BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

Candidates found questions **1**, **7**, **10**, **18**, **29**, **30** and **36** most straightforward. Questions **3**, **14**, **15**, **19**, **21**, **23**, **25**, **34**, **38** and **40** were the most challenging.

Comments on specific questions

Question 1

Nearly all candidates selected option **C** or option **D** suggesting that candidates were able to apply the correct calculation to the figures. Those incorrectly selecting option **C** appear to have made an error in converting the measured length of the onion cell to micrometres.

Question 2

The majority of the stronger candidates answered correctly. Weaker candidates selecting incorrect options may not have realised that plant cells have 70S ribosomes in their mitochondria and chloroplasts.

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Question 3

Option **C** was incorrectly selected by most candidates. These candidates had noted that semi-conservative replication of DNA occurs in the nucleus but had not considered that semi-conservative replication of DNA must also occur in chloroplasts and mitochondria.

Question 6

Many candidates selected incorrect options. Option **A** was the most commonly selected incorrect option. Candidates selecting this option were unaware that virus particles lack carbohydrates and have genomes of either DNA or RNA, not both. Candidates selecting options **B** or **C** had not appreciated that the capsid that forms part of the structure of all viruses is made of proteins.

Question 9

Option **A** was the most frequently selected incorrect option. Candidates had not noticed that condensation reactions release water, rather than using water.

Question 12

Many candidates incorrectly selected option **D**, indicating uncertainty over the difference between a molecule of collagen and a collagen fibre.

Question 14

Options **A** and **C** were frequently selected. Both of these options included the statement that channel proteins are fixed in position. This is not a correct statement about the fluid mosaic model of a membrane.

Question 15

Many candidates incorrectly selected options **B** and **C**. Irrespective of understanding the changes in water potential expected when a drooping or wilted leaf becomes firmer, these candidates had not appreciated that whatever change in water potential occurs to the external solution will be reflected with the same change in water potential in the immersed cells.

Question 19

Most candidates selected options that included the incorrect statement 4. Mitosis cannot repair damaged cells, but it can produce cells to replace damaged tissue.

Question 21

Most of the stronger candidates selected the correct option. Weaker candidates selected either option **A** or option **B**. Those selecting option **A** had accounted for the fact that the DNA molecule was double stranded but had not noted that three nucleotides are needed to code for a single amino acid. Those selecting option **B** had recognised that three nucleotides code for each amino acid but had not noted that the DNA molecule was double stranded.

Question 23

Almost all options were selected equally by candidates. Candidates selecting incorrect options had not appreciated that replication of DNA depends on complementary pairing between bases so necessarily always results in DNA molecules rather than DNA strands and that DNA molecules are polymers of nucleotides (which include a base as part of their structure), not polymers of bases.

Question 24

Candidates were aware that phloem sieve tube elements and xylem vessel elements lack nuclei, but many incorrectly believed that both also lack cytoplasm.

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Question 25

Many candidates incorrectly selected options that included the Casparian strip. Understanding that water cannot move across the Casparian strip and must therefore pass through the cell surface membranes of endodermal cells is essential to understanding the movement of water across the root.

Question 28

Many candidates considered that sucrose moves through co-transporter proteins by active transport and therefore selected option **D**. Movement through co-transporter proteins is passive as a result of the concentration gradients that are set up by active transport elsewhere.

Question 33

A significant proportion of candidates selected option **D**. These candidates recognised that carbon monoxide and hydrogen ions would reduce the oxygen-carrying capacity of blood but did not realise that carbon dioxide would have the same effect.

Question 34

Many weaker candidates selected either options **A** or **B** suggesting that they had not accounted for diffusion of carbon monoxide across the alveolar wall.

Question 38

All of the uses of antibiotics mentioned were recognised by many candidates to have the potential to result in antibiotic-resistant bacteria. However, relatively few individual candidates recognised that all three uses could result in antibiotic resistance.

Question 40

Many weaker candidates were unaware of why spleen cells are fused with myeloma cells during monoclonal antibiotic production.

