Pearson Edexcel

Mark Scheme (Results)

November 2021

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk for our BTEC qualifications.
Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

If you have any subject specific questions about this specification that require the help of a subject specialist, you can speak directly to the subject team at Pearson.
Their contact details can be found on this link:
www.edexcel.com/teachingservices.

You can also use our online Ask the Expert service at www.edexcel.com/ask. You will need an Edexcel username and password to access this service.

Pearson: helping people progress, everywhere
Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

November 2021
Question Paper Log Number P65457A*
Publications Code 9BI0_02_2111_MS*
All the material in this publication is copyright
© Pearson Education Ltd 2021

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)	A 0.14 s *B is incorrect as the valve has already closed* *C is incorrect as the valve is open* *D is incorrect as the valve is open*		**1**

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	D sinoatrial node, atrioventricular node, bundle of His *A is incorrect as the impulse starts at the* sinoatrial node *B is incorrect as the impulse starts at the* sinoatrial node *C is incorrect as the bundle of His is after the* atrioventricular node		**1**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An explanation that makes reference to three of the following: • tissue fluid leaves the capillary through pores (1) • because the hydrostatic pressure is greater than the oncotic pressure (1) • plasma proteins are present in the blood but not in tissue fluid / more protein in blood plasma (1) • plasma proteins are too large to leave capillary (1)	**Allow** fenestrations / other terms for pore **Allow** oncotic pressure is lower than hydrostatic pressure	**3**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An explanation that makes reference to two from: • there is less protein in the blood plasma (1) • so that less tissue {fluid / water} enters blood (1) • because the oncotic pressure is less / there is less capillary length where oncotic pressure is greater than hydrostatic pressure (1)	**Allow** more fluid leaves than enters	**2**

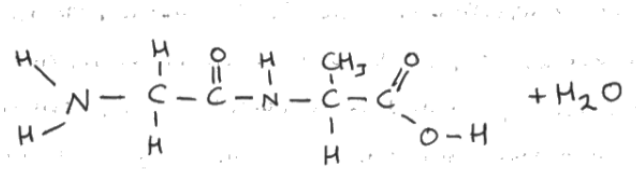
Question Number	Answer	Additional Guidance	Mark
2(a)(i)	B Female with Turner's syndrome *A is incorrect because the human has one X* *B is incorrect because the human is female* *C is incorrect because the human is female*		1

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	A Non-disjunction producing a monosomy B is incorrect because it is a monosomy C is incorrect because it is due to non-disjunction C is incorrect because it is due to non-disjunction		1

Question Number	Answer	Additional Guidance	Mark
2 (b)(i)	B ovum and secondary oocyte A is incorrect because secondary oocyte is diploid C is incorrect because the secondary oocyte is diploid D is incorrect because the primary oocyte is diploid		1

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	*An explanation that makes reference to:* • crossing over (1) • which swaps {alleles / DNA / genes} between {homologous chromosomes} (1) • independent / random assortment (1) • because it is random movement of homologous chromosomes to poles (1)	**Allow** random movement of paternal and maternal chromosomes / random combinations of paternal and maternal chromosomes	**4**

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	**A** CH_3 *B is incorrect because it is the carboxylic acid group* *C is incorrect because it is not the R group* *Dis incorrect because it is the amino group*		**1**

Question Number	Answer	Additional Guidance	Mark
3 (a)(ii)	*An answer that makes reference to:* • correct peptide bond between the amino acids (1) • a water molecule (1)		**2**

Question Number	Answer	Additional Guidance	Mark
3(a)(iii)	*An answer that makes reference to three from:* • three polypeptide chains (1) • that are (left hand) helices joined together (1) • (helices are held together) by hydrogen bonds (1) • many tropocollagen molecules / triple helices joined together (1)	**Allow** repeating sequences of amino acids / every third amino acid is glycine / lots of proline **Allow** triple helix	**3**

