BIOLOGY

Paper 9700/12
Multiple Choice

Question Number	Key	Question Number	Key	Question Number	Key	Question Number	Key
1	A	11	C	21	C	31	A
2	C	12	D	22	B	32	B
3	C	13	B	23	D	33	C
4	B	14	A	24	C	34	C
5	D	15	B	25	A	35	B
6	C	16	B	26	D	36	C
7	A	17	D	27	D	37	B
8	B	18	B	28	D	38	A
9	A	19	A	29	C	39	D
10	D	20	C	30	A	40	C

General comments

The majority of candidates found **Questions 1**, **4**, **8**, **13**, **14**, **15**, **20**, **37** and **38** to be straightforward.

Questions 12, **23**, **27**, **30**, **31** and **33** were particularly challenging.

Comments on specific questions

Question 2

Candidates selecting the correct option recognised that increasing the magnification of the objective lens by a factor of 4 (×10 increased to ×40) would increase the number of eyepiece graticule units per stage micrometer division by a factor of 4. A significant minority of candidates either selected option **A** or option **B**. Those selecting option **A** had not considered that there would be any change to the scaling factor when using a ×40 objective lens. Those selecting option **B** had assumed that the number of eyepiece graticule units per scale micrometer division would decrease by a factor of 4 when using a ×40 objective lens.

Question 11

Option **D** was the most frequently selected incorrect option. Candidates selecting this option had not noted that the secondary structure of proteins is based on hydrogen bonds and does not involve covalent bonds.

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Question 12

Most candidates did not realise that triglycerides always contain at least three double bonds and consequently selected the incorrect option **B**. When triglycerides are formed from fatty acids and glycerol, the C=O double bond in the carboxyl group of fatty acids is unaffected by the condensation reaction between –OH of glycerol and –OH of the fatty acid. As a result, triglycerides always contain three C=O double bonds left over from the carboxyl group of fatty acids.

Question 16

About a quarter of candidates selected option **D** instead of the correct answer. These candidates recognised that hydrogen peroxide will break down at a slow but steady rate in the absence of enzyme. However, they had confused the relationship between substrate concentration and rate of reaction in the presence of a competitive inhibitor with that in the presence of a non-competitive inhibitor. With competitive inhibitors, an increase in substrate concentration can overcome inhibition so that the maximum possible rate of breakdown is unchanged.

Question 17

Option **C** was the most commonly chosen incorrect answer. This option could be eliminated since glucose ($C_6H_{12}O_6$) cannot cross the phospholipid bilayer of cell surface membranes. Glucose requires the presence of transport proteins to cross the cell surface membrane.

Question 21

Most candidates selected the correct option **C**. A significant minority selected option **B**. Option **B** can be eliminated because nucleotides include a base as part of their structure and do not undergo condensation reactions with other bases.

Question 23

Most candidates selected incorrect options. Option **B** was the most frequent incorrectly selected option. Candidates selecting option **B** had not considered that all genes will be present in all nuclei. It is only whether the gene is expressed or not that can vary.

Question 24

The correct option, option **C**, was selected by most candidates. Many other candidates selected option **A**. Option **A** could be eliminated since adenine and inorganic phosphate are present in RNA and DNA, so cannot be used to distinguish the presence of mRNA from the presence of DNA.

Question 26

Although most candidates selected the correct option, approximately one third of candidates selected option **A** instead. Lignin is largely hydrophobic (it has some hydrophilic regions) so replacement of cellulose with lignin does not help adhesion.

Question 27

The majority of candidates did not realise that all of the listed vessels carry fluids by mass flow.

Question 29

Option **B** was the most frequently selected incorrect option. Candidates selecting this option had not noted that arrow 6 crosses from the cell wall to the cytoplasm and therefore cannot represent movement of water only in the apoplast pathway.

Question 30

Many candidates identified storage cells of seeds as sinks. This is true as seeds develop but when seeds start to grow (germinate), the storage cells become sources.

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Question 31

Few candidates recognised that this artery, located within alveolar tissue, must be carrying deoxygenated blood. Only after blood has passed through capillaries in the lungs will it have been oxygenated. Arteries that are near to their destination are muscular, rather than elastic.

