BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

There were a number of strong performances on the paper.

Comments on specific questions

Question 2

The majority of weaker candidates found this challenging. Stronger candidates were aware that changing the magnification when observing structures under the microscope does not result in a change in the distance they are apart.

Question 3

The majority of stronger candidates were able to identify the nucleus which measures 10 eyepiece graticule units long. They then worked out that 10 epg units is 25 µm.

Question 6

The majority of weaker candidates did not recognise that ATP is synthesised in the chloroplasts as well as mitochondria.

Question 11

The majority of weaker candidates found this challenging with each option being chosen almost equally.

Question 12

The differences between collagen molecules and collagen fibres were understood by the majority of stronger candidates.

Question 14

This question was challenging for many candidates. The concentration of enzyme-substrate would start off high and then fall to zero over time.

Question 15

Candidates needed to understand that as the readings were only taken every ten degrees, the rate could then reach the maximum between the measurements. This could mean between 30°C and 40°C or between 40°C and 50°C for this data.

Question 17

Only the strongest candidates answered this question correctly, recognising that the higher the temperatures, the more the structure of the phospholipids and proteins would change resulting in an increasing loss of pigment through the membrane.

Question 28

Most weaker candidates found this difficult with each option being chosen almost equally.

Question 35

Stronger candidates determined which statements could explain the difference; many candidates found this question challenging.

Question 38

Stronger candidates could identify the viral diseases and select the correct figures to add up.

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Paper 9700/22
AS Level Structured Questions

Key messages

When space is provided to illustrate answers with diagrams, candidates need to be aware that although they do not have to include diagrams, a diagram might be helpful in explaining their answer. If they do choose to include a diagram, they should remember to annotate diagrams.

When data is provided (either in the form of tables or graphs) candidates should quote relevant data to support the answer where possible and should remember to include the relevant units.

Candidates should be reminded to read each question thoroughly to ensure they are clear of the focus and that they can produce an answer that is relevant to the question as set.

General comments

Many candidates were well prepared for this examination and had a good knowledge and understanding of the syllabus learning outcomes. As a result, such candidates were able to answer well.

Comments on specific questions

Question 1

(a) A majority of candidates knew about the existence of telomeres and correctly labelled the chromosome. Weaker responses sometimes did not answer this question while others labelled the centromere.

(b) The only acceptable answers were anaphase or telophase. Many candidates gave interphase as their answer.

(c) Quite often this stage was incorrectly given as telophase and not as cytokinesis. The question refers to the cell cycle and not mitosis.

(d) The answer here had to include the term receptor. A common incorrect answer was receptor cell.

Question 2

(a) (i) Stronger responses gave the answer written correctly with a capital V for the genus name and lower case c for the specific epithet.

(ii) Candidates had not always read this question carefully. Stronger answers named structures, which can be found in both prokaryotic and plant cells and then described the difference.

A The only acceptable structure here was ribosomes. As the difference was size, correct differences could have been 70S versus 80S, 18 nm versus 25–30 nm or simply smaller versus larger.

A fairly common incorrect answer was ‘rough endoplasmic reticulum’, with the difference being stated as ‘present in plant cells but absent from prokaryotic cells’ or ‘the ribosomes are attached to membranes in plant cells but are free in the cytoplasm of prokaryotic cells’.

B It was quite common for candidates to incorrectly state the structure was a nucleus then to describe the difference as being present in plant cells, but absent from prokaryotic cells. Some candidates described the chromosomes as 'naked' when they meant 'not enclosed in a nucleus'. This was accepted when candidates gave correct information to show that they understood the DNA was not enclosed by a nuclear envelope.

C The only correct answer here was cell wall, with the difference being that it is composed of peptidoglycan/murein in prokaryotes versus cellulose in plants. Some candidates wrote some rather confused answers about cell membranes rather than walls.

(b) A majority of answers gained at least partial credit for this question.

(c) There were many correct answers to this question.

(d) When answers gained full credit here, it was generally for describing the invagination of the cell membrane, the formation of a vacuole (or vesicle) and the fact that this would require energy/ATP.