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Paper 9700/22
AS Level Structured Questions

Key messages

- Candidates should focus on the meaning of command words when thinking about the type of answer required for a particular question. For example, in **Question 2(d)(i)** some candidates **described** the shape of the curve in Fig. 2.3 when the question asked them to **explain** the shape. In **Question 4(c)**, many candidates provided a description of sickle cell anaemia, rather than explaining why it is an example of a disease.

  The syllabus lists and explains some common command terms. Candidates may also come across combinations of command words or instructional terms, such as 'underline', 'complete', 'list' and 'name'.

- Candidates should carefully note the requirements of each question and ensure that they are fully addressed. For example, in **Question 6(d)** candidates were asked to explain the contributions of two different approaches to reducing the number of cases of cholera. Some only wrote about one and so were unable to fully answer the question.

- Images of unfamiliar cells can be used to practise making links between cell structure and cell function. In **Question 3**, many candidates were unable to deduce the identity of the unknown cell from the information provided.

General comments

Some candidates showed excellent knowledge and understanding of the syllabus contents and a very good ability to apply knowledge to unfamiliar contexts.

Candidates need to make sure they note the instructions for each question and follow these carefully. For example, in **Question 2(b)**, some candidates did not place a tick or cross in every box, as instructed. Similarly, in **Question 3(b)(ii)**, candidates were asked to underline the correct answer from the list; many did not follow this instruction.

Some candidates would have benefited from improving their understanding and interpretation of images, e.g. Fig. 1.1 in **Question 1(a)** and Fig. 3.1 in **Question 3(b)(i)**.

Comments on specific questions

Question 1

(a) A number of candidates correctly identified **X** and **Y**. Goblet cell was a very common incorrect response for both **X** and **Y**.

(b) Most candidates knew that collagen is an example of a protein. A number of candidates incorrectly stated polypeptides or amino acids.

(c) Some candidates were able to complete Table 1.1 correctly. Indicating that alveoli contain smooth muscle was a frequent error.

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Question 2

(a) (i) Many responses addressed the question fully. Incorrect answers included describing a gene as a strand of DNA or a sequence of amino acids. Others stated that a gene codes for a sequence of nucleotides. Some responses referred vaguely to genes containing information to control characteristics of organisms. More specific details were required.

(ii) Some candidates did not note that the molecular structure of glycine was required, rather than that of an amino acid in general. These candidates simply referred to the side-chain as –R, rather than deducing from the information provided that it must be –H.

(iii) This was well known. Occasionally amylase was given instead of amylose. Some responses incorrectly named the two molecules as glucose and fructose.

(b) Not all candidates followed the instructions to place ticks and crosses in every box.

Glucose and starch were well known. Candidates frequently did not use the information provided to deduce the nature of maltase and maltose and were therefore unable to correctly select the terms that applied.

(c) Many responses provided reasonable suggestions for an advantage of using enzymes from microorganisms. Candidates identifying heat stability as an advantage had not noted that this was excluded as a possible answer in the question.

Responses such as 'less expensive' and 'cheaper to produce' were not credited unless qualified with further detail, such as 'because they are easier to extract'.

(d) (i) Good responses used the correct terminology and gave full explanations of the effects of increasing temperature up to and then beyond the optimum, including ideas relating to kinetic energy, successful collisions, enzyme/substrate complex formation and details of denaturation.

(ii) Not all candidates appreciated that a heat-stable enzyme would still have an optimum temperature.

Question 3

(a) Many responses correctly stated a role of cytokines in immune responses. Some candidates referred to stimulation of T-helper lymphocytes. These had not considered that the cytokines referred to here were those secreted by T-helper lymphocytes. A number of responses confused the roles of cytokines with cytokinesis.

(b) (i) Many candidates noted that Fig. 3.1 was characterised by a large quantity of smooth endoplasmic reticulum (and the absence of rough endoplasmic reticulum) and were able to make valid deductions based on these observations.

Some responses focused on the presence of mitochondria. This did not provide a way to decide whether the machinery of the cell was geared towards lipid synthesis or protein synthesis. Other responses referred to ribosomes or the size or shape of the nucleus without linking these to a valid line of argument.

