BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

Candidates found **Questions 17**, **32** and **40** to be relatively straightforward. **Questions 6**, **13**, **14**, **15**, **16**, **18**, **30**, **31**, **37** and **39** were more challenging.

Comments on specific questions

Question 1

Most candidates selected the correct option. Option **C** was the most frequently selected incorrect option. Candidates selecting **C** had recognised that, as the largest of the four organelles, chloroplasts are visible with a light microscope while ribosomes, as the smallest of the four organelles, are too small to be viewed. However, they had not appreciated that, as part of the ultrastructure of the cell, the endoplasmic reticulum and centrioles cannot be observed with a conventional light microscope at a magnification of 400.

Question 5

Most candidates selected the correct answer, but a significant minority chose option **A.** Peptidoglycans are a characteristic constituent of the cell wall of bacteria and are not found in viruses.

Question 6

Option **D** was selected by a large minority of candidates. Prokaryote cells are surrounded by a single cell surface membrane.

Question 11

Most candidates selected the correct option, but options **A** and **C** were selected by a minority. Candidates were confident that 1,4 glycosidic bonds occur in cellulose but there was some confusion as to the nature of the monomers from which it is constructed.

Question 13

Option **C** was selected by a small majority of candidates indicating some uncertainty over the meaning of hydrolysis. Hydrolysis uses water to split molecules and cannot therefore result in the release of metabolic water.

Question 14

Nearly all candidates recognised the involvement of hydrogen bonding (bond 1) and disulfide bonds (bond 3) in holding the quaternary structure of proteins together. However, a large minority incorrectly considered that peptide bonds (bond 2) are also involved. Peptide bonds are limited to the primary structure of proteins where they are responsible for joining amino acids into chains.

Question 15

A large minority of weaker candidates selected option **B**. These candidates had not recognised that peptide bonds are limited to the primary structure of proteins and had not learnt that many fibrous proteins, including the syllabus example of collagen, have a quaternary structure.

Question 16

Nearly all candidates recognised that a colorimeter could be used to investigate the rate at which a solution changes from green to colourless. However, there was less certainty regarding the other investigations. A significant proportion of candidates considered that a change in skin colour of lizards could be monitored using a colorimeter and therefore selected **C**, an incorrect option. Colorimetry depends on detecting light that passes through a sample (typically a coloured solution) so would not be suitable for detecting skin colour changes in lizards, which depends on reflected light.

Question 18

Many candidates incorrectly selected option **D**. These candidates had not noted that the ethanol was released from within the yeast cells. In this situation, decreasing the permeability of cell membranes (including the cell surface membrane) will result in the accumulation of ethanol within cells, rather than preventing it.

Question 19

Option **A** was incorrectly selected by a large proportion of candidates. At equilibrium, when the water potential of the cell is equal to the water potential of the external solution, there is no net or overall movement of water molecules. However, water molecules continue to move in and out of the cells in equal amounts.

Question 30

Candidates selecting option **A** had not noted that the wall of H was much thicker than the wall of G, showing that H cannot have been the right ventricle.

Question 31

Option **C** was incorrectly selected by a significant proportion of candidates. These candidates had omitted to include one of the three listed structures that blood must pass through, or pass by, before reaching the semilunar valve: the sinoatrial node, the atrioventricular node and the Purkyne tissue.

Question 36

Option **A** was the most frequently selected incorrect option. Candidates identifying V as the diameter of an alveolus had not considered the presence of much smaller air sacs in the surrounding tissues and the relative thickness of the wall.

Question 37

Option **D** was incorrectly selected by a large proportion of candidates. Although rehydration therapy is highly successful in preventing deaths from cholera, it will not decrease the spread of the pathogen. While receiving treatment that significantly reduces the risk of death, people with cholera will continue to shed the pathogen in their faeces.

Question 38

A substantial proportion of candidates incorrectly selected option **B**. These candidates may not have noted that the heading referred to inhibition of a process.

Question 39

More candidates selected options **C** and **D** (combined) than the correct option, **B**. Lymphocytes and myeloma cells are essential for the formation of the required hybridoma cells, but it is from clones of selected hybridoma cells that monoclonal antibodies are obtained.