Question 33

The majority of candidates recognised that blood pressure drops as blood passes through capillaries and that the blood pressure at X will therefore be higher than the blood pressure at Y. Few realised that leakage of plasma out of capillaries into the tissue fluid while retaining (and therefore concentrating) plasma proteins would lead to a decrease in water potential of the blood.

Question 40

Many candidates did not realise that exocytosis is part of the mode of action of phagocytes. After phagocytosis of bacteria and other foreign particles, waste products of digestion are released by exocytosis.

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Paper 9700/22
AS Level Structured Questions

Key messages

When asked to draw diagrams based on photomicrographs or electron micrographs, candidates should draw what they see and not what they would expect in a textbook. In **Question 1(b)**, many candidates drew a diagram showing a textbook-style representation of the fluid mosaic model of a cell surface membrane.

Pairs of similar scientific terms with very different meanings were sometimes confused. For example, some candidates mixed up the terms antibiotics and antibody, antibodies and antigens, and introns and exons.

Candidates should take care in distinguishing the cell surface membrane from internal cell membranes. For example, when explaining exocytosis in **Question 2(b)(i)**, describing fusion of a Golgi vesicle with a membrane or cell membrane is not confirmation that the contents are being released to the external environment.

General comments

Some candidates were well prepared, with good knowledge and understanding of the range of topics assessed. Many of these showed a strong ability to apply knowledge when answering questions based on unfamiliar contexts, for example in **Question 2(d)(iv)** and in **Questions 4(c)**.and **4(d)**.

Some candidates did not note the requirement of particular questions with sufficient care. For example:

- In **Question 1(c)(ii)**, some misread mitogens and gave a response relating to mutagens, while others did not focus on the consequences for the cells and wrote about tumours.
- In **Question 3(a)(ii)**, some wrote about mass flow within phloem sieve tubes rather than the process of transferring sucrose into the companion cell for passage to the phloem sieve tube.
- In **Question 4(d)(i)**, candidates were asked to explain about vaccination programmes, but some wrote about the process of vaccination.
- In **Question 6(b)**, some candidates wrote about the effect of temperature on the activity of collagenase even though the *x*-axis of Fig. 6.1 was labelled pH.

Candidates did not always consider the instructions. For example, in **Question 1(a)** candidates were asked to use a tick (✓) or a cross (✗) in every box. A number of candidates left some boxes blank. In **Question 1(b)**, candidates were asked to draw a diagram to show four dark lines, but many did not draw these four lines. In **Question 2(a)**, candidates were asked to draw a circle around an R-group, but many drew a circle around each of the R-groups shown.

Question 5(a) highlighted the importance of reading all the material at the beginning of whole and part-questions. A number of candidates completed Fig. 5.1 without taking account of any of the details provided in the second paragraph of the introductory text.

Comments on specific questions

Question 1

(a) Most candidates knew that prokaryotic cells have circular DNA and 70S ribosomes but lack Golgi bodies. Fewer recognised that many eukaryotic cells have small circular DNA and 70S ribosomes as a consequence of having mitochondria (and, sometimes, chloroplasts).

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(b) Some candidates drew an accurate labelled diagram to represent the four dark lines shown in box **R**. However, many others drew theoretical diagrams of cell surface membranes without reference to Fig. 1.1. Some of these only drew a single membrane.

The space between the adjacent cells was not always labelled correctly.

(c) (i) The phases of the cell cycle were well known by a majority of candidates.

(ii) Effective responses focused on the consequences of mitogens for the target cells, with most candidates explaining that it would result in the cells dividing uncontrollably. Some correctly suggested that the cells would only have a certain number of cell surface receptors so, without increasing the number of these receptors, there would be no difference between the cells in their response to mitogens.

Weaker responses did not focus on the cells and wrote instead about tumour or cancer development. Some confused the term mitogen for mutation,

Question 2

(a) Most candidates correctly circled one of the R-groups, although some circled both. A common error was for either an amino group or a carboxyl group to be circled.

(b) (i) This was not well answered. Many candidates stated peptide, hydrogen or sulfide bonds.

(ii) Most candidates answered this question well. Effective responses included the name of the transport mechanism concerned (exocytosis) and continued with a clear explanation of the process. Some did not refer to the role of the Golgi body or make clear that the vesicles released from the Golgi body fuse with the cell surface membrane, and not one of the intracellular membranes.

