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Paper 9700/12
Multiple Choice

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

*This question has been removed.

General comments

The paper differentiated well.

Comments on specific questions

Question 1

Many candidates were unaware of the limitations of simple light microscopy when viewing cellular structures. Candidates with experience of viewing cells in this way should know that the Golgi body, mitochondria and endoplasmic reticulum are not visible under these conditions.

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Question 2

A number of candidates were unable to identify the calculation for deriving the correct magnification. Candidates should be familiar with converting linear measurements to the same units and then substituting these values into the appropriate formula.

Question 3

A large proportion of candidates selected incorrect options. Incorrect selections were largely attributable to errors in calculating either the ratio or the magnification.

Question 5

Many candidates selected incorrect options. These candidates had not been able to link knowledge of the sequence of steps in protein production to the organelles in which these steps occur.

Question 7

A large proportion of candidates incorrectly selected option **B**. These candidates did not appear to have considered the relative concentrations of reducing sugar that were present in the different solutions.

Question 14

Nearly all candidates were aware of the involvement of protein tertiary structure in determining the specificity of an enzyme. Many did not consider that the primary, secondary and quaternary structures are also important.

Question 15

A significant minority of candidates selected option **D**. Since there is no increase in the rate of reaction as substrate concentration increases from **S** to **T**, the number of substrate molecules cannot be limiting the rate of reaction.

Question 20

Many candidates selected option **B**. These candidates were aware that chromosome shortening occurs due to telomere loss when most cells undergo successive rounds of mitotic cell division. Eventually no more cell division is possible. However, these candidates had not considered that this problem must be avoided by stem cells, since stem cells can undergo unlimited rounds of mitotic cell division. For these cells, telomere shortening is not a consequence of mitotic cell division.

Question 24

Many candidates selected option **A**, suggesting confusion about negative water potentials. Since osmotic flow of water into phloem sieve tube elements is a consequence of loading from a source, the water potential of the phloem sieve tube element must be more negative than the source.

Question 27

Candidates selecting option **A** comprised a significant proportion of the candidates. These candidates did not appear to realise that transport of phloem sap is dependent on a living tissue – phloem. Heating to 60 °C will denature proteins and kill the cells, therefore preventing movement of phloem sap.

Question 36

A large proportion of candidates selected option **B**. These candidates had not considered that measles is caused by a virus and, consequently, does not have any cytoplasm.

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Paper 9700/22
AS Level Structured Questions

Key messages

Candidates should be reminded that learning outcomes containing a practical element, including microscope work, can be assessed in this paper. **Questions 1(a)**, **1(b)**, **5(b)** and **6(d)(ii)** are all examples of this type of assessment.

It is good practice for candidates, once they have completed each of their responses, to carefully check that they have addressed the question, made use of all relevant information and responded in appropriate detail considering the number of marks available.

General comments

Many candidates were well prepared for this exam and demonstrated good knowledge and understanding of the syllabus learning outcomes. Most of these candidates responded effectively to questions that included unfamiliar material.

Some candidates needed to read questions more carefully. For example, in **Question 1(b)**, a number of candidates listed features of each leaf independently. They should have made comparative statements in which specific differences between the leaves were clearly identified. Similarly, in **Question 2(c)**, candidates were asked to consider the extent to which Fig. 2.2 shows the primary, secondary and tertiary structure of carbonic anhydrase. This required consideration of the limitations of the diagram in Fig. 2.2 including any omitted details, not just a description of the aspects that were visible.

In **Question 3(a)(i)**, candidates needed to describe a bar chart. This was interpreted effectively by a number of candidates. Other candidates lacked confidence in dealing with a bar chart that shows positive percentage changes and negative percentage changes at the same time.

Comments on specific questions

Question 1

(a) This was generally well answered, with many candidates correctly identifying all three types of tissue.