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Paper 9700/22
AS Level Structured Questions

Key messages

- Candidates need to understand how the structure of a chromosome changes throughout the whole mitotic cell cycle and relate the structure to the number of DNA molecules complexed with histone proteins. In **Question 2(a)(ii)** some candidates incorrectly drew daughter chromosomes with two chromatids in the anaphase stage of mitosis.

- Paper 2 uses a variety of command words with which candidates need to be familiar. Many candidates did not note the distinction between 'describe' and 'explain'. This was seen especially in **Question 3(c)(i)**, where candidates were asked to explain the shape of the curve showing the effect of substrate concentration on the initial rate of reaction. Many candidates gave a description of the shape of the curve and extracted values to support this description, rather than providing a biological explanation of the relationship between substrate concentration and initial rate of reaction.

- **Question 4(d)** was based on the estimated number of deaths from TB and HIV/AIDS and candidates were asked to discuss whether the data provided support for a particular prediction. Some candidates did not appreciate that a discussion should include consideration of both sides of an argument. Other candidates s attempted to produce a discussion that did not include reference to the data provided.

General comments

Some candidates were well prepared and produced answers of a high quality. These candidates had a good knowledge and understanding of the topics covered and were able to make correct links between different areas to produce comprehensive responses. They were also able to recognise where they could use their knowledge to answer questions based on unfamiliar material.

Other candidates were less well practised in this, although many of these were still confident in addressing questions requiring more direct knowledge of the syllabus learning outcomes.

It is important that candidates follow straightforward instructional terms that may appear in some part questions. Examples of where some candidates did not follow instructions were in:
- **Question 1(a)**, where candidates were asked to use ticks (✓) or crosses (x) to complete Table 1.1, so that all boxes were filled
- **Question 1(b)(i)**, where candidates were asked to draw a label line and label with the letter **C**
- **Question 4(b)**, where candidates needed to express their answer to two significant figures.

In **Question 3(c)(ii)**, some candidates demonstrated understanding of what to do to derive the correct value for K_m but lacked care in extracting an accurate value from Fig. 3.4.

Comments on specific questions

Question 1

(a) Some candidates were confident in their knowledge of the three transport processes stated in Table 1.1. Other candidates had more limited knowledge that was restricted to only one or two of the processes.

(b) (i) Many candidates labelled the Casparian strip on Fig. 1.1 accurately and clearly. The labelling lines of some candidates were imprecise, pointing in the general area but terminating short of the Casparian strip. A number of candidates did not answer in the required format, omitting to include a labelling line that was labelled with the letter **C**. A small, but significant, number of candidates left this question blank.

(ii) How root hairs are adapted for the absorption of water was generally well explained and most candidates found this straightforward.

(iii) The majority of candidates identified the pathway correctly.

(c) This was well understood and answered by most candidates, with many making a correct reference to transpiration pull. Some confused the terms cohesion and adhesion, while others tried to include root pressure as part of the answer.

Stronger candidates gave further details about hydrogen bonding, often noting that the negative and positive charges involved were small and using the correct symbol, δ, to represent this.

Question 2

(a) (i) The majority of candidates recognised the stage of mitosis shown in Fig. 2.1. The most frequent incorrect answer was anaphase.

(ii) The strongest responses included neat, accurate diagrams and considered all relevant aspects, including the relative chromosome sizes and shading.

Many responses omitted these key details with some only including two, instead of four chromosomes. As noted in **Key messages**, a number of candidates incorrectly drew chromosomes with two chromatids.

(b) The role of telomeres during DNA replication was well understood by most candidates.

(c) Effective responses focused on the context of the question, rather than considering stem cells in general. Some responses did not make clear the difference between cell division (mitosis) and cell differentiation.

Question 3

(a) Most candidates completed Fig. 3.1 correctly.

A common error was for candidates to write **H** where it should have been an **R** group. A number of candidates did not attempt this question.

(b) (i) Many candidates were able to calculate the rate of reaction correctly.

A common error was to interpret 2 minutes 30 seconds as 2.3 minutes.

(ii) Many candidates simply stated that the rate of reaction increased as the percentage concentration of the enzyme increased. This is a correct description of what the graph shows but further detail is required to explain how the results show that the substrate was always in excess.

