

Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCE
In Biology B (9BI0/02)
Paper 2: Advanced Physiology, Evolution and Ecology

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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.

Question Number	Answer	Additional Guidance	Mark
1(a)	The only correct answer is: **D** phosphodiester *A is incorrect as this bond is found in lipids* *B is incorrect as this bond is found in carbohydrates* *C is incorrect as this bond pair bonds nucleotides*		**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)	A description that makes reference to the following points: • {DNA polymerase} {joins the sugar phosphate backbone (between nucleotides) / forms phosphodiester bonds / joins adjacent nucleotides} (1) • DNA {ligase} {joins fragments of DNA / short pieces of DNA / Okazaki fragments} (1) • DNA {helicase} {breaks hydrogen bonds / unzips double helix / separates strands} (1)	**Accept** {RNA primase} makes {RNA to start replication of DNA}	**(3)**

Question Number	Answer	Additional Guidance	Mark
1 (c)	A calculation that makes reference to the following points: • correct calculation of percentage cytosine (1) • correct calculation of number of nucleotides (1)	 15 % cytosine 15 % of 10 000 = **1500** Correct answer with no working gains full marks **One mark** for 15 %	 **(2)**

Question Number	Answer	Additional Guidance	Mark
2 (a)(i)	The only correct answer is: **C** low auxin, high cytokinin *A is incorrect as high auxin inhibits lateral shoots* *B is incorrect as high auxin inhibits lateral shoots* *D is incorrect as low cytokinin inhibits lateral shoots*		**(1)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	An explanation that makes reference to three of the following points: • auxin binds with {receptor / transcription factor} (inside cell / in cytoplasm / in nucleus) (1) • transcription factor becomes active / is activated (1) • transcription factor binds to {DNA / promoter} (1) • switches on / causes {transcription / production of RNA} (1)	**Accept** forms auxin-receptor complex **Accept** forms hormone-receptor complex **Do not accept** if receptor on cell membrane **Accept** transcription factor changes shape **Accept** auxin-receptor complex becomes a transcription factor **Accept** auxin-receptor complex binds to DNA / promoter (1)	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(b)	An answer that makes reference to four of the following points: • **more** seeds germinate when last colour is red (1) • number of exposures to light makes no difference (1) • significant difference when last colours are different as standard deviations do not overlap (1) • red light converts P_R into P_{FR} / far red light converts P_{FR} into P_R (1) • {P_{FR} stimulates/ P_R inhibits} {germination / gibberellin release / activation of amylase / abscisic acid}	**Allow** converse for FR light **Accept** no significant difference when last colours are same as standard deviations overlap (1) **Accept** P725 or P730 for P_{FR} / P665 or P660 for P_R **Accept** high P_{FR} : low P_R ratio stimulates germination	**(4)**

Question Number	Answer	Additional Guidance	Mark

3 (a) (i)	The only correct answer is: **D** smooth endoplasmic reticulum *A is incorrect as centriole has microtubules* *B is incorrect as a nucleus has a nucleolus* *C is incorrect as there are no ribosomes*		**(1)**

Question Number	Answer	Additional Guidance	Mark
3 (a)(ii)	The only correct answer is: **D** P S R *A is incorrect because the SER is not involved in protein synthesis* *B is incorrect because Golgi should be after the RER* *C is incorrect because the SER is not involved in protein synthesis*		**(1)**

Question Number	Answer	Additional Guidance	Mark

3(a)(iii)	An explanation that makes reference to the following: • (because lysosomes) contain enzymes (1) and **one** from • to {digest / hydrolyse} {pathogens / bacteria / viruses / proteins / antigens} (1) • to digest (old) organelles (1) • for apoptosis / autolysis of cells (1)	**Accept** correct named hydrolytic enzyme, e.g. protease / lysozyme **Accept** other correct biological molecules **Accept** breakdown pathogens / bacteria / viruses / proteins / antigens **with** hydrolytic / digestive enzymes for **2 marks** **Accept** self-digest (damaged) cell	**(2)**

Question Number	Answer	Additional Guidance	Mark
3 (b)(i)	• correct reading from graph (1) • correct calculation of mean total cell volume (1) • correct conversion into two significant figures (1)	Example: 17 or 16 952.94 or 956.25 (ignore dps) **950** or **960** (952.94 or 956.25 gains **two marks)** (950 or 960 gains **three marks**) Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
3 (b)(ii)	An answer that makes reference to three of the following points: • (ratio) ICM increases up to 3/4 days (at a steady rate) / trophectoderm cells increase up to 3/4/5 days (1) • (after 3/4 days) ratios increases more steeply for ICM cells / (after 3/4/5 days) levels off for trophectoderm cells (1) • (as ratio increases) {volume of cytoplasm / volume of cells} decreases (over time) (for ICM cells) (1) • cells are differentiating (1)	**Accept** ratio increases up to 3 days **Accept** faster increase for ICM cells **Accept** ICM divide faster than trophectoderm cells	**(3)**