A number of responses stated that molecules of lipid or cholesterol could be seen in the image. When interpreting electron micrographs, candidates need to be aware of the significant difference in size between organelles and molecules and the fact that it is unlikely that a transmission electron micrograph of part of a cell would show individual molecules.

(ii) Many responses correctly identified the type of image and provided a correct explanation.

(c) (i) Candidates who noted from the information provided that testosterone is a steroid (lipid) hormone were able to address this question. Weaker responses often focused incorrectly on active transport or facilitated diffusion.

(ii) Most candidates made valid suggestions that cytokines must be polar molecules or that the molecules must be too large. Fewer considered that there might be a need for a specific membrane transport protein and that this transport protein might be absent.

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Question 4

(a) (i) The majority of candidates recognised that the type of cell represented by **C** was a red blood cell. **D** was frequently named simply as a white blood cell, which was too vague. There was often confusion in identifying **E** and **F**.

(ii) Strong responses used the correct terminology and made clear the link between an infectious disease, an immune response and the presence of an increased number of lymphocytes and phagocytes. Others gave vague references to the need for white blood cells to 'destroy pathogens' or 'fight disease'.

Some candidates considered the possible consequences of infection with HIV and were able to provide explanations for reduced numbers of white blood cells.

(b) Many responses noted that although the percentage saturation of haemoglobin with oxygen had dropped, the volume of oxygen delivered to the tissues by 100 cm^3 of blood remained unchanged. Correct links were then made to the concentration of haemoglobin or red blood cells in the blood.

Weaker responses attempted explanations based on the partial pressure of oxygen at increased altitude. Few were able to explain how the body responded to this change.

(c) Many responses clearly stated what is meant by a disease and were then able to explain why sickle cell anaemia conforms to this definition. Others tried to explain the cause of sickle cell anaemia, which was not the focus of the question.

Question 5

(a) (i) This was generally well answered, with most responses including a detailed account of the events in metaphase and anaphase that are important in the production of genetically identical cells. Responses referring to synthesis of DNA in S phase did not fully address how this contributes to the production of genetically identical daughter cells. Further qualification or use of the term replication rather than synthesis would have addressed this aspect of the question more effectively.

Some responses explained the process of transcription, which is not an event related to the production of genetically identical daughter cells.

(ii) Not all candidates noted that the required comparison was between the two daughter cells, rather than between the daughter cells and parent cell.

(b) (i) Many candidates used their knowledge of how the structure of xylem vessel elements is related to their function to address this question. Most were able to suggest structural changes that occur, such as lignification, and then relate these changes to their role in establishing an uninterrupted flow of mineral ions and water. Fewer considered the significance of cell death and loss of cell contents.

(ii) Most candidates correctly labelled the xylem tissue. The most frequent error was to label the phloem. Some candidates labelled the boundary between the phloem and xylem and a few labelled regions away from the vascular bundle.

Question 6

(a) Most candidates were able to name the pathogen that causes cholera. Some only provided the genus name and others abbreviated the name to *V. cholerae*. A common misspelling of the specific epithet was *cholera*.

(b) Many candidates were able to provide valid suggestions and explanations. Some responses were too vague referring, for example, to polluted or dirty water instead of water contaminated with faeces or the pathogen.

Few candidates showed an understanding that there must already have been *V. cholerae* in the area before the cyclone event.

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(c) (i) Many candidates attempted to use their knowledge of the action of penicillin on cell walls to explain the effect of doxycycline on bacterial cells. These candidates had not noted the information provided that doxycycline binds to the bacterial ribosome.

Few candidates considering the consequences for translation of binding doxycycline to bacterial ribosomes were able to suggest further details, such as preventing access of mRNA to the ribosome. Many did not go on to consider the effect of reduced protein synthesis of bacterial growth and function.

(ii) The majority of candidates gave a correct response.

(d) The strongest responses considered both stated approaches, made use of correct scientific terminology and kept to the context of preventing further cases of cholera occurring.