Many candidates explained that choleragen would bind to cell surface membrane receptors but only gained credit if they made it clear that the receptors and the protein molecule would have to be complementary. Stronger answers went on to state that between invagination and the formation of the vesicle, the membrane would have to fuse around the molecule. Stronger candidates included a well annotated diagram to support their answer.

(e) (i) A majority of candidates gained credit for stating that it is used because subunit B is the part of the molecule which binds to the cell surface membrane. Alternatively, it was acceptable to suggest that subunit A would cause damage/disrupt the normal functioning of the cell whereas this would not be the case with subunit B. Some answers pointed out that subunit B is larger/made up of five polypeptides and so would be more likely to provoke an immune response.

(ii) Generally, this was well answered and it was not uncommon for candidates to gain full credit.

Question 3

(a) A majority of candidates answered correctly.

(b) Answers were sometimes rather confused. This question required the understanding and interpretation of a graph and only needed reference to **X**, **Y** and **Z**. It could therefore be answered even if the candidates had not been sure about the answer to **(a)**.

Good answers stated that both **X** and **Y** have a V_{max} of 10 arbitrary units but **Z** has a V_{max} of 5 arbitrary units. The question stated that V_{max} is the maximum rate of reaction so candidates should have been able to answer this even if they were unsure as to the meaning of V_{max}.

In order to answer the next section, it was necessary to understand what is meant by K_m the Michaelis-Menten constant; not all candidates knew this. Those candidates who gained full credit explained that **X** and **Z** both have the same K_m (4 mmol dm^{-3}) whilst the K_m of **Y** was higher at 6.5 mmol dm^{-3} and also made reference to the fact that both V_{max} and K_m are related to the affinity of the enzyme to the substrate.

(c) The structure of DNA was well known and there were many answers achieving full credit. Where errors were made it was often referring to the sugar component as a pentose sugar (or ribose) or confusing bases with nucleotides.

(d) Many answers here were not very clear. Often it was stated that hydrogen peroxide is considered a mutagen because it causes mutations. This was given in the question. Many candidates were able to explain that mutations arise because the DNA is damaged by the peroxide and then errors occur in the subsequent repair process for at least partial credit. Stronger responses went on to state that this will lead to a change in base/nucleotide sequence (not gene or DNA sequence) resulting in the production of an altered polypeptide/changed amino acid sequence (not changed protein).

Question 4

(a) Many candidates gained full credit.

(b) (i) Most candidates gained partial credit; a significant number suggested that blood cells are dissolved or that haemoglobin is transported in solution.

(ii) There were quite a few ideas that could be credited in **(ii)** and a number of candidates gained full credit. Quite often, answers confused 'cohesion' and 'adhesion'. While some candidates gained credit by describing water molecules as being cohesive or that cohesion exists between water molecules, adhesion had to be described as the attraction between the water molecules and the cellulose lining of the xylem. Further credit was available for explaining that the hydrogen bonding ensures that a continuous column of water can be maintained, which can be transported up by the transpiration pull.

Question 5

(a) Quite often candidates got the trachea and bronchus the wrong way round in their answers to this question.

(b) Most candidates answered this question well.

(c) Candidates found this question challenging. Stronger answers noted the complete absence of cilia (not just fewer or damaged cilia) and that the lining at **X** was much thicker than it would have been in a healthy person. Many candidates thought that the thick lining was made up a layer of mucus, excessively secreted by the large number of goblet cells. Many answers also referred to the narrow lumen, which cannot be seen in this section.

Question 6

(a) (i) A number of candidates left this question blank suggesting that they did not know how to work out a surface area to volume ratio (SA:V).

Of those who did calculate it correctly, the majority expressed the answer as 5:3. This was acceptable, as were 1.67:1 or 1.7:1. Of those who did not express the ratio in one of these ways, a number correctly calculated a surface area of 90 cm^2 and a volume of 54 cm^3 for partial credit.