(c) (i) Strong responses to this question made use of correct scientific terminology and included molecular explanations for the initial steep increase in the rate of reaction with substrate concentration, the gradual levelling off and the eventual plateau of the curve in Fig. 3.4.

A number of responses made no mention of the active site, referring only in more general terms to enzymes.

As stated in **Key messages**, some responses to this question were descriptions, rather than explanations.

(ii) As noted in **General comments**, while many candidates understood the process of calculating the Michaelis–Menten constant, only some of these read the graph accurately.

(iii) Many candidates correctly stated that a lower K_m value indicates a higher affinity between an enzyme and its substrate. However, a number of these candidates went on to contradict their original assertion by concluding that catechol oxidase therefore has a higher affinity with catechol than with methylcatechol. Careful checking of responses may have helped candidates to avoid this error.

Question 4

(a) The majority of candidates knew the species name for one of the bacteria that causes TB. The spelling was usually correct, and most correctly formatted the scientific name with an upper-case letter for the genus and a lower-case letter for the species epithet.

Common errors in spelling were *Micobacterium* or *Microbacterium* for the genus name.

Some candidates only gave a genus name.

(b) Most candidates used the correct formula and many stated the calculated answer correctly.

A number of candidates used incorrect figures in their formulae and some did not express their answer to two significant figures, as required in the question.

(c) Most candidates were able to provide two structural features specific to prokaryotic cells.

Some candidates confused prokaryotes with eukaryotes and a small number confused prokaryotes with viruses.

(d) Some candidates developed effective responses that were expressed clearly and considered both sides of the question.

Many responses included valid points, but these were often limited to statements in support of the prediction.

A number of candidates tried to support their discussion using incorrectly extracted values from Fig. 4.2.

(e) Some candidates provided clear and well-written explanations in which specific knowledge about the role of T-helper cells was applied effectively.

Most candidates were able to include relevant ideas, but these were sometimes vague or incomplete.

Question 5

(a) (i) Many candidates were able to provide a comprehensive list of structures in the correct sequence. Some did not include the valves, while others incorrectly considered the right side of the heart and the pulmonary circulation.

The weakest responses listed incorrect sequences and omitted a number of expected structures.

(ii) Many candidates realised that the problem would be a reduced delivery of oxygen or glucose and, consequently, reduced rates of aerobic respiration. Weak responses only made reference to a reduced supply of blood.

(b) Some candidates were able to provide clear and detailed responses that recognised how AF would interfere with the role of the sinoatrial node as the pacemaker for the heart.

Most responses included valid aspects but were lacking in some details.

A number of candidates limited their responses to repeating the information provided in the question. These candidates simply stated that the sinoatrial node will be disrupted by AF and that this will result in rapid and irregular atrial contractions.

(c) (i) Most candidates identified enzyme **X** correctly; many also knew molecule **Y**. Some incorrectly identified molecule **Y** as haemoglobin.

(ii) Many candidates incorrectly considered that the exchange of hydrogencarbonate ions and chloride ions was to maintain the pH. Fewer considered the need to maintain balanced charges.

(d) The majority of candidates identified the aqueous environment correctly. The most common incorrect answer was plasma.

(e) Many candidates provided comprehensive and accurate explanations.

Some incorrectly considered that the particles were trapped and removed by the cilia, without any consideration of the role of mucus.

A small number of candidates wrote about ciliated cells moving, rather than cilia.

Question 6

(a) (i) Some candidates stated that **E** was a pentose sugar. The latter was too vague as a response to the command word, 'identify'. A number of other candidates incorrectly identified structure **E** as ribose.

Nearly all candidates recognised that structure **F** was a base but fewer were able to provide a correct identification.

Guanine was the most frequent incorrect response by candidates. These candidates may have appreciated the significance of the number of hydrogen bonds but appeared uncertain of the structural difference between purines and pyrimidines.

(ii) The majority of candidates were able to draw a circle around the correct structure. The most common errors involved only circling a base or part of a nucleotide. Some candidates circled a pair of complementary bases and a small number circled two nucleotides joined by hydrogen bonds.

(iii) Most candidates named the covalent bond correctly. The most frequent incorrect answers were hydrogen bonds or peptide bonds. A few candidates wrote 'nucleotide bonds'.

(b) Many candidates worked through this question carefully to complete Fig. 6.2 correctly. The most common error was to include U in the answer. Some candidates only put one or two bases in each of the four boxes.

