# Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE
In Biology Spec A (9BN0) Paper 03
General and Practical Applications 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.

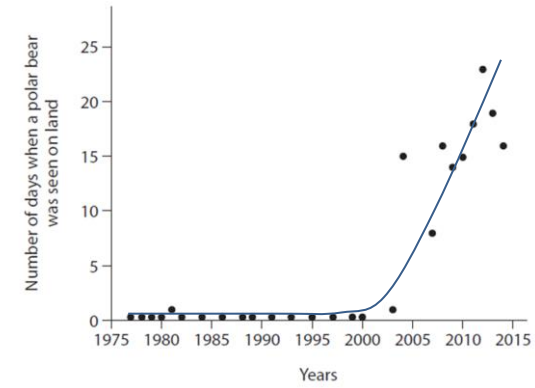
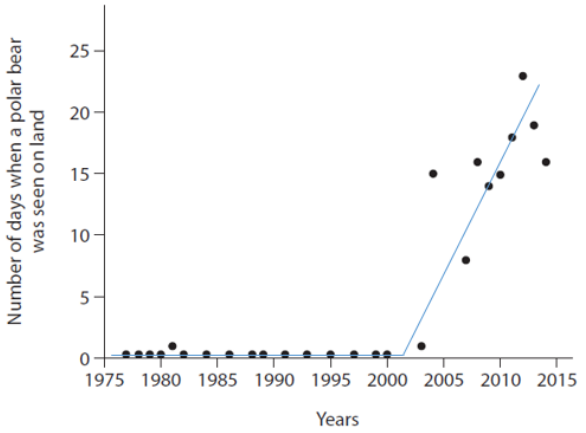
| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(a)(i)** | A description that makes reference to three of the following:<br><br>• heat to 90-98°C { to break hydrogen bonds between (DNA) strands / separate the strands of DNA} (1)<br><br>• { joining of primers / annealing } at 50-75°C (1)<br><br>• { elongating / extension / addition of nucleotides } / DNA polymerase involved in formation of phosphodiester bonds (1)<br><br>• to double the quantity (of the DNA) (1) | ALLOW heating to 90-98°C to break hydrogen bonds or to unzip DNA or to denature the DNA<br><br>ALLOW 'binding/aligning' for joining<br><br>ALLOW description of production of complementary strands of DNA<br>ALLOW taq polymerase<br><br>ALLOW replication for doubling | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(a)(ii)** | • calculation correct (1)<br>• correct answer provided (1) | <u>Example of calculation</u><br><br>$2^{20}$<br><br>1 048 576 (> 1 000 000) or $1.05 \times 10^6$<br><br>Correct answer without working scores full marks | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(b)** | An explanation that makes reference to five of the following:<br><br>• detail of loading of electrophoresis tank (1)<br><br>• { current / potential difference } applied across the gel (1)<br><br>• use { gene probe / DNA stain} (1)<br><br>• use of { STRs / DNA } of black panther (1)<br><br>• compare { bands / DNA profiles } (1)<br><br>• a match would indicate that (DNA from) a black panther was present (1) | e.g. use of agarose gel, use of a buffer, sample placed in wells<br><br>ALLOW voltage<br><br>e.g. fluorescent dye, methylene blue, iodine or ethidium bromide<br>ALLOW reference to Southern blot technique<br><br>ALLOW compare lines | **(5)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(a)(i)** | An explanation that makes reference to the following:<br><br>• trend shows a reduction in number of days per year when (sea) ice is present (1)<br><br>• (sea) ice { melting / absent / not forming } due to { global warming / rise in (surface) temperature } (1) | <br><br>ALLOW description of (sea) ice being present for less time per year<br>ALLOW use of data to illustrate a reduction in days with sea ice over time<br><br>IGNORE greenhouse effect for global warming<br>IGNORE climate change | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(a)(ii)** | An explanation that makes reference to four of the following:<br><br>• cannot assume a trend will continue (1)<br><br>• not enough data collected (1)<br><br>• data only from { one location / one island / part of one island } (1)<br><br>• data fluctuates / no trend before 1994 (1)<br><br>• ice { rarely present from 2006 / not present from 2012 } so cannot be used to judge future temperature rise (1) | <br><br>ALLOW extrapolation may not be accurate<br><br>ALLOW data does not go back far enough<br><br><br>ALLOW appropriate comment on range of fluctuations e.g. 0 days to 210 days in 2/3 years | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)** | • correct trend line drawn (1) | Examples:<br><br><br><br> | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(c)** | An answer that makes reference to the following:<br><br>• negative correlation described (1)<br><br>• polar bears eating fewer seals (1)<br><br>• as the length of time that ice is present decreases more polar bears are seen on land (1)<br><br>• (because polar bears are on land more often) more eggs are eaten (1) | e.g. as presence of ice decreases the number of eggs taken increases<br><br>ALLOW hunting / feeding on / catching<br><br>ALLOW polar bears seen more often on land | **(4)** |

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>3(a)(i)</td><td>An answer that makes reference to the following:<br><br>• correct ranking for both columns (1)<br><br>• correct difference in rank (1)<br><br>• correct difference squared (1)</td><td><table>
