

Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCE
In Biology B (9BI0)
Paper 02: 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	Mark
1(a)(i)	The only correct answer is B (X) *A is incorrect as W is not found in a disaccharide* *C is incorrect as Y is not found in disaccharide* *D is incorrect as Z is not found in disaccharide*	**1**

Question Number	Answer	Mark
1(a)(ii)	The only correct answer is B (V and Z) *A is incorrect as X is not found in proteins* *C is incorrect as W is not found in proteins* *D is incorrect as W s not found in proteins*	**1**

Question Number	Answer	Mark
1(a)(iii)	The only correct answer is A (V) *B is incorrect as W is not found in cellulose* *C is incorrect X does not hold molecules together in cellulose* *D is incorrect as Y is not found in cellulose*	**1**

Question Number	Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to three of the following: • in raw egg white ovalbumin {polar /charged} groups are on the outside (1) • because {they associate / bond with water molecules / are hydrophilic} (1) • heating denatures (the ovalbumin) (1) • because {hydrogen bonds / ionic bonds} break (1) • new bonds form between {nonpolar / hydrophobic} groups of ovalbumin molecules (to form a solid) (1)	**Allow** {nonpolar / uncharged} groups on inside **Allow** uncharged {do not associate with water / are hydrophobic} **Allow** tertiary structure changes	**3**

Question Number	Answer	Mark
2(a)	The only correct answer is A *B is incorrect as the graph shows an endothermic reaction* *C is incorrect as the enzyme has increased activation energy* *D is incorrect as the graph shows a endothermic reaction*	**1**

Question Number	Answer	Additional guidance	Mark
2 (b)	• 3^2 x pi x 1 and 1^2 x pi x 1 • 28.26 – 3.14 = 25.12 25.12 x 1000 = 25120 = 25000	• 25 000 **or** 2.5 x 10^4 = **3 marks** • 25 120 = **2 marks** (**Allow** range up to 25133) • 28260 (**Allow** up to 28274.33…) **OR** 3140 (**Allow** up to 3141.59…) **OR** 28000 **OR** 3100 **OR** 28.26 (**Allow** up to 28.274…) **and** 3.14 (**Allow** up to 3.1415…), **OR** 25.12 (**Allow** up to 25.1327…= (**1 mark)** **correct answer gains all three marks**	**3**

Question Number	Answer	Additional guidance	Mark
2 (c)(i)	An explanation that makes reference to two of the following: • rate increases then levels off (1) • increases as {higher chance of enzyme – substrate collisions / enzyme is in excess / there are unoccupied active sites / substrate concentration is the limiting factor} (1) • rate levels off when {active sites are occupied / all (enzymes) have formed E-S complexes / enzyme concentration is limiting} (1)	**Allow** more enzyme-substrates complexes can form (when rate increases) **Allow** all enzymes occupied / full **Allow** bromelain for enzyme	**2**

Question Number	Answer	Additional guidance	Mark
2 (c)(ii)	An explanation that makes reference to two of the following: • copper (sulfate) is an (non competitive) inhibitor (1) • binds to the enzyme and changes {shape / structure} of active site (1) • so that substrate does not bind / E/S complexes can not form (so rate falls) (1)	**Do not accept** if competitive inhibitor **Allow** changes enzyme shape / binds to allosteric site / changes tertiary structure	**2**

Question Number	Answer	Mark
3(a)(i)	The only correct answer is A (Prophase I of meiosis) *B is incorrect as the primary spermatocytes do not have prophase II stage* *C is incorrect as primary spermatocytes do not perform mitosis* *D is incorrect as primary spermatocytes do not perform mitosis*	**1**

Question Number	Answer	Additional guidance	Mark
3(a)(ii)	• correct division of 0.8 cm by 1500 • correct conversion to micrometres and to one decimal place	÷1500 **or** 5.333… = **one mark** 5.3 = **2 marks** **correct answer with no working gains full marks**	**2**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	• 12		**1**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	An answer that makes reference to four of the following: Support • for pregnancies not going full term there are {more men with sperm with greater than 25% DNA damage / few men have less than 25 % DNA damage} (1) • no men where pregnancies go full term have more than 60% damage / no men with 0-5% DNA damage where pregnancies do not go full term (1) Against • some men had partners with pregnancies that go full term with high % DNA damage (1) • small sample size / uneven group sizes (1) • other factors of men not accounted for e.g. age / diet / genetic conditions (1) • maternal factors affect pregnancy (1)	**At least one from support and at least one from against** **Allow** the majority of men (with pregnancies going full term) had less than 25% damage **Allow** correct numerical comparison e.g only 12(%) of men have less then 25(%) **Allow** converse **Allow** most men with pregnancies that go full term have between 0-5% damage **Allow** description (e.g. some with 55-60%, some with >25%)	**4**

