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Paper 9700/12
Multiple Choice

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

General comments

Candidates found **Questions 3**, **4,** **7**, **17**, **20**, **36** and **40** to be relatively straightforward. **Questions 14**, **22**, **23**, **28**, **31**, **33**, **37**, **38** and **39** were challenging.

Comments on specific questions

Question 1

Many candidates considered that both the calibration of an eyepiece graticule with a stage micrometer and the magnification of the eyepiece lens would be required to determine the diameter of the white blood cell. If the eyepiece graticule has been calibrated, the actual length represented by each division is known and therefore no further information is required. In any case, the magnification of the eyepiece lens on its own is insufficient to determine the magnification of the image viewed through the microscope. The magnification of the objective lens also needs to be known.

Question 5

Most candidates selected the correct option. However, a significant proportion considered that capsids, a feature of viruses, were present in prokaryotes.

Question 8

Nearly all candidates recognised that diagram 1 showed the formation of a glycosidic bond. Far fewer recognised that diagrams 1 and 2 also showed the formation of glycosidic bonds.

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Question 10

A significant proportion of candidates did not select the correct option. The most frequently selected incorrect options were **C** and **D** suggesting that candidates had selected terminology that they associated with triglycerides (ester bond and hydrophobic) without considering the overall meaning of the statements incorporating these terms.

Question 11

Most candidates selected the correct option. However, a significant proportion considered that **D** was the correct option, suggesting uncertainty over the identification of the disaccharides sucrose and maltose as reducing sugars or non-reducing sugars.

Question 12

The majority of candidates were able to count the number of peptide bonds correctly. Although most candidates recognised the type of glycosidic bond formed between the sugars, a significant proportion incorrectly identified these as β-1,4. These candidates had not noted the significance of the 180° rotation in the orientation of the two adjacent sugar molecules.

Question 13

Although more candidates selected the correct option than any other option, a significant proportion selected option **C**. These candidates had not recognised that the rate of reaction is given by the tangent of the slope, rather than the *y*-axis value. Rates of enzyme-controlled reactions are expected to be proportional to the concentration of substrate meaning that rates of reaction decline with time and cannot increase.

Question 14

An incorrect option, option **B**, was the most frequently selected option. Candidates selecting this option had not appreciated that hydrolysis of fats releases fatty acids that cause the pH to fall. This decrease in pH can eventually lead to denaturation of lipase.

Question 19

More candidates selected the correct option, option **C**, than any other option. However, a significant proportion selected option **A**, which was incorrect. To distinguish between option **A** and option **C** candidates had to use the information that the diagrams were all drawn to scale.

Question 21

Many candidates selected the correct option, but a large proportion chose incorrect options. Candidates selecting incorrect options may have considered that the subdivisions of the mitotic cell cycle shown corresponded to the main stages of mitosis. These subdivisions should have been interpreted as G_1, S, G_2 and meiosis.

Question 22

Relatively few candidates selected the correct option, with most judging all statements about features of stem cells to be correct. In fact, statements 2 and 4 were incorrect. All body cells that have a nucleus retain all of their genetic information throughout their lifetime. Furthermore, although telomeres will shorten as cells have been through more rounds of mitosis, the number of telomeres will remain the same.

Question 23

This was a challenging question that required detailed knowledge of nucleotide structure. Candidates who understood that polynucleotides have a sugar–phosphate backbone were able to eliminate statement 4.

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Question 24

More candidates selected the correct option than any other option. Nevertheless, significant numbers of candidates selected options **A** or **B**. These candidates had not taken into account that DNA is double stranded. Candidates selecting option **C** had not understood the implications of having circular DNA.

Question 26

The most frequently selected incorrect answer was option **D**. Candidates selecting this option had divided 150 million by 50 to obtain the length of time in seconds it would take to replicate the DNA in a typical human chromosome if there was a single replication fork. A further manipulation in which 3 million was divided by the actual time in seconds (1 hour = 3600 seconds) to replicate the DNA in a typical human chromosome was required to calculate the number of replication forks.

Question 27

Although the correct option was selected by more candidates than any other, a majority of candidates selected other options. These candidates had not considered that the direct products of gene (DNA) expression were proteins with all other biomolecules derived from subsequent chemical reactions involving enzymes.

Question 28

Most candidates selected option **A** which was incorrect. Although phloem sieve tubes lack a nucleus and have reduced cytoplasmic contents, they do still have mitochondria.

Question 29

Candidates selecting incorrect options had not noted that lanthanum ions did not pass through the endodermis where the Casparian strip blocks the apoplast pathway. Transport through the symplast pathway is not affected.

