Mark Scheme (Results)

Summer 2017

Pearson Edexcel GCE Biology (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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when 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.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Additional Guidance	Mark
1 (a)(i)	The only correct answer is **C** (they are bonded to each other by hydrogen bonds) **A** is not correct because cellulose molecules are not branched polymers **B** is not correct because cellulose molecules do not contain α - glucose, they contain β - glucose **D** is not correct because cellulose molecules do not contain 1,6 glycosidic bonds, they contain 1,4 glycosidic bonds		**(1)**

Question Number	Answer	Additional Guidance	Mark
1 (a) (ii)	The only correct answer is **A** (statement 1 and statement 2) **B** is not correct because calcium pectate does not prevent the movement of water **C** is not correct because calcium pectate is also found in the middle lamella **D** is not correct because calcium pectate does not prevent the movement of water		**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)	An explanation that makes reference to three of the following: • {removing tip / removing meristem / absence of auxin} results in lateral shoot growth (1) • because auxin inhibits lateral shoot growth (1) • cytokinin stimulates lateral bud growth (1) • auxin {represses / inhibits / is dominant over} cytokinin action (1)	**Accept** if auxin is higher than cytokinin, lateral shoot growth stops **Accept** if cytokinin is higher than auxin, lateral shoot growth occurs	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(a)	The only correct answer is **D** (Z,Y,X) **A** is not correct because X regulates temperature and Z controls breathing rate **B** is not correct because Y controls balance and Z controls breathing rate **C** is not correct because X regulates temperature and Y controls balance		**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)	The only correct answer is **C** (open, closed) **A** is not correct because Na^+ channels are open not closed **B** is not correct because Na^+ channels are open, not closed and K^+ channels are closed not open **D** is not correct because K^+ channels are closed not open		**(1)**

Question Number	Answer	Additional Guidance	Mark
2 (c)(i)	127.6 – 130.4 beats per minute / bpm	**Accept** any number between and including 127.6 and 130.4 beats per minute / bpm	**(1)**

Question Number	Answer	Additional Guidance	Mark
2 (c)(ii)	A description that makes reference to four of the following: • exercise {increases carbon dioxide / lowers pH / increases H^+ / increases lactate} in blood (1) • detected by chemoreceptors in the {carotid artery / aorta / aortic body / carotid body} (1) • impulses sent to {medulla / cardio acceleratory centre / cardiac control centre} (1) • impulses along sympathetic {nervous system / nerve / neurone} (1) • noradrenaline {is released onto / stimulates} SA node (1)	 **Do not accept** signal / message **Do not accept** signal / message **Accept** adrenaline stimulates SA node	**(4)**

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	The only correct answer is **B** (diploid , triploid, haploid) **A** is not correct because the endosperm nucleus is not diploid but triploid **C** is not correct because the pollen tube nucleus is not diploid but haploid **D** is not correct because the zygote nucleus is not haploid but diploid and the pollen tube nucleus is not diploid but haploid		**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	The only correct answer is **A** (meiosis, mitosis, mitosis) **B** is not correct because the third division is not meiosis but mitosis as the DNA mass remains the same **C** is not correct because the first division is not mitosis as the DNA mass halves and the second and third divisions are both mitosis as the DNA mass remains the same and does not halve **D** is not correct because the first nuclear division halves the DNA mass and the third nuclear division does not halve the DNA mass so is not meiosis		**(1)**

Question Number	Answer	Additional Guidance	Mark
3 (b) (i)	• reading from graph at $1x10^{-2}$ • reading multiplied by 7.5 and divided by 100	Example of calculation: 76 % 76 ÷100 X 7.5 mm = 5.7 mm **Accept** 5700 μm **TE** for wrong reading from graph A Correct answer gains full marks 5.7 with no units = maximum 1 mark	**(2)**