When considering vaccination, weaker responses often omitted to mention the development of artificial active immunity in individuals or did not consider the idea of herd immunity.

In the context of setting up medical centres, weaker responses often omitted details of treatments, such as oral rehydration therapy or antibiotics for more severe cases. Few candidates considered the ability of medical centres to isolate people with cholera or deal with contaminated faeces more safely and hygienically.

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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 necessary skills for this examination.

Candidates should carefully note the wording of questions so that they can fully address the requirements of each question. For example, the command word 'explain' may imply reasoning or some reference to theory, depending on the context. It requires an explanation.

General comments

The majority of centres returned the seating plan and supervisor's report (including supervisor results) with the candidate papers. The information included in the supervisor's report is essential to examiners, allowing any problems encountered by the candidates to be taken into account during marking.

Candidates who have had the opportunity to follow instructions carefully and have used materials and apparatus in a variety of practical work as part of the course are likely to be better prepared for the examination.

In general, 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

Question 1

(a) (i) Many candidates correctly completed Table 1.2 with the correct volumes of **H** and **W** to make up the required concentrations of hydrochloric acid.

(ii) Most candidates correctly stated an appropriate piece of apparatus.

(iii) The majority of candidates organised their results clearly in the form of a ruled table with headings for the concentration of hydrochloric acid with units (mol dm^{-3}) and time with units (seconds). Most candidates recorded three times for each concentration of hydrochloric acid, with the pattern of results fitting the expected trend. Many candidates recorded the times to an appropriate degree of precision (nearest whole second).

(iv) Most candidates correctly stated the dependent variable in the investigation.

(v) Most candidates correctly stated one significant source of error when carrying out step 2 to step 6. Many referred to the difficulty of judging the end-point and were able to describe a relevant improvement to the method.

(vi) The majority of candidates indicated that their results did not support the hypothesis and quoted times from their results as evidence for their decision.

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(vii) Many candidates described a suitable modification to investigate the effect of changing the temperature on the rate of diffusion. Stronger responses described standardising the concentration of hydrochloric acid and using a thermostatically controlled water bath to heat the water to at least five different temperatures.

(b) (i) Most candidates correctly used the headings given in the table to label the *x*-axis (time / hours) and the *y*-axis (distance / cm). Some candidates labelled the incorrect axis or gave incomplete headings. The majority of candidates used an appropriate scale for both axes.

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

The most common errors were not using the most suitable scale and drawing lines which were too thick.

(ii) Many candidates showed on their graph the distance that the salt had diffused at three hours and correctly calculated the mean rate of diffusion to an appropriate precision.

(iii) Many candidates were able to explain the difference in the rate of diffusion between the two temperatures with relevant references to kinetic energy.

Question 2

(a) (i) Most candidates did not include any cells in their diagrams and used most of the space available. Many carefully followed the instructions by restricting their drawings to the shaded region shown in Fig. 2.1. Most drew at least two layers of tissue, showed the correct shape of the epidermis and used a label line to correctly identify the epidermis.

(ii) Many candidates used a sharp pencil to produce drawings with thin lines that joined up precisely and used most of the available space. Most followed instructions by drawing four adjacent cells from the central tissue with each cell touching at least two of the other cells. Many correctly represented the walls with two pencil lines, indicating its relative thickness.

The most common errors were to draw lines that did not meet up precisely or were too thick.

Most candidates used a label line to identify the cell wall of one cell.

(b) (i) Most candidates accurately measured the diameter of the stem and stated the appropriate units. Many candidates showed division of this measurement by two to determine the radius and used this figure correctly in the formula for calculating the area of the image of the stem.

(ii) Most candidates used the information in the question and their answer to **(b)(i)** to calculate the percentage area of the stem that contained air spaces.

(iii) Most candidates made a valid suggestion. Valid suggestions included the idea that the function of the air spaces was for buoyancy or for the storage and movement of oxygen or carbon dioxide.

(c) Many candidates organised the table appropriately, with features for comparison set out in the same row of the table. Some achieved this by adding a third column at the beginning to specifically identify the feature that was being compared.

