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Mark Scheme (Results)

October 2020

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

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- 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)	A description that makes reference to the following: • enters through spiracles (1) • diffusion {in tracheae / in tracheoles / into cells} (1) • down concentration gradient (1)		**(3)**

Question Number	Answer	Additional Guidance	Mark
1 (b)(i)	{mm/cm/mm^3/cm^3} min^{-1} g^{-1}		**(1)**

Question Number	Answer	Additional Guidance	Mark
1 (b)(ii)	A description that makes reference to the following: • named factor (1) • how controlled (1)	 e.g. temperature, {size / mass / age} of insect e.g. thermostatically controlled water bath / water bath set at a constant temperature / ac room choose equal { size / mass / age} of insect	**(2)**

Question Number	Answer	Additional Guidance	Mark
1 (b)(iii)	An explanation that makes reference to the following: • it has already absorbed the maximum amount of carbon dioxide / no more carbon dioxide can be absorbed (1) • (therefore) coloured liquid {would not move / would move less} / readings {are an underestimate / will not be valid} (1)	 Accept it is able to absorb less carbon dioxide (for the second insect) Accept (it is replaced) so that coloured liquid will move / so that readings will be valid	**(2)**

Question Number	Answer	Additional Guidance	Mark
2 (a)	A description that makes reference to three of the following: • (folded into) {spherical / rounded / 3D} shape (1) • {polar / hydrophilic} {R groups / amino acids} on outside (1) • {non polar / hydrophobic} {R groups / amino acids} on inside (1) • ionic / hydrogen / disulfide bonds (1)	Accept disulfide bridges	**(3)**

Question Number	Answer	Additional Guidance	Mark
2 (b)	An answer that makes reference to five of the following: • (put albumin tubes into a) range of at least five pepsin concentrations (1) • control {temperature using water bath / pH using buffer} (1) • use same {concentration / source / mass / length / volume} of albumin (1) • leave for {same / stated} time or measure at regular time intervals (1) • measure {length of albumin remaining / mass of albumin} (at end of investigation) (1) • {use several capillary tubes / repeat} and {calculate mean / calculate SD / identify anomalies} (1) • control tube with no enzyme (for comparison) (1)	Time how long it takes for albumin to disappear = 2 marks Accept measure absorbance using a colorimeter	**(5)**

Question Number	Answer	Additional Guidance	Mark
3(a)	9 / 90		**(1)**

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	• calculation of volume (1) • calculation of cardiac output (1) • conversion to $dm^3\ min^{-1}$ (1) OR • change units for radius (1) • calculation of volume (1) • calculation of cardiac output (1)	$= \frac{4}{3} \times 3.142 \times 0.001$ $= 0.004189 \times 200$ $= 0.0000008379\ (dm^3\ min^{-1})$ **Accept** 8×10^{-7} / 8.4×10^{-7} / 8.38×10^{-7} / 8.379×10^{-7} / 0.0000008 / 0.00000084 / 0.000000838 Correct answer gains full marks, with no working shown. 8 / 8.4 / 8.38 / 8.379 to wrong power of 10 gets 2 marks Ecf if diameter used instead of radius 0.1mm = 0.001 dm $= \frac{4}{3} \times 3.142 \times 0.001$ $= 4.189 \times 10^{-9} \times 200\ (dm^3\ min^{-1}) = 8.38 \times 10^{-7}$ **Accept** 8×10^{-7} / 8.4×10^{-7} / 8.379×10^{-7} / 0.0000008 / 0.00000084 / 0.000000838 / 0.0000008379	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	more cells that need supply of {glucose / oxygen} (1)		**(1)**

Question Number	Answer	Additional Guidance	Mark
3(c)(i)	• calculate sum of d^2 and divide (1) • calculate square root (1)	50 ÷ 2 = 25 5.0 Correct answer gains full marks, with no working shown.	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)(ii)	An answer that makes reference to the following: • one axis labelled mean heart rate with units, linear scale starting at 0 (not broken scale), bars labelled and covers at least half the grid (1) • accurate plot and standard deviations (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)(iii)	An answer that makes reference to two of the following: • for valid comparison / to get a valid result (1) **and any one from the following**: • temperature because {water fleas are ectotherms / affects heart rate} (1) • {carbon dioxide / pH} affects heart rate (1) • time of measuring because water fleas may fatigue (1) • acclimatisation to allow equal time for substances to take effect (1)	Accept to ensure the treatment is the only factor affecting heartrate	**(2)**

Question Number	Answer	Additional Guidance	Mark
4 (a)	An explanation that makes reference to the following: • clotting takes longer at low temperature due to {low kinetic energy / fewer enzyme-substrate collisions} (1) • clotting time is least at {body/optimum} temperature (1) • (clotting takes longer) at {temperatures above 37°C / high temperatures} (because) enzymes are denatured (1)	Accept clotting takes less time as temperature increases because {kinetic energy increases / more enzyme-substrate collisions}	**(3)**