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	• 1.3 N (1)		**1**

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	An explanation that makes reference to three of the following: • arteries stretch more / (have weaker collagen which means that) less force produces a longer extension (1) • because the elastic constant is lower (1) • and (blood in arteries) has high pressure (1) • and less force is required to break the artery (1)	**Allow** less elasticity in arteries **Allow** arterial blood has high hydrostatic pressure	**3**

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	D sympatric speciation A is incorrect because allopatric speciation requires geographical separation B is incorrect because genetic speciation is the wrong term C is incorrect because stabilising selection is the wrong term		**1**

Question Number	Answer	Additional Guidance	Mark
4 (a)(ii)	*An answer that makes reference to:* • have not seen if they can breed and produce fertile offspring with modern mosquitoes (1)		**1**

Question Number	Answer	Additional Guidance	Mark1
4(a)(iii)	*An answer that makes reference to:* • peer review / published in journals / conferences (1)		**1**

Question Number	Answer	Additional Guidance	Mark
4(a)(iv)	• Phylum and class (1) • Prisoculex and burmanicus (1)		**2**

Question Number	Answer	Additional Guidance	Mark
4 (b)(i)	A calculation that makes reference to: • correct calculation to find q (1) • correct calculation to find p (1) • correct calculation to find 2pq and number of mosquitoes (1)	q = 0.899… **Allow** any dp p = 0.101… **Allow** any dp **Allow** ecf for mp2 and mp3 1183 = three marks Correct answer with no working gains full marks	**3**

Question Number	Answer	Additional Guidance	Mark
4 (b)(ii)	An explanation that makes reference to four of the following: • The frequency of the resistance allele increased in 2015 (1) • because the (resistant) acetylcholinesterase enzyme is not affected by the pesticide / enzyme still works (1) • acetylcholine is still broken down in synapses (1) • the mosquitoes survive and breed (1) • the resistance allele carries a cost as it is reduced when no pesticide is used / after 2015 (1)	**Allow** Number of resistant mosquitoes increases in 2015 **Allow** converse **Allow** converse **Allow** converse **Allow** resistant mosquitoes are at a selective advantage **Allow** lost by genetic drift / non-resistant mosquitoes out compete resistant ones after pesticide use stops **Allow** no selective pressure to retain the resistant allele	**4**

Question Number	Answer	Additional Guidance	Mark
5(a)(i)	D phosphodiester *A is incorrect because peptide bonds are found in proteins* *B is incorrect because disulfide bonds are found in proteins* *C is incorrect because glycosidic bonds are found in carbohydrates*		**1**

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	A description that makes reference to four of: • hydrogen bonds between nucleotides broken by DNA helicase (1) • complementary nucleotides bind (1) • because {hydrogen bonds} will only form between cytosine and guanine and adenine and thymine (1) • phosphodiester bonds are formed by DNA polymerase (1) • (the leading strand is synthesised continuously but lagging strand required) DNA ligase to join fragments (on lagging strand) (1)	**Allow** unzipped by helicase	**4**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	*An answer that makes reference to:* • correct indication of selection of RNA virus (for TMV) (1) • correct use of graph to identify intercept between 0.000001 and 0.0005 (1)	**Allow** correct use of standard form e.g. 10^{-4} **Allow** ecf for correct use of y axis with wrong selection of virus type correct answer gets both marks	**2**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	*An answer that makes reference to three from:* • as genome size increases, mutation rate decreases (1) • RNA / ss DNA /ss nucleic acid has a higher mutation than ds DNA (1) • because it is single stranded template so does not produce copies with complementary bases / is less stable (1) • viruses have a higher mutation rate than bacteria / eukaryotes (1)	**Allow** converse / allow correlation **Allow** eukaryotes have lowest mutation rates **Allow** RNA viruses have highest mutation rates	**3**

Question Number	Answer	Additional Guidance	Mark
6(a)(i)	**A** **1** and 2 *B is incorrect because lidocaine binds to voltage gated sodium channels* *C is incorrect because lidocaine binds to voltage gated sodium channels* *D is incorrect because lidocaine binds to voltage gated sodium channels*		**1**