Question 31

The majority of candidates recognised that mass flow depends on a higher hydrostatic pressure in the source compared to the sink and therefore selected either option **A** or option **B**. This pressure is generated by the inflow of water into phloem sieve tubes in the source through osmosis, as a result of sucrose loading. Many candidates selected option **A** incorrectly. These candidates had not considered that sucrose loading will lower the water potential.

Question 33

The majority of candidates selected either option **A** or option **B**. Candidates selecting option **A** had recalled that water is sometimes referred to as the universal solvent but had disregarded the fact that a number of biological molecules, including triglycerides and phospholipids, are insoluble in water. Those selecting option **B** had not realised that non-polar molecules are usually hydrophobic and therefore insoluble in water.

Question 37

Many candidates incorrectly selected option **C**. These candidates had not considered that if the smooth muscles in the bronchioles contracts, this will reduce the diameter of the bronchioles, decreasing the flow of air into the alveoli. A significant proportion of candidates selected option **B**, which was also incorrect. These candidates appeared to have confused collagen with cartilage.

Question 38

This was a challenging question with the majority of candidates selecting option **A** or option **D**, which were incorrect. Candidates selecting these options had not considered that the protein products of genes include enzymes that have a role in the synthesis of all other biomolecules. Consequently, mutations can affect the structure of all biomolecules.

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Question 39

A significant majority of candidates selected option **A**, which was incorrect. Candidates selecting option **A** agreed with statement 1 that monoclonal antibodies could divide by mitosis to produce the large numbers of antibodies required for treatment. Monoclonal antibodies are proteins, not cells, so cannot replicate themselves and certainly cannot divide by mitosis. Statement 1 is therefore incorrect.

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Paper 9700/22
AS Level Structured Questions

Key Messages

- Candidates should take care to note and understand the command word in each question, together with any further instructions. An explanation of the main command words is included in the 9700 syllabus. Understanding the distinction between 'State', 'Outline,' 'Describe' and 'Explain' is important in determining the type of response required.

- When asked to label a structure on a diagram or photograph, it is essential for candidates to make sure that the label line can be clearly seen and actually touches the structure concerned.

- Candidates should be practised in distinguishing between photomicrographs, transmission electron micrographs and scanning electron micrographs. The image of *Vibrio cholerae* cells in Fig. 5.1 was incorrectly identified as a transmission electron microscope by many candidates in **Question 5(a)(i)**.

General Comments

Many candidates were able to demonstrate a sound knowledge and understanding of the syllabus topic areas assessed. Most noted the requirements of questions carefully and ensured that their responses addressed these requirements.

However, there were a number of instances where it was clear that the command words were not being considered sufficiently. Some examples include:

- In **Question 1(a)(ii)**, candidates were asked to 'Explain' the orientation of cholesterol molecules, but many simply stated the positioning of the molecules.
- In **Question 1(c)(iii)**, some candidates gave an extensive descriptive account of cell signalling for a question that asked only for an outline.
- In **Questions 4(a)(iii) and 4(a)(iv)**, which used the command 'State **and** explain', a number of candidates only addressed one of the two command words.
- In **Question 5(b)**, candidates were asked to 'Identify **and** correct the factual error …', but many only identified the error, without providing a correction.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly stated that **A** was glycerol. Many incorrectly thought **A** was an ester bond and some confused glycerol with glycogen.

(ii) Many candidates correctly explained the orientation of cholesterol in the phospholipid bilayer in terms of hydrophobic and hydrophilic interactions. Some responses were quite vague, suggesting only that the polar part of the molecules is facing 'outside' while the non-polar part is facing the 'interior' of the phospholipid bilayer.

A small number of candidates did not provide any explanation but simply described the orientation of cholesterol in the phospholipid bilayer. The vaguest responses only stated that the cholesterol molecules are situated between the phospholipid molecules.

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(iii) Many responses referred specifically to the role of cholesterol in regulating membrane fluidity. Some responses were too vague, considering only the maintenance of the structure of the bilayer or holding the phospholipids together. Where candidates referred to increasing or decreasing the membrane fluidity, this needed to be in the context of changing temperatures.

(b) (i) Many candidates understood that charged particles such as sodium ions cannot cross phospholipid bilayers by simple diffusion. Some correctly made reference to the hydrophobic nature of the interior of the phospholipid bilayer without making it clear that this repels the charged sodium ions. A proportion of candidates thought that the explanation was related to size and suggested that the sodium ions are too large to pass through. Of these, a number incorrectly referred to the sodium ions as 'large molecules'. A small number of responses stated that sodium ions cannot pass through by simple diffusion because they need to be transported by facilitated diffusion (or active transport). This did not amount to an explanation.