Question Number	Answer	Additional Guidance	Mark
3 (b) (ii)	An answer that makes reference to four of the following: • {chemical A / stopping transcription} has {less effect / smaller reduction} on pollen tube growth (1) • growth levels off when chemical A increases and growth {falls steeply / drops to zero} when chemical B increases (1) • mRNA is already present (1) • (pollen tube) growth requires production of new proteins / enzymes (1)	**Accept** converse for chemical B / stopping translation **Accept** correct mathematical comparison e.g. overall chemical A causes a 29% drop and chemical B causes a 100 % drop **Accept** transcription occurred before chemical A added **Accept** pollen tube cannot grow without synthesis of new proteins	**(4)**

Question Number	Answer	Additional Guidance	Mark
4(a) (i)	The only correct answer is **B** (bipolar cell, rod cell, cone cell) **A** is not correct because X is a rod cell and Y is a cone cell **C** is not correct because W is a bipolar cell, X is a rod cell and Y is a cone cell **D** is not correct because W is a bipolar cell		**(1)**

Question Number	Answer	Additional Guidance	Mark
4(a) (ii)	an arrow that is directed from left to right		**(1)**

Question Number	Answer	Additional Guidance	Mark
4(a)(iii)	An explanation that makes reference to three of the following: • {many / more / 3} {rods / cell X} connect to {cell W / bipolar cell} / one {cone / cell Y} connects to {cell Z / bipolar cell} (1) • therefore (spatial) summation occurs / retinal convergence / add together several generator potentials (1) • so threshold potential / depolarisation occurs in {cell W / bipolar cell} (1) • rods have more pigment than cones / rhodopsin is very sensitive to light (1)	**Accept** converse for cones / cell Y **Accept** converse for cell Z **Accept** iodopsin (in cones / cell Y) is less sensitive to light	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	An explanation that makes reference to the following: • {4 / 9} is colour blind and the (mother / 2 / 6) is not (1) • therefore {mother / 2 / 6} must be {heterozygous / carrier} (1) **OR** • only males are colour blind and their X chromosome is from their mother (1) • none of the mothers are colour blind so they must be heterozygous / carriers (1) **OR** • if colour blindness were dominant {2 / 6 / mother} would have a dominant allele (1) • and {2 / 6 / mother} would therefore be colour blind (1)	**Accept** {4 / 9} is colour blind and the parents are not colour blind **Accept** {6 / 2} are not colour blind but have a son who is colour blind **Do not accept** both parents are heterozygous / carriers	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	An answer that makes reference to the following: • parental genotypes of X^RY and X^RX^r (1) • offspring genotypes of X^RX^R, X^rX^R, X^RY, X^rY (1) • 0.25, ¼, 25% (1)	**Accept** different letters e.g. X^BX^b **Accept** TE for mp2 and mp3 for wrong parents if sex-linked **Accept** 25 % if cross is not sex-linked	**(3)**

Question Number	Answer	Additional Guidance	Mark
5 (a)(i)	A description that makes reference to four of the following: • arrival of {action potential / impulse} at presynaptic {knob / terminal} (1) • calcium channels open / calcium ions enter (presynaptic knob) (1) • vesicles {move to / fuse with} presynaptic membrane (1) • acetylcholine {diffuses across / released into} the {synapse / cleft} (1) • binding to receptors on postsynaptic membrane {opening sodium channels / allowing sodium ions to enter} (1)	**Accept** calcium ions pass through membrane **Do not accept** calcium ions enter membrane **Accept** neurotransmitters for acetylcholine	**(4)**

Question Number	Answer	Additional Guidance	Mark
5 (a)(ii)	The only correct answer is **B** (excitatory, inhibitory, inhibitory) **A** is not correct because lidocaine is inhibitory affecting the Na^+/K^+ ATPase pump, and cobra venom is inhibitory, blocking acetylcholine receptors **C** is not correct because nicotine is excitatory, mimicking acetylcholine, lidocaine is inhibitory affecting the Na^+/K^+ ATPase pump, and cobra venom is inhibitory, blocking acetylcholine receptors **D** is not correct because nicotine is excitatory, mimicking acetylcholine		**(1)**