Question Number	Answer	Mark
4 (a)(i)	The only correct answer is B (high high low) *A is incorrect as high humidity would reduce transpiration rate* *C is incorrect as low wind speed would reduce transpiration rate* *D is incorrect as low temperature would reduce transpiration rate*	**1**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that makes reference to four the following: • {reduced leaf surface area / smaller leaves} so {less transpiration / evaporation / reduces water loss} (1) • {thick epidermis / waxy cuticle} {reduces evaporation / reduce water loss} (1) • stem used as photosynthetic organ / palisade cells (in stem) used for photosynthesis (1) • (when submerged) air spaces provide {oxygen for respiration / carbon dioxide for photosynthesis} (1) • high salt concentration (in cells) {lowers water potential / maintains water potential gradient} (1) • so less water loss by **osmosis** / water can enter by **osmosis** (1)		**4**

Question Number	Answer	Additional guidance	Mark
4(b)(i)	A description that makes reference to two of the following: • not quantitative / it is qualitative / not numerical (1) • cannot do statistical tests (1) • difficult to standardise / subjective (1)	 **Allow** scales are different for different species **Allow** different people make different estimates	**2**

Question Number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that makes reference to four of the following: • succession (has occurred) (1) • samphire is a {pioneer (species) / coloniser} (1) • samphire roots bind the silt / stabilises soil / stabilises substrate (1) • more {organic matter / humus} (in silt) due to {death / decomposition} (of plants) / more {nutrients / minerals / named nutrients} in soil (for other plant species) (1) • competition from {sea lavender / scurvy grass} results in less samphire (1) • abiotic factors change further in from sea / more sheltered further from sea (1)	**Allow** Samphire is only species that can live close to water / only samphire has adaptations to live by water **Allow** increased soil depth due to decomposition **Allow** decay **Allow** plants have different niches **Allow** competition between scurvy grass and sea lavender **Allow** named factors e.g. less wind / less salt / less exposed / less often flooded	**4**

Question Number	Answer	Mark
5 (a)(i)	The only correct answer is A (1 and 2) *B is incorrect as there is reduced diffusion of sodium ions into the cell* *C is incorrect as there is reduced diffusion of sodium ions into the cell* *D is incorrect as there is reduced diffusion of sodium ions into the cell*	**1**

Question Number	Answer	Additional guidance	Mark
5 (a)(ii)	An explanation that makes reference to two of the following: • more cones in {centre / fovea} / fewer rods in {centre / fovea} (1) • cone cells are less sensitive (to low light levels) (1) • as (only) one (cone) attaches to each (bipolar) neurone / cones do not have {(spatial) summation /convergence} (1)	**Allow** fovea **Allow** more rods in periphery / fewer cones in periphery **Allow** rhodopsin is more sensitive (than iodopsin) / iodopsin is less sensitive (than rhodopsin) **Allow** several rods attach to one (bipolar) neurones / have {summation / convergence}	**2**

Question Number	Answer	Mark
5 (b)(i)	The only correct answer is C (4) *A is incorrect as 2, 4, 10 and 6 are heterozygotes* *B is incorrect as 2, 4, 10 and 6 heterozygotes* *D is incorrect as 2, 4, 10 and 6 heterozygotes*	**1**

Question Number	Answer	Additional guidance	Mark
5 (b)(ii)	An explanation that makes reference to the following: • cross 6 and 7 produces {11 who is colourblind / colourblind child} (1) • because 6 must be {a carrier / heterozygous / have a hidden recessive allele} (1) **OR** • cross 3 and 4 produces {8 who is colourblind / colourblind child} (1) • because 8 has inherited recessive alleles from both parents / 4 must {be a carrier / be a heterozygote} **OR** (it is not dominant because) • 10 (and 8) from cross 3 v 4 would be colour blind (1) • as they would inherit a (dominant) allele from 3 (1) **OR** (it is not dominant because) • neither 6 or 7 is colour blind (1) • and because {11 / one child} is colour blind 6 would have to be colour blind (1) **OR** • 1 and 2 produce 4/6 {who is a carrier} (1) • so 2 must have a recessive allele / is a carrier / 4/6 must have inherited a recessive allele from 2 (1)	**Mark in pairs** **Allow** 11 is colourblind but has parents who are not **Do not accept** both parents are carriers / heterozygotes **Do not accept** both parents are carriers / heterozygotes **Allow** 3 and 4 must both have recessive alleles	**2**