(ii) Most candidates noted appropriate similarities and differences between simple diffusion and facilitated diffusion. Some errors occurred as a result of uncertainty over the differences between carrier proteins and channel proteins.

(c) (i) Many responses included ideas of compartmentalisation, with references to keeping different reaction pathways separate to reduce interference and maintaining optimum conditions. Some stronger responses considered the benefit of being able to easily package the prostaglandin products into vesicles for export from the cell.

(ii) Most responses recognised that modification of the R-group of one of the amino acids could have an effect on various bonds within the molecule (hydrogen, ionic or hydrophobic interactions), which could then distort the shape of the active site. Many went on to explain how this would affect the formation of enzyme–substrate complexes. Weaker responses tried to explain the reduction in catalytic activity of the COX enzyme as a consequence of aspirin acting as a (non-competitive) inhibitor. This did not address the question, which required consideration of how modifying the R-group of an amino acid could reduce the activity of the enzyme.

(iii) Most candidates were able to outline the main events in cell signalling. Receptor binding was almost universally recognised although fewer identified the location of the receptors or considered the specificity of the binding. Some responses included additional details of events within target cells following receptor binding, such as activation of second messengers, enzyme cascades, phosphorylation and transduction.

Question 2

(a) Stronger candidates were able to identify all three types of white blood cell. However, most candidates found it difficult to identify the monocyte and a small number were unable to recognise any of the cell types.

(b) Many candidates had noted that camel blood becomes more viscous as a result of dehydration and used this information to suggest how features of the red blood cells of camels could be adaptive, for example by making it easier for red blood cells to flow. Some candidates tried to develop explanations based on reducing water loss, but there was insufficient data available to support this attempt.

(c) (i) Many candidates noted from Fig. 2.3 that llama haemoglobin has a higher percentage saturation of oxygen at a given partial pressure of oxygen. Stronger candidates related this to a higher affinity for oxygen than human haemoglobin and extracted relevant data from the graph to support the idea that llamas are better adapted than humans to live at high altitudes.

Some candidates quoted data relating to the uptake of oxygen at high partial pressures of oxygen. Since the question was about adaptations to survive at higher altitudes, it would have been more relevant to focus on conditions where partial pressures of oxygen were low.

Some answers were too vague to gain credit, such as stating that llama haemoglobin is more efficient than human haemoglobin.

(ii) Most candidates sketched a correct curve to illustrate the Bohr effect. Some incorrectly shifted the new curve up or down, rather than just to one side.

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(iii) The Bohr shift was generally well understood, and most candidates were able to explain its importance in metabolically active organs. One common misconception was that haemoglobin has a higher affinity for carbon dioxide than oxygen so that in areas where the partial pressure of carbon dioxide is high, haemoglobin releases oxygen to take up the carbon dioxide.

Question 3

(a) (i) Many candidates identified at least two of the labelled tissues, with **R** being the tissue that fewest candidates could identify. Tissue **R** was sometimes misidentified as epidermis or root hair cell (which is not a tissue). Some candidates named cell types, such as xylem vessel and sieve tube, instead of tissues when identifying the labelled tissues.

(ii) Candidates who had identified tissue **R** correctly were usually able to outline its role.

(iii) Most candidates were able to state the name of an organic compound that is translocated in the root of an iris. A small number of candidates suggested compounds that were not organic, such as water and minerals.

(b) Many candidates were able to label one of the plasmodesmata visible in the electron micrograph. However, a significant number of candidates labelled other cell structures, Some candidates added labelling lines that almost, but did not quite reach, a plasmodesma.

(c) Most candidates were able to complete the table with few or no errors. The most common error was to indicate that glycogen is used for energy storage in plants.

Question 4

(a) (i) Candidates knew that they needed to complete Table 4.1 by applying the rules of complementary base pairing. Some candidates did not appreciate that the primary transcript was an RNA molecule and therefore included T in their responses instead of U.

(ii) Most candidates were able to identify the correct amino acids. Where errors occurred, these appeared to be due to a lack of care and checking, rather than due to any misconceptions.

(iii) The majority of candidates were able to explain the consequence of the mutation on the final protein structure.

(iv) Most candidates noted that this was an example of a frameshift mutation. Many assumed that this would change the sequence of all the amino acids after the frameshift mutation. Fewer realised that the deletion would produce the codon CAT, which specifies the same first amino acid, valine.

Some candidates correctly noted that translation might be interrupted by the production of a premature stop codon.

(b) Many candidates recognised that DNA replication occurs in S phase. Fewer recalled that S phase occurs during interphase and that this stage should therefore also have been circled. A number of candidates incorrectly circled several phases, including mitosis.

