (1) • weighing, drying and reweighing (1) • constant mass (1) OR • sample at intervals along transect / sample from same place in quadrat (1) • insert probe into the soil (1) • at same {depth / length of time}	**DO NOT ACCEPT** burning	**(3)**

Question Number	Answer	Mark
6(d)	An explanation that makes reference to three of the following: • less {evaporation / transpiration / diffusion} (1) • because {leaf is curled / small gap / hairs / sunken stomata / stomata in pits / waxy cuticle} (1) • trap water vapour / reduce {diffusion / concentration / water potential} gradient (1)	**(3)**

Question Number	Answer	Mark
7(a)	An explanation that makes reference to the following: • fatty acid because it has a {carboxylic acid / COOH / carboxyl group} (1) • (mono)unsaturated because it has {a double bond / C=C / carbons with only one H} (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)	A description that makes reference to four of the following: • use of restriction enzyme to cut {gene / DNA / allele / plasmid} (1) • use of ligase to insert / join {gene / DNA / allele} (1) • use of vector (1) • use of plasmid / *Agrobacterium* / gene gun / virus / electroporation / microinjection (1) • use of cloning (1)	**ACCEPT** remove cell wall / produce a protoplast	**(4)**

Question Number		Additional Guidance	Mark
7(c)	An answer that makes reference to five of the following: • use mice not exposed to the {virus / antigen} (1) • mice given vaccine and mice {not given vaccine / saline / placebo} / GM plant and normal plant} (1) • assess {antibodies / white blood cells / named white blood cell} (1) • {large number of mice / 10+ mice} for each treatment (1) • control {sex / age / species} of mice (1)	**ACCEPT** range of vaccine concentration if one is zero **ACCEPT** (infection with virus and) {observe symptoms / ill / diseased / survive} **DO NOT ACCEPT** group	**(5)**

Question Number	Answer	Additional Guidance	Mark
8(a)	A description that makes reference to the following: • acts as an {electron / e^- / H^+ / proton} acceptor / becomes reduced (1) • forms water (1)	**DO NOT ACCEPT** hydrogen **ACCEPT** for 2 marks $2H^+ + O^{2-} \longrightarrow H_2O$	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(b)(i)	• divide oxygen consumption by body mass (1) • express answer in standard form (1)	<u>Example of calculation</u> 50 ÷ 4 000 = 0.0125 1.25×10^{-2} Correct answer gains full marks, with no working shown **ACCEPT** one mark in working for 0.0125	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	An explanation that makes reference to four of the following: • {small(er) mammals / small(er) body mass} consume more oxygen (per kg) (1) • mammals are endotherms / maintain body temperature / regulate body temperature (1) • small mammals have larger surface area to volume ratio (1) • therefore lose more heat (1) • heat by respiration (1)	**ACCEPT** large(r) mammals consume more oxygen in $dm^3\ h^{-1}$ **ACCEPT** converse for Mps 1, 3 and 4 and 5	**(4)**

Question Number	Answer	Mark
8(c)	An explanation that makes reference to four of the following: • use {soda lime / KOH / NaOH} to absorb carbon dioxide (1) • put {water / dye / ink} (1) • use ruler / scale to measure distance (1) • use {syringe / cross sectional area multiplied by distance / use $\pi r^2 d$} to measure volume of oxygen (1) • use {syringe / 3-way tap} to reset / do repeats (1) • control temperature using water bath (1)	**(4)**

Question Number	Answer	Additional Guidance	Mark
9(a)	An explanation that makes reference to five of the following: • {impulse / depolarisation / wave of excitation} starts at SAN / pacemaker (1) • takes 0.03s to travel to AVN (1) • atrial systole takes 0.07s / takes 0.07s for atria to contract (1) • delay at AVN (1) • {0.16s / 0.17s at septum / Bundle of His} / {0.17s / 0.22s at Purkyne fibres (1) • ventricular systole ends at 0.22s / ventricles {contract / depolarise} from base / upwards (1) • atrioventricular valves {open during atrial systole / atrial contraction} / {close during ventricular systole / ventricular contraction} (1)	**DO NOT ACCEPT** signal / message	**(5)**

Question Number	Answer	Additional Guidance	Mark
9(b)	• obtain duration of one heart beat by dividing number of seconds in one minute by heart rate (1) • subtract duration of ventricular systole (1)	<u>Example of calculation</u> 60 ÷ 72 = 0.83 / 0.833 0.83 – 0.06 = 0.77 / 0.773 0.83 – 0.05 = 0.78 / 0.783 Correct answer gains full marks, with no working shown	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(c)(i)	An explanation that makes reference to four of the following: • {low pH / carbon dioxide / lactic acid / lactate} detected by {chemoreceptors / aortic body / carotid body} (1) • affects {cardiac centre / medulla oblongata / cardiovascular centre} (1) • sympathetic nerve is stimulated / sends impulse / action potential (1) • noradrenaline at SAN (1) • therefore {more } {impulses / depolarisation / waves of excitation} which increase heart rate (1)	**DO NOT ACCEPT** message / signals	**(4)**