(c) Many candidates gave correct responses. Some candidates tried to answer the question in terms of transcription or translation.

(d) Many candidates provided comprehensive and accurate responses.

A significant number omitted relevant details such as the complementary base pairing between codons and anticodons. The weakest responses mixed up details of translation with details of DNA replication.

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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 be able to describe clearly, in words or diagrams, improvements to a procedure or modifications for extending an investigation.

General comments

Preparing the correct materials and providing the specified apparatus are essential for the success of the examination. The majority of centres provided all the materials required and most candidates experienced no problems with materials or apparatus when completing the question paper.

Centres are reminded that they should contact Cambridge International if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or the apparatus provided to them without prior consultation with Cambridge International. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and clean apparatus where applicable. Extra supplies of solutions and materials should be made available to any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

Most candidates demonstrated that they had a good understanding of the skills required and 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 completed Fig. 1.2 correctly.

(ii) Many candidates were able to complete Fig. 1.3 to show how to carry out a serial dilution of the 1.00 mol dm^{-3} sucrose solution. Most candidates showed the correct concentration of sucrose solution below each beaker, the transfer of 50 cm^3 of the previous concentration to the next beaker and the addition of 50 cm^3 distilled water to each beaker.

(iii) The majority of candidates stated a suitable method that could be used to standardise the surface area of all five potato cylinders.

(iv) Most candidates correctly stated the appropriate volume of sucrose solution used to just cover the eight pieces of potato in each large test-tube.

(v) Most candidates organised their results clearly in a ruled table and included an appropriately detailed heading for the independent variable and the dependent variable. The most common error was to omit the heading for the independent variable.

The majority of candidates recorded the speed of movement of the drop in an appropriate manner. Some were able to record the direction and speed of the drop for more than one trial.

Many candidates recorded the correct direction and speed of movement for all the concentrations.

(vi) Most candidates correctly estimated the concentration of sucrose with a water potential equal to the water potential of the potato cells.

(vii) Many candidates described how to modify the procedure to obtain a more accurate estimate of the concentration of sucrose with a water potential that is equal to the water potential of the potato cells. Most of these candidates suggested using a narrower range of sucrose concentrations either side of their original estimate.

(viii) Many candidates correctly described the movement of water molecules when the water potential of the sucrose solution surrounding the piece of potato is the same as the water potential of the potato cells. Not all recognised that although there was no net movement of water molecules, the water molecules move at an equal rate in both directions.

(ix) Most candidates were able to state one source of error in the procedure.

(b) (i) Most candidates used the headings given in the table to label the *x*-axis and the *y*-axis appropriately. Some candidates labelled the incorrect axis or gave incomplete headings.

Strong candidates used appropriate scales for both axes so as to make full use of the space provided while allowing values to be easily read from the graph. Many plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear ruled line that accurately connected the plotted points.

The most common errors were not including the correct label for each axis, omitting the units for the axis labels and not labelling the scales at appropriate intervals.

(ii) Many candidates were able to correctly estimate the percentage change in mass when the sodium chloride concentration was $0.3\,\text{mol}\,\text{dm}^{-3}$.

Question 2

(a) (i) The majority of candidates produced appropriate plan diagrams that did not include any cells or shading and used most of the space provided. Many carefully followed the instructions and drew one quarter of the stem on slide **J1**. Most candidates included at least three layers of tissue in their plan diagrams and showed the correct proportions for the size of the vascular tissue and the depth of the cortex. Strong candidates drew two lines for the epidermis. Most candidates used a label line to correctly identify the xylem.

(ii) Most candidates followed the instructions by drawing four adjacent xylem vessel elements where each vessel touched at least one other and using a label line to identify the lumen of one cell. Many used a sharp pencil to draw thin continuous lines that joined up precisely and correctly represented the thickness of the cell walls with double lines. Strong candidates showed the correct shape of the vessel elements. The drawings of the majority of candidates used most of the space available,

The most common error was for candidates to draw lines that did not meet up precisely.

(b) Many candidates listed at least three observable differences between the stem on slide **J1** and the stem in Fig. 2.2.

(c) (i) Most candidates correctly measured the lengths of the five air spaces in Fig. 2.3 and showed how to calculate the mean length. The most common error was not showing the working.