Question Number	Answer	Additional Guidance	Mark
4 (b)	6771		**(1)**

Question Number	Answer	Additional Guidance	Mark
4 (c)(i)	substitution	Accept point mutation	**(1)**
Question Number	**Answer**	**Additional Guidance**	**Mark**
4 (c)(ii)	1 in 50	Accept other correct probabilities e.g. 2% or 0.02	**(1)**

Question Number	Answer	Additional Guidance	Mark
4 (c)(iii)	An explanation that makes reference to the following: • (excess prothrombin means) more thrombin (1) • therefore increased {conversion / catalysis} of fibrinogen to fibrin (1) • fibrin {is insoluble / traps blood cells / forms mesh / forms net} (1)	Accept if there is more fibrin it is more likely to clot	**(3)**

Question Number	Answer	Additional Guidance	Mark
4 (d)(i)	cut DNA to produce {short sections of DNA / short tandem repeats / mini satellites} (1)	Accept cut DNA into fragments / cut DNA to give sticky ends	**(1)**

Question Number	Answer	Additional Guidance	Mark
4 (d)(ii)	A description that makes reference to three of the following: • use (DNA) primers / nucleotides (1) • use {high temperature / 95 °C} for 30 seconds (to separate DNA strands) (1) • use {lower temperature / 55 °C} for 20 seconds (to bind primers) (1) • heat to 72°C with polymerase (to replicate DNA) (1) • repeat process (to obtain many copies of DNA) (1)		**(3)**

Question Number	Answer	Additional guidance	Mark
5(a)	endosperm		**(1)**

Question Number	Answer	Additional guidance	Mark
5(b)(i)	A description that makes reference to two the following: • DNA strands separate (1) • antisense strand used as template (for mRNA) (1) • RNA polymerase synthesises mRNA (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	A description that makes reference to five of the following: • mRNA leaves through nuclear pores (1) • {translation occurs at / mRNA travels to} ribosomes / rough endoplasmic reticulum (1) • codons (on mRNA) pair with anticodons on tRNA / tRNA brings amino acid (to the ribosome) (1) • peptide bonds form between amino acids (1) • amylase enters Golgi and is {modified / processed} / amylase {is packaged into vesicles / travels in vesicles} (1) • exocytosis releases {amylase / protein} (1)	Accept protein for amylase Accept description for exocytosis	**(5)**

Question Number	Answer	Additional guidance	Mark
5(c)	An answer that makes reference to five of the following: • (soak grains in) range of at least five salt concentrations (1) • use {surface sterilised seeds / sterile agar / sterile Petri dishes} (1) • {wash / cut} grains and place onto starch agar (1) • leave for 24-48 hours (1) • add iodine (solution) (1) • measure {diameter/area} of clear zone (1)	Accept wash grains with bleach Accept leave {washed / cut} seed in starchy solution If alternative method used (grain in starch solution), accept use a colorimeter to measure absorbance	**(5)**

Question Number	Answer	Additional Guidance	Mark
6 (a)	H / hydrogen		**(1)**

Question Number	Answer	Additional Guidance	Mark
6 (b)	An explanation that makes reference to two of the following: • {bacteria / microbes} cannot {reproduce / undergo binary fission} (1) • (because) complementary base pairing cannot occur (1) • (because) mRNA synthesis prevented (1)	Accept bacteria cannot replicate / multiply Accept T cannot pair with A Accept no transcription occurs	**(2)**

Question Number	Answer	Additional Guidance	Mark
6 (c)	An answer that makes reference to two of the following: • {flame / sterilise / autoclave} apparatus to kill bacteria (1) • clean surfaces with {bleach / disinfectant / alcohol} to kill bacteria (1) • open lid of Petri dish slightly to prevent access by bacteria (1) • work near Bunsen flame to {create updraft / prevent bacteria settling} (1)	Accept microbes / spores for all points	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(d)(i)	An answer that makes reference to three of the following: **Similarity** • both have peptidoglycan (1) **Two differences from:** • positive has {more / thicker layer of} peptidoglycan than negative / positive has a thicker cell wall than negative (1) • positive has teichoic acid, negative does not (1) • negative has outer membrane, positive does not (1) • negative (most) has periplasmic space, positive does not (1) • negative has {more lipid / lipopolysaccharide / porin proteins}, positive does not (1)	Accept periplasm	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(d)(ii)	• subtraction using values from graph (1) • calculation of percentage change (1)	$10^8 - 10^2 = 99\ 999\ 900$ $\div 10^8 \times 100 =$ **99.9999** Correct answer gains full marks, with no working shown.	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(d)(iii)	An answer that makes reference to the following: • it is effective if irradiation longer than 3 hours (1) • it is effective against E. coli which infect the intestine (1) • not all species of {pathogenic bacteria / bacteria causing food poisoning} investigated / only three types of bacteria investigated (1) • toxins may remain in food (1)	Accept effectiveness depends on how long it is irradiated for	**(4)**