Many candidates listed at least three observable differences between the two stems.

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Paper 9700/42
A Level Structured Questions

Key messages

1 Candidates should make sure that their responses are as precise as possible, and that relevant terminology is used correctly. For example, in question **6(a)**, some candidates referred to Ca^{+} instead of Ca^{2+} and to tropomyosin when they meant troponin.

2 Candidates should take careful note of the command words in each question and ensure that their responses address the requirements of the question. For example, there are important differences between what is expected in a 'describe' question compared to an 'explain' question.

General comments

Most candidates were able to demonstrate sound subject knowledge and understanding throughout the question paper. Questions **1** and **6** proved to be more challenging for many.

Comments on specific questions

Section A

Question 1

(a) The majority of candidates mentioned predation, competition for food and disease as factors limiting population size. Some only described selection pressures in general terms without giving specific examples.

(b) Few candidates were able to explain what is meant by the general theory of evolution to convey the ideas of descent with modification or survival of the fittest.

(c) Most candidates correctly described the relationship shown in the graph. Some candidates were able to go on to explain the relationship, suggesting why a shorter generation time could be linked to a faster rate of evolution.

(d) There were many considered responses that explained why the tuatara had remained unchanged for millions of years. Most candidates noted that the tuataras were well adapted to an environment that had not changed very much. Others considered the effect of inbreeding on island populations or the possibility of a lack of natural predators.

Question 2

(a)(i) Nearly all candidates correctly identified the genus of the grey wolf as *Canis*. Occasional incorrect responses included *lupus*, Animalia and Eukarya.

(ii) Most responses considered the immediate effects on the grey wolf's prey should the species become extinct. More developed responses linked the extinction of grey wolves to wider effects on biodiversity and the local ecosystem or food web. Few responses described the effect on genetic variation or considered the time scale over which the changes to biodiversity would occur.

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(b) The most frequent correct responses referred to grey wolves having large territories and an ability to migrate, both of which prevent accurate population estimates by this method. Relatively few responses considered that, as a large predator, trapping and marking such an animal could be dangerous.

(c)(i) Most candidates completed the percentage calculation correctly and followed the instruction to write the answer to the nearest integer. A few candidates gave their answers to one or more decimal places.

(ii) Nearly all responses were based on the population sizes given in Table 2.1. Most responses identified the overall increase in grey wolf numbers and the decrease of the Sierra Morena population and included a data quote in support. Relatively few candidates considered the data in Fig. 2.2 and the apparent changes in population areas. A number of responses incorrectly described each population as if it were a separate species.

(d)(i) Nearly all candidates suggested the use of fences or barriers as a means of protection for the farmers' livestock, with some suggestions of compensation. Occasional incorrect answers included building compounds for the grey wolves rather than the livestock.

(ii) Nearly all responses described the banning of hunting, with extended responses describing the designation of national parks or the development of public awareness programmes. A few responses stated research, but this was rarely qualified with an indication as to the type of research that would assist in maintaining wild grey wolf populations.

Several candidates did not note that the question was limited to protecting wild populations and considered the roles of zoos and captive populations.

Question 3

(a) Most candidates demonstrated basic knowledge of using restriction enzymes, DNA ligase and some form of vector to transfer the required gene into the rice embryos, with more extended responses describing this as a form of recombinant DNA. A few candidates described the use of mRNA as the gene source (as an alternative to DNA) and the additional steps needed to prepare DNA from mRNA.

Many responses did not state that the DNA sequence required would be a gene. Few considered how the gene could be expressed once transferred to a rice embryo.

The most frequent incorrect responses described the direct insertion of carotene into rice with no reference to genetics or described the production of Vitamin A in the rice with no consideration of how the gene would be inserted.

(b) Nearly all candidates recognised from the information provided that using GM rice has the potential to decrease the effects of Vitamin A deficiency, especially by reducing child mortality and blindness. Some candidates showed with simple calculations that even small quantities of GM rice in the diet could provide an individual's recommended dietary allowance.

Despite the direction of the question requiring arguments to support the position of the scientists, some responses only considered concerns over the use of genetically modified crops.