(b) The most frequent correct answers were the presence of trichomes or hairs in Fig. 1.1, but not in Fig. 1.2, the curled or rolled shape of Fig. 1.1, compared with the cylindrical shape of Fig. 1.2 and the thicker cuticle in Fig. 1.1. Some candidates incorrectly identified the trichomes as spines, spikes or thorns.

(c) Many candidates knew that water vapour was lost to the external atmosphere through stomata, but fewer explained that stomata are open during the day and closed at night. Well-expressed responses related stomatal opening to the requirement of carbon dioxide for photosynthesis.

Some candidates considered that the main reason for the difference in rate of transpiration from day to night was higher temperatures in the day. Although temperature does influence the rate of evaporation of water, these candidates had not appreciated that the escape of water vapour from the inside of a leaf to the atmosphere is far more dependent on stomatal aperture. When stomatal pores are closed, escape of water vapour from the leaf will be greatly reduced irrespective of any increases in temperature.

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Question 2

(a) Many candidates were able to give a comprehensive outline of the features of enzymes. Most included the ideas that enzymes are globular proteins that function as (biological) catalysts and many provided further relevant details. Well-expressed responses demonstrated a good understanding of how one feature linked to the next, e.g. the increased rate of reaction is linked to a reduction in activation energy, and the fact that enzymes are not changed during the reaction explains why they can be reused. A number of candidates were able to explain the formation of enzyme–substrate complexes.

(b) Most candidates were able to complete Fig. 2.1 to show the reversible reaction involving carbonic anhydrase. Since the question was limited to the reaction involving carbonic anhydrase, candidates who included the further dissociation of carbonic acid were going beyond the requirements of the question.

(c) Most candidates recognised α-helices and β-pleated sheets as secondary structures visible in Fig. 2.2. Many also identified features present in the diagram that are characteristic of tertiary structure.

Candidates were less confident in recognising the limitations of the diagram in Fig. 2.2. Few commented on features that would be required to show primary, secondary and tertiary structures but which were not represented. For example, there was no information about amino acid sequences so it was not possible to represent primary structure. Similarly, Fig. 2.2 includes no details about disulfide bonds or hydrophobic and hydrophilic interactions.

Question 3

(a) (i) Effective responses depended on understanding that the bar chart showed percentage changes in case incidence and mortality rate for malaria. Some candidates misinterpreted the bar chart and thought that absolute changes in case incidence and mortality rate were shown.

Many candidates made relevant comments about case incidence and mortality rate, supported by accurately extracted values. Some candidates pointed out that Lao PDR was the only country to show an increase in case incidence, whereas the other countries all showed a decrease. Most candidates correctly identified Papua New Guinea as the country making the best progress in reducing case incidence. Although the values for percentage change in mortality rates for Lao PDR and Cambodia were very similar, most candidates correctly stated that the greatest decrease occurred in Cambodia.

(ii) Most candidates appreciated that the nets prevent the mosquitoes gaining access to people, which reduces the chances of being bitten. There were many clear explanations of the role of female (*Anopheles*) mosquitoes as the vectors of the parasite, and some candidates recognised the tendency of the mosquitoes to take blood meals at night when people are sleeping. A number of candidates pointed out that the insecticide would kill the mosquitoes and this would help to break the transmission cycle.

(b) (i) Good answers showed an understanding of the specificity of antibodies and how this property could be applied in test strips to identify the presence of different antigens or proteins. Many candidates linked the idea of specificity to the antigen binding site of the monoclonal antibody.

A few candidates incorrectly thought that the test sticks actually contained malarial parasites.

(ii) The majority of candidates were able to explain a correct diagnosis.

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Question 4

(a) Most candidates knew that the left ventricle has to pump blood all the way round the body (the systemic circulation), whereas the right ventricle only has to pump blood to the lungs (pulmonary circulation). Many used this information to explain the greater thickness of the wall of the left ventricle. The thicker muscular wall allows a higher pressure to be generated, necessary to overcome the greater resistance of the systemic circulation.