(ii) Many candidates gained partial credit for explaining that this was because block **X** has a larger surface area; some candidates could not go on to explain why this would cause it to change colour in a shorter time. Most candidates were unable to relate this to the different sizes of the blocks which meant that the diffusion distance (from the surface to the centre) is shorter in block **X** than block **Y**.

(iii) Answers were often unclear with many based on the assumption that plants have a small surface area to volume ratio. This resulted in some rather complicated answers, which were difficult to follow. Stronger responses focused on the idea that diffusion would be too slow or that plants cannot rely on diffusion alone and that an efficient transport system is needed to cover the distances involved in reaching all the cells/tissues (in large multicellular organisms).

(b) Some candidates were able to name the correct reagent.

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Paper 9700/33
Advanced Practical Skills

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.

When drawing the observable features of cells in a specimen, the drawings must have the correct proportions. Plant cell walls should be drawn with two lines and the relative thickness of the cell walls should be in the correct proportion to the size of the cells.

Candidates should be able to calculate the magnification of a photomicrograph using the actual size of the diameter and state the answer to the correct degree of accuracy. Candidates should show their reasoning and clearly display all the steps in the calculation.

General comments

Stronger responses showed familiarity with the materials and apparatus for practical work. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in practical work will be better prepared to organise and complete unfamiliar activities.

In general, many candidates demonstrated that they had a good understanding of the skills required for this paper. The majority of candidates showed that they were familiar with the use of the microscope.

Comments on specific questions

Question 1

(a) (i) Many candidates were able to decide on at least three temperatures other than room temperature and 40°C, with suitable units (°C) and for a suitable range.

(ii) Most candidates recorded colours for each temperature, using the letters stated in the key at 15 second intervals, until no colour change, starting with blue black and ending with the colour of iodine or at 180 seconds.

(iii) The majority of candidates organised their results clearly by presenting a ruled table. Stronger responses included the heading for temperature with units (°C) and the heading for time with units (seconds). The majority of candidates recorded the times for at least four temperatures. Most candidates recorded the same times as recorded for raw results.

(iv) Stronger responses stated two significant sources of error that may have affected the trend in results. Many candidates described the difficulty of judging the colour of the iodine solution when mixed with a sample of the enzyme and starch mixture. Some candidates correctly stated that another source of error was that the temperature of the contents of the test-tube went down after it was removed from the water bath.

(v) Strong answers referred to the optimum temperature of enzyme **E** being higher than the optimum temperature of the human body.

(vi) Many candidates were able to state that temperature could be standardised using a thermostatically-controlled water bath. Many candidates described how the effect of enzyme concentration could be investigated by using at least five enzyme concentrations which could be achieved by using proportional serial dilution.

(b) (i) Most candidates correctly used the headings given in the table to label the *x*-axis (temperature / °C) and the *y*-axis (activity of enzyme/arbitrary units). Some candidates labelled the incorrect axis or gave incomplete headings. Most candidates used a scale of 5.00 to 2 cm for the *x*-axis and 5.00 to 2 cm for the *y*-axis. Many candidates plotted the five points accurately and joined the points with a thin line. The most common errors were not including a full axis label for each axis, omitting the units for the *y*-axis, not labelling the scale every 2 cm or drawing lines which were too thick.

(ii) Most candidates correctly described the effect of temperature on the activity of the enzyme by stating that as temperature increased, the activity of the enzyme decreased.

Question 2

(a) (i) Many candidates were able to demonstrate their experience of drawing plan diagrams as part of their course and answered this well. Credit was awarded to candidates whose drawings used most of the space provided and did not include any shading. Stronger responses gained credit for drawing the stele in the correct proportion to the diameter of the root. Credit was given for drawing the shape of the xylem correctly. Many candidates gained partial credit for using one label line and a label to identify the xylem.

(ii) The clearest drawings were made using a sharp pencil to provide clear, thin lines which joined up precisely and used most of the space provided. The most common error was to draw lines that did not meet up precisely. The majority of candidates gained credit for drawing four adjacent cells and for drawing the cells walls as double lines. Many candidates included a cell with at least five sides and used a label line and label to identify the cell wall.