Question 4

(a)(i) Nearly all candidates identified the peak absorption of phycoerythrin from Fig. 4.1. Some responses omitted the units or gave a range despite a clear peak.

(ii) Many candidates described the numerical difference between the absorption spectrum and action spectrum at the same wavelength or stated that phycoerythrin has two observable peaks within its absorption spectrum. Neither of these comments demonstrate that other photosynthetic pigments must be present. Candidates who noted that the action spectrum of red algae for photosynthesis extended beyond the absorption spectrum of phycoerythrin were able to address the question.

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(iii) Most candidates described the role of phycoerythrin as an accessory pigment, although usually without referencing this term. Responses often referred to light of different wavelengths without specifically stating that the light energy was absorbed.

(b) (i) The majority of answers correctly stated the name of the technique. The most frequent incorrect response was electrophoresis.

(ii) Many responses referred to comparisons between green plants and red algae, but few indicated specifically how the presence of phycoerythrin could be confirmed. Those that did were often able to provide details of how to calculate the R_f values and how they could then be used.

Several responses included long descriptions of conducting the technique, which were not required.

Question 5

(a) Many responses demonstrated a good knowledge of the roles played by ions in plants and animals. The most common errors were writing the calcium ion as Ca^{+} instead of Ca^{2+} or stating that tropomyosin changes shape instead of troponin.

(b) (i) Only a minority of candidates were able to correctly identify the ions. Many incorrectly stated that the ions were sodium or potassium ions.

(ii) A large number of candidates made valid suggestions, usually by stating that this would help to avoid the plant wasting energy.

(iii) Many candidates stated that exocytosis was the mechanism by which enzymes are released by the leaf cells. Incorrect answers included negative feedback.

(iv) Few candidates correctly suggested that the reason why the Venus fly trap needs to capture insects is that they grow in soil deficient in nitrogen or minerals.

Question 6

(a) Few candidates were able to link their knowledge of chemoreceptor cells in the taste bud of the tongue to the context of this question.

(b) The majority of candidates recognised the advantages of using dogs to screen people for lung cancer.

Question 7

(a) (i) Most candidates identified **R** and **S** correctly.

(ii) Many candidates accurately noted that the two chromosomes had the same genes at the same loci and that the chromosomes were the same length. Some used the word ‘similar’ instead of ‘same’.

(iii) Only a minority of candidates were able to complete Fig. 7.3 correctly.

(b) Most candidates stated the correct stage of meiosis.

(c) Some candidates correctly described the independent alignment of paired chromosomes leading to new combinations of chromosomes in daughter cells. Most candidates mistakenly wrote about genetic variation caused by crossing over instead of independent assortment.

Question 8

(a) (i) The majority of responses correctly labelled the site of the Krebs cycle. Occasional incorrect responses including labelling one of the cristae or one of the stained structures within the mitochondrion.

(ii) The majority of responses correctly named the structure labelled **B**. A few candidates named the structure as a thylakoid.

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(iii) Most responses correctly identified the inner mitochondrial membrane as the site of ATP synthesis. Many candidates incorrectly referred to the enzyme as ATPase rather than ATP synthetase (or ATP synthase). More detailed responses considered the importance of a proton gradient and how this was maintained.

Consideration of the structure was largely confined to the folding of the cristae and how this increases the surface area available for ATP synthetase. Few considered the impermeable nature of the inner membrane. Most responses omitted any mention of the electron transport chain.

(b) Many candidates were able to name a redox indicator, but few were able to explain why this indicator could be used to measure the activity of the enzyme. Several candidates simply named any indicator of any reaction (e.g. pH indicators).

(c) (i) Most candidates were able to describe the main trends shown in Fig. 8.4. Data quotes were often not provided in support of the answers. Weaker responses tended to describe data points rather than the trends. Description of the levelling off of the reaction at 1 mmol dm^{-3} succinate was often not well described, with the concentration often omitted entirely.

(ii) Rather than providing an explanation, as required by the command word, many candidates gave another description of the data provided in the figure. Stronger responses included explanations that muscle tissue requires more energy (or ATP) for muscle contraction.