A minority of candidates suggested alternative explanations. Providing that these conformed to the information provided, these were acceptable.

(c) Most responses were based on the importance of cilia in maintaining a healthy gas exchange surface. The main ideas expressed were that the movement of cilia would be impaired leading to an accumulation of mucus with trapped pathogens, which would increase the risk of infection of the gas exchange surfaces.

The most common incorrect suggestions were that thicker mucus would restrict the movement of air down into the alveoli or that cilia would be destroyed.

(d) (i) Most candidates correctly identified the type of gene mutation. Some stated that the mutation was a frameshift. Deletions often result in frameshift mutations but in this case, where a complete DNA triplet is lost, the reading frame is unaffected.

(ii) Many responses stated the correct term. The most frequent incorrect answers were ‘coding strand’ or ‘leading’ strand.

(iii) Most candidates completed Table 2.1 correctly to show the missing bases in row 3. The most common error was not to substitute T with U in the RNA sequence.

(iv) Many responses were detailed and accurate. Some were unclear when considering the removal of introns, with inconsistent use of the terms primary transcript and messenger RNA (mRNA).

Some candidates suggested that a stop codon could be present in the middle of the allele. However, a stop codon would signify the end of the allele so base pairs after the stop codon would not be counted as part of the allele.

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Question 3

(a) (i) Most candidates were able to account for the different appearances of cell **X** and cell **Y**. Some candidates overlooked the information provided that cell **X** and cell **Y** are sieve tube elements and suggested that the difference was because cell **X** was a xylem element. Others considered that the difference in appearance could be the result of cutting the cells at different angles. These candidates had not noted that the overall cross-sections of the cells were the same shape and that within the vascular bundles, sieve tube elements would be arranged parallel to one another.

(ii) This was well understood by a majority of candidates with most accounts including proton pumping, the role of ATP, the co-transport of protons and sucrose and the diffusion of the sucrose into the sieve tubes via plasmodesmata. Fewer responses considered concentration gradients or the movement of sucrose and protons between the apoplast and cytoplasm of companion cells.

Some responses explained the movement of water within the sieve tubes in terms of hydrostatic pressure. This did not answer the question.

(b) (i) Hydrogen bonding between two water molecules was well understood. Some candidates incorrectly made reference to hydrogen ions, oxygen ions and OH^- ions, or suggested that hydrogen bonds are examples of covalent bonds.

(ii) Many candidates gave clear and concise answers that covered all the main points. When describing adhesion, responses were not always sufficiently precise, sometimes referring to the cell wall or lignin with no further qualification, rather than to cellulose or the hydrophilic regions of lignin.

A number of candidates confused adhesion with cohesion. Some responses suggested that adhesion and cohesion were sufficient on their own to account for the transport of water in the xylem.

(iii) Some candidates suggested coherent reasons as to why a high latent heat of vaporisation of water is important to plants. Others confused a high latent heat of vaporisation with a high specific heat capacity. Some wrote about other properties of water that were not relevant to the question.

Question 4

(a) (i) Most responses correctly stated that infectious diseases are caused by pathogens. Fewer clearly conveyed the idea of transmissibility with many descriptions limited to vague references to 'spread' or the involvement of vectors.

(ii) Most responses correctly named a species of organism that causes tuberculosis. Spellings were not always correct with *Microbacterium* and *Myobacterium* frequently given. Bacteria, cows and humans were included amongst the incorrect answers.

(b) Many responses correctly selected a correct combination of two words from the choices listed in the first sentence. Some responses were incomplete and only stated one of the terms. A number of responses stated two terms that were mutually exclusive, as in artificial and natural or passive and active.

(c) Some responses provided detailed explanations for why different antibodies need to be produced to give immunity to new strains of the influenza virus.

A common error was to suggest that the viruses become resistant to the antibodies. Many responses confused the terms antibodies and antibiotics.

(d) (i) Strong responses applied knowledge of the principles behind vaccination programmes to answer the question. Reference was frequently made to the development of herd immunity to control the spread of the disease. More detailed responses often described the importance of breaking the transmission cycle.

Some responses concentrated on the principles of vaccination rather than the principles of vaccination programmes.

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(ii) The majority of responses included one of a range of valid reasons to explain why penicillin is not effective against viruses.