(c) Many responses provided detailed and comprehensive accounts of DNA replication that were well organised and correctly sequenced. Weaker responses often included events occurring in transcription and translation or even meiosis. The most frequent errors were to refer to RNA or the removal of introns by splicing.

(d) The majority of candidates correctly identified **A**. Some candidates gave answers that were too vague, such as pentose sugar. Others incorrectly identified **A** as deoxyribose.

Question 5

(a) (i) Most candidates recognised that the image had been taken with a scanning electron microscope. The abbreviation SEM was not sufficient as an answer since the command word was ‘Name’.

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(ii) Many candidates stated that *Vibrio cholerae* is the species of prokaryote that causes cholera. Errors in spelling that could not be confidently attributed to the correct answer could not be credited.

(b) Most candidates recognised that prokaryotes do not have cellulose cell walls. Others thought that the factual error was the reference to size, or the lack of organelles bound by a double membrane, or the presence of a cell surface membrane. All of these statements were correct descriptions.

Question 6

(a) Most candidates correctly identified structure **X**. Common errors included caspid (spelling error), plasmid and cell membrane.

(b) Most responses demonstrated that candidates knew the role of T-helper cells. However, that knowledge was not always applied in a way that addressed the question. For example, many candidates stated that T-helper cells secrete cytokines, but fewer made this relevant to the question by noting that destruction of T-helper cells would result in fewer cytokines being produced.

(c) This question referred to a mutation of the gene coding for the coreceptor protein, CCR5, and not the gene coding for the receptor protein, CD4. Many candidates noted this distinction and were able to suggest how mutation of the gene coding for the CCR5 protein could be protective against HIV infection. However, a significant minority assumed that this was a mutation of the gene coding for the receptor protein and so suggested, incorrectly, that this mutation would prevent the virus from binding to the host cell.

(d) This question was generally well answered. Some of the more frequent errors included suggesting that small mammals such as mice would be injected with the pathogen, rather than the relevant antigens. Another error was to state that antibodies, rather than B-lymphocytes, were removed from the spleen of the mammal. Many candidates knew that the next step was to fuse the removed B-lymphocytes with myeloma cells. Vague references to mixing B-lymphocytes with myeloma cells were not acceptable. Some stronger responses outlined screening the resulting hybridomas to identify those producing the required monoclonal antibodies or described separating hybridomas to clone and produce larger quantities of antibody.

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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 familiar with the requirements of different command words. For example, the command words 'describe' and 'explain' can often be used in the same context but carry very different meanings. Describing a set of results only requires that the pattern or trends shown is translated into words, often with some kind of illustrative data quote. On the other hand, explaining a set of results requires that the underlying scientific principles that account for the pattern or trends of results are communicated.

When asked to suggest modifications to a procedure, candidates are not expected to describe a different method that will achieve the effect intended. Instead, candidates should restrict their response to stating the changes to the existing method that need to be implemented.

General comments

The majority of Centres returned the supervisor's report with a set of results obtained by the supervisor. The information included in the supervisor's report is essential, allowing any problems encountered by the candidates to be taken into account.

Preparing the correct materials and providing the specified apparatus are essential. The majority of Centres provided all the materials required.

In general, 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) Most candidates correctly completed Fig. 1.3 to show how the serial dilution would be completed. Most indicated the correct concentrations below each beaker to an appropriate precision and indicated what would need transferring to the next beaker to reduce the concentration by half.

(ii) The majority of candidates organised their results clearly in a ruled table. Most included the heading for percentage concentration of reducing sugar and the heading for time with units, and recorded a time for each of the five concentrations of reducing sugar. A small number of candidates incorrectly included units in the body of the table and some recorded times to an inappropriate degree of precision. The nearest whole second is all that can be expected in experiments of this type.

(iii) Most candidates correctly stated that the dependent variable was the time taken to the first appearance of a colour change.

(iv) Most candidates correctly recorded results for **G1** and **H1**, with **G1** having the shorter time.

(v) Many candidates correctly completed the scale in Fig. 1.4 showing the correct positions of all the reducing sugar concentrations that they had prepared.

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(vi) Many candidates used their results correctly to estimate the concentrations of reducing sugars in **G1** and **H1**.

(vii) Some candidates correctly proposed testing concentrations close to the estimated concentrations of **G1** and **H1** to allow more accurate estimates to be made. A number of candidates suggested plotting a calibration graph using the results for the standard concentrations and then reading off the values for **G1** and **H1**. This is a valid approach but is dependent on the confidence with which a best fit line can be fitted to the standard results.