(b) (i) Many candidates were able to identify the organ as a stem and stated that the feature which supported this identification was that the vascular bundles were situated peripherally.

(ii) Many candidates were able to calculate the magnification of the organ in the figure by accurately measuring the diameter of the organ along the line **Z** and included the appropriate units for the measurement. Stronger responses showed the multiplication of the diameter of the organ by 1000 to convert the measurement from millimetres to micrometres and showed the division of the diameter by 4500. Most candidates stated the magnification of the organ to the appropriate degree of accuracy. The most common errors were omitting units and not showing all the steps in the calculation.

(iii) Strong answers showed the table organised into three columns, with one column for features, one headed **P1** and one headed Fig. 2.2. Many candidates listed at least three observable differences between **P1** and Fig. 2.2 such as the epidermis in **P1** being thinner as compared to Fig. 2.2.

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Paper 9700/42
A Level Structured Questions

Key messages

Calculations in the application of the Hardy-Weinberg principle were not well applied and this is an area that would benefit from further focus in the classroom.

Candidates should note the number of marks available for each question as this will guide them in the number of points expected in their answers.

General comments

The paper proved to be accessible to all candidates with a spread of marks achieved by candidates. On some occasions candidates would have benefited from reading the question more carefully to ensure they answer the question as set.

Candidates found **Questions 6** and **7** to be the most challenging.

Comments on specific questions

Section A

Question 1

(a) (i) Most candidates were able to state that as the loop of Henle increased in length, the water potential of the urine would decrease. Credit was also given to those who mentioned that there was an inverse correlation.

(ii) Many candidates were able to state that camels needed to conserve water; some did not say that it was due to the dry environment they lived in and simply stated it would be hot.

(b) Many candidates were able to explain the importance of microvilli in providing a large surface area for the absorption of sodium ions, glucose or amino acids. Similarly, a majority of candidates showed that the mitochondria would provide energy or ATP for active transport of sodium or potassium ions. Better answers explained that the tight junctions held the cells together; some stated that substances would have to pass through the cells rather than around them.

Question 2

(a) (i) This question was generally well answered. Despite the question stating that the precise location was required, there were some vague answers given for the link reaction and Krebs cycle, such as 'in the mitochondria', with no reference to the mitochondrial matrix.

(ii) Many candidates answered this question well and suggested that the phosphorylated glucose would be too large, preventing its movement directly across the membrane or through the glucose channel protein. Some candidates also recognised that the phosphate group carries a charge, causing the phosphorylated glucose to become paler.

(b) This question generated a wide range of answers, as most candidates stated that the electron transport chain or associated processes do not function in anaerobic respiration, with some answers going on to state that this is due to oxygen not being present as the final electron (and proton) acceptor. Few candidates added that this is where most of the ATP is produced in aerobic conditions to provide context as to why this is important. More thorough answers stated that only glycolysis occurs in anaerobic respiration and added that this stage only generates two molecules of ATP (net). Few candidates provided detail about the alternative pathway that pyruvate follows, preventing it from proceeding into Krebs cycle. Good answers described the production of lactate and that this molecule retains a lot of unreleased chemical energy. Some answers made reference to the ethanol pathway, which was not credited as the question was given in the context of a muscle cell and an athlete going into anaerobic respiration.

(c) Most candidates made reference to the oxygen debt that needed to be repaid by inhaling additional oxygen after exercise. Fewer candidates described how this extra oxygen would then be used. Of those answers which provided additional detail, the conversion of lactate back into pyruvate/glucose/glycogen was most common and good answers recognised that the lactate has to be transported to the liver for this process to occur.

Question 3

(a) (i) There were many correct answers to this question; a large number of candidates had no knowledge of the structure of a grain of wheat. Some candidates did not answer this question.

(ii) Many candidates were able to use the diagram to describe the sequence of events from the imbibing of water by the seed to the start of germination. Some candidates did not refer to the diagram and gave an incorrect order of events.