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	B parasympathetic neurone reduce *A is incorrect because acetylcholine reduces the heart rate* *C is incorrect because acetylcholine is released by parasympathetic neurones* *D is incorrect because acetylcholine is released by parasympathetic neurones*		**1**

Question Number	Answer	Additional Guidance	Mark
6(a)(iii)	An answer that makes reference to three from: • action potential / impulse arrives at pre-synaptic {terminal / knob}(1) • calcium channels open and calcium ions diffuse in (1) • vesicles move to membrane (1) • vesicles fuse with membrane and release acetylcholine (1)	**Allow** action potential stimulates presynaptic membrane **Allow** Ca^{2+} **Allow** exocytosis	**3**

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	An explanation that makes reference to three from: • capsaicin binds to (TPV) receptors in membrane of receptors cells (1) • this causes neurotransmitter (from receptors) to be released onto sensory neurone {generating an epsp / opening sodium channels / causing sodium ions to flow in} (1) • high concentrations of capsaicin generate an epsp that) overcomes threshold to form an {action potential} (1) • action potential moves along the neurone by (opening sodium channels) (1)	**Allow** low concentrations does not overcome threshold **Allow** high concentrations opens voltage gated sodium channels	**3**

Question Number	Indicative content	
6 (b)(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. **Descriptions** • 100 mg / 50 mg / higher doses / of capsaicin increase mass of sweat produced D • sweat production from 100 mg decreases after 5 days D • 10 mg has less effect D • 10 mg / 50mg have same effect for all seven days D • 100 mg effect decreases after 3/4/5 days D • 100 mg generates less sweat than 50 mg after 5/6 days D **Explanation / Optimal Dose** • increased sweating and evaporation of water E • evaporation of water requires heat energy E • latent heat of vaporisation is high for water so sweating removes a lot of heat energy E • 50 mg is optimal dose E • because there 100 mg begins to lose effect after 3/4/5 days E • and 100 mg produces more side effects / burning sensations / red rash E **Validity of data** • 50 mg dose has consistent sweat production as error bars all overlap V • 100 mg and 50 mg are significantly higher than 10 mg as error bars do not overlap V • 10 mg has a high variation between responses of volunteers V • no control experiment has been carried out V • sample size is small V	**6**

	• capsaicin may interfere with other medicines / may make illness worse / no tests done on ill people V		
Level	**Marks**		
Level 0	Marks	No awardable content	
Level 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. **Basic description of the effects of each dose** **one mark: any one from D, E, V** **two marks: 3D, 2D + 1E, 2D + 1V**	
Level 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. **Detailed description and either E or V** **three marks: at least four points from D + E or D + V** **four marks: at least five points from D + E or D + V**	
Level 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. **Must have elements of D, E and V.** **five marks: at least six points from D, E and V** **six marks: at least seven points from D, E and V AND must refer to standard deviations**	

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	• correct calculation of energy in primary consumers (1) • correct calculation of percentage efficiency of energy transfer (1)	1.2×10^4 / 12000 (1200 / 14000) x 100 = 8.6 % Allow 8.57	**2**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	An explanation that makes reference to three from: • (large amounts of) energy from producers is not transferred to primary consumers as producers have more {indigestible parts / inedible parts / parts not consumed}(1) • animals / primary consumers / secondary consumers have higher respiration rates than producers (1) • as more energy lost in {movement / heat loss} (1) • animals / primary consumers / secondary consumers lose more energy as {urea / excretion} (compared with producers) (1)	**Allow** more faeces released when consuming producers **Allow** different organisms have different amounts of indigestible / inedible parts **Allow** different organisms have different respiration rates **Allow** organisms have different levels of movement /heat loss	**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. **Descriptions** • crop yield is highest between 5 m and 10 m from hedgerow D • crop yield is lowest next to the hedgerow / crop yield is lower than the centre of the field up to 2.5 m • crop yield increases up to between 5 m and 10 m from the hedge and then decreases D • wind speed is lowest by the hedge D • wind speed increases with distance from the hedge D • temperature is higher by hedgerow / falls with distance D • hedgerows can increase crop yields, but fields need to be smaller D • hedgerows can take up land that could be used to grow crops D **Abiotic Explanations** • humidity is higher by the hedgerow A • reduced wind speed (by the hedge) increases the temperature A • transpiration /water loss / evaporation will be lower around hedgerow A • hedgerow acts as a wind break A • less than 2m from hedgerow productivity is lower due to competition / shading reducing photosynthesis A • between 5m and 15 m, higher temperature will increase photosynthesis rate A • higher temperature is closer to optimal enzyme temperatures A • wind can affect crops pollinated by wind A	**6**