Question Number	Answer	Additional Guidance	Mark
7 (a)	50 (1)		**(1)**

Question Number	Answer	Additional Guidance	Mark
7 (b)	An explanation that makes reference to the following: • because food attracts mouse into trap (1) • because {small entrance / size of trap} allows {small animals / mice} to enter trap / larger animals cannot enter trap (1) • because door slides down when the mouse {approaches the food / walks on board} (1)	Accept the entrance is big enough for mice to enter the trap	**(3)**

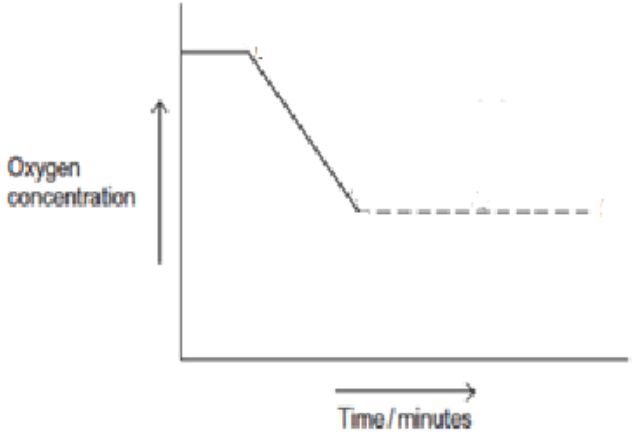
Question Number	Answer	Additional Guidance	Mark
7 (c)	An explanation that makes reference to four of the following: • mice have large surface area to volume ratio (1) • (therefore) {lose a lot of heat / lose heat quickly} (1) • heat generated by {metabolism / respiration} (1) • insufficient food to {maintain (high) metabolic rate / release enough energy} (1) • no bedding {for insulation / to prevent heat loss} (1)		**(4)**

Question Number	Answer	Additional Guidance	Mark
7 (d)	An answer that makes reference to five of the following: **Inaccurate because** • {births / deaths} may occur (1) • migration may occur (1) • marking may affect survival (1) • mice may lose bands (1) • food encourages capture / trap discourages capture (1) **Accurate because** • {time / a week} is long enough for random dispersal (1) • a lot of traps were set / sample size large (1) • traps were randomly placed (avoids bias) (1)	Accept that some animals are more or less likely than others to enter trap	**(5)**

Question Number	Answer	Additional Guidance	Mark
8 (a)	inner membrane / cristae		**(1)**

Question Number	Answer	Additional guidance	Mark
8(b)(i)	An explanation that makes reference to five of the following: • (cyanide) changes tertiary structure / changes active site / substrate no longer fits {active site / enzyme} (1) • therefore transport of {electrons / hydrogen ions} stops (1) • carrier(s) cannot be reduced (1) • (so that) ATP manufacture stops / less ATP made (1) • muscles {cannot contract / go into spasm} / breathing stops / heart stops (1) • any other named biological process that requires ATP stops eg active transport (1)		**(5)**

Question Number	Answer	Additional guidance	Mark
8(b)(ii)	• mass of cyanide that kills = 10 mg (1) • mass of cyanide inhaled per minute • time taken to inhale lethal dose (1) OR • mass of cyanide that kills = 10 mg (1) • volume that provides lethal dose (1) • time taken to inhale lethal dose (1)	1 x 10 = 10 mg 0.24 mg dm^{-3} x 15 = 3.6 (mg per minute) 10 ÷ 3.6 = **2.78** minutes (3sf) 1 × 10 = 10 mg 10 ÷ 0.24 = 41.67 (dm^3) 41.67 ÷ 15 = **2.78** minutes (3sf)	**(3)**

Question Number	Answer	Additional Guidance	Mark
8 (c)	An answer that makes reference to the following: • line decreasing from 5 to 15 minutes (1) • line level from 15 to 25 minutes (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
9 (a)	N		**(1)**

Question Number		Additional Guidance	Mark
9 (b)	An explanation that makes reference to four of the following: • (because) there are more species of woody plants in the older hedges (1) • If hedges were destroyed {there would be a large loss of biodiversity / many species would be lost} (1) • older hedges provide more niches (1) • (so that) more species of {invertebrates / vertebrates / animals / plants} (are associated with older hedge) (1) • (Therefore) hedges provide {shelter / food / nesting sites} / allow safe movement of animals (for {interbreeding / genetic variation}) (1)	Accept there is a positive correlation Accept if hedges were destroyed it would take a long time {for biodiversity to recover / for species number to recover} / if hedges are destroyed there are less niches Accept some plants are found only in older hedges Accept biodiversity increases as age of hedge increases	**(4)**