Question Number	Answer	Additional guidance	Mark
5(c)(i)	An answer that makes reference to three of the following: • the condition is **recessive** (1) • but not sex linked / is on an autosome (1) • because 4 **and** 5 are not affected but 6 is affected / 4 **and** 5 must both be {carriers / heterozygous} (1) • it cannot be sex linked as 3 is not affected (1)	autosomal recessive = **2 marks** **Allow** not X-linked **Allow** from correct genetic diagram **Allow** 3 would be affected if the allele were sex linked	**3**

Question Number	Answer	Additional guidance	Mark
5(c)(ii)	An explanation that makes reference to two of the following: • there has been a (genetic / population) bottleneck / founder effect (1) • which increases frequency of affected **allele** / reduces the frequency of the unaffected **allele** (1) • few new alleles introduced (as little immigration) (1) • so there is a higher chance of two {heterozygotes / carriers} having children together (1)	**Allow** more people will carry the affected allele **Allow** small gene pool / little genetic variation **Allow** many people are {carriers / heterozygous} **Allow** high chance of inheriting two recessive alleles	**2**

Question Number	Answer	Mark
6(a)(i)	The only correct answer is C (movement of sodium ions into the neurone) *A is incorrect as calcium channels are closed* *B is incorrect as potassium channels are closed* *D is incorrect as sodium ions move in*	**1**

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	An explanation that makes reference to two of the following: • (voltage gated) potassium channels open (1) • and sodium channels close (1) • so that potassium **ions** diffuse **out** of the neurone repolarising the membrane (1)	 **Allow** potassium channels become (more) permeable **Allow** sodium channels become impermeable **Allow** K^+	**2**

Question Number	Answer	Mark
6(b)(i)	The only correct answer is B (1, 2 and 3) *A is incorrect as the rat has physiological adaptations* *C is incorrect as the rat has behavioural adaptations* *D is incorrect as the rat has anatomical adaptations*	**1**

Question Number	Answer	Additional guidance	Mark
6(b)(ii)	An explanation that makes reference to three of the following: • fewer sodium **ions** are pumped **out** (of the neurone) / fewer potassium **ions** pumped **in** (1) • so that the resting potential is reduced / not maintained (1) • there is a lower (diffusion) gradient for sodium ions / sodium ions leak through membrane (1) • so sodium ions will not {diffuse / move} in (during stimulation) / membrane cannot depolarise (if stimulated) / action potential cannot occur (1)	**Only penalise once for not referring to ions** **Allow** inside is no longer more negative / outside membrane is less positive / no potential difference (across membrane) **Allow** {movement of ions / membrane} is at equilibrium	**3**

Question Number	Answer	Mark
7(a)(i)	The only correct answer is D (no yes yes) *A is incorrect as the genetic code is not overlapping* *B is incorrect as the genetic code is not overlapping* *C is incorrect as eukaryotes do have introns*	**1**

Question Number	Answer	Additional guidance	Mark
7(a)(ii)	An explanation that makes reference to two of the following: • because most amino acids have more than one triplet / code is degenerate (1) • (genes contain) introns / non-coding DNA (1) • changing amino acid sequences affects {secondary structure / tertiary structure / quaternary structure / bonding / protein structure} (1)	 **Allow** codon for triplet **Allow** converse	**2**

Question Number	Answer	Additional guidance	Mark
7 (a)(iii)	A description that makes reference to the following: • **DNA** sequencing (1) • use gel electrophoresis (1) • comparing DNA band patterns / use bioinformatics to compare sequences in databases (1)	 **Allow** Sangar sequencing **Allow** description of gel electrophoresis **Allow** fragments for bands **Allow** DNA hybridisation between two species	**2**