Some candidates incorrectly considered that the thicker wall was necessary to withstand higher pressures.

(b) Good answers focused on features that enable a steep oxygen diffusion gradient to be maintained from the alveoli into the blood, rather than just describing the diffusion of oxygen from the alveolus to the blood.

Many candidates tried to include the diffusion of carbon dioxide in their explanations of how the steep diffusion gradient for oxygen is maintained. This was not relevant to the question.

(c) (i) The most common correct answers referred to an increased secretion of mucus, which accumulates and creates a thick layer. Some candidates also knew that contraction of the smooth muscle in the walls of the bronchi will lead to a decrease in the diameter of the lumen.

A number of candidates considered long-term reasons for a decrease in the volume of air per breath. These candidates had not noted that the question specifically referred to changes occurring within a short time.

(ii) The majority of candidates understood that the decrease in the ability of red blood cells to carry oxygen was due to the presence of carbon monoxide in tobacco smoke. Some candidates explained this more fully with a description of the interaction between haemoglobin and carbon monoxide.

Question 5

(a) Many candidates realised that glucose is the source of energy needed to produce breast milk or considered that glucose is needed to make lactose.

A number of candidates incorrectly stated that glucose is a component of breast milk.

(b) (i) Most candidates correctly stated the colours expected after testing. Some candidates indicated that there was no colour change when the solution in Visking tubing was tested with biuret solution. This did not address the requirement of the question to state the colour.

(ii) Most candidates were able to explain the movement of hPRL and reducing sugar in terms of the different sizes of the molecules.

(c) Most candidates knew how glucose crosses cell surface membranes and were able to outline the mechanism.

(d) Many candidates provided good answers that addressed the question effectively. They identified aspects of cell signalling processes that corresponded to the information provided about the production of breast milk.

Question 6

(a) Many candidates gave valid reasons for mitosis in both plants and animals.

A common error was to state that mitosis is used to repair damaged cells. Some candidates described the importance of mitosis during clonal expansion in the immune system. This was not an acceptable response since this process is not relevant to plant cells.

(b) Most candidates were able to identify a structure formed from microtubules that is needed for mitosis.

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(c) Most candidates were familiar with this area of the syllabus and were able to apply the correct terminology.

In **D**, a number of candidates confused translation or transpiration with transcription.

(d) (i) Candidates found it difficult to clearly state three key features of viruses. Some responses implied that viruses only exist within host cells and a number suggested that the protein coat or capsid was the membrane or cell wall of viruses.

(ii) The majority of candidates were able to complete the calculation correctly.

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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 are assessed in the exam.

Candidates should carefully consider the wording of questions to ensure that they identify and address the requirements. For example, when instructed to show working, all steps in a calculation should be clearly displayed.

When showing the final answer of a calculation, candidates should consider the number of significant figures or decimal places to which answers should be expressed.

General comments

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

Comments on specific questions

Question 1

(a) (i) The majority of candidates completed Table 1.2 by correctly recording the expected observations.

(ii) Many candidates correctly identified the tissue and provided a valid reason.

(b) (i) Most candidates were able to describe a procedure to find the volume of distilled water needed to fill the large test-tube to the mark.

(ii) The majority of candidates correctly stated the volume of distilled water needed to fill the large test-tube to the mark.

(iii) Most candidates correctly described the expected trend.

(iv) The majority of candidates organised their results clearly within a ruled table. Many used appropriate column headings together with the relevant units. Most correctly recorded times for each of the four samples in whole seconds and obtained the expected trend.

(v) Many candidates correctly identified whether their results provided evidence to support or reject the hypothesis. Many explained their decision by referring to their times for **S2**, **S4**, **S6** and **S8**.

(c) (i) Most candidates correctly orientated and scaled the axes of the graph, and labelled the axes appropriately to reflect the column headings in Table 1.4. Some candidates labelled the wrong axes or gave incomplete headings.