(ii) Many candidates showed the division of the mean length by the magnification and correctly calculated the actual mean length of the air spaces.

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Paper 9700/42
A Level Structured Questions

Key messages

1. Candidates should name the process involved when describing the transport of ions and molecules.
2. When quoting data from a table or graph, candidates should check whether the data needs to be comparative and that they have used the correct units.

General comments

Many candidates demonstrated sound knowledge and understanding across the breadth of the syllabus coupled with an ability to effectively analyse data.

Comments on specific questions

Section A

Question 1

(a) (i) Most candidates were able to suggest two or more reasons to explain why the population of hedgehogs on Alderney had increased substantially following their introduction.

(ii) Candidates found this question problematic. Many considered that blonde spines could give a selective advantage to hedgehogs although few referred to directional selection by name. A small number of candidates recognised the possibility of genetic drift due to an initially small gene pool (founder effect).

(b) Many candidates recognised the need to control invasive alien species and a variety of valid explanations were suggested. Competition with native species for food (and other resources) and predation on native species were often cited as problems. Other valid explanations recognised that alien species may have no predators to control their numbers or may reproduce more successfully than native species. Some responses correctly noted that the consequence of these problems would be a reduction in biodiversity.

Question 2

(a) (i) Candidates generally recognised that blocking mitochondrial movement would limit the production of ATP at the sites where ATP is required and tried to relate this idea to a restriction in the transmission of action potentials. However, most were only able to relate the transmission of action potentials to ATP production in vague terms. Very few candidates recognised the essential role of ATP in the active transport of ions across the cell surface membrane to restore and maintain the resting potential.

A frequent error was for candidates to attribute a role to ATP in the depolarisation and repolarisation of the cell surface membrane. These processes depend on voltage-gated ion channels rather than ATP-dependent active transport

Some candidates incorrectly attempted to answer the question in terms of events at synapses. The question required explanations in terms of action potential transmission along the axon membrane.

(ii) Nearly all candidates identified that the speed of transmission was reduced as a result of GAN. Few candidates went on to extend this description with further details or processed the data to support their interpretation.

(iii) Candidates found this question challenging. The most common correct suggestions for the effect of GAN included stating that walking would be slower than usual or that the likelihood of tripping would increase. Most responses were vague, often describing effectors without noting that these effectors would be muscles. Many candidates re-used some of the terms in the question without explaining the effects on walking.

(b) Most candidates correctly noted that gene therapy had a beneficial effect on GAN because the mean balancing time was longer for treated mice than for untreated mice. Discussions as to whether the therapy was a cure were less well articulated.

Evaluating the effect of age on the results of the rotarod test was more complex with candidate statements sometimes lacking clarity or a well-defined point relevant to the discussion. Many candidates were able to select supporting data to show that the results of the rotarod test were affected by age, but few responses engaged fully with the data to develop a coherent line of reasoning.

Question 3

(a) Some candidates were able to develop comprehensive responses linking the gene mutation to the reduced oxygen-carrying capacity of red blood cells.

However, many responses did not describe the gene mutation and were therefore limited to describing the effects of the disease, without any rationale referring back to the mutation. A small number of responses appeared to consider that the mutated gene encodes red blood cells directly.

Some responses misunderstood the difference between nucleotide sequences in DNA and amino acid sequences in the primary structure of proteins.

(b) (i) Few responses considered the complete sequence of events from the role of osmoreceptors through to the effect of ADH on kidney function. Some responses stated the wrong effect on ADH secretion or did not describe the consequence of a change in ADH secretion.

(ii) Few candidates were able to link an increase in blood pressure in the pulmonary capillaries to an increase in fluid entering the alveoli. Those considering the analogous effect of high blood pressure in the glomeruli for ultrafiltration were best placed to make this link.

(c) The majority of responses recognised that kidney disease was consistent with a higher risk of TACO following blood transfusion, with some candidates providing supportive data quotes as evidence for this interpretation. The explanatory element of the question was less well incorporated into responses. Few candidates recognised that kidney disease compromises the ability of the kidney to excrete excess water from blood transfusions so as to reduce blood pressure and thus avoid TACO. A minority of candidates considered that TACO caused kidney disease, despite the descriptive narrative of the study provided in the question.