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. **Descriptions (D)** • more diversity in wild for trees / non-woody species / non-endangered species / most species have higher diversity in wild / converse for seedbank • more diversity in seedbanks for endangered species / species of economic interest / converse for wild • non-woody species and non-endangered species have high variability / wide standard deviations • endangered species / trees how lower variability / lower standard deviations • the age in seed banks increases, the number of differences increases **Explanations (E)** • less breeding in seed banks / reproduction in wild increases variation • less gene flow in seed bank / more genetic drift occurs in wild • in wild more meiosis / crossing over / independent assortment / mutation / random breeding (to generate variation) • in the wild there is more selection pressure / natural selection • trees are slower growing / live longer, so less diversity • non-woody species have high reproduction rate so increased number of genetic changes • (for most) having fewer seeds stored means lower diversity • for endangered species there is inbreeding / genetic bottleneck / small gene pool (so lower diversity) • non-endangered species have high diversity due to higher numbers of each species / more breeding **Validity of data and conservation role (V)** • correct comment on whether differences are significant or not linked to overlapping error bars • (there is a correlation between genetic differences of seeds with age) but many outliers / less data for longer times • different group sizes so difficult to make (valid) comparisons / some groups have low numbers / low sample size (reduces validity) • shows need to keep rebreeding plants in seed banks to maintain diversity

	• show seedbanks play role in maintaining genetic diversity for conservation of endangered species (as more diversity in the seedbank) • no idea which dot is which species in scatter graph

Level	Marks	
0	**0**	**No awardable content**
1	1-2 (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. **One mark: any one comment from D, E, or V** **Two marks: any two comments from D, E, or V**
2	3-4 (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. **Three marks: any three from two of D, E, or V** **Four marks: any four from two of D, E, or V**
3	5-6 (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. **Five marks: any five from D, E and V** **Six marks: any six from D, E, and V and must relate to both graphs**

Question Number	Answer	Additional guidance	Mark
8(a)	An explanation that makes reference to the following: • {fast transport of / more} **oxygen** for **respiration** / so that **oxygen** for **respiration** is delivered (to tissues) at a high rate (1) **and one from** • keeps oxygenated and deoxygenated blood separate (1) • maintains high pressure to body / maintains lower pressure to lungs (1) • pulmonary (lungs) and systemic circulatory (body) systems are separate (1)		**2**

Question Number	Answer	Additional guidance	Mark
8(b)(i)	• correct reading from graph for duration of one heart cycle • correct division of 60 seconds by the duration of one heart cycle	0.80 – 0.86 (s) **or** 60 ÷ duration of one beat **= one mark** 70 – 75 (bpm) **(2)** **Correct answer with no working gains both marks**	**2**

Question Number	Answer	Additional guidance	Mark
8(b)(ii)	An explanation that makes reference to three of the following: • there is a long(er) gap between the P and QRS waves / extended PQ time (1) • delay between atrial systole and ventricular systole / ventricular systole is delayed (1) • (may be damage to) bundle of His / Purkinje fibres (1)	 **Allow** contraction **Allow** takes longer to pass through Purkinje fibres / bundle of His	**2**

Question Number	Answer	Additional guidance	Mark
8(b)(iii)	An explanation that makes reference to three of the following: • acetylcholine is released from the parasympathetic neurones / nervous system (1) • acetylcholine slows heart rate / reduces frequency of depolarisation (1) • atropine binds / blocks (acetylcholine) receptors (1) • at SAN (1) • stops / prevents / reduces acetylcholine binding (to receptor) (1)	 **Allow** atropine stops acetylcholine inhibiting depolarisations **Allow** impulses **Allow** competes for receptor	**3**

Question Number	Answer	Additional guidance	Mark
8(b)(iv)	A description that makes reference to four of the following: • (increased) respiration rate so blood {carbon dioxide (concentration) increases / oxygen (concentration) decreases} • **blood** {pH decreases / acidity increases} (1) • detected by chemoreceptors (1) • {baroreceptors / stretch receptors} detect (changes in) blood pressure (1) • (chemoreceptors in) {aorta / carotid artery / medulla} (1) • impulses (from neurones of peripheral receptors) sent to {medulla / cardiac centre / cardio-acceleratory centre}(1)	**Allow** carbonic acid **Allow** aortic body / aortic arch / carotid body / carotid sinus **Allow** baroreceptors in {aorta / carotid artery / carotid body / carotid sinus / aortic body / aortic arch} **Do not accept** signals / messages / pulses	**4**