(iii) Stronger responses demonstrated an understanding of the need for the muscle to continue contracting in order to maintain position, essential life processes or generate heat. Several responses provided only a re-wording of the question, rather than an explanation.

Section B

Question 9

(a) Many candidates demonstrated a very good knowledge of the characteristic features of the domains Eukarya and Bacteria. The most effective responses described the differences or similarities between Eukarya and Bacteria for one feature at a time or used a table to present the comparisons with one feature per row.

Candidates writing about Eukarya in one paragraph and writing about Bacteria in another paragraph were frequently unable to make the similarities and differences clear.

(b) Some candidates recognised the role played by botanic gardens, seed banks and treaties like CITES in conserving endangered plant species. Stronger responses considered the need for optimum growing conditions with control of light, temperature, water and nutrient availability during propagation and expansion of collections.

Many candidates appreciated the importance of seed banks in conserving genetic diversity and realised that seeds in seed banks needed to be stored at low temperatures and in dry conditions. Some recognised that stored seeds would need to be tested for viability at regular intervals.

Many responses lacked sufficient precision with vague statements that contained few details.

Question 10

(a) Some candidates demonstrated very good knowledge of bioinformatics and its role following the sequencing of genomes of humans and parasites. Effective responses mentioned the use of computer software and the storage of large databases of gene or DNA sequences. Fewer were able to show how bioinformatics could be used to find methods to control parasites or identify new diseases.

Many candidates knew very little detailed information and provided only vague responses.

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(b) Most candidates had a very good knowledge and understanding of the process of using microarrays. Many identified probes as single stranded pieces of DNA but fewer stated that each probe was unique to a particular gene. Obtaining mRNA was usually described as the starting point. Tagging with a fluorescent dye, hybridising of cDNA with probes and the method of detecting expressed genes with UV light were well described.

A common error was to state that mRNA was converted to cDNA rather than being used as a template from which cDNA could be made.

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Paper 9700/52
Planning, Analysis and Evaluation

Key messages

Candidates are advised to read the whole paper through before starting their answers. Practice in general investigational procedures and the use of statistical techniques is important in preparing for this paper.

General comments

Many responses demonstrated a firm grasp of the skills expected in this assessment supported with sound knowledge and understanding of the relevant syllabus areas.

Care is needed to ensure that the requirements of each question are understood and that responses address these as precisely as possible. Command words, in particular, should be noted since these define the approach required. For example, 'state', 'describe' and 'explain' can often be substituted with one another to obtain a series of valid questions, but each question would require very different responses.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly stated the data that would need to be collected. Weaker responses sometimes referred to types or varieties of plants, rather than species, or mentioned the numbers of plants without making it clear that the numbers of individuals of each species were needed. A few candidates went on to describe how the data might be collected via quadrat sampling, which was not relevant to the question here. A few candidates suggested collecting data on abiotic factors. This is not information that is needed to assess biodiversity.

(ii) The majority of candidates identified the independent variable correctly. Some responses were too vague. For example, references just to 'type of land' or 'trampled land' did not convey the nature of the variable that was changing. A few candidates suggested over-complicated variables that were not directly related to the investigation, such as 'the type of plants trampled'.

(b) Most candidates were able to describe the basic details of a suitable method. Many candidates developed this into a thorough plan including details of appropriate sampling approaches (e.g. quadrat or transect) for both trampled and untrampled areas. Systematic or random sampling approaches were both valid. A number of candidates planned to throw quadrats randomly; this is not a suitable approach to achieve random sampling. Some candidates only planned to sample trampled areas, which would not have allowed the effect of trampling to be determined.

Many candidates considered the need for replication, but details were often vague or did not amount to meaningful replication. For example, some candidates planned to carry out repeat counts in the same quadrats, rather than sampling new quadrats.

Most candidates recognised that the size of the sample site (e.g. size of quadrat) should be the same throughout the whole investigation. Some candidates planned to use quadrats of a size that was unsuitable, e.g. quadrats larger than 1 m × 1 m would be too large to fit on the path (as determined from the scale on Fig. 1.1).