Many candidates plotted the five points accurately and either joined the points with a smooth curve or with a straight line between adjacent points.

(ii) Many candidates correctly stated the rate of movement of sucrose solution at 5 minutes and showed clearly on their graph how this was determined.

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(iii) Most candidates were able to suggest a suitable time period and justify this with an acceptable reason.

(iv) Many candidates correctly stated suitable concentrations of sucrose solution to use and described how these concentrations could be prepared by proportional dilution or serial dilution.

Question 2

(a) (i) Most candidates carefully followed the instructions and included all expected details in their drawings. Some candidates incorrectly included cells within their plan diagrams or only used a small proportion of the space available.

(ii) Many candidates followed the instructions carefully and drew the required structures, representing cell walls with two continuous lines, or three lines where adjacent cells touch. Some candidates drew lines that were interrupted or disjointed and others only used a small proportion of the space available. Many candidates used a label line and label to correctly identify the lumen in one of the cells.

(b) (i) The majority of candidates correctly measured the lengths of the three vascular bundles along lines **R**, **S** and **T**, and used the same units of measurement for each.

(ii) Many candidates correctly showed how to calculate the mean length and derived an acceptable value.

(iii) Most candidates correctly calculated the mean actual length of the three vascular bundles.

(iv) The majority of candidates followed the instructions correctly. Most described suitable differences between the labelled structures and the corresponding structures in **P1**.

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Paper 9700/42
A Level Structured Questions

Key messages

- Working should be clearly displayed in calculations. The number of decimal places expressed in the final answer should also be appropriate.
- Candidates should consider the number of marks available for a question in assessing the level of detail expected in the answer.

General comments

Most candidates had been well prepared for this exam and were able to demonstrate a good level of knowledge and understanding across the range of topics assessed.

Comments on specific questions

Section A

Question 1

(a) (i) Only a minority of candidates were able to explain a correct function of apparatus **X**.

Many incorrectly suggested that the column of water could be used to modify the intensity of light. In this experiment, light intensity was varied by changing the distance from the pond plant to the lamp.

(ii) Most candidates were aware of the reason for adding sodium hydrogencarbonate to the water surrounding the pond plant. Some mistakenly thought that the compound was used to absorb carbon dioxide or to neutralise the pH of the water.

(iii) The vast majority of candidates correctly identified the gas collected in the test-tube.

(b) (i) Many candidates correctly stated the relationship between the rate of photosynthesis and light intensity. These candidates had recognised that the distance from the lamp to the pond plant was a measure of light intensity and the rate of movement of the air bubble was a measure of the rate of photosynthesis. Candidates who did not make these links were unable to address the question effectively.

Candidates often supported their answers by quoting figures from the graph. A number of candidates read off figures from the graph incorrectly or used incorrect units.

(ii) Most candidates based their explanations on the concept of limiting factors but specific details were often omitted. Few stated that at distances of less than 10 cm from the lamp to the pond plant, light intensity was no longer a limiting factor.

(c) There were many good descriptions of the process of cyclic photophosphorylation and a range of relevant details were included in responses. Few candidates mentioned the role of the primary pigment in absorbing light energy or the role of chemiosmosis in the production of ATP.

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Question 2

(a) Candidates were uncertain of the sequence of events in increasing the concentration of glucose in the blood and, as a result, candidates proposed a wide range of different answers.

(b) (i)(ii) Most candidates were able to read off the graph and give the correct times.

(iii) The majority of candidates correctly identified negative feedback as the homeostatic mechanism involved in the control of the concentration of blood glucose.

(iv) The majority of candidates correctly identified two non-carbohydrate respiratory substrates.

Question 3

(a) Most candidates knew that transcription factors regulate or control transcription. Fewer candidates recognised that transcription factors work by binding to DNA at specific locations, such as the promoter. Some candidates were able to explain that transcription factors regulate a pattern of gene expression, such that expression of multiple genes is coordinated within the cell.