Question Number	Answer	Additional Guidance	Mark
4 (a)(i)	The only correct answer is: **D** Z *A is incorrect because W is the hypothalamus* *B is incorrect because X is the cerebrum* *C is incorrect because Y is the cerebellum*		**(1)**

Question	Answer	Additional Guidance	Mark

Number			
4 (a)(ii)	The only correct answer is: **C** release of noradrenaline by the sympathetic nervous system *A is incorrect because acetylcholine decreases the rate* *B is incorrect because acetylcholine decreases the rate* *D is incorrect because noradrenaline is released by the sympathetic nervous system*		**(1)**

Question Number	Answer	Additional Guidance	Mark
4 (b) (i)	• correct identification of pressure when the valve closes (1) • conversion of cm^2 into m^2 (1) • correct calculation of force (1)	Example of calculation: 0.8 kPa **Accept** reading between 0.6 – 0.8 **(one mark)** 0.00035 m^2 or 3.5×10^{-4} **(one mark)** **0.00028 N (three marks)** **Accept** final answer between **0.00021 – 0.00028** **Accept** correct standard form 2.1×10^{-4} to 2.8×10^{-4} Correct answer with no working gains full marks **ECF for mp 3** if either or both wrong graph reading / wrong area conversion	**(3)**

Question Number	Answer	Additional Guidance	Mark

4 (b)(ii)	An explanation that makes reference to four of the following points: • pressure rises in the atrium during contraction (of ventricle) (1) • (because) blood is flowing back into the **atrium** (1) • lower pressure in aorta / lower pressure in ventricle / lower pressure in systemic (circulatory system) (1) • therefore less oxygenated blood flows to muscles / slower flow of oxygen to muscles (1) • so there is less respiration (in muscles) (1)	**Accept** pressure in atrium rises during systole **Accept** valve prevents backflow into **atrium** **Accept** less / slower (deoxygenated) blood to lungs **Accept** less ATP produced / more anaerobic respiration	**(4)**

Question Number	Answer	Additional Guidance	Mark
5 (a)	The only correct answer is: **A** bipolar neurone *B is incorrect because ganglion neurones are after bipolar neurones* *C is incorrect because motor neurones are not found in the retina* *D is incorrect because optic neurone is an incorrect term*		**1 comp**

Question Number	Answer	Additional Guidance	Mark

5 (b)	An explanation that makes reference to three of the following points: • rhodopsin breaks down into opsin and (trans) retinal (1) • causing sodium channels (on the rod cell) to close / to be blocked (1) • leading to the (rod cell) hyperpolarising (1) • so that less { (inhibitory) transmitter / glutamate} is released (1)	**Accept** cis retinal is converted to trans retinal **Do not accept** voltage gated sodium channels **Accept** sodium ions stop moving into the cell **Accept** blocks cation channels **Accept** membrane becomes more positive outside / more negative inside **Accept** correct descriptions of hyperpolarising	**(3)**

Question Number	Indicative content
5 (c)*	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. • spending longer in the dark reduces the minimum intensity at which light is seen / increases sensitivity D • retina is less sensitive to 620 nm light / more sensitive to 500 nm light / D • sensitivity continues to increase over time with 500 nm light / levels off with 620 nm light D • 620 nm light stimulates cones but not rods D • 500 nm light stimulates rod cells and cones D • exposure to light bleaches / breaks down rhodopsin / iodopsin B • trans retinal is converted back to cis retinal in the dark B • rhodopsin / iodopsin is (re)synthesised in the dark B • (cis) retinal binds to opsin (in dark) B • cone cells / iodopsin dark adapt faster than rod cells B • rhodopsin takes longer to be reconverted from opsin and retinal than iodopsin B • rhodopsin is more sensitive than iodopsin B • rod cells are more sensitive / stimulate at lower minimum light R • due to spatial summation / (retinal) convergence of rods R • so that several rod cells are stimulated to overcome a threshold / generate action potential in bipolar cells R • levelling off with 620 nm light shows that cone cells are less sensitive than rod cells R

Level 0	Marks	No awardable content
Level 1	1-2 (1-3)	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. **1 mark : one point from D, R or B** **2 marks : one from D and one from D, R or B**
Level 2	3-4 (4-6)	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure. **D with some of R or B** **3 marks: 1D and 2 from R or B OR 2 D and 1 from R or B** **4 marks: 2 D and at least 2 from R or B OR 1 D and at least 2 from R or B**
Level 3	5-6 (7-9)	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **D, B and R** **5 marks : at least two descriptions of data and one R and one of B** **6 marks : at least two descriptions of data and at least two of R and two of B**