(viii) Most candidates provided a valid explanation, either by considering that the second temperature was high enough to denature the enzymes so that no hydrolysis occurred or that the increase in rate of reaction at the higher temperature ensured that all sucrose had been hydrolysed. Not all candidates included relevant details such as references to kinetic energy, tertiary structure of the active site and rate of formation of enzyme–substrate complexes.

(b) (i) Most candidates used the headings given in Table 1.2 to label the *x*-axis and the *y*-axis. Some plotted the axes the wrong way round and not all included units in their axis labels. Most used suitable scales for their axes, plotted the points accurately and joined the plotted points appropriately using straight lines or by drawing a line of best fit. The most common error was not using a suitable scale for the *y*-axis.

(ii) Many candidates correctly used the graph to estimate the activity of amylase at 60 hours after germination.

Question 2

(a) (i) Many candidates presented plan diagrams that showed the expected features and conformed to the instructions provided. The most common errors were for candidates to present drawings that were too small, or which included cells.

(ii) Many candidates were able to draw four adjacent epidermal cells, arranged in a line, with each cell touching at least one other cell and with double lines representing the cell walls. The most common error was to draw lines that did not meet up precisely or were too thick. Not all candidates identified the cell wall with a labelling line and label.

(b) (i) Many candidates completed the table with three observable differences between the leaf in Fig. 2.1 and the leaf on **P1**. Some candidates did not make the difference between the features that they were comparing sufficiently clear.

(ii) Many candidates correctly stated a feature visible in Fig. 2.1 that adapted the plant to living in water. Most went on to suggest a function for this feature.

(c) (i) Most candidates accurately measured the lengths of the four air spaces and used the appropriate units. Many candidates went on to show how the mean length could be calculated.

(ii) Most candidates calculated the mean actual length of the four air spaces correctly from their previous calculation and the magnification of the photomicrograph. Not all correctly converted the units of length to micrometres (μm) or expressed their final answers to an appropriate number of significant figures.

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Paper 9700/42
A Level Structured Questions

Key messages

- In questions requiring comparisons to be made such as **4(d)**, similarities and differences must be made clear with statements that address one feature at a time and indicate how this feature is the same or different for the two (or more) things being compared. One way to do this is to construct a table with each row considering one feature only. The same principle applies in questions requiring differences to be identified, such as **8(c)**.
- Candidates are often expected to quote data relating to graphs or table. When quoting data, it is essential that appropriate units are used.

General comments

Candidates found questions **2**, **5** and **6** relatively straightforward. Many candidates found questions **3**, **4** and **10** to be more challenging.

Comments on specific questions

Question 1

(a) Most candidates were able to correctly label a region that contains urine.

Only a minority were able to correctly identify a region that contains podocytes. A significant number of candidates incorrectly labelled the glomerulus instead. Some recognised that podocytes are found in the Bowman's capsule but many labelled regions of the Bowman's capsule that were not adjacent to the glomerulus.

Most candidates were able to identify a region of the nephron that is within the medulla although some labelled a blood vessel and not part of the nephron.

Candidates labelled a variety of regions as the afferent arteriole. A significant number labelled the artery above the afferent arteriole or the vessel leading to the vasa recta. Some labelled the efferent arteriole to the left of the glomerulus, not taking note of the wider diameter of the arteriole to the right of the glomerulus.

(b) Many candidates did not note that the question required descriptions and explanations. Candidates often provided descriptions without explaining how the cells were adapted.

A large number of candidates considered how selective reabsorption takes place and referred to details of the process such as the cotransport of sodium ions. Fewer described adaptations of the cells for cotransport, as was required by the question. Candidates who did refer to the cotransport of sodium ions often omitted to consider the adaptation of having cotransporter proteins present in the cell surface membrane.

A significant minority of candidates who did consider the presence of cotransporters in cell surface membranes, only referred to the transport of sodium ions and did not mention the other molecules or ions that were being cotransported.

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A number of candidates identified the presence of sodium-potassium pumps in the basal cell surface membrane; few highlighted that there were many of them due to the folding of the membrane.

Many candidates referred to the presence of tight junctions, but few were able to explain this adaptation sufficiently to address the question. There were many vague references to leakage.

Some candidates referred to the presence of many mitochondria and linked this correctly to the production of ATP for active transport. Other candidates referred vaguely to the role of mitochondria in releasing energy, without being more specific.

Question 2

(a) Many candidates accurately described the test cross that was required to determine the genotype of a tall plant, even if the terminology for this type of cross was not used. Many went on to provide good descriptions of how the genotype of the parental plant could be inferred from the observed offspring phenotypes.