Question Number	Answer	Additional Guidance	Mark
5 (b)	An explanation that makes reference to three of the following: • an action potential only occurs {when stimulation of A is high and B is low / when threshold is reached} (1) • because the levels of acetylcholine are high and the levels of glutamate are low (1) • an action potential does not occur when levels of glutamate are high (1) • because movement of chloride ions causes {hyperpolarisation / reduces depolarisation} (1)	 **Accept** EPSP is greater than IPSP **Accept** because enough sodium ions enter the neurone / enough sodium channels open **Accept** excitatory transmitter for acetylcholine **Accept** IPSP is greater than EPSP **Accept** inhibitory transmitter for glutamate **Accept** description of hyperpolarisation e.g. inside becomes more negative	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(a)	Q: nucleus	**Do not accept** nucleolus	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(b)	• correct calculation of magnification (x 10 000) • correct calculation of diameter (1)	Example of calculation: magnification: 10 000 μm ÷ 1 μm = × 10 000 diameter: 54 mm ÷ 10 000 = 5.4 μm **Accept** range between 5.3 μm to 5.5 μm Correct answer with units gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(c)	A description that makes reference to three of the following: • vesicles containing protein from rER {move to / fuse with} Golgi (1) • proteins {modified / glycosylated / carbohydrates / lipids attached} (1) • proteins leave (Golgi) in vesicles (1) • vesicles fuse with cell membrane (1)	**Accept** quarternary structure formed / conjugated protein formed **Accept** package into vesicles	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(d)	An explanation that makes reference to the following: • rate of diffusion increases due to {increased diffusion / concentration} gradient (1) • and rate of uptake levels off as {calcium ion channels / transport proteins / channel proteins} limit rate (1) • because (calcium) ions enter by facilitated diffusion (1)	**Accept** all calcium ion channels are being used	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	A description that makes reference to the following: • {independent / random} assortment of chromosomes (1) • {crossing over / recombination / chiasmata formation} between homologous chromosomes (1)	**Accept** correct descriptions of crossing over between homologous chromosomes	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	An answer that makes reference to the following: • CC, Cc^{ch}, Cc^{h}, Cc (1)	**Accept** alleles in different order e.g. $c^{h}C$	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(a)(iii)	An answer that makes reference to the following: • parents identified as Cc^{h}, Cc^{ch} (1) • F_1 that are crossed identified as $c^{ch}c^{h} \times c^{ch}c^{h}$ (1) • F_2 identified as $c^{ch}c^{ch}$, $c^{ch}c^{h}$, ($c^{ch}c^{h}$), $c^{h}c^{h}$ (1)	**Accept** all mps from Punnett squares **Accept** any clear indication that $c^{ch}c^{h} \times c^{ch}c^{h}$ are crossed	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(b)	An answer that makes reference to three of the following: • both change the frequency of alleles / change genetic diversity (1) • both select against (less well adapted) phenotypes (1) • disruptive selection selects against {middle / mean / median} phenotypes but stabilising selection selects against extreme phenotypes (1) • disruptive selection leads to {two distinct populations / bimodal distribution} but stabilising selection maintains one population (1)	**Accept** change gene pool **Accept** converse **Accept** alleles for phenotypes **Do not accept** genes **Accept** converse **Accept** alleles for phenotypes **Do not accept** genes **Accept** clear labelled diagrams	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(a)(i)	An answer that makes reference to the following • {gross primary productivity / total energy fixed by photosynthesis} minus energy released from {respiration / metabolism}	**Accept** energy available to other organisms / next trophic level **Accept** NPP = GPP – R / GPP - R	**(1)**