Question	Answer	Additional Guidance	Mark

Number			
6 (a)	The only correct answer is **B** W and X A is incorrect because glucose passes out of the glomerulus C is incorrect because glucose is absorbed in the PCT D is incorrect because glucose is absorbed in the PCT		**(1)**

Question Number	Answer	Additional Guidance	Mark
6 (b)(i)	An explanation that makes reference to three of the following points: • there is more protein in plasma than tissue fluid (1) • because plasma proteins are too large to pass out of the capillary (1) • and **oncotic** pressure generated by (plasma) proteins (1) • (so fluid moves in) as {oncotic / osmotic} pressure is greater than hydrostatic pressure (1)	**Accept** converse **Accept** converse	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	An explanation that makes reference to four of the following points: • sodium ions are not removed from the **ascending** limb (1) • so the water potential of medullary fluid is higher (1) • therefore less water is removed from the **descending** limb (1) • and less water is removed from the {collecting duct / distal tubule} (1) • (a higher volume of) {dilute / low concentration} urine is produced (1)	**Accept** less negative water potential **Accept** water potential gradient is lower **Accept** osmotic gradient is lower	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(a) (i)	• only one copy (of this allele) is required to affect the phenotype (1)	**Accept** (allele that is) always expressed / expressed in heterozygotes	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	An explanation that makes reference to two of the following: • there are two main peaks as there are only two different alleles (that are not codominant) (1) • environment affects the colour of the feathers (as there are intermediates) / (intermediates are due to) subjective scoring (1) • grey owls have a selective / survival advantage (1)	**Accept** grey peak are homozygous (recessive) owls and brown peak, owls have a dominant allele **Accept** named environmental factors e.g. diet **Accept** converse **Accept** grey survive better due to camouflage	**(2)**

Question Number	Answer	Additional Guidance	Mark
7 (a)(iii)	• correct calculation of q (1) • correct calculation of p (1) • correct calculation of number of heterozygotes (1)	Example calculation 0.84 (accept any number of dp) 0.16 (accept any number of dp) 33 (**Accept** 32) Correct answer with no working gains full marks	**(3)**

Question Number	Indicative content
7 (b)*	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. • with increasing snow depth, there is higher survival of grey owls / fewer brown owls survive / more grey owls D • snow depth has decreased over time D • the percentage of brown owls has increased over time / percentage of grey owls has decreased D For • with less snow, more ground is visible / uncovered / more twigs and trees visible E • with less snow, grey owls more obvious (to predators / prey) / less camouflaged E • with less snow, natural selection would favour brown owls / more brown (advantageous) alleles passed on / fewer grey alleles passed on / brown owls outcompete grey owls E • enhanced greenhouse effect due to carbon dioxide emissions reflecting radiation back / absorbing radiation (causing melting) E Against • no direct measure of greenhouse gas / temperature / fossil fuel emissions A • graphs show correlations not causal links A • data for owl survival with snow depth is scattered / gaps in data / weak correlation A • data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A • other factors (named factors) could be affecting the owl population A • reduced snow may not be due to greenhouse gas release A

Level 0	Marks	No awardable content
Level 1	1-2 (1-3)	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made . **1 mark : any 1 from D, E, A** **2 marks : any 2 from D, E, A**
Level 2	3-4 (4-6)	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. **D and, E OR A** **3 marks : at least 3 points. Any combination of D, plus E, or A** **4 marks : at least 4 points. Any combination of D, plus E, or A**
Level 3	5-6 (7-9)	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. **D, E, AND A** **5 marks : at least 5 points. Must have combination of D, E, and A** **6 marks : at least 6 points. Must have combination of D, E, and A**

Question Number	Answer	Additional Guidance	Mark
8(a)	*The only correct answer is:* **B** correlation coefficient *A is incorrect because chi squared compares frequencies* *C is incorrect as standard deviation is a measure of dispersion* *D is incorrect as t-test compares mean values*		**(1)**

Question Number	Answer	Additional Guidance	Mark
8(b)	An explanation that makes reference to five of the following points: • {pioneer species / mosses / lichens arrive} (after glaciers melt and colonise bare rock) (1) • {decomposition /decay} increases the soil depth / humus content / minerals / nutrients (1) • therefore (larger) plants can grow (due to soil depth / minerals / nutrients) (1) • leaf litter increases after 40 / 100 years as more herbaceous plants / shrubs / trees are present (1) • (steep) increase in nitrate after 40 / 100 years as more leaves / plants / animals / faeces (1) • leaf litter falls (towards the end / from 150 – 250 years) as climax community has emerged (1)	**Accept** animals arrive / increased niches **Accept** larger plants **Accept** increase from 12.8 to 277 as equivalent to 40/100 **Accept** increase from 5.3 to 21.8 as equivalent to 40 / 100 **Accept** nitrate continues to increase due to presence of animals / faeces (as leaf litter falls)	**(5)**