Question Number	Answer	Additional guidance	Mark
9(a)	An answer that makes reference to three of the following: • phytoplankton (biomass) is {higher in November / lower in December} **and** {zooplankton / sardines} (biomass) is {lower in November / higher in December} (1) • phytoplankton were consumed (by zooplankton) / sardines (increased) as had more {food / zooplankton} (1) • energy decreases (along the food chain) / not all energy transferred (1) • as energy is lost due to respiration / egestion / excretion / not eaten (1) • biomass pyramids have different shapes as they are {calculated per month / one moment in time} but energy pyramids are calculated for a year (1)	**Allow** phytoplankton biomass decreases (in December) **and** {zooplankton / sardines} biomass increases (in December) **Allow** phytoplankton is highest in November and zooplankton is highest in December **Allow** energy pyramid does not show seasonal changes	**3**

Question Number	Answer	Additional guidance	Mark
9(b)(i)	• correct calculation of energy that is transferred (1) • calculation of percentage of energy that is transferred and given to nearest whole number (1)	Example of calculation 6800000 – 6080000 = 720000 720000/6800000 x 100 = 11 % **11(%) = 2 marks** 720000 **OR** 6800000 – 6080000 **OR** 10.588 **for one mark** **Correct answer with no working gains full marks**	**2**

Question Number	Answer	Additional guidance	Mark
9(b)(ii)	An explanation that makes reference to three of the following: • seals maintain (constant) body temperature / sardines are same temperature (as environment) (1) • so seals maintain high metabolic rate / have high respiration (rate) / fast metabolism (1) • because seals lose (more) **heat** (to the environment) (1) • seals may have more indigestible parts / less edible eaten / excretion (1)	**Allow** sardines can not control temperature **Allow** sardines rely on environment for temperature **Allow** converse for sardines **Allow** converse **Allow** converse **Allow** converse	**3**

Question Number	Answer	Additional guidance	Mark
9(c) (i)	• GPP – R (1)	**Allow** energy available for (primary) consumers / energy available for growth / energy left after respiration / energy stored in biomass	**1**

Question Number	Indicative content
9*(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. **Description (D)** • increasing light intensity increases biomass (of phytoplankton) • at 10 °C, as LI increases biomass increases then levels off • at 20 °C as LI increases biomass increases and does not level off • at 30 °C increase in biomass is low(er) at low LI • at 30 °C, increase in biomass is greater at higher LI • at (high LI / 20-25) increase in temperature increases biomass / at (low LI / 5-15) increase in temperature increases then decreases biomass **Explanations (E)** • at 10 °C, temperature limits biomass production at high LI • at 20 °C / 30 °C, light limits biomass production • respiration rate increases with temperature • warmer temperatures increase evaporation so more clouds • clouds decrease light intensity (so less photosynthesis) • (so) at low light intensity with high temperatures there is less NPP / phytoplankton growth / less energy for food chain • lower phytoplankton growth means less food for orcas so fewer orcas / population decreases • at warmer temperatures and high LI more energy entering food chain / higher GPP so orca population would stay same / increase • NPP shows relationship between photosynthesis and respiration • nitrates used to make proteins / amino acids / DNA (or other named nutrients) (so can limit phytoplankton) • increased carbon dioxide may increase GPP / photosynthesis **Fossil fuel hypothesis and validity (F)** • fossil fuel use releases carbon dioxide • lowering fossil fuel use will lead to less global warming and cloud cover • the data is only from one experiment / only one month trial • no evidence cloud cover will increase • other factors (rather than fossil fuel use) can affect global temperature / carbon dioxide levels • other greenhouse gases are present (e.g. methane) • carbon dioxide could cause acidification affecting photosynthesis /

	phytoplankton growth / GPP • phytoplankton are affected by other factors / eaten by other organisms / part of other food chains • other factors may affect orcas • orcas eat other food sources /orcas are part of other food chains

Level	Marks	
0	**0**	**No awardable content**
1	1-2 (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 any one point described from any of D, E, or F** **2 any two points described from any of D, E, or F**
2	3-4 (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. **3 any three points, from at <u>least two</u> of D, E, F** **4 any four points, from at <u>least two</u> of D, E, F**
3	5-6 (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. **5 any four points and must be from <u>all</u> three of D, E, and F** **6 any five points and must be from <u>all</u> three of D, E, and F**