Question 5

(a) Some candidates made use of the information provided in the second paragraph to complete Fig. 5.1 correctly. Many did not appear to consider this information when answering this question and were unable to show how the ECMO machine is connected to a person.

(b) (i) Most candidates identified a structure in the gas exchange system with the same function as the partially permeable membrane of the oxygenator. Cell membrane, squamous epithelium and epithelium were not specific to the gas exchange system and were the most common incorrect answers.

(ii) Strong responses related the events that occur in the lungs to the functioning of the oxygenator. Weaker responses often only included details of events occurring in the lungs. Few candidates were able to explain the significance of the counter flow system.

(c) Stronger comparisons considered the relative quantities of elastic fibres and smooth muscle tissue in the tunica media of muscular arteries and the aorta, before relating these differences to the function of the aorta. Many of these noted the high blood pressure and pulsatile blood flow in the aorta and the consequent need for the aorta to stretch and recoil to avoid damage. Not all candidates used appropriate terminology, with some incorrectly using the terms contract and relax to describe changes in elastic tissue and others describing changes in smooth muscle in terms of stretch and recoil.

Some responses incorrectly stated that there would be differences in the relative thickness of the tunica media. This is significant when comparing arteries and veins but is not a relevant difference between muscular arteries and elastic arteries.

A number of responses related differences to the function of muscular arteries rather than to the function of the aorta.

(d) (i) This part-question was well answered, with a majority of candidates recognising that carbonic anhydrase is an enzyme and providing the correct details of the reaction catalysed.

(ii) The majority of responses described the chloride shift and were able to explain why it is not needed in *C. latirostris*. Some responses were limited to copying out the second and third bullet points with no further elaboration or explanation.

Question 6

(a) The majority of candidates described how the structure of collagen molecules, rather than fibres, provides the skin with strength. This did not answer the question.

Few responses described features of collagen fibres that were relevant, such as cross-linking between molecules in fibres and a staggered alignment of adjacent fibres.

(b) Most responses provided comprehensive explanations. Some candidates mis-read the question and considered factors relevant to the effect of temperature rather than pH, such as kinetic energy.

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Paper 9700/33
Advanced Practical Skills 1

Key messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course in order to develop the skills that can be applied to the requirements of the examination.

Candidates should carefully note the wording of questions to understand what is required. For example, the word 'explain' implies that reasoning or some reference to theory is required, depending on the context.

General comments

Many candidates demonstrated that they had a good understanding of the skills required. The majority of candidates showed that they were familiar with the use of the microscope.

Comments on specific questions

Section A

Question 1

(a) (i) The majority of candidates correctly stated three temperatures within the required range and separated by regular intervals.

(ii) The majority of candidates organised their results clearly in an appropriate table. Most used informative column headings corresponding to the dependent and independent variable and with the correct units where applicable. Results were recorded correctly using the specified symbols and most showed the expected trend.

(iii) The majority of candidates stated correctly that the independent variable was temperature.

(iv) Many candidates used their knowledge of cell surface membranes to explain their results. Most considered the effect of temperature on membrane fluidity and permeability. Some explained that, at higher temperatures, membrane proteins could be denatured, reducing the integrity of the membrane and increasing its leakiness.

(v) Most candidates suggested washing the discs in distilled water to remove any pigment released in the cutting process. Fewer noted that repeating this until the distilled water remained clear would provide confirmation that all the pigment had been removed.

(vi) The majority of candidates suggested suitable improvements.

(b) (i) Most candidates used the headings given in the table to label the *x*-axis (time of day / hours) and the *y*-axis (mean width of stomata / arbitrary units) appropriately. Some candidates orientated the axes incorrectly and some used incomplete headings. Most candidates used simple scaling factors for the *x*-axis and *y*-axis.

Many candidates plotted all five points accurately and joined the points accurately with a thin line.

(ii) Many candidates used the graph to estimate the mean width of stomata at 03:00 hours. Not all showed on the graph how the answer was estimated, as required by the question.

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(iii) Most candidates correctly described changes in the mean width of stomata over the stated time period. Not all identified the time at which the trend changed from decreasing to increasing and units (arbitrary units) were not always included when quoting data.