<tr><td>E</td><td>48.8</td><td>4</td><td>23.6</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>F</td><td>50.1</td><td>7</td><td>24.2</td><td>5</td><td>2</td><td>4</td></tr>
<tr><td>G</td><td>49.2</td><td>6</td><td>23.1</td><td>2</td><td>4</td><td>16</td></tr>
</table>-2 and -4 are incorrect differences in rank</td><td>(3)</td></tr>
</table>

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)(ii)** | • numerator (top line of formula) correctly calculated (1)<br><br>• denominator (bottom line of formula) correctly calculated (1)<br><br>• correct answer (1) | <u>Example of calculation</u><br>6 x 34 or 204<br><br>7 x 48 or 336<br><br>0.3929 / 0.393 / 0.39<br><br>Correct answer with no working scores full marks | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)(iii)** | An answer that makes reference to the following:<br><br>• no (significant) correlation (1)<br><br>• as the calculated figure is less than { 0.786 / the critical value for p= 0.05 } (1) | ALLOW not statistically significant<br><br>ECF - ALLOW significant correlation if the value calculated for 3aii is greater than { cv for 0.05 / 0.786 }<br><br>ALLOW 5% FOR 0.05<br><br>ECF- ALLOW calculated value is greater than the cv if the value calculated for 3aii is greater than 0.786 | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(b)(i)** | An answer that makes reference to the following:<br><br>• measure temperature from { several readings / random positions } (within the group of larvae) (1)<br><br>• description of how mean calculated (1) | ALLOW stated number of measurements<br><br>e.g. readings summated and answer divided by number of readings taken<br>ALLOW 'average' for mean | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(b)(ii)** | An explanation that makes reference to the following:<br><br>• increases enzyme activity for ( larvae / species F ) (1)<br><br>• high temperature { kills / denatures enzymes of } other species (1)<br><br>• (high temperature) increases food availability by { reducing competition from other species / increasing rate of decomposition of rhino } (1) | ALLOW description of increase in activity including maximizes rate of growth/digestion, shorter lifecycle<br>IGNORE ref to metabolic activity unqualified<br><br>ALLOW outcompetes other {species / larvae} for food | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(a)(i)** | A description that makes reference to three of the following:<br><br>• percentage germination decreases as length of time stored increases (for both varieties) (1)<br><br>• correct calculation of decrease for both varieties (1)<br><br>• { little change / 1 or 2 % } in percentage germination when stored for up to 48 hours for both varieties (1)<br><br>• greatest decrease in percentage germination occurred { later for P than Q / from 72 hours for P and from 48 hours for Q } (1) | ALLOW correct reference to negative correlation<br><br>e.g. (from 0 to 120 hours) 40% decrease for P and a 36% decrease for Q | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(a)(ii)** | An explanation that makes reference to two of the following:<br><br>• allowed a comparison between { the two varieties / stored seeds and seeds that had not been stored }(1)<br><br>• to see the effect of seeds being stored at { 80% humidity / 42°C } (1)<br><br>• data showed that the percentage germination success was { high / not 100% } in the control seeds (1) | ALLOW wheat seeds were viable or suitable for this investigation | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(b)(i)** | A description that makes reference to three of the following:<br><br>• condensed / visible (1)<br><br>• seen as pairs of chromatids (held together by a centromere) (1)<br><br>• joined to the spindle (fibres) (1)<br><br>• aligned on the equator of the cell (1) | ALLOW from annotated drawing<br><br>ALLOW thickened /shortened<br><br>ALLOW correct reference to sister chromatids<br><br>ALLOW middle for equator | **(3)** |

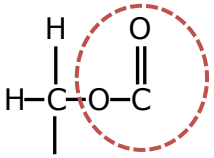
| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(b)(ii)** | An explanation that makes reference to two of the following:<br><br>• with longer storage time growth (of the seedling) will be slower (1)<br><br>• as there is less { mitosis / cell division } (after increased storage time) (1)<br><br>• because storage conditions lead to { enzymes being denatured / (stem) cell death / fungal growth } (1) | ALLOW less or decreased growth<br><br>ALLOW decrease in percentage undergoing mitosis of 18% after 120 hours | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(c)** | An answer that makes reference to the following:<br><br>• description of how {day and night / light and dark } conditions provided / collect root tips { during day and night / from plants grown in light and dark conditions } (1)<br><br>Plus four of the following:<br><br>• use same source of root tips (1)<br><br>• controlled environmental variable in which plants grown (1)<br><br>• use of appropriate named stain (1)<br><br>• squash { under a coverslip / on a microscope slide } (1)<br><br>• description of how comparison considered (1) | <br><br><br><br><br><br><br><br>ALLOW same species / same variety / type Q / same plant / same age of plant<br><br>e.g. temperature, humidity, mineral ion concentration<br><br>e.g. (propionic) orcein, toluidine blue, Schiff's reagent, Feulgen's reagent<br><br>ALLOW macerated or a description of maceration<br><br>e.g. percentage of cells undergoing mitosis, mitotic index calculated | **(5)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)** | A description that makes reference to the following:<br><br>• (calcium ions) {bind / attach} to the troponin (1)<br><br>• causing tropomyosin to be { displaced / shape altered } (1)<br><br>• exposing myosin binding sites (on actin) (1) | ALLOW changes shape of troponin<br><br>ALLOW tropomyosin moved, 'shifted', 'pulled'<br><br>ALLOW correct reference to the sliding filament hypothesis e.g. myosin head can bind to actin filament or actin-myosin cross bridges can form | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(i)** | An answer that makes reference to the following:<br><br><u>Advantage</u><br>• controlled variable / increases validity (1)<br><br><u>Disadvantage</u><br>• may not be representative / only one type of muscle tested (1) | ALLOW genetically the same / same age / same ratio of fast to slow twitch muscle fibres<br>ALLOW same level of development / same level of exercise<br><br>e.g. muscle might be damaged | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(ii)** | An explanation that makes reference to four of the following:<br><br>• no force produced at { low / less than 1.0 a.u. } calcium ion concentration (1)<br><br>• (as calcium ion concentration increases) force produced increases (1)<br><br>• (because more) { actin and myosin interact / myosin binding sites exposed } (1)<br><br>• there is no increase in force produced at { high / from 2.4 a.u. } calcium ion concentration (1)<br><br>• as all actin and myosin are { interacting / all myosin binding sites occupied } (1) | ALLOW there is a threshold concentration for calcium ion concentration<br><br>ALLOW more tropomyosin displaced or more actin-myosin cross bridges formed<br><br>ALLOW 2.5 a.u.<br><br>ALLOW all troponin has $Ca^{2+}$ bound to it , no troponin available or no more actin-myosin cross bridges can be formed | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(i)** | • ester bond correctly identified (1) |  | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(ii)** | An answer that makes reference to the following:<br><br>• double bond between carbon atoms (1)<br><br>• a kink in the fatty acid chain (1) | ALLOW as a diagram if clear<br><br>IGNORE double bonds unqualified<br>ALLOW carbon-carbon double bond, C=C or double bond in the fatty acid chain<br><br>ALLOW 'bend' in fatty acid chain<br>ALLOW 'zigzag' for fatty acid chain | **(2)** |

| Question Number | Indicative content |
|---|---|