(d) This question was generally well understood by candidates. Many provided sound descriptions of changes to water potential in the filtrate and were able to use this to explain decreased water reabsorption in the kidneys and the consequential reduction in risk of developing TACO following a blood transfusion.

Question 4

(a) (i) Nearly all responses correctly identified the site of crossing over on the figure. Infrequent incorrect responses included labelling the centromere and labelling any point where non-sister chromatids were aligned but not crossing over. Some candidates did not use a labelling line, as required by the question.

(ii) Responses tended to lack detail in describing how crossing over produces genetic variation in a population. For example, many did not note that crossing over must be between non-sister chromatids to generate variation or referred only vaguely to the exchange of genetic information rather than alleles. References to the exchange of genes in some responses were incorrect. Few candidates linked the formation of genetically variable gametes by meiosis to the production of genetic variation in a population.

A few strong responses correctly described the effect of crossing over on disrupting linkage groups.

(b) (i) Explanations of the term F1 generation were mostly limited to referring to the offspring from a parental generation. Fewer candidates noted that the parents of the F1 generation must be homozygous or that the F1 offspring would be heterozygous. Some responses implied that genes were crossed, rather than individuals.

(ii) The data table for the chi-squared test was completed correctly by most candidates. More frequent incorrect responses included: incorrect rounding applied to the final column, copying across line four of the table into the empty spaces in line three (presumably due the observed numbers being identical), and not summing the four values in the final column.

(iii) The chi-squared results were generally interpreted correctly, with the key points in the mark scheme observed across many responses. Some responses considered that a calculated value in excess of the critical value meant there was no significant difference between observed and expected results. Other responses included ambiguous comments about the number of degrees of freedom instead of the critical value.

(iv) The most likely genetic reasons for phenotypic ratios not matching expecting ratios, such as autosomal linkage and gene interactions (epistasis), were rarely cited by candidates. Most candidates referred to the occurrence of mutations instead.

Some responses correctly referred to random sampling effects when there are small numbers of offspring or considered the effects of the environment on phenotypes.

Question 5

(a) (i) Most candidates were able to name the correct disease. A few candidates gave Huntington's disease as an incorrect answer.

(ii) The majority of candidates were able to give two advantages for using recombinant human factor VIII, instead of factor VIII from donated blood. The most popular reasons given related to medical considerations such as reduced risk of disease transmission or fewer problems with immune responses. A number of candidates described valid ethical considerations.

Some responses were too vague, simply noting that recombinant factor VIII could be produced in large quantities or was easily available.

(b) (i) Many candidates correctly named reverse transcriptase as the enzyme that uses mRNA as a template. The most frequent incorrect answers were DNA ligase and DNA polymerase.

(ii) Most candidates gave vague references to obtaining DNA from a nucleus or mitochondria. Few candidates appeared familiar with the underlying syllabus Learning Outcome assessed in this question.

(c) A large number of candidates were familiar with the role of a promoter and were able to provide effective responses.

Question 6

(a) (i) Most candidates correctly used the graph to read off a correct value for carbon dioxide uptake at 1000 lux. Many incorrectly attributed the negative value to the occurrence of respiration in the absence of photosynthesis. Fewer recognised that the slope of the graph showed that some photosynthesis must also be occurring, although at a lower rate than the rate of respiration.

A small number of candidates misread the light intensity as 10 000 lux.

(ii) Many candidates addressed both aspects of the question fully and were able to quote values from the graph in support of their answers.

(iii) Most candidates answered this question correctly.

(b) (i) Many candidates correctly named a suitable enzyme. A few candidates simply copied 'digestive enzymes' from the question and used this as their answer.

(ii) A large minority of candidates were unable to suggest a nitrogen-containing compound and were therefore unable to name a Calvin cycle intermediate from which it could be synthesised.

Question 7

(a) Many candidates developed comprehensive and well-focused responses that outlined all the relevant steps of oxidative phosphorylation in the correct sequence and referred to specific processes when describing transport across the inner mitochondrial membrane.