A number of candidates confused the role of transcription factors with the regulation of gene expression in bacteria and described features of the *lac* operon.

(b) Knowledge of the various types of gene mutation was generally very good and a number of candidates went on to describe effects on protein structure.

Many candidates limited their responses to the effects of mutation at the level of transcription and did not develop this further to describe changes in the protein product. Such responses did not address the requirements of the question fully.

A small number of candidates considered how mutation can cause the introduction of a premature stop codon, preventing production of a full-length protein.

A number of candidates described silent mutations. Since such mutations do not cause changes to the protein produced, they were not relevant to the question.

(c) Many candidates successfully used the information provided to deduce a logical series of steps linking mutation in the gene coding for BLIMP-1 to a continuous mitotic cell cycle. Some candidates realised that this would prevent differentiation into plasma cells or memory B-cells.

A number of candidates did not make effective use of the information provided so were unable to deduce valid explanations.

(d) (i) Most candidates demonstrated some appreciation of how a microarray could be used in the study of gene expression.

Candidates were not always clear that studies of gene expression require the use of mRNA as the starting material, rather than genomic DNA.

(ii) Candidates found this question challenging. Many incorrectly considered that the microarray was to be used for investigating the expression of the gene coding for BCL6, rather than the effect of BCL6 on the expression of other genes.

Few candidates recognised that differences in results between samples from cells producing BCL6 and samples from cells that were not producing BCL6 would allow identification of genes for which expression is affected by BCL6.

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Question 4

(a) Many partial explanations, incorporating a wide range of different marking points, were proposed. Few candidates were able to combine all relevant marking points in a full and coherent answer.

Most candidates recognised that disruptive selection was occurring but many found it difficult to account for selection against the intermediate phenotypes.

Some candidates explained the change in tadpole phenotypes in ponds with high availability of detritus and algae as well as in ponds with low availability of detritus and algae. This question only asked for an explanation in ponds with low availability of detritus and algae.

(b) The majority of candidates were able to complete the calculation correctly. A small number misread the figures from the bar chart. Some errors in rounding also occurred.

(c) (i) Nearly all candidates correctly identified which type of natural selection was acting.

(ii) Most candidates were able to explain the decrease in frequency of omnivore-type tadpoles but fewer considered reasons to explain why the carnivore-type tadpoles were less affected.

(d) Few candidates developed a valid explanation by using the information that carnivore-type tadpoles grow faster than omnivore-type tadpoles and that adult toads do not live in water.

Frequent incorrect answers included suggestions that carnivore-type tadpoles can eat land animals when the ponds dry up or that it is easier for carnivore-type tadpoles to catch prey in smaller ponds.

Question 5

(a) (i) Most candidates were able to suggest at least one valid reason.

A small number of candidates described the trend in the graph instead of answering the question.

(ii) General descriptions were good with most candidates recognising the main differences in trends between the two countries.

Many candidates supported their answers by quoting relevant figures from the graph. Some, however, misread the graph and not all quoted relevant figures for both countries, as is necessary when making comparisons of this type.

(b) (i) Nearly all candidates were able to recall the benefits of producing GM crops that are insect resistant. A small number of candidates stated that herbicides would not be required; these candidates had confused insect resistance with herbicide resistance.

(ii) Most candidates either simply re-worded the question to state that Bt maize has a genetic modification to be resistant to insects, or used imprecise phrasing implying that the gene, rather than the protein it encodes, is toxic. Very few candidates knew the source of the inserted gene.

(c) (i) Most candidates referred to concerns about human health but few were able to propose a second reason. Vague references to the development of ‘superweeds’, undesirable effects on the crop or morally held beliefs were insufficient on their own to answer the question. Further qualification to identify the nature of the problem was required.

(ii) Most candidates were able to make reasonable suggestions, often focusing on beneficial effects of GM crops.