Question Number	Answer	Additional Guidance	Mark
9 (c)	• avoid {bias / underestimate / overestimate} (1)	Accept to get a representative sample	**(1)**

Question Number	Answer	Additional Guidance	Mark
9 (d)(i)	An answer that makes reference to one of the following: • stems are {stronger / less likely to break / better supported} • more {mineral ion / water} transport (1)		**(1)**

Question Number	Answer	Additional Guidance	Mark
9 (d)(ii)	A description that makes reference to three of the following: • cut thin sections (of the stem) (1) • from same height of stem in young and old plants (1) • {use a stain / named stain} to see xylem (1) • measure thickness of xylem tissue (1)	Accept cut a core (if rings are being measured) Measure thickness of {rings / xylem} 1 mark if potometer used in method	**(3)**

Question Number	Answer	Additional guidance	Mark
9 (e)	An answer that makes reference to five of the following: • cut potato into chips of same size as this {gives equal surface area (to volume ratio) / affects osmosis} (1) • place potato chips in range of {salt / sucrose} solutions to allow {osmosis / water to enter / water to leave} (1) • blot chips to remove surface water (1) • measure (percentage) change in {mass / length} and {determine loss or gain of water / plot graph} (1) • identify where line crosses x axis as this represents {no change in mass / length / the estimate of water potential} (1) • compare these lines for different ages of potato tissue (1) • use same temperature as this affects {osmosis / diffusion} / leave potato for same time in solutions as this affects {osmosis / diffusion} / use same {potato / variety of potato} as this affects {water potential / osmosis / diffusion} (1)	Accept use a cork borer to give samples of standard size (linked to SA or osmosis) Accept dry using a paper towel Accept measure initial {length / mass} and final {length / mass} to find change	**(5)**

Question Number	Answer	Additional Guidance	Mark
10 (a)(i)	An explanation that makes reference to the following: divide energy in producers by energy in sunlight (1) multiply by 100 (1)	 85 000 ÷ 7 000 000 × 100 = 1.21 Correct answer gains full marks, with no working shown.	**(2)**

Question Number	Answer	Additional Guidance	Mark
10 (a)(ii)	An answer that makes reference to one of the following: • light reflected (from leaf) (1) • light misses {chloroplast / chlorophyll} (1) • only certain wavelengths absorbed (1)	 Accept transmitted / not absorbed by {chloroplast / chlorophyll} Accept limiting factors eg lack of CO_2, water etc may reduce rate	**(1)**

Question Number	Answer	Additional Guidance	Mark
10 (a)(iii)	An explanation that makes reference to two of the following: • because some of the energy is lost through {respiration / heat / movement} (1) • some of the producers not eaten (1) • some of the producers not digested (1)		**(2)**

Question Number	Indicative content
***10(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. <u>Light:</u> **(L)** • more light at equator / less light at higher latitudes <u>Light dependent stage:</u> **(L)** • light excites electrons • photolysis occurs • ATP made / photophosphorylation • NADPH / reduced NADP made <u>Light independent stage:</u> **(L)** • Calvin cycle • NADPH / ATP used • Carbon fixation • to reduce carbon dioxide to carbohydrate / GP / GALP / glucose <u>Temperature:</u> **(L)** • temperature is higher at the equator / lower at higher latitudes • temperature affects enzymes • eg. RUBISCO enzyme • temperature affects active uptake of mineral ions • temperature affects rate of transpiration <u>Other abiotic variables:</u> **(A)**

- identifies other abiotic variables eg carbon dioxide / water / mineral ions / pH
- carbon dioxide unlikely to be a limiting factor
- comment on lack of available water eg in deserts / polar regions or excess of water eg flooded areas
- water needed for photolysis / mineral ion transport
- use of named mineral ion eg. nitrate for amino acids / protein
- soil edaphic factors
- abiotic factors in the oceans discussed

<u>Biotic factors:</u> **(B)**

- biotic factors also affect productivity
- disease / infection / bacteria / fungi / named pathogen
- grazing / herbivore populations / pest populations
- competition eg for light
- decomposition is slower at higher latitudes (affects mineral ion availability)
- human factors eg deforestation / pesticide use / fertilizer use / crop planting
- biotic factors in the oceans discussed

<u>Productivity factors</u> **(B)**

- productivity subject to limiting factors
- productivity in cool temperate can exceed warm temperate
- productivity in the oceans not taken into account
- unequal size of latitude ranges (makes comparison difficult)
- idea of interaction between multiple / complex factors affecting productivity

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **Up to three from L, A or B**
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. **At least two from L and at least two from A or B**
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **At least two from L plus at least two from A <u>and</u> two from B with no major errors**

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