Common incorrect responses included descriptions of methods based on molecular analysis rather than phenotypical observation and attempting to determine genotypes through multiple generations of breeding (although the question referred only to carrying out a single cross and analysing the results of that cross).

(b) (i) Most candidates knew that gibberellin is a hormone. Frequent incorrect responses included: enzyme, transcription factor and secondary messenger.

(ii) The majority of candidates were able to state the effect of gibberellin on stem length, but fewer were able to describe this in terms of the response to gibberellin by the cells within the internode.

Question 3

(a) Most candidates had a working understanding of the terms ‘homozygous’ and ‘recessive’ but many found it difficult to translate this into clear and complete definitions. Definitions of ‘homozygous’ often omitted references to genes or genotype. Similarly, when defining ‘recessive’, most responses did not consider the effect on the phenotype of an organism with respect to a recessive allele or trait.

(b) (i) Many candidates were able to use the data provided to calculate the number of heterozygotes using the Hardy–Weinberg equilibrium equations. Most candidates obtained the value of p and applied subsequent calculations correctly. However, some rounded intermediate steps in calculations excessively resulting in final values that were insufficiently accurate. A number of candidates did not complete the question and gave their final answer as the value of $2pq$, instead of carrying out the final step of the calculation to derive the number of heterozygous individuals in the population.

(ii) Only a minority of candidates recognised that selection pressures against individuals with cystic fibrosis meant that the conditions under which the Hardy–Weinberg equilibrium applies had not been met. Few of these were able to explain why this would artificially reduce the value of q, and thus $2pq$, in the calculations.

A small proportion of candidates listed many factors required for the Hardy–Weinberg equilibrium that were not evidenced by the data provided, such as migration and random mating.

(c) (i) Most candidates accurately interpreted the data in the table provided to identify a trend and supported this with a data quote. Many recognised that the early screening programme would have contributed to this trend by allowing earlier treatment.

(ii) Discussions about the social and ethical implications of genetic testing for carrier status in cystic fibrosis were largely confined to consideration of issues related to family planning and cost. A small number of candidates based their responses on the misconception that genetic testing would identify individuals with undiagnosed cystic fibrosis.

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Question 4

(a) Candidates who carefully noted the requirements of the question were able to describe the trends evident in the data. Many candidates did not take account of the limited time period over which the trends were to be identified and attempted to describe trends over the whole year. A significant proportion of candidates mis-read the axes or key.

(b) Most candidates recognised the type of variation shown by milk yield and were able to give a reason for their choice.

Many candidates made effective use of the information provided and were able to identify, with reasons, relevant genetic and environmental factors that affect milk yield. A number suggested environmental factors for which there was no supporting data, such as diet, and some did not provide reasons for choosing the factors that they had identified.

(c) The majority of candidates observed that the presence of the *SLICK* allele increases milk yield, with stronger responses describing the nuances at different temperatures when heat stress may or may not have a contributing effect.

(d) Relatively few candidates attempted to identify similarities in the two methods, although this is always expected when the command word is 'compare' and, in this case, was specifically included in the question as an elaboration of the command word.

Most candidates indicated an awareness of differences between the two methods, but fewer structured their answers in a way that clearly identified these differences. Many simply listed features of the two methods separately without linking them into meaningful comparative statements.

Question 5

Most candidates were able to complete the majority of gaps in the text with appropriate words.

Most recognised that speciation occurs over time although fewer were able to find an appropriate word to describe how the nucleotide sequences of closely related species compare to more distantly related species. Many appreciated that meiosis or crossing over would not affect the nucleotide sequence of mitochondria since these are only inherited from the female parent. Some candidates gave incorrect spellings of meiosis that could not be confidently distinguished from mitosis. The majority of candidates correctly stated that databases can be used to store DNA sequence data but relatively few recognised that the relevant sequence for proteins was that of amino acids. Many gave the answer as bases or nucleotides, which are applicable to DNA sequences. Most candidates knew that microarrays could be used to detect many different mRNA molecules at the same time.

Question 6

(a) Most candidates knew the function of potassium hydroxide solution in the respirometer. A small number of candidates stated that potassium hydroxide solution reacted with carbon dioxide without going on to say that this resulted in the removal of carbon dioxide.

(b) Many candidates did not appear to be sure of the meaning of validity. Most suggested repeating the experiment but few went on to suggest how repeated results could be used to assess validity. A small number recognised that a relevant statistical test could be carried out if results were repeated and specific suggestions included calculation of standard deviation or standard error.

A minority of candidates suggested using some form of control to obtain results that could be used to compare with the experimental results. Some candidates confused the use of a control with the idea of controlling a variable.

Checking that variables such as the number (or volume) of germinating peas were effectively controlled was suggested by a number of candidates.