(b) (i) A majority of candidates were able to calculate the overall rate of increase in mean cell length and many added the correct units.

(ii) Knowledge of the exact action of auxin was not secure with only a small number of candidates answering correctly.

(iii) Many candidates were able to show that the expansins would be activated; stronger responses correctly explained that this would lead to a loosening of the bonds in the microfibrils. Many were then able to state that water would enter the cells by osmosis due to the influx of potassium ions and that this would cause the wall to stretch.

Question 4

(a) (i) Nearly all candidates made reference to limiting factors, with the majority extending their answer into stating that the photosynthesis rate levels off, despite the increasing carbon dioxide concentration, demonstrating that the carbon dioxide concentration was no longer a limiting factor, or that temperature or light intensity were potentially now acting as limiting factors.

(ii) Nearly all candidates selected the relevant data from the graph provided. The comparisons made were generally poor, as many made vague references to barley having a higher rate than sugar cane, which was not true throughout. Stronger responses made reference to the maximum rate achieved at 10°C. Similarly, few answers referred to to the rate of photosynthesis levelling off for sugar cane at a lower rate and at a lower carbon dioxide concentration than barley. Many candidates misread the graph, stating that sugar cane levelled off at a carbon dioxide concentration of 50 AU, when the graph clearly showed a small increase beyond this concentration.

(iii) Only the strongest answers showed a good understanding of C4 plant biology. Where credit was awarded, this was in the context of the sugar cane plant's enzymes having a higher optimum temperature, hence the higher rate. Few candidates extended their answers into a discussion of the mechanisms that C4 plants use to avoid photorespiration, which was required for full credit.

(b) This question was usually answered correctly with candidates giving any of a number of environmental conditions that cause stomata to close. Answers also needed to state why the plant would need to close the stomata and this was generally answered in the context of conserving water within the plant by reducing the rate of transpiration. Some answers gave details of the mechanism of stomatal closure in response to environmental conditions, which was not part of the question.

Question 5

(a) A majority of candidates were able to correctly explain homozygous as being the possession of two identical alleles.

(b) Only about half of the candidates were able to show that the genotype would be heterozygous for both genes.

(c) Those who gave the correct genotype in **(b)** usually correctly constructed the Punnett square. Some of these candidates did not match phenotypes with genotypes and some gave the correct ratio but did not add the colour of the flowers.

Question 6

(a) Only the strongest responses applied the calculations underpinning the Hardy-Weinberg principle to calculate the frequency of the heterozygous genotype in the scenario provided. The majority of candidates did not use the quadratic equation provided and stated that the 40% of the butterflies with the phenotype displayed by the homozygous recessive phenotype represented q, rather than q^2. Another frequent error was not multiplying pq by 2, as stated in the equation given, or converting the proportion into a percentage.

(b) Describing the situations in which the Hardy-Weinberg principle does not apply was answered better than the calculation. The majority of candidates offered a variety of migration, non-random mating, small populations or genetic mutations.

Question 7

(a) Many candidates could name the neurones; the descriptions of the functions were not strong in many cases. It should be noted that messages, signals or information are not substitutes for impulse or action potential.

(b) Candidates found this question challenging. Often candidates did not state whether the membrane or neurone was pre-synaptic or post-synaptic, which was required in answers.

Question 8

(a) This was answered correctly by almost all candidates.

(b) (i) Many candidates incorrectly made reference to allopatric speciation as a result of separation of Sumatran orangutan family groups, but missed the immediate genetic consequences prior to that event, as requested in the question. Only candidates who discussed the immediate effects of separation of family groups gained credit for discussing inbreeding depression and a decrease in homozygosity as a result of fewer breeding options.

(ii) Candidates answered better when discussing the methods employed to protect the Sumatran orangutan in its natural environment. The majority of candidates discussed methods to control human activity, such as preserving the Sumatran orangutan's habitat as a national park and the introduction of legislation to prevent hunting. Extended answers discussed awareness campaigns to educate local people or planting more trees to replenish those lost. Some candidates incorrectly focused on captive methods of protecting endangered species by zoos.