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	An explanation that makes reference to the following: • (at high light intensities) as temperature increases NPP increases because light is not limiting photosynthesis (1) • (at low light intensities) as temperature increases NPP decreases because respiration increases more than photosynthesis (1)	**Accept** increasing temperature increases rate of photosynthesis more than respiration **Accept** photosynthesis rate {does not increase / is limited by light} but respiration rate does increase	**(2)**

Question Number	Indicative content
8(b)*	Answers will be credited according to candidates’ deployment of knowledge and understanding of the 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. <u>Succession (S)</u>: • succession begins with seeds / roots (from previous crops etc), followed by herbaceous plants, shrubs and trees • increased plant diversity increases number of niches for animals, resulting in an increase in index of diversity • steep increase in diversity at approximately 20 years with herbaceous plants / shrubs providing high numbers of niches • index of diversity stabilises and then decreases as trees shade area • shade reduces herbaceous / shrub plant species reducing niche number and index of diversity <u>NPP (N):</u> • NPP increases as more herbaceous plants and shrubs with higher leaf areas grow • NPP reduces as the community ages due to increase in proportion of non-photosynthetic tissue (wood / roots) reducing photosynthesis rate compared to respiration rate • reduced mineral ion content due to lack of decay of leaves may reduce NPP <u>Mineral ions (M):</u> • starting mineral ions are low due to farming • mineral ions in soil increase with time due to humus / dead organic material from plants and animals • organic material is decomposed by microbes to release minerals • mineral ion content decreases in climax community as few leaves are dropped from pine trees so there is less decay

Level	Marks	Descriptor
0	0	No awardable content
1	1-2	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. **Level 1: Description of succession (S) with little / no reference to graph**
2	3-4	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. **Level 2: Explanation of succession (S) as shown in the graph linked to either N or M with some errors.**
3	5-6	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. **Level 3: Detailed explanation of succession (S) as shown in the graph over 50 years using N and M with only minor errors.**

Question Number	Answer	Additional Guidance	Mark
9(a)(i)	A calculation that makes reference to the following: • correct tangent to the curve (1) • correct measurement of the y axis and x axis distances (1) • correct calculation of gradient (1)	**Accept** a straight line that must through or between 19.0 mg cm^{-3} or 24.0 mg cm^{-3} at 30 s. **TE** for mark points 2 and 3 from wrong tangent **TE** for mark point 3 for correct gradient calculation with no tangent (y ÷ x) <u>Example of calculation:</u> 21.0 / 30 = 0.70 mg cm^{-3} s^{-1} (accept range of between 0.63 mg cm^{3} s^{-1} to 0.80 mg cm^{3} s^{-1}) Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
9(a)(ii)	A explanation that makes reference to two of the following: • active site (of enzyme) {shape / structure} changes (1) • because {H^+ ions / acid} {affects ionic bonds / affects hydrogen bonds} (of enzyme) (1) • so {substrate/ monophenol} no longer fits / binds (1)	**Accept** {shape / structure} of monophenol changes so it no longer fits active site **Accept** because H^+ ions / bind to monophenol **Accept** E/S complexes do not form	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(a)(iii)	An explanation that makes reference to two the following: • tropolone is similar in {shape / structure} to monophenol (1) • tropolone acts as a competitive inhibitor / binds in the active site (1) • so it prevents {binding of monophenol / enzyme substrate complexes forming} decreasing the {rate of reaction / production of quinone / enzyme activity}(1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
9(b)(i)	The only correct answer is **B** (hydrogen, ionic and disulfide) **A** is not correct because glycosidic and ester bonds are not tertiary structure bonds **C** is not correct because glycosidic bonds are not tertiary structure bonds **D** is not correct because ester bonds are not tertiary structure bonds		**(1)**

Question Number	Answer	Additional Guidance	Mark
9(b)(ii)	A explanation that makes reference to three of the following: • different {sequence of amino acids / primary structure} (1) • so there will be different R groups (1) • therefore {secondary / tertiary / quaternary} structure is different (1) • {active site is not complementary to monophenol / active site has different shape} so {monophenol cannot bind / enzyme substrate complexes cannot form} (1)	**Accept** insertion of a stop codon leads to shorter polypeptide (1) **Accept** different hydrogen bonds / disulfide bonds / ionic bonds **Accept** correct references to α-helix and β-sheet **Accept** references to substrate for monophenol	**(3)**