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(c) This question was well answered by most candidates. Incorrect suggestions included the idea of adjusting conditions to atmospheric pressure, keeping the temperature constant, keeping the rate of respiration constant and reaching the optimum temperature for the enzymes.

(d) Most candidates were able to plot all five points accurately, but fewer were able to draw a curved line of best fit. One common error was for candidates to extrapolate the line to start at 0 °C. Some candidates also joined the plots with straight lines, ignoring the instructions in the question to draw a curved line of best fit.

(e) A large number of candidates did not note the command word 'Explain' and instead described the effect of temperature on the transpiration rate. Some of these descriptions were very detailed and supported with meaningful data quotes.

Of the candidates who did attempt to explain the effect of temperature on respiration rate, many referred only to the optimum temperature and omitted any mention of enzymes. When the nature of enzymes was considered this was largely limited to negative consequences above the optimum temperature that could result in enzymes denaturing. Few responses considered the effect of increasing temperatures at temperatures below the optimum.

Question 7

(a) (i) Most candidates recognised that the suspensions were kept in the dark so that no photosynthesis occurred before the investigation started, which would have begun to decolourise the DCPIP.

(ii) The majority of candidates described the graph accurately and made correct comparisons between the three colours of light. Many supported their descriptions with correct data readings from the graph. The most common mistake was for candidates to confuse absorbance of light in the colorimeter with the absorption of light by chloroplast pigments. A small number of candidates attempted to explain the results instead of just describing them.

(iii) Many candidates developed sound explanations based on the relative absorbance of light of different wavelengths and the consequences for the number of excited electrons emitted.

(b) Candidates who had a good understanding of both the light-dependent and light-independent stages of photosynthesis were able to provide effective responses. The most common mistake was for candidates to consider that the rate of photophosphorylation is independent of temperature. These candidates may not have considered that photophosphorylation is dependent on enzymes and therefore must be affected by temperature.

Question 8

(a) (i) Most candidates accurately stated that the type of receptor used in the sense of smell would be a chemoreceptor.

(ii) Many candidates stated that the different pathogens causing TB could be detected because they all belong to the same genus or have similar genes. Few went on to say that the chemicals produced by these bacteria, and detected by the rats, may be similar. Even fewer noted that the same chemoreceptors would be stimulated.

(b) Nearly all candidates were able to complete the classification table for the African pouched rat correctly. The most common error was to omit either phylum or order.

(c) Many candidates provided detailed summaries of the differences. A minority listed features of the two domains separately and therefore did not make the differences clear. A small number of candidates discussed differences in membrane-bound structures, ignoring the instruction not to include these in their responses.

(d) Many candidates used their knowledge of virus structure to describe ways in which viruses could be classified.

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Question 9

(a) Many candidates made full use of the information provided to describe the effect of blue light on the germination of barley seeds, supported with appropriate data quotes. Most went on to develop a coherent explanation based on the results for abscisic acid concentration.

(b) The majority of candidates used their knowledge and understanding of the syllabus to describe and explain the role of auxin in cell elongation. A small number of candidates were uncertain of the details, suggesting that for these candidates this area of the syllabus was not well known and understood.

Question 10

(a) Effective responses concisely outlined the role of each of the four proteins in the contraction of a sarcomere. Many candidates were confused about the action of ATP in the sliding filament model and incorrectly described its use in the power stroke.

(b) Many candidates recognised that the consequence of succinylcholine having a similar structure to acetylcholine is that succinylcholine could bind to, and block, acetylcholine receptors. These candidates were able to develop appropriate responses. However, not all candidates made use of the information that succinylcholine has a similar structure to acetylcholine, leading to unsupported suggestions that succinylcholine in vesicles would fuse with the presynaptic membrane or that succinylcholine would have a direct effect on the binding of calcium ions with troponin.

(c) Most candidates recognised that sex linkage could account for the greater incidence of the condition in boys than girls. These candidates were able to develop coherent explanations based on this premise. A small number of candidates who incorrectly inferred that the gene must be on the Y chromosome had not considered that the condition could then not occur in girls. A few candidates considered that boys would be more likely to be affected than girls because they are more muscular.

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BIOLOGY

Paper 9700/52
Planning, Analysis and Evaluation

Key messages

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

When planning an investigation, it is important to set out the work in a logical way and for it to be detailed enough for another person to follow.

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

General comments

Most candidates demonstrated a good understanding of the requirements of this paper and were able to apply the relevant syllabus knowledge where required. Candidates understood what was expected in the planning question and most were confident in completing the steps of a chi-squared calculation.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly identified the independent variable as the concentration of sodium chloride solution.