Question Number	Answer	Additional Guidance	Mark
9(c)(ii)	An explanation that makes reference to the following: • use larger sample to identify anomalies (1) • people have same {lifestyle / health / diet / fitness level / sex / ethnicity / age / mass} (1) • control {intensity / type} of exercise / same exercise (1) • control {duration / length} of exercise (1)	**DO NOT ACCEPT** calculate mean / SD / use statistics **ACCEPT** 10 mins	**(4)**

Question Number	Answer	Additional Guidance	Mark
10(a)(i)	• deduce expected values (1) • calculation of Chi squared (1)	Example of calculation C: $(42 – 20)^2 ÷ 20 = 24.2$ and M: $(6 – 10)^2 ÷ 10 = 1.6$ and S: $(12 – 30)^2 ÷ 30 = 10.8$ Chi squared value = 36.6 Correct answer gains full marks, with no working shown **ACCEPT** one mark in working for expected values of 20, 10 and 30 or 37.2	**(2)**

Question Number	Answer	Additional Guidance	Mark
10(a)(ii)	An answer that makes reference to the following: • reject {null hypothesis / H_0} significant difference between observed and expected results (1) • because calculated value is greater than the critical value at {p = 0.05 / p = 0.01} / because calculated value is greater than 5.991 / 9.210 (1) • uses 2 degrees of freedom / 5.991 / 9.210 (1) • concludes mice show preference for corner squares (1)	**ACCEPT** converse for all Mps if answer in (i) produces a calculated value less than 5.991	**(4)**

Question Number	Answer	Mark
10(b)	An answer that makes reference to three of the following: • use more mice as one mouse might behave as an anomaly / mice behave differently (1) • control {temperature / light} because it affects preference (1) • control {sex / age / species} as they affect behaviour (1) • clean before using other mice so scent removed (1)	**(3)**

Question Number	Answer	Additional Guidance	Mark
10(c)	A description that makes reference to five of the following: • rhodopsin bleached / rhodopsin forms opsin and retinal (1) • closing of sodium (ion) / Na^+ channels (1) / sodium (ion) / Na^+ cannot enter cell / membrane less permeable to sodium (ion) / Na^+ (1) • sodium pump continues (1) • inside more negative / hyperpolarisation / generator potential (1) • release of {neurotransmitter / glutamate} stops (1) • {depolarisation / action potential} in {bipolar cell / ganglion cell / sensory neurone} (1)	**DO NOT ACCEPT** optic nerve	**(5)**

Question Number	Answer	Additional Guidance	Mark
11(a)	Eukarya / Eukaryota / Eukaryotes / Eukaryotae	**DO NOT ACCEPT** Animalia eukaryotes	**(1)**

Question Number	Answer	Additional guidance	Mark
11(b)	An explanation that makes reference to the following: • large surface area (to volume ratio) for diffusion (1) • thin for shorter diffusion distance (1) • {blood flow / countercurrent} to maintain {diffusion gradient / concentration gradient} (1)	**DO NOT ACCEPT** thin membranes	**(3)**

Question Number	Answer	Mark
11(c)(i)	An explanation that makes reference the following: • anaerobic respiration takes place (1) • therefore {lactic acid / lactate} is produced (1) • because pyruvate reduced / NADH oxidised / NADH converted to NAD^+ / NADH donates H^+ or proton or e^- (1)	**(3)**

Question Number	Indicative content
***11(c)(ii)**	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Description: D** shape of curve is sigmoid / S-shaped tadpole curves are steeper tadpole curves are further to the left than frog curves lower pH moves curve to left in tadpole lower pH moves curve to the right in frog tadpole curves are closer together than frog curves reference to correct comparative % ONCE **Explanation: E** at higher ppO_2 blood more saturated / as ppO_2 increases saturation increases at lower ppO_2 blood less saturated / as ppO_2 decreases saturation decreases tadpole is more saturated at lower ppO_2 tadpole more dissociation with change in $pp0_2$ tadpole has higher % saturation than frog tadpole blood has greater affinity than blood movement lowers pH in blood Bohr shift in frog conformational change makes binding easier

steep part of curve means small change in ppO_2 causes large change in percentage saturation
top part of curve represents situation in gills or lungs
bottom part of curve represents situation in tissues

Habitat: H

less oxygen in water than in air / ppO_2 in water lower than ppO_2 in air
(lowering pH) tadpole is more able to obtain oxygen from polluted water
(lowering pH) frog more able to release oxygen to tissues during exercise / activity / movement
adaptations allow tadpole / frog to survive
harder to move in water than on land

Level	**Marks**	
0	**0**	No awardable content
1	**1-3**	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **1 to 3 from D, E or H**
2	**4-6**	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. **1H and 4 to 6 in total**
3	**7-9**	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.

		Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **2H and 7 to 9 plus in total**

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