Many other responses, however, omitted details (or included incorrect details) and sequenced the steps in the wrong order. For example, a number of responses referred vaguely to NAD, rather than reduced NAD and described the release of H^+ ions instead of hydrogen atoms. A small number of responses incorrectly stated that energy is **produced** (rather than released) by electrons moving along the electron transport chain. Some responses were confused about the purpose of ATP synthase, often incorrectly linking it to the pumping of H^+ from the matrix into the intermembrane space. Many candidates incorrectly named the intermembrane space as the inner membrane space.

(b) Candidates who took care to describe the differences between population **A** and population **B** in terms of the concentration and rate of production of ATP were often able to develop effective explanations for the differences.

Many weaker candidates described the data for each population separately and did not make a comparison. Data quotes were sometimes inaccurate and, even when accurate, had often not been selected with sufficient care to illustrate a difference between the two populations. Many of these responses recognised that mitochondria are the site of oxidative phosphorylation but fewer appreciated that substrate-linked phosphorylation also occurs in mitochondria.

Question 8

(a) Stronger candidates noticed that there was no geographical barrier between the two species in this example and correctly identified and explained how sympatric speciation may have occurred. Weaker candidates often did not engage with the information provided and assumed that allopatric speciation was occurring.

(b) This question, directly assessing a syllabus Learning Outcome, was not well answered by the majority of candidates. Few considered, in comparison with crops, the longer time needed for cattle to become sexually mature, the smaller number of offspring that can be produced in each cross or that milk yield can only be determined in half the offspring. Issues relating to the husbandry of large mammals were considered by very few candidates.

(c) Most candidates were able to give two features that would help to increase the yield in crops.

Question 9

(a) Candidates who had learnt this area of the syllabus provided detailed and effective responses.

Many candidates, however, did not note the requirements of the question and described the different species concepts vaguely rather than focusing on the biological species concept.

(b) Only a minority of candidates were able to make a correct suggestion.

(c) This area of the syllabus did not appear to be familiar to many candidates and often responses did not highlight similarities and differences.

Some responses referred to a feature that was different between the two domains, such as the cell surface membrane or cell wall, without stating specifically the nature of the difference.

Question 10

(a) Most candidates were able to correctly identify the three structures visible in the diagram of two guard cells.

(b) The majority of candidates were able to demonstrate a good understanding of the role of abscisic acid in stomatal closure. Many responses included a range of relevant details such as inhibition of the proton pump, the role of calcium ions, the diffusion of potassium ions out of the cell and the resultant changes to water potential in the cell and how this leads to stomatal closure.

When referring to transport across the cell surface membrane, not all candidates named the transport processes involved.

BIOLOGY

Paper 9700/52
Planning, Analysis and Evaluation

Key messages

Careful reading of the whole paper before starting to write is important.

Providing opportunities for candidates to practise analysing a variety of statistical data will help candidates feel more at ease in these areas.

General comments

Many candidates demonstrated a good grasp of the ideas covered in the paper.

Comments on specific questions

Question 1

(a) Many candidates did not understand the distinction between an experimental control and a control variable. The latter refers to a variable that is kept constant within an investigation. In contrast, an experimental control is a set of experimental conditions for which results can be collected that, when compared with other results of the investigation, allow the validity of particular aspects of the experiment to be checked.

Candidates that understood the nature of an experimental control were able to make a range of suggestions that would be suitable as controls. For example, replacing *Egeria densa* with inert material checks that results are related to the effect of different light intensities on *E. densa*, rather than the effect of different light intensities on other components of the experimental set-up.

(b) (i) Nearly all candidates were able to describe some aspects of a suitable method to investigate the relationship between light intensity and rate of photosynthesis. Many developed clear and appropriate plans that focused on all of the key aspects of the method.

Changing the distance from the apparatus to the lamp was the most common approach to achieve varying light intensities. Most candidates suggested at least five different distances to test so that a meaningful graph could be plotted showing the relationship between light intensity and rate of photosynthesis.

A number of candidates suggested distances between the plant and the lamp that were unrealistic, e.g. distances in excess of 2 m or all distances tested within 10 cm of the lamp.

Some candidates suggested other valid methods to vary light intensity, such as adjusting the voltage across the lamp.

Strong responses included consideration of how the different light intensities could be quantified, for example by using a light meter or assuming that the relationship between light intensity and distance followed an inverse square law ($1 / d^2$).