(ii) The majority of candidates identified distilled water as the solvent, but some only referred to water, which was not sufficiently precise. Many candidates were able to complete Table 1.1 with the correct volumes.

(b) (i) Many responses noted in general terms that calculation of percentage changes would allow results to be compared. However, further qualification was required since it is the ability to make valid comparisons that is important and calculating percentage changes overcomes the problem of having different starting masses.

(ii) The majority of candidates were able to give a suitable data quote as evidence in support of the judgement that the student's conclusion should not be accepted. Most noted that the conclusion was not supported for onions left for 48 hours. Many realised that the water potential of each onion cell might vary, and others noted the absence of a statistical test. A number of candidates stated that there were no repeats. This was not true since 5 small onions were used at each concentration.

Ideas relating to a lack of standardisation in the experimental procedure, such as the temperature or the variety of onion used, were also valid. The need to test more concentrations of sodium chloride between 1% and 5% was correctly stated by some candidates. Only a few candidates linked the fluctuations seen in Fig. 1.2 to possible anomalous results or to uncertainty regarding the position of the *x*-axis intercept.

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(c) (i) This question was well answered, and most candidates were able to describe a suitable method to investigate the effect of increasing the temperature on the rate of osmosis in turnip blocks.

Standardising variables is essential and must be carried out carefully. Many candidates stated that the same species of turnip should be used even though this was already made clear in the information provided. Others referred to the need to use blocks of the same size. This needed further qualification since size can refer to several aspects including volume and mass. In this case, all blocks needed to be exactly the same linear dimensions.

Candidates did not always consider the apparatus that would be needed. For example, obtaining blocks of turnip of the same linear dimensions would require not only a sharp knife but also a ruler.

The majority of candidates considered how they would measure the dependent variable. Most recognised that recording a start and end mass would be sufficient. However, some proposed unrealistically small time intervals over which to allow osmosis to occur, such as 5 minutes. Stronger responses considered how measurements of mass could be made more valid, such as by removing excess water with a paper towel before measuring mass.

Most candidates recognised the need for replicates in the investigation, but few elaborated this with sufficient details. At least three results for each temperature were needed so that a mean value could be calculated. The term 'average' is vague and should usually be avoided.

(ii) Candidates were asked to complete the sketch graph, including labelled axes, to show the predicted results. Most responses included correctly labelled axes with a line that showed the rate of osmosis increasing as temperature increased from 10 °C to 50 °C. Only a few candidates plotted the axes the wrong way round or did not include units for temperature. The *y*-axis should be labelled 'rate of osmosis', as indicated in the question stem, rather than 'percentage change in mass'.

(iii) Most candidates were able to identify a relevant hazard, state the risk that this might pose to the person carrying out the investigation, and indicate the precaution that should be taken.

Question 2

(a) Many candidates recognised that separating the parent flies from the offspring was essential if the offspring were to be used subsequently in specific crosses.

Some candidates suggested that unless the parent flies were separated it would not be possible to be certain of the phenotypes of the offspring. This was not correct, since the number and phenotypes of the parental flies were known.

A number of candidates suggested that separating the parental flies would reduce competition for resources. This was not a concern in the context of this study.

(b) Many candidates used Fig. 2.1 to suggest that differences in the abdomens of the fruit flies could be used to determine their sex; some went on to propose the use of a hand lens or magnifying glass in this task. Fewer considered how the physical manipulation of the anaesthetised fruit flies would be managed, for example by using blunt forceps. Complete responses needed to address both the identification of male and female flies and a method to separate them.

(c) (i) Many candidates were able to state an appropriate null hypothesis. A small number of candidates incorrectly referred to a correlation between the two data sets rather than a difference.

(ii) The majority of candidates completed the calculation correctly. A small number of candidates used the expected offspring phenotypic ratios rather than the expected numbers of each phenotype in their calculation.

(iii) Many candidates completed the analysis correctly to determine whether the null hypothesis should be accepted or rejected. Some candidates selected the wrong critical value from Table 2.4.

(d) (i) The majority of candidates were able to calculate the Rf value of pigment 1 as 0.73. Some errors were caused by measuring to the top of the pigment on the chromatogram rather than to the centre of the pigment as instructed.

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(ii) Most candidates used the results from both experiments to draw appropriate conclusions. In the fruit fly breeding experiment, the majority of candidates were able to derive one or two conclusions, often including identification of phenotypes with their genotypes. Few candidates considered the results of the chi-squared test to conclude that the two genes were not linked.

In the chromatography experiment, most candidates were able to derive one or two conclusions, often concerning the identity of pigment 4 and the lack of pigments in the eyes of fruit flies with white eyes.

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