| ***6(b)** | Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme.<br><br>The indicative content below is not prescriptive and candidates are not required to include all the material which is relevant. Additional content included in the response must be scientific and relevant.<br><br>Give examples of relevant biological knowledge and understanding:<br><br>Evidence of isolated elements of biological knowledge:<br>• glucose for respiration in both<br>• starch for energy storage in plants /glycogen for energy storage in animals<br>• cellulose for cell walls in plants<br><br>Evidence of adequate biological knowledge with linkages made<br>• starch composed of amylose and amylopectin in plants<br>• sucrose as a transport sugar in phloem in plants, glucose in animals<br>• lactose in milk for energy<br>• a judgement on the importance of carbohydrates in plants and animals is made e.g. cellulose as a structural carbohydrate in plants therefore a greater proportion of carbohydrate in plants than animals or animals require more energy, therefore need more carbohydrate<br><br>Evidence for comprehensive biological knowledge and understanding with sustained linkages<br>• pentose sugars ribose and deoxyribose { in nucleic acids / DNA/ RNA / ATP} in both<br>• ribulose as part of the Calvin cycle in plants<br>• glycoprotein in { mucus / receptors on cell surface membranes /antibodies}<br>• glycolipids in cell membranes<br>• a supported judgement on the relative importance of carbohydrates in plants and animals is given e.g. animals store more energy in lipids than carbohydrate, therefore carbohydrate more important as a storage molecule in plants **or** the idea of carbohydrates as part of complex molecules **or** the proportion of carbohydrates present is not the same as importance |

| Level | Mark | Descriptor | Additional guidance |
|---|---|---|---|
| 0 | 0 | No awardable content | |
| 1 | 1-3 | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.<br><br>A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made. | Glucose for respiration<br>Polysaccharides for energy storage<br>Cellulose for plant cell walls<br><br>Simple conclusion made |
| 2 | 4-6 | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.<br><br>A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. | Branched storage molecules for rapid energy release in starch<br>Roles of sucrose, lactose<br><br>A judgement on the importance of carbohydrates in plants and animals is made |
| 3 | 7-9 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.<br><br>A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. | All of the above plus discussion of carbohydrates as part of complex molecules<br><br>A supported judgement on the relative importance of carbohydrates in plants and animals |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(a)** | A description that makes reference to the following:<br><br>• vesicles (containing hormone) (1)<br><br>• fuse with the cell (surface) membrane (of fat cells) / by exocytosis (1) | | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)** | A description that makes reference to the following:<br><br>• (dopamine) released { from presynaptic membrane / from the synaptic knob / into the synaptic cleft } / diffuses across synaptic gap (1)<br><br>• binds to receptors on post-synaptic membrane (1)<br><br>• alters permeability of post-synaptic membrane / opens { sodium ion channels / channel proteins } (in the post synaptic membrane) (1)<br><br>• initiating { depolarisation / action potential } in the post-synaptic neurone (1) | ALLOW dopamine diffuses across the synapse<br><br>ALLOW influx of $Na^+$<br><br>ALLOW pd / voltage | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(c)** | A description that makes reference to two of the following:<br><br>• { methylation of / addition of methyl groups to } DNA (1)<br><br>• modification of histones (1)<br><br>• (therefore) affecting regulation (1) | <br><br>ALLOW methylation of cytosine or gene<br>ALLOW CpG for DNA<br><br><br>ALLOW alters gene expression e.g. switching on or off of the gene<br>ALLOW prevention of transcription of the gene (by methylation)<br>ALLOW link to effect on promotor region | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(d)** | An explanation that makes reference to three of the following:<br><br>• (addition of bacteria) changes the { gut flora / gut microbes / microbiome } (1)<br><br>• resulting in a change in taste perception (1)<br><br>• resulting in a change to { cravings / food preferences } (1)<br><br>• preventing one type of bacterium controlling { food preferences / taste perception / cravings } (1) | <br><br>ALLOW (probiotics) outcompete other gut microbes<br><br>ALLOW affects taste receptors | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(e)** | A description that makes reference to four of the following:<br><br>• restriction endonuclease used to { cut plasmid / isolate gene } (1)<br><br>• forming sticky ends (1)<br><br>• ligase enzymes used to add isolated gene to plasmid (1)<br><br>• (ligase) forms phosphodiester bonds (between nucleotides) (1)<br><br>• recombinant { DNA / plasmid } produced (1) | ALLOW 'endonuclease' or 'restriction enzyme'<br><br>ALLOW 'sticky ends' in context of the DNA or plasmid being cut by enzymes if restriction enzymes not specified<br><br>ALLOW integrase for ligase | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(f)** | • two obesity-related conditions given (1) | e.g. diabetes / wear and tear on joints / sleep apnoea / increased risk of cancer / {increased blood pressure /hypertension} / {CVD / CHD} / atherosclerosis / stroke / {heart attack / myocardial infarction }<br><br>ALLOW one obesity-related condition and a relevant idea of a negative effect on the NHS | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(g)** | An answer that makes reference to four of the following:<br><br>• bacterial molecules are engulfed by { macrophages / phagocytes / B cell } (1)<br><br>• antigen presented on the surface of cell / antigen presenting cell produced (1)<br><br>• T (helper) cells with complementary { CD4 / receptor } bind to APCs (1)<br><br>• cytokine released causes { cloning of B cells / formation of B effector cells } (1)<br><br>• plasma cells { produce / release } antibodies (1) | ALLOW reference to antigens on MHCs<br>ALLOW APC | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(h)** | An explanation that makes reference to the following:<br><br>• drugs not delivered to { other / healthy} tissues (1)<br><br>• overall dosage needed is less (1) | ALLOW drug does not {affect / reach} other tissues, drug not delivered to the whole body<br>ALLOW converse<br><br>ALLOW {higher concentration / more of the drug} delivered to area where needed | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(i)** | A description that makes reference to two of the following:<br><br>• (skin flora) {prevents /reduces } colonisation by other microbes (1)<br><br>• make environment hostile for other microbes (1)<br><br>• outcompetes other microbes (1) | ALLOW {bacteria / pathogenic bacteria / pathogens} for other microbes<br><br>e.g. produce { lactic acid / lactate } | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(j)** | An answer that makes reference to the following:<br><br>• made up of { many different types of cell / more than one type of tissue } (1)<br><br>• (tissues) working together { for various functions / to carry out an overall function } (1) | ALLOW 'tissues' plural | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(k)** | An answer that makes reference to three of the following:<br><br><u>Similarities</u><br>• both contain { genetic material / RNA } (1)<br><br>• both have a phospholipid bilayer (1)<br><br><u>Differences</u><br>• (only) bacteria have { cytoplasm / ribosomes / pili / slime capsule / flagellum /cell wall / cell membrane / plasmid } (1)<br><br>• (only) HIV has { capsid / protein coat / GP 120 } (1) | IGNORE both have DNA<br><br>ALLOW lipid bilayer<br><br>ALLOW converse i.e. HIV does not have…<br><br>ALLOW converse i.e. bacterium does not have… | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(l)** | • peer review (1) | ALLOW reviewed by other scientists<br>IGNORE peer assessment | **(1)** |

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