The methods planned by the majority of candidates clearly stated the measurements that would need to be taken. The most frequent errors included measuring the distance moved by the meniscus without measuring the time taken or suggesting impractically long times to wait before measuring the distance moved by the meniscus.

Some candidates proposed counting bubbles released in a set time period as a measure of the rate of photosynthesis. This was not appropriate for the apparatus provided.

Most candidates considered the variables that would need to be controlled in this investigation, such as background light, and how control of these variables could be achieved. Not all suggestions were practicable, e.g. some candidates suggested that temperature could be controlled using a water-bath. For the experimental set-up suggested, this would not be a feasible option.

Candidates noted a wide range of other key variables together with appropriate methods to control them.

Most candidates recognised the need for replicates in the investigation and linked these to the calculation of a mean or some other valid statistical measure. Some responses were imprecise, referring to calculation of averages rather than means.

The majority of responses incorporated some form of risk assessment. Where particular investigations are low risk this is all that needs to be stated. Where potential hazards were identified, not all responses clearly indicated how associated risks could be reduced.

(ii) Most responses suggested suitable axis labels and orientated these correctly with the dependent variable on the *y*-axis. Not all candidates included appropriate units in their axis labels.

Candidates plotting the distance to the lamp on the *x*-axis, rather than light intensity, did not always remember to show a negative gradient.

(c) (i) Nearly all candidates calculated the R_f value correctly. A small number of candidates rounded their final values incorrectly.

(ii) Strong responses used candidates' knowledge and experience of using chromatography to suggest problems inherent with the procedure that could lead to inaccuracies in measuring R_f values.

Weak responses included vague suggestions that were not specific to chromatography, such as 'human error' or 'difficulty in measuring accurately'.

Question 2

(a) Most candidates identified the independent variable correctly. The most common error was to identify the independent variable as 'the number of trees' or 'the number of saltcedar trees'. A few responses identified the dependent variable instead.

(b) (i) The majority of candidates listed three variables that were standardised. A few candidates incorrectly stated that the rodents trapped were standardised.

(ii) Many candidates were familiar with random sampling using quadrats and made appropriate suggestions based on mapping out a grid and using random numbers to select coordinates at which traps could be placed. The order of these two steps is important; some candidates incorrectly selected a trap site first and then assigning it a number using a random number generator.

Some candidates suggested randomly throwing traps (or some form of marker) in the study area. This was not a suitable approach.

(c) (i) Many candidates correctly calculated Simpson's index of diversity from the data provided. A small number of candidates completed the table correctly but did not carry out the last step of the calculation by subtracting the final total from 1.

The most frequent error was that candidates rounded intermediate values in the calculation too early, resulting in an inaccurate final answer when expressed to three significant figures.

(ii) The majority of candidates correctly concluded that the biodiversity (of rodents) in the woodland with a mixture of native tree species and saltcedar trees was greater than that of the woodland with saltcedar trees alone. Some elaborated this further by noting that the number of species of rodents was greater in the mixed habitat or identified named species of rodent that were absent in the area with only saltcedar trees.

Fewer candidates were able to suggest explanations for these differences by considering the habitat or niche diversity.

(d) (i) Many candidates plotted the SE error bars correctly. However, a significant minority plotted the error bars at half size or smaller, or only drew them above the top of the plotted data. A small number of candidates drew shaded-in boxes at various incorrect positions alongside the existing bars.

(ii) Strong responses noted that standard error is a measure of the range from the calculated mean within which the true mean could be expected to be found. Many noted the implication of the fact that the error bars for the two sets of data overlapped and drew appropriate conclusions.

(iii) The large majority of candidates were able to state the null hypothesis in an appropriate way. The most common error was to state that there was no correlation or no relationship between the data sets, rather than no difference between the means. Some candidates incorrectly expressed the null hypothesis in terms of there being a difference between the means.

Question 3

Many candidates recognised the principle that a suitable control method must involve a balance between killing the most slipper limpets and harming the fewest mussels. Strong responses evaluated the stated conclusion against this principle and quoted data from Fig. 3.3 to support their line of reasoning. Many of these responses recognised that there were uncertainties in interpreting the data and noted some of the relevant limitations.

Weaker responses were sometimes confused and lacked clarity in expressing relevant ideas. Some did not consider the effect of temperature on the different treatments.