Question 2

(a) (i) Many candidates followed the instructions by drawing a plan diagram of the area shaded in Fig. 2.1. Most were able to show the correct position and proportions of the tissues. Many labelled the position of the xylem correctly.

(ii) Most candidates used a sharp pencil to draw a group of four adjacent cells, using clear, thin lines that joined up precisely and filled most of the space provided. Many correctly showed the thickness of the cell wall with double lines and some included an intercellular space between the cells.

The most common errors were to draw lines that did not meet up precisely or that were too thick. Most candidates used a label line to show the cell wall of one cell.

(b) (i) Most candidates presented differences clearly in a table, with each row used to compare the same feature. Some candidates listed the feature being compared in a third column at the start to make this process more straightforward.

(ii) Many candidates measured the length of the scale bar and used this to calculate the magnification of Fig. 2.3. Most went on to correctly calculate the actual diameter of the root section by dividing the measured length of **X–Y** by the magnification. Not all candidates expressed the final answer with the correct units. Some candidates did not adequately show their working, as required by the question.

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Paper 9700/42
A Level Structured Questions

Key messages

1 Candidates should read each question carefully and answer with precision, paying particular attention to the command words, such as describe, explain, suggest and outline.

2 When presented with a graph or table, candidates should carefully note whether they are asked to describe or explain the data. In some questions, such as question **8(b)**, candidates are required to describe and explain the data, in which case both aspects must be addressed.

General comments

Responses to questions **1**, **6**, **9** and **10** demonstrated sound knowledge and understanding of the topics assessed. Responses to questions **4**, **5** and **7** showed these to be more challenging.

Comments on specific questions

Question 1

(a) Most candidates were able to identify the locations of the loops of Henle, Bowman's capsules and glomeruli. Few candidates recognised that both region **B** (the pelvis) and region **D** (the ureter) would contain urine at the final concentration.

A minority of candidates were unable to link regions of the kidney longitudinal section to specific parts of the nephron or urine-collecting duct.

(b) Most candidates demonstrated a broad knowledge and understanding of the role of aquaporins in osmoregulation, including reabsorption of water in the urine collecting duct. Fewer were able to provide further details such as recognising that aquaporins are examples of channel proteins for water.

Some responses only gave general descriptions of the movement of water, with vague references to water leaving the collecting duct or being absorbed with no indication of the destination of the water.

Responses often linked permeability to the structure of the collecting duct, its walls or its cells, without considering the cell surface membrane.

(c) Many responses correctly described the role of osmoreceptors in the hypothalamus. However, a significant minority either omitted any mention of osmoreceptors or incorrectly referred to them as osmoregulators.

A large number of candidates incorrectly stated that the secretion of ADH from the posterior pituitary gland would increase in response to an increase in water potential of the blood above the set point.

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Of those candidates who recognised that less ADH would be secreted, only some noted that fewer impulses would be sent from the osmoreceptors to the posterior pituitary. Some incorrectly stated that no impulses would be sent as the water potential increases and that no ADH would be secreted.

A number of responses used vague terms such as message or signal when referring to nerve impulses or action potentials.

Question 2

(a) (i) Many candidates understood that the repressor protein coded for by *lacI* would prevent transcription of *IFNA2* in the absence of lactose. Some incorrectly suggested that *lacI* represses transcription directly. A number of responses lacked detail.

(ii) Most candidates provided good descriptions. Some candidates quoted values inaccurately in support of their descriptions. A number of candidates did not note the command word describe and attempted to explain why the changes were occurring. Some compared the effect of the different culture conditions although the question was restricted to description of the culture to which IPTG was added.

(iii) Many responses simply repeated information in the question without suggesting reasons for the difference in the concentration of IFN-α. The most effective responses recognised that lactose has to be converted to allolactose before it interacts with the repressor and that the concentration of lactose will decrease as it is metabolised.

(iv) Very few candidates recognised that the declining concentration of IFN-α indicates that IFN-α is breaking down. Most candidates did not note the information that IPTG cannot be broken down and suggested that IPTG was used up.

(b) Many candidates addressed the question effectively. A number of candidates stated that the plasmid would make the bacteria resistant to ampicillin but did not go on to describe how this would allow bacteria with the plasmid to be identified.