Question Number	Answer	Additional Guidance	Mark
10(a)(i)	A description that makes reference to two of the following: • CITES prevents {exploitation / hunting / sale / trade / poaching} (1) • by countries that sign up to the treaty (1) • by {protecting / conserving} endangered species (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
10(a)(ii)	An explanation that makes reference to two of the following: • (genetic / population) bottleneck (1) • causing reduced {genetic diversity / gene pool / number of different alleles} (in populations) (1) • therefore the chance of inheriting two harmful recessive alleles increases (1)	**Accept** small / restricted gene pool	**(2)**

Question Number	Answer	Additional Guidance	Mark
10(b)	The only correct answer is **B** (X,Z,Y) **A** is not correct because adult haemoglobin is Z, not Y and fetal haemoglobin is Y, not Z **C** is not correct because myoglobin is X, not Y and fetal haemoglobin is Y, not X **D** is not correct because myoglobin is X, not Z, and adult haemoglobin is Z, not X		**(1)**

Question Number	Answer	Additional Guidance	Mark
10(c)(i)	• total blood volume in one seal (1) • conversion of g dm^{-3} to g cm^{-3} (1) • total mass of haemoglobin (concentration of haemoglobin x volume of blood in a seal) (1)	<u>Example of calculation:</u> 400 x 207 = 82800 cm^3 **Accept** calculation of total haemoglobin per cm^3 kg^{-1} blood: 207 × 216 = 44712 **Accept** calculation of concentration of haemoglobin in one seal: 216 × 400 = 86400 216 ÷ 1000 = 0.216 g cm^{-3} 0.216 x 82800 = 17885 g Correct answer with no working gains full marks **Accept** for two marks a correct answer with no units / wrong units **Accept** for three marks: 17884.8 g / 17880 g / 17890 g / 17900/ 18000 g / 17.8848 kg / 17.885 kg / 17.89 kg / 17.9 kg / 18 kg	**(3)**

Question Number	Indicative content
10(c)(ii) *	Answers will be credited according to candidates' deployment of knowledge and understanding of the 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. <u>A: Depth and diving</u>: • positive correlation between maximum depth and maximum time holding breath • weak positive correlation between mass of animal and depth • weak correlation between maximum time holding breath and mass of mammal • because diving deeper requires larger oxygen storage as can't breathe underwater • aerobic respiration requires oxygen to release energy <u>B: Blood and muscle:</u> • positive correlation between volume of oxygen in body and maximum depth • positive correlation between concentration of haemoglobin in blood and maximum depth • no correlation between oxygen stored in muscle and maximum depth • all the mammals must possess myoglobin acting as an oxygen store in muscle • bottlenose dolphin and harbour seal have more oxygen stored in lungs / Weddell seal and Northern elephant seal have less oxygen stored in lungs • oxygen stored in lungs results in more buoyancy so deeper diving mammals have less stored in lungs • combined effect of high blood volume and haemoglobin concentration results in very high blood oxygen storage • more oxygen stored in blood so higher haemoglobin concentration and blood volume in animals that dive deeper • all have similar proportions of oxygen stored in muscle <u>Quantitative analysis</u> • Q1: quoting of data to support explanation • Q2: manipulation of data to support explanation, for example, determining total haemoglobin concentrations in mammals.

Level	Marks	
0	0	No awardable content
1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **Level 1: Description of some patterns from at least one of A or B**
2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. The discussion shows some linkages and lines of scientific reasoning with some structure. **Level 2: Description of patterns with explanation from at least one of A or B**
3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **Level 3: Detailed description and explanation of patterns from both A and B with quantitative analysis (Q)**

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