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More detailed responses included a range of relevant additional considerations such as how to ensure that all plant species, including those that are small, inconspicuous or likely to be hidden under other larger species were counted. Many referred to appropriate ways to identify the species of plants present and some described the use of measures of abundance as alternatives to simple counting. A number of candidates planned to complete the sampling in a single day; stronger candidates recognised the relevance of sampling at intervals throughout the year to account for seasonal variation. Many candidates considered how the data could be analysed, often planning to calculate the Simpson's Index of Diversity.

Fieldwork is rarely free from risk, as suggested by a number of candidates. Many candidates mentioned a range of potential hazards including allergies to plants or pollen, trip hazards in rough vegetation, high sun exposure and insect bites. Complete assessments of risk included reference to the hazard and its associated consequence, together with a suitable method to mitigate the risk.

(c) (i) Nearly all responses stated evidence from the results in support of the conclusion but features of the results that did not support the conclusion were rarely recognised. Few candidates noted that there was no data on whether trampling actually reduces the size of air spaces in the soil. Candidates referring to large standard deviations as a way in which the data did not support the conclusion had not noted the much larger differences in the mean values between the shortcut path and untrampled area.

(ii) The vast majority of candidates completed the calculations correctly. Some candidates rounded the values incorrectly.

(iii) Few responses clearly stated the additional information gained from the calculated values for the 95% confidence intervals. Some candidates correctly noted that because the confidence intervals of the means for the shortcut path and untrampled area did not overlap, the means for the two areas were significantly different (at 5% probability).

Candidates struggled to put into words what a 95% confidence interval actually implies, with few considering the difference between the true mean and sample mean and how they can be related to one another.

(d) (i) Most candidates outlined a method based on gridding out the leaf in some way, such as drawing round on graph paper and counting the squares. Not all considered how partially filled squares should be counted.

A few candidates suggested the application of a mathematical formula such as that for an area of a circle. However, these approaches can only be used if the shape of the leaf conforms to a shape for which an established formula for calculating area exists.

(ii) Most candidates identified a negative correlation. A few responses incorrectly suggested that a negative number meant that there was no correlation.

(iii) Most candidates recognised that the relevant probability threshold to consider was that of $p = 0.05$. Fewer were able to explain that the correlation was significant because the calculated value (0.455) was greater than the critical value in the table (0.447).

Some candidates did not note that the table was based on the number of pairs of items in the sample and incorrectly read values off against the number of degrees of freedom ($n - 2$).

Question 2

(a) (i) Most candidates correctly identified the dependent variable. A few candidates referred vaguely to the time taken to change colour, without stating what had changed colour.

(ii) The majority of candidates stated a correct example. A few candidates had not noted the wording of the question and stated temperature or one of the variables standardised in Fig. 2.1.

(b) (i) Incorrect calculations were frequent. Since several examples of the same calculation had already been completed in the table, candidates could have checked that their method of calculation worked.

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(ii) The majority of candidates recognised the two factors that affected the rate of photosynthesis. Fewer correctly identified when each of the factors became limiting. To identify when a particular factor becomes limiting, both the light intensity (distance from lamp) and concentration of carbon dioxide (sodium hydrogencarbonate concentration) must be stated. For example, at a lamp distance of 20 cm, carbon dioxide concentration is the limiting factor at sodium hydrogencarbonate concentrations of 0.75% or less.

(iii) Most candidates recognised that confidence in the conclusions was limited by the fact that only two different light intensities and four different carbon dioxide concentrations were tested. Some also considered the subjectivity of judging the end-point by eye. A small number noted that only a single-celled protoctist had been tested and that this limited the application of conclusions to a wider range of photosynthetic organisms.

Some candidates suggested that a lack of a control also reduced confidence in the conclusion. This is, in principle, a valid comment but requires further qualification to constitute a reason.

A number of candidates referred to the need to keep key variables constant. These candidates had not noted that the information provided in the question included a statement that all other variables in the investigation were standardised.

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