(c) Most candidates understood the role of mutation and natural selection in general terms. Some responses provided more specific details by considering the role of antibiotics as the selection pressure and how alleles for resistance could be passed on between bacteria. Few candidates developed comprehensive responses that considered all aspects.

Question 3

(a) Most candidates gave very good descriptions of continuous variation and its causes. A few responses did not consider this latter aspect.

(b) (i) Most candidates calculated the value of *t* correctly using the data provided. Some candidates used a negative value for the numerator or omitted to take the square root of the denominator.

(ii) The majority of candidates correctly interpreted the results of the *t*-test. Wording was sometimes imprecise with not all responses conveying the idea of statistical significance. Few candidates considered that working to a probability of 0.05 means that 5% of tests for which there is no real difference would give a result indicating that there is a difference.

(iii) Most candidates recognised that injecting recombinant growth hormone each week is much more labour intensive and time consuming than using GM salmon. Some candidates incorrectly suggested that the GM salmon grow larger, although there was no evidence for this.

Question 4

(a) Many candidates described the microarray procedure used in studies of gene expression rather than that used for the analysis of genomes. Some candidates described techniques other than microarrays, such as plasmid cloning or PCR.

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(b) (i) Relatively few candidates were able to use the information provided to interpret the graph and estimate the number of nucleotides deleted. Some candidates did not give their answer to the nearest 100 000 nucleotides.

(ii) Most candidates understood that the DNA can bind to probes on the microarray, but few were able to explain this further.

(iii) Most candidates were able to explain phenotypic differences by considering differences in the numbers of nucleotides deleted and relating this to deletion of genes. Some also considered the potential role of the environment in affecting outcomes, which is a valid factor. A number of candidates incorrectly considered the phenotypic variability of the syndrome to be linked to heterozygosity. These candidates had not recognised that since DiGeorge syndrome is caused by a deletion mutation, heterozygosity is eliminated for the affected nucleotide sequences.

Question 5

(a) Few candidates were able to accurately outline the behaviour of the spindle fibres during anaphase I. Descriptions were often vague, referring to the movement of chromosomes rather than the spindle fibres themselves, or to the ends of the cells rather than the poles. Some responses incorrectly stated that bivalents were pulled to the poles.

Many, but not all, candidates correctly identified prophase II as the stage of meiosis in which the spindle re-forms in daughter cells. A wide range of incorrect suggestions were also seen.

Few candidates recognised that telophase II results in the formation of four daughter cells. Of those that did, not all realised that the daughter cells would not have fully separated until cytokinesis had occurred. Most candidates incorrectly drew chromosomes in this stage that consisted of two sister chromatids joined at the centromere. The chromatids would have been separated during the previous stage (anaphase II).

(b) Many responses addressed this question fully.

Weaker responses often focused on the role of meiosis in producing genetic variation, rather than reduction of chromosome number, and omitted relevant terminology such as gamete and zygote.

Question 6

(a) (i) The majority of candidates recognised that active transport of protons occurs across the inner mitochondrial membrane, but there was uncertainty over the direction of transport and many selected **A**.

(ii) A significant number of candidates only identified arrow **C**. Since decarboxylation occurs in the mitochondrial matrix, carbon dioxide must diffuse across both the inner and outer mitochondrial membrane.

(b) Most candidates recognised that both the link reaction and the Krebs cycle occur in the mitochondrial matrix and were associated with specific enzymes. However, some candidates additionally identified the matrix as the site of oxidative phosphorylation and glycolysis, which is incorrect.

Stronger responses considered the formation of reduced NAD and reduced FAD in the mitochondrial matrix and their roles in delivering electrons and protons to the inner mitochondrial membrane for oxidative phosphorylation. A few also identified the matrix as the site of substrate-linked phosphorylation. Candidates who mentioned the presence of DNA and ribosomes did not always establish the link to respiration through the protein products.

(c) Many candidates were able to answer this question well. Not all identified the role of oxygen as the final electron acceptor and the consequence, therefore, of a lack of oxygen in halting the flow of electrons through the electron transport chain and preventing the regeneration of NAD and FAD. A small number of candidates referred incorrectly either to preventing the regeneration of reduced NAD or reduced FAD or to preventing the re-oxidation of NAD or FAD.

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A common misconception was that oxidation of reduced NAD and reduced FAD results in the removal of a hydrogen ion (proton). In fact, a hydrogen atom is released, which subsequently splits into an electron and hydrogen ion.