A small number of candidates repeated their response to **(c)(i)**, which did not answer the question.

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Question 6

(a) Candidates found this question to be challenging. Full explanations required interpretation of several different observations to show that MELAS syndrome is inherited through mitochondrial DNA and not through the X chromosome.

Most candidates described how the data supported mitochondrial DNA inheritance, by stating either that it is never inherited from an affected male or that all children of affected females are affected.

Very few candidates developed their answer to explain why X-linked inheritance was not supported by the data.

Few candidates made use of the numbering to allow easy referencing of individuals when describing relevant examples.

(b) Candidates recognised a number of properties of mitochondrial DNA relevant to the study of evolution. Of these, relevant references to mutation rates were the most frequent. Few candidates considered that since there are many mitochondria within a single cell, there are many more copies per cell of mitochondrial DNA sequences than of nuclear DNA sequences.

Question 7

(a) (i) Many candidates were able to link the addition of ADP to increased oxygen demand as a result of oxidative photophosphorylation.

(ii) Most candidates realised that the line of the graph starts to level out during phase **C** due to raw materials, such as ADP and oxygen, running out.

(b) Many candidates mentioned aerenchyma tissue and the trapping of air by leaves, but few described the significance of these adaptations.

Most candidates realised that submerged root cells would have to tolerate high levels of ethanol, since ethanol accumulates during respiration under anaerobic conditions. Some recognised the role of the enzyme ethanol dehydrogenase in breaking down the ethanol.

Question 8

(a) Many candidates demonstrated a good conceptual understanding of biodiversity.

(b) (i) The majority of candidates were able to complete the table and calculate Simpson's Index of Diversity.

(ii) Most candidates correctly interpreted the value for Simpson's Index of Diversity.

Section B

Question 9

(a) Most candidates demonstrated a sound knowledge and understanding of the sliding filament model and many gave full and detailed descriptions. A number of candidates described the transmission of action potentials across neuromuscular junctions; this was not relevant to the question.

There was some confusion about the role of ATP in the process. Many candidates were not sure at which point hydrolysis of ATP occurs. Several candidates incorrectly stated that ATP hydrolysis provides energy directly for the power stroke.

Some candidates confused myosin with tropomyosin.

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(b) Quality of responses to this question varied widely. Some candidates were able to provide detailed descriptions of the role of each hormone, including their effects on other hormones. Others provided vague answers that were lacking in descriptive details.

Many candidates structured their answers by describing the roles of the hormones through one complete menstrual cycle, rather than describing the role of each hormone in turn. There was no requirement to do so but this approach was helpful in making clear the interactions between the different hormones.

Question 10

(a) Many candidates found it difficult to express clearly the salient points relating to evolution and natural selection. Important aspects, including the overproduction of offspring and the relationship between phenotypic variation and genetic variation, were often omitted.

Some candidates focused on specific examples without making clear the underlying principles.

(b) Many candidates were able to give very good and well-structured accounts.

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Paper 9700/52
Planning, Analysis and Evaluation

Key messages

This paper is based on practical aspects of biology. It is therefore important to give candidates experience in the practical techniques expected in the syllabus as well as the principles of planning, analysis and evaluation.

Candidates need to be familiar with the statistical techniques stated in the syllabus, including when it is appropriate for each of them to be used. In preparing for the exam, candidates will benefit from undertaking practice questions involving statistical analysis.

General comments

Overall, candidates demonstrated a thorough knowledge and understanding of the topics covered in the paper. Many appeared to have been well prepared for the exam.

Comments on specific questions

Question 1

(a) The majority of candidates correctly identified the independent variable and the dependent variable.

Some candidates incorrectly identified the water potential of onion tissue as the dependent variable.

(b) (i) Most candidates were able to describe a suitable method.

A few candidates focused on the mass of sucrose that would be required and omitted to mention the addition of water.