(iii) This section was well answered. A variety of roles of zoos to preserve endangered species were included in answers, with a view to returning animals to their natural habitats and replenishing wild populations.

Section B

Question 9

(a) Candidates who chose this question were usually able to explain that an ecosystem was self-contained and had a community of organisms who interacted with each other and the non-living environment. Fewer mentioned food webs or that an ecosystem was self-sustaining. Most were able to state that a niche was the role of an organism but did not say that it is where the organism lives including its position in a food web.

(b) This question was quite well answered by those who had obviously carried out sampling techniques themselves. Random and systematic sampling methods were usually described well. Mark, release and recapture was sometimes described with a lack of detail. For example, little reference was made to the type of marking or the time required for the animals to randomly mix with the population.

Question 10

(a) Many candidates understood the basic purpose of PCR to amplify specific genes or sections of DNA from an initial small sample which could subsequently be used for other purposes. The initial denaturation of DNA at high temperatures was well described, as was the subsequent addition of primer DNA and the requirement for a DNA polymerase. Some candidates mixed up primers with DNA probes and gave a discussion of microarrays. There was often some confusion over the temperatures required for the annealing and elongation steps. Most candidates understood that this technique is a cyclical process that is repeated many times to exponentially increase the amount of DNA. Only stronger answers went further to describe the source of *Taq* polymerase and its thermal stability allowing it to be reused cycle after cycle without denaturation, making PCR an efficient method.

(b) This section was less well answered as candidates often struggled to provide more than two or three uses of plasmids. Basic answers described the use of plasmids as vectors and suggested their extraction from, or transformation of, bacteria; both points were rarely given in the same answer. Only stronger extended answers included the ability to cut specific sites with the plasmic DNA using restriction enzymes and ligate in specific genes or described the basic structure of plasmids as small circular independent pieces of DNA, or that they can carry marker genes or antibiotic resistance genes in order to isolate transformed cells.

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Paper 9700/52
Planning, Analysis and Evaluation

Key messages

Candidates should read questions carefully to ensure that their answers are relevant to the question that is being asked.

Any data should be analysed to look for any patterns and trends that are important to the question asked. If data quotes are used, candidates should check that they are accurate and relevant to the question.

Candidates need to take note of the instruction with questions that involve planning: 'Your method should be detailed enough for another person to follow'. Descriptions of methods need to be clear and follow a logical sequence so that anyone could follow the method described and be able to carry out the experiment. These answers do not need to identify the different variables as it should be obvious from the method which variables are being standardised and which are being tested and measured. If a question asks for the dependent and independent variable to be identified, restating them in a method is not necessary.

General comments

The paper produced a range of marks and there was no evidence to suggest that candidates were unable to complete the paper in the time available. There were many examples of vague answers where imprecise phrases were given such as 'a microscope is used to measure the fibres' and 'natural selection is acting on the moths so the population increases'. Candidates should ensure their language is precise and clearly addresses what is required in the questions.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly identified the independent and dependent variables. Weaker answers for the independent variable tended to list the solutions and omit Ringer solution without additional ATP or glucose. For the dependent variable, these answers often stated 'percentage decrease in length'. This is a calculated value, not a measured value and so it was not acceptable as the independent variable.

(ii) Most candidates gave a correct answer usually referring to allowing valid comparisons to be made. Stronger answers also included a reference to differing starting lengths. Weaker answers often stated that the length changes were too small and so needed to be converted to percentages to make them more understandable.

(iii) Better performing candidates referred to a control and gave a valid explanation of its purpose. A number of answers showed confusion between a control and a controlled variable. These candidates did not show an understanding of the difference between a variable that has been standardised (controlled) and a control.