Some candidates described the role of oxygen in oxidative phosphorylation rather than the consequence of a lack of oxygen. This limited their access to all of the marking points.

Question 7

(a) Most candidates were able to engage with the question and provide at least partial explanations for the results. However, many responses were vague and lacking in specific details.

(b) Most candidates found this question to be challenging. Not all made direct comparisons of equivalent features to clearly express differences. Few considered features such as the position of the cell body, the position of the dendrites or the presence of an axon. Some responses referred vaguely to messages or signals instead of impulses or action potentials.

Question 8

(a) Many responses demonstrated a very good knowledge and understanding of the functions of the internal membranes of a chloroplast.

(b) Most candidates correctly described the results and recognised that the effect of adding rubisco activase was to increase the activity of rubisco. Most attempted to support this observation by quoting data from the graph but many did not read off values with sufficient care and stated inaccurate figures as a consequence.

Explanations of the results often noted that rubisco activase activates rubisco by enabling the substrate to bind to the enzyme. However, very few elaborated this further by considering conformational changes to the active site or changes to the activation energy.

Question 9

(a) (i) Most candidates correctly labelled an actin filament and a myosin filament. A number of candidates did not attempt this question.

(ii) Many responses correctly stated that the A-band stays the same and that the I-band gets shorter. A common error was to state that the I-band contracted.

(b) (i) This question was generally well answered with most responses correctly describing a sequence of events that would lead to muscle paralysis.

Some responses gave accounts of the actions of curare on a cholinergic synapse rather than a neuromuscular junction.

(ii) Most candidates were able to suggest how muscle paralysis could lead to the death of a mammal.

Question 10

(a) Most candidates were able to complete the passage with appropriate scientific terms.

(b) (i) Many candidates calculated the increase in the number of endangered species between 2007 and 2019, rather than the rate of increase. The latter requires division by the number of years, as indicated by the unit on the answer line of ‘per year’.

Some candidates did not give their answers to the nearest whole number, as required by the question.

(ii) The most common reason given for there being more endangered fish species than mammals species was overfishing. Pollution and climate change were often mentioned but, without further explanation, could not account for the difference between fish and mammals.

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Paper 9700/52
Planning, Analysis and Evaluation

Key messages

Careful reading of each question before starting to write is important.

When planning investigations, candidates should read and take note of the instructions to identify what is required and what is not required. For example, **Question 1(b)(ii)** specifically stated that details of the glucose assay and use of a colorimeter should not be included. A number of candidates included these details in their plans unnecessarily.

Candidates should be given opportunities to practise analysing a variety of statistical data.

General comments

Question 1

Most candidates engaged with **Question 1** to demonstrate a sound understanding of the skills assessed. Explanations were not always fully developed and, at times, key information in the text was overlooked.

In **Question 2**, most candidates demonstrated a good working knowledge of statistics and were able to accurately interpret the results from a *t*-test.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly stated that the colorimeter should be calibrated, often including details about the use of distilled water to set the colorimeter to zero. Some candidates additionally noted that a coloured filter should be used in the colorimeter. Fewer appreciated that the filter used should not be the same as the colour of the solution being tested.

A number of candidates suggested cleaning the colorimeter tubes, although the instructions stated that clean colorimeter tubes were to be used. Some suggested using the colorimeter in the dark, which is not necessary.

(ii) Most candidates stated a suitable number of different concentrations over an appropriate range. Chosen concentrations were not always evenly spaced and several candidates gave unsuitable units for concentration, such as $mol\,dm^{-3}$. Since the concentration of the stock solution was stated as a percentage, the concentration of the solutions to be prepared from the stock solution should also be stated as percentages.

When describing how the solutions should be prepared, many candidates constructed a table to show the volumes of distilled water and stock solution that would need to be mixed. This was an effective strategy. Some candidates had not noted the requirements of the question and described a serial dilution rather than a proportional dilution. Others provided instructions that did not give a final volume of $20\,cm^3$.

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(iii) Many candidates chose the correct axis labels and orientation. Fewer recognised that absorption would decrease as the concentration of glucose increased. Some candidates sketched curves that showed negative gradients throughout most of the range plotted but which then rose at the end, perhaps accidentally.