Question Number	Answer	Additional Guidance	Mark

8(c)(i)	An explanation that makes reference to three of the following points: • (leghaemoglobin / myoglobin) is not S shaped / is linear / is a straight line (1) • because (leghaemoglobin / myoglobin) affinity for oxygen does not alter (1) • because (with leghaemoglobin) there is no cooperative binding (1) • (leghaemoglobin) binds to one molecule (of oxygen) (1)	**Accept** converse for haemoglobin **Accept** converse for haemoglobin **Accept** converse for haemoglobin **Accept** shape change to subunits / conformation change **Accept** (leghaemoglobin / myoglobin) has only one oxygen binding site **Accept** haemoglobin has four binding sites / binds to four molecules of oxygen	**(3)**

Question Number	Answer	Additional Guidance	Mark

8(c)(ii)	An explanation that makes reference to three of the following points: • (waterlogged soil has) little / low / less / no oxygen (1) • (leghaemoglobin) provides oxygen for **respiration** (1) • which enables active uptake of mineral ions / named mineral ion (1) • such as (calcium) to make calcium pectate / (nitrate) to make amino acids / (magnesium) to make chlorophyll (1)	**Accept** binds to / stores oxygen for respiration **Accept** other correct active processes e.g. synthesis of amino acids / protein synthesis / mitosis **Accept** other correct examples of minerals with functions	**(3)**

Question Number	Answer	Additional Guidance	Mark
9(a)(i)	The only correct answer is **B** β glucose *A is incorrect because cellulose does not contain a glucose* *C is incorrect because cellulose does not contain ribose* *D is incorrect because cellulose does not contain ribose*		**(1)**

Question Number	Answer	Additional Guidance	Mark

9(a)(ii)	A drawing showing the following: • Correct structure drawn (1) *Hexagonal ring with oxygen in correct place in ring.* *CH_2OH in correct place.* *All OHs apart from Carbon 1 in right places.* *Allow Hydrogens to be just stalks.* • OH groups shown correctly on carbon 1 (1) *pointing in same direction as CH_2OH*	**Do not accept** if water molecule also released / drawn	**(2)**

Question Number	Answer	Additional Guidance	Mark

9(a)(iii)	An explanation that makes reference to three from the following points: • (cellulose molecules are) straight / not helical (1) • (many) hydrogen bonds hold molecules / chains / layers together (1) • (strong) to prevent cell lysis / cells bursting / maintain turgidity / resist (turgor) pressure (1) • (polar nature of glucose) allows water /minerals to diffuse through (1)	**Accept** not coiled **Accept** hydrogen bonds between microfibrils **Accept** other correct functions of strong cell wall	**(3)**

Question Number	Answer	Additional Guidance	Mark
9(b)(i)	• (index of diversity) takes into account populations (of each species) (1)	**Accept** considers abundance / number of each species **Accept** because an area could have many different species but different populations	**(1)**

Question Number	Answer	Additional Guidance	Mark

9(b)(ii)	An answer that makes reference to two from the following points: • other species are also conserved (in the ecosystem) (1) • animals are not humanised / behaviours are natural / no change to behaviour (1) • less inbreeding occurs (1)	**Accept** converse for *in situ* **Accept** other species are protected / food webs are maintained / maintains biodiversity / maintains links in ecosystem **Accept** more space for animals **Accept** no need to transport animals **Accept** less inbreeding depression / maintain gene pool	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(b)(iii)	An explanation that makes reference the following points: • biodiversity has increased (in the paper project area) **more** (than the protected area) (1) • as less / no grassland is burnt / less poaching (1) • (more) niches are available / habitats are not destroyed / elephants transfer plant seeds (1) • local people make money from the paper project / if the elephants are not present, local people lose a source of income (1)	**Accept** biodiversity has increased but {did not increase / went down} in area where people are banned **Accept** grassland burning / poaching still occurs in unprotected area **Accept** converse for protected area **Accept** converse for protected area **Accept** people have a vested interest in the elephants / make a profit	**(4)**

Question Number	Answer	Additional Guidance	Mark
9(c)	A description that makes reference to two of the following points: • not all countries sign the treaty / signing the treaty is voluntary (1) • many species move across national boundaries (1) • monitoring is expensive / some countries are too large to monitor / high financial rewards for {poaching / smuggling} / CITES (only) prevents trade (1)	**Accept** the treaty is not legally binding (within nations) **Accept** some species migrate / have very large ranges **Accept** not all species are classed as endangered **Accept** countries may not be able to monitor within their borders **Accept** some poaching will continue	**(2)**

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