(b) (i) The majority of candidates gave a suitable method of diluting 0.5% glucose stock solution. Better answers stated that a minimum of five dilutions were necessary and matched the suggested dilutions to the method used. Weaker answers gave too few dilutions or in some cases, the dilutions given did not match the stated method. Other answers, otherwise correct, changed the dilutions from percentage to mol dm^{-3}. The majority of candidates knew that the length of the muscle fibres should be measured using a microscope; better performing candidates referred to using the eye-piece graticule for measuring. A common error was to use the stage micrometer to calibrate the muscle fibre. A micrometer screw gauge, suggested by a number of candidates, is not suitable for measuring soft tissue. Many candidates had not read the given procedure carefully enough and so immersed the muscle fibres in the different concentrations of ATP solutions for two hours before measuring, rather than adding the ATP solutions to muscle strips on a slide. Better answers showed a good understanding of the variables that needed to be standardised. The variables given most commonly were the time for immersion in the different solutions solution on a slide and a constant volume of each solution. Relatively few candidates referred to having the same number of muscle strips in each ATP solution. Many candidates stated that they should all be the same length, although the information in the question inferred they were of different lengths. Better answers referred to a control, although water was often used instead of Ringer solution. Almost all candidates stated that the experiment was a low risk; in a few cases, hazards like 'cutting' were given without any suitable precaution. The majority of candidates also referred to doing replicates or repeats. It was often not clear from their answers that there was a minimum number of three replicates and that a mean rather than an average was calculated. For the majority of answers, it is unlikely that another person could have used the method described to carry out the expected investigation.

(c) Only the strongest candidates answered this question fully correctly. The most common error was to omit 'percentage' from one or both axes, or to change the units on the *x*-axis to mol dm^{-3}. Although mol dm^{-3} is a possible unit for ATP concentration, the question refers to a percentage solution. Candidates should not change any units given in the question unless specifically asked to do so. Weaker responses reversed the axes and then produced an incorrect curve.

(d) Most candidates found this question challenging. Many candidates did not recognise that the strips were not individual fibres. Very few candidates mentioned the obvious difference of the muscle strips *in vitro* being dead tissue as opposed to living tissue. Common incorrect answers were 'not enough potassium or sodium', 'pH not controlled' and 'variable ATP concentration'.

(e) Most candidates gained partial credit for this question for testing muscle strips in a solution containing glucose and ATP. Better answers also stated that the results need to be compared with strips tested with only ATP. Better answers also showed an understanding that the ATP concentration should be standardised for both tests.

Question 2

(a) Better answers gave two variables that should be controlled. A number of weaker responses thought this question was about an experiment that released the same number of moths into the two areas along with the same number of birds.

(b) Many candidates had not read the question carefully enough, as they did not make a comparison between the populations in the two areas. A common imprecise answer was 'the population of melanic moths increased in both areas'. Some candidates attempted to describe the overall changes in both populations, but rarely completed the sequences. Others linked their answers to changes occurring at incorrect generations or percentage figures. Explanations were often omitted or simply stated it was 'natural selection'. Better answers showed the understanding that the selection pressure was greater in area **X** than in area **Y** because of the greater smoke pollution. None of the candidates suggested why the population did not become 100% melanic in area **X**.

(c) Most candidates gave a correct answer. The only common error was to show an immediate drop from generation 10.

(d) This question proved challenging for many candidates. A few better answers referred to predators other than birds and possible resistance to disease or toxins. The majority of candidates described natural selection and the effect on the proportion of melanic moths. These answers were more relevant to **(b)**. Some weaker answers showed little understanding of the question as they referred to the birds or the non-melanic moths migrating to a less polluted area, leaving only melanic moths in the population.

(e) (i) Many candidates knew that the expected ratio from the test cross and answered correctly. There were candidates who made errors in addition, or changed the number of decimal places within their answers. A few candidates used fractions. Candidates should be aware that the figures should be consistent within a calculation and that decimals, not fractions, should be used. Some weaker responses did not recognise that the total for expected number (*E*) of moths should be the same as the observed number (*O*) of moths.

(ii) Most candidates were able to use the probability table correctly. The only common error was to state that a calculated chi-squared value lower than the critical value was significant.