(b) (i) Most candidates correctly identified the dependent variable. A small number stated the independent variable instead.

(ii) Most candidates were able to describe some aspects of a suitable method to investigate the effect of storage time on the glucose concentration of potatoes. Few comprehensive responses covered all required aspects of the plan.

One common error was to suggest storing blocks of potato or potato juice for varying lengths of time. The investigation concerned the storage of potatoes and therefore whole potatoes should have been stored.

Most candidates considered the standardisation of storage conditions. Suggested conditions were sometimes described too vaguely. For example, instead of stating a storage temperature to use, some candidates simply stated that all potatoes would be stored at the 'same temperature'.

Few candidates suggested suitable timescales for the storage of potatoes, although most selected an appropriate number of different storage times. Most candidates stated that the absorbance of the potato juice should be measured after the potatoes had been stored for the required length of time. Several candidates overlooked the information that details of how to carry out the glucose assay or how to prepare and use the colorimeter were not needed.

The majority of candidates standardised the volume of potato juice to be tested and many suggested repeating the procedure several times and calculating a mean. The term 'average', rather than 'mean', was incorrectly used by some candidates.

Most responses included some form of risk assessment with the most effective stating the hazard, the risk associated with the hazard and the precaution that should be taken to minimise the risk.

(c) Several candidates correctly described the relationship between gamma radiation dose and the percentage of volatile nitrogen compounds. Some developed their responses further by noting that the percentages of volatile nitrogen compounds were significantly different between different treatments.

A few candidates noted that the percentage of glucose did not change, and some applied this information correctly to conclude that glucose was not responsible for the decrease in acrylamide concentration.

(d) (i) The majority of candidates were able to correctly calculate the percentage decrease. Not all followed the instructions to 'show your working'.

(ii) Most responses explained how the information shown in Table 1.2 and Fig. 1.5 supported the conclusion, for example by noting that treatment 2 decreased the acrylamide concentration of potato chips more than treatment 1. Strong responses explained that the two treatments are significantly different because the 95% confidence intervals do not overlap. Some supported the conclusion with an appropriate data quote, but not all candidates stated the units.

Fewer responses considered how the information did not support the conclusion. Of those that did, the use of only one potato variety and the absence of a statistical test were most frequently included as limitations of the investigation. A small number of candidates realised that hot water treatment alone (treatment 2 at 0 $J\,kg^{-1}$ gamma radiation dose) decreased the acrylamide concentration of potato chips and some elaborated this further by considering the overlap in 95% confidence intervals for treatment 2 at all gamma radiation doses, including 0 $J\,kg^{-1}$. The overlap in confidence intervals indicated that the decrease in acrylamide due to hot water and gamma radiation was not significantly different compared to treatment with hot water alone.

Weaker responses made vague reference to overlaps in 95% confidence intervals without explaining where the overlaps occurred or why this was of significance.

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Question 2

(a) (i) Most candidates correctly identified one of the two independent variables as distance from the GM rice plants. Few candidates correctly described the other variable as direction from the GM rice plants. Candidates suggesting that wind direction was an independent variable had not considered that this variable was not manipulated or changed.

(ii) Most candidates stated that the rice plants should be treated with herbicide. Fewer went on to state that the surviving rice plants should be counted.

Some candidates overlooked the instruction that the method should not involve the extraction of nucleic acids and suggested techniques involving DNA, electrophoresis, PCR or microarrays.

(iii) This was very well answered with most candidates stating at least two valid conclusions.

(b) (i) The majority of candidates correctly calculated the mean percentage gene flow from GM rice plants to weedy rice plants.

(ii) Most candidates correctly calculated the number of degrees of freedom and used this figure to identify the critical value from Table 2.2. The majority then went on to derive a correct conclusion and expressed this in terms of significant difference. Some candidates referred to significant decrease, which is incorrect since this version of the *t*-test does not consider the direction of the difference. A number of responses vaguely referred to the results being statistically significant.

(iii) Most candidates were able to provide a valid reason to counter the student's conclusion. Many described limitations in the study. Others identified features of the results that were not completely consistent with the conclusion. For example, gene flow from GM rice plants to weedy rice plants was not zero.

A small number of candidates overlooked the fact that thousands of seeds had been collected and tested and suggested that the sample size was too small.

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