(ii) Many candidates provided sufficient information to prepare the required volume of a suitable number and range of sucrose concentrations using proportional dilution. Most, but not all, candidates gave correct units for the concentrations. Approaches to presenting the information varied; some candidates used tables and others provided written descriptions. Providing the requirements of the question were addressed, all such approaches were acceptable.

Some responses described serial dilution; this did not match the requirements of the question.

(iii) A range of valid answers were proposed with most focusing on the greater ease of observing changes to the cells.

Some candidates were not clear on what occurs during plasmolysis and made incorrect references to the colour disappearing or leaking out of the vacuoles. A small number of candidates suggested that sucrose enters the vacuole where it is stained.

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(iv) Most candidates were able to outline the main steps in the investigation, including suitable references to safety and the need to standardise variables. Some candidates described a large range of variables that needed to be standardised. Many of these, such as light intensity, pH and temperature, were not of direct relevance to this investigation. Candidates should focus on the variables that are most relevant.

The first step involved obtaining strips of onion epidermis and immersing them in different concentrations of sucrose solution for a suitable period of time. References to the source of tissue to be used were sometimes vague. Most candidates recognised that the tissue needed to be immersed in sucrose solution, but not all described this clearly. In some cases, the time suggested for immersion was too short, e.g. one minute.

After immersion, epidermal peels needed to be mounted on microscope slides for plasmolysed and non-plasmolysed cells to be counted. Not all candidates noted that the epidermal peels would need mounting in the same sucrose solution used in the immersion step. Some candidates incorrectly suggested mounting the epidermal peels in distilled water.

More complete responses considered the need to collect sufficient data and replicate the whole experiment again to allow results to be checked.

Finally, candidates needed to show how to carry out the calculation of percentage of plasmolysed cells from the data collected. Not all candidates included this step.

(v) Many candidates realised that plotting a graph of the results would allow a line of best fit to be constructed, from which the concentration of sucrose in which 50% of the cells are plamolysed could be read off. This was expressed clearly in many responses.

Proposals to carry out further experiments focusing on concentrations of sucrose between the two values bracketing 50% cell plasmolysis were also suitable.

Some candidates suggested that it would be acceptable to approximate the answer to the concentration of sucrose that most closely resulted in 50% of cells being plasmolysed. This was not a valid approach.

(c) Many candidates provided detailed explanations that demonstrated a clear understanding of the principles of osmosis and water potential.

A number of candidates produced confused descriptions as a consequence of considering the most negative water potentials to be the highest water potentials.

Question 2

(a) (i) The majority of candidates calculated the answer correctly, but not all followed the instruction to express the answer to three decimal places. The commonest mathematical error was to reverse the denominator and numerator.

(ii) Many candidates were aware that since the data was categoric, the chi-squared test could be used.

(b) (i) Many candidates correctly described the relationship. A number of candidates recognised the significance that even at zero exposure to radiation there were people who developed blood cancer or referred to factors that could explain this.

(ii) Some candidates were able to precisely identify radiation-induced mutation in the stem cells as a possible explanation for the relationship. Involvement of stem cells was referred to before Table 2.1 and underlines the importance of carefully reading and referring back to any information provided.

Other candidates referred to more general ideas on mutation.

A number of candidates were unable to link the data provided to the expected syllabus knowledge and understanding. Some of these suggested that mutated cells from the mother crossed the placenta; others reiterated the relationship without providing any explanation.

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(c) Candidates needed to consider the various aspects of the study and decide to what extent these aspects increased or decreased the validity of any results. Many candidates were able to identify relevant aspects of the study corresponding to both of these effects on validity and discuss these appropriately.

A number of candidates considered that the sample was not large enough despite involving thousands of participants. Others were concerned that sample sizes were unequal, although this is of limited concern when sample sizes are large.

(d) This was generally well answered. Candidates were able to identify a wide range of factors that would need to be standardised.

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