	Biotic Explanations • pollinating species and predators increase productivity B • predators consume herbivores / pests B • pollinators are essential for seeded crops / example B • hedgerow may compete for nutrients / water / light B • less need for pesticides to be used when predator species live in hedgerows B		
Level	**Marks**		
Level 0	Marks	No awardable content	
Level 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. **Descriptions of factors** **one mark: any two from D** **two marks: three from D**	
Level 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. **Descriptions and explanations** **three marks: any four points from D, A or B** **four marks: any five points from D, A or B and**	
Level 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.	

		Detailed explanation of all factors and how use of hedges can be beneficial **Descriptions and explanations** **five marks: any six points from D, A and B** **six marks: any seven points from D, A and B**	

Question Number	Answer	Additional Guidance	Mark
8 (a)(i)	D X^HY and X^HX^h A is incorrect because 4 must have inherited a haemophilia allele from 1 B is incorrect because 1 does not have haemophilia C is incorrect because 1 does not have haemophilia		**1**

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	An answer that makes reference to: • correct genotypes for 4 and 5 (X^hY and X^HX^h) (1) • correct gametes (1) • correct (genotypes of F_1 and) 0.25 / 25 % (1)	ecf for correct gametes only (mp2)	**3**

Question Number	Answer	Additional Guidance	Mark
8(b)	An answer that makes reference to 5 from: • the mean clotting time has increased for both drugs / for drug A and drug B (1) • there is little variation in the control group (1) • there is high variation with drug B (1) • drug B does not change clotting rate for some (blood types) as there is overlap with the control group (1) • drug B has a slower clearance time so patients would be at risk of bleeding (1) • drug A would be better as it works for all samples and is cleared from body faster / will allow blood to clot sooner after dialysis (1)	piece together **Allow** low range in control group / with no drug **Allow** largest range / drug B has more spread / variation than drug A **Allow** drug A increased clotting time for all samples as there is no overlap with control	**5**

Question Number	Answer	Additional Guidance	Mark
9(a)	An explanation that makes reference to three from: • auxin is released from the terminal bud (1) • and (diffuses down the stem) to inhibit cytokinin action / inhibit lateral shoot growth (1) • cytokinin stimulates lateral shoot growth (1) • and is produced from base of shoot (1)	Allow one mark for antagonistic effect if no MP1 or MP3?	**3**

Question Number	Answer	Additional Guidance	Mark
9(b)	An explanation that makes reference to two from: • uncharged auxin can diffuse through the {uncharged / hydrophobic / nonpolar} fatty acid tails (1) • (negatively) charged auxin has to move through protein channels / carrier proteins (1)		**2**

Question Number	Answer	Additional Guidance	Mark
9(c)(i)	• correct calculation of increase of elongation from graph from tangent (1) • increase in elongation divided by time taken (1)	ecf for mp2 **Allow** answer between 9.5 and 12.8 μm min^{-1} one mark for correct answer with no units a correct answer gains full credit	**2**

Question Number	Answer	Additional Guidance	Mark
9(c)(ii)	An answer that makes reference to three from: • as pH falls / at lower pH, elongation increases (1) • because expansin is activated by lower pH (1) • weakening (intermolecular) bonds between cellulose molecules / calcium pectate / hemicelluloses (1) • cell takes in water causing it to expand (1)	**Allow** converse for increase in pH for all MPs **Allow** low pH / hydrogen ions change shape of expansin so it can weaken cell walls	**3**

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom