BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

The paper differentiated well.

Comments on specific questions

Question 1

The majority of candidates were able to do the correct mathematical processing and use standard form correctly.

Question 2

The majority of candidates found this question challenging. Better performing candidates were aware that due to the presence of DNA and ribosomes in both chloroplasts and mitochondria, both of these organelles undertake protein synthesis. In this question the correct answer was B, the mitochondrion.

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Question 5

Better performing candidates knew that cholera is caused by a bacterium; as this is a prokaryote, option A was correct.

Question 9

Candidates who performed less well incorrectly thought that the fatty acids in phospholipids are always saturated.

Question 11

The majority of candidates found this challenging and each type of regulation was chosen almost equally.

Question 12

Most candidates incorrectly selected option B, thinking that kinetic energy of the enzyme and substrate is highest at point Q and forgetting that it would increase beyond point Q as the temperature increases further.

Question 16

The majority of candidates found this challenging. All three statements were correct.

Question 18

Only those candidates who were able to process the information provided, realised that only the nucleus would typically contain linear chromosomes and therefore have telomeres.

Question 27

The majority of the better performing candidates selected an option which included the correct statement 1.

Question 31

The majority of candidates found this information challenging to process. During ventricular diastole, the blood returning to the heart flows into the atria and then the ventricle. Therefore the ventricle has a significant volume of blood present in it before atrial systole occurs.

Question 34

Candidates who performed less well found this challenging. It is expected that all candidates have had the opportunity to study various biological tissues using a microscope.

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Paper 9700/22
AS Level Structured Questions

Key messages

- When describing graphical results, numerical values extracted should be accompanied by both the *x*-axis and *y*-axis descriptions, with units given.
- A description of a mode of transmission for a named disease must show understanding that the pathogen is passed from an infected person to an uninfected person.
- The shape of the active site of an enzyme, when compared to its specific substrate shape, should be described as complementary, and not as similar, same or matching.

General comments

Overall, excellent performances were seen from a number of candidates, who were able to apply adeptly knowledge and understanding of learning outcomes of the syllabus to new contexts and to draw from different areas of the syllabus when answering whole questions, particularly in **Questions 3**, **4** and **5**. For other candidates, a very sound knowledge of the syllabus topics was displayed. One main area where they could have improved was in application of this knowledge. All scripts were legible and candidates appeared to have enough time to answer all questions: part-questions left blank tended to be those that were more challenging for those particular candidates. Candidates generally made good use of the space provided and some drew out diagrams as a prompt to help them answer a question or included them as part of an answer. This was particularly so in **Questions 2(b)**, **3(a)(ii)** and **5(c)(iii)**.

Many good answers were seen in **Question 1**, which required candidates to consider all three types of biological molecule covered in Topic 2 of the syllabus.

Question 2 was well tackled by many candidates; these candidates gave full answers to both parts of the question. In part **(b)**, which asked for a description of the structure of the nucleus, good responses avoided giving the functions for the various features of the nucleus described.

Question 3 used a theme on a novel context, erythropoietin (EPO), to assess candidates on a number of syllabus topics. The question included graphical results, which needed both a description and an explanation. In **Question 3**, better performing candidates were able to stay focused and to use the common theme to switch from one area of the syllabus to another when responding, while many others would have benefited from reading the question and trying to link it with the correct area of the syllabus before preparing their answer. **Question 3(a)(ii)**, where candidates were asked to outline how EPO is released from cells, shows the importance of understanding the difference between 'Outline how...' and 'Outline why...', as a number of candidates gave the latter as a response.

There were a number of different parts to **Question 4**, which was based on a theme of the causative organisms of measles and HIV/AIDS. Those candidates who performed well were able to draw from their knowledge of different syllabus topics, and in parts **(c)(ii)** and **(c)(iii)** applied their knowledge to answer questions with the 'suggest' command term. Part **(b)** was a good example of the need to re-read an answer before moving onto the next question, or to allow time to check at the end of the examination. Although the question was about antibiotics, some candidates wrote about antibodies, while others used both terms within one sentence.

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Question 5, based on ATP and covering three syllabus topics, consisted of part-questions requiring short answers and straightforward knowledge with understanding of the relevant subject areas. Well-revised candidates performed well on this question.

Comments on specific questions

Section A

Question 1

This short question assessed candidate knowledge with understanding of syllabus ***Topic 2***.

A was generally well known. 'Disaccharide' was only precise enough for a question that asked for a type of molecule. 'Maltose' was the most common incorrect response, and other named sugars were also seen.

B was also well done, with only the weakest candidates naming the bond as glycosidic or hydrogen or leaving this blank. Some were on the right lines but incorrectly gave 'dipeptide' as the bond type. It is possible that some misread the question and thought they needed to name the type of molecule formed.

C was more challenging than **A** or **B** for many candidates and although some noted the description of unbranched, they possibly did not notice the reference to β-glucose and gave 'amylose' as an answer instead of cellulose.

D was very well known. Some candidates gave the two reagents used to prepare biuret reagent, which was acceptable; a number only gave one of the two. A proportion gave the correct spelling of 'biuret'. Other incorrect responses included Benedict's and iodine solution.

E was known by many, with 'glyceride', 'diglyceride' and 'lipid' being the most common incorrect responses. A few candidates gave 'alcohol' as a response, which was not sufficiently precise.

Question 2

The theme of this question was based on syllabus ***Topic 1***. Some candidates also applied knowledge of the interphase cell from **Topic 5**, when answering part **(b)**. The ability to manipulate data was assessed by asking candidates to determine the magnification of an image in part **(a)**.

(a) Many answered this correctly, making the correct calculation and completing the box with the correct formula to determine the magnification of the image. Some candidates who wrote out the calculation then went on to give the answer to 2 or 3 significant figures. Weaker candidates, who needed to improve their ability to make this type of calculation, showed knowledge of magnification by completing the box with the formula to use. A common error was dividing the actual length by the measured length.

(b) Some excellent accounts of the structure of the nucleus were seen. Stating that the nucleus contained DNA was only sufficient when it was further qualified with some extra detail. Quite a few responses were unclear about the term 'nuclear envelope', describing an inner nuclear membrane with an outer membrane known as the envelope. Some only described the nucleus as being bound by a single membrane. For a cell in interphase, if chromatin is not described, then the term 'chromosomes', rather than 'chromatids', needs to be used. Only at late interphase will chromatids be present, and if describing a cell at this stage, a helpful point is to only consider a chromatid as being attached to a sister chromatid by a centromere. Some described the nucleolus as the place within the nucleus where all the chromosomes were located. Some candidates were tempted to state functions; generally this was ignored, especially if the correct function was stated for the structure described. A number of weaker candidates only gave the function of the nucleus, which suggests that they should have read the question more carefully. Others described the location of the nucleus within a cell.

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Question 3

Better performing candidates were able to use skills of handling information and solving problems to perform well in this question. Others found it difficult to assimilate and sort the information given so that they could make links to the correct area of the syllabus. Assessment was based on a number of syllabus topics; ***Topics 4***, ***5***, ***6*** and ***8***, with some knowledge from ***Topics 1*** and ***2*** required.

(a) (i) This question asked about the presence of mRNA in the specialised cells in the kidney. Although most suggested correctly that mRNA was linked to translation, or protein synthesis, only some candidates read the question correctly and so did not write about cells of the bone marrow and haemoglobin synthesis. There were fewer that also mentioned the increased quantity of mRNA resulting from transcription. Better performing candidates understood that the question was about EPO synthesis and also mentioned the presence of a gene coding for the protein in their response.

(ii) There were some very good sequential accounts outlining how EPO is released from cells. The best responses used the correct terminology, understood that ATP was required and avoided unnecessary information about transport vesicle formation at the rough endoplasmic reticulum (RER) and processing in the Golgi body. Some began with synthesis at the RER and described the action of the Golgi body but did not continue to outline the release of EPO, while others wrote only about secretory vesicle formation. A number described the release as bulk transport without providing further details. Some candidates incorrectly gave descriptions of diffusion through the membrane or described why EPO is released, rather than how.

(b) (i) Some candidates were able to apply knowledge and understanding of protein receptors of cell surface membranes and cell signalling to provide a complete answer. Some candidates took note of the information provided that EPO was a glycoprotein, so were able to consider that this molecule had a shape that would be complementary to receptors on target cells. A number did continue their account by correctly explaining that binding to the receptor of the target cell was necessary in order to trigger the responses within the cell. Others stated that EPO was a receptor or wrote about EPO as if it were a cell type with its own receptor, with a proportion of these using the term 'receptor cell'. Some appeared to understand that EPO was a signalling molecule but mistakenly termed it an antigen. There were a few responses that confused the response of the specialised kidney cells to low oxygen concentration in circulating blood and stated that only cells with a low concentration of oxygen would bind EPO. Some would have benefitted from re-reading the information provided, stating that EPO acts at the surface of cells, as they suggested that the molecule passed across the membrane and acted within the cell. Candidates who performed less well described an antigen binding to a receptor, which triggered an immune response.

(ii) A high proportion of responses answered this correctly, with the most popular suggestion being related to the large size of the molecule. Some candidates stated that EPO was hydrophilic, or polar, and went onto to explain that the hydrophobic core of the phospholipid bilayer would prevent entry of the molecule. Here, stating that the membrane was hydrophobic or to make statements such as "cell membranes don't allow polar molecules to pass through" needed greater amplification and detail. Similarly, statements such as "because the membrane is partially permeable" needed more qualification.

(c) The majority knew that stem cells were being described. Other responses included 'immune system cells' or named cells of the immune system, 'diploid cells' and 'haemoglobin'.

(d) Candidates who performed well in this question paid careful attention to the information given at the start. They did not become involved in a consideration of fluctuating oxygen concentrations and EPO release, as this was not relevant for the investigation. High quality responses were precise in their descriptions of time and dispensing of the EPO injections. For example, 'in the second week of the investigation', described the duration of time between week 1 and week 2 on the graph, rather than the time when the first injection was given. Good responses also used the correct units when describing mean Hb concentration and were precise when extracting values from the graph, realising that each square on the graph corresponded to 0.2 g per kg body mass, and always taking care to give the time value when quoting a mean Hb concentration. The best responses gave one or more valid explanations for their descriptions, while many others gave a very good description of the results.

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(e) Good answers to part **(e)** followed on from the information provided about a decrease in oxygen partial pressure and explained how this would lead to a lower uptake of oxygen and lower saturation of haemoglobin with oxygen. It was not necessary to repeat the information in the question, as some candidates did. The best answers continued to explain that the increase in red blood cells in response to the increase in EPO concentration meant that there would be more haemoglobin and they also made it clear that this was a compensatory response, rather than imply that the body would have more oxygen than at sea level. Many stated that more red blood cells meant that more oxygen would be taken up than previously and so could have improved their response by linking this to the increase in haemoglobin.

Question 4

Two of the causative organisms of diseases named in syllabus ***Topic 10****, Morbilliivirus* and HIV*,* were the theme of this question, and in addition to assessing this topic, there were also part questions assessing ***Topics 4****,* ***6*** and ***11***. In part **(b)**, candidates could also use knowledge of viral structure from ***Topic 1***, to answer the question.

(a) Some candidates gave very detailed and well-organised responses to compare the two modes of transmission. Precise accounts of the main mode of transmission of *Morbillivirus* included both the exit of the virus from the infected person and the entry into the body of the uninfected person, and explained that the pathogen was in airborne droplets, rather than just stating that the virus was airborne. A common misconception was to describe measles as a direct contact disease. Transmission of HIV was better understood than *Morbillivirus*, although only a proportion remembered to consider mother to foetus/baby transmission of HIV. Answers that could have been more precise generally were for the description of blood transfer via use of needles and/or syringes contaminated with the virus. Hence, stating that transmission was from sharing syringes was accepted to the benefit of the candidate, whereas stating that transmission could occur from unsterilised syringes, or from a person using the same needle was considered too ambiguous or too vague to be credit-worthy. Some candidates used the terms ‘it’ or ‘they’, which did not allow identification of the actual organisms they were trying to describe. Some candidates could have saved time by not including a description of prevention and control. Others wrote only about people most at risk from the diseases.

(b) This was straightforward for those with a good understanding of the particular learning outcome concerned. As the outcome concentrated on penicillin as an antibiotic it was sufficient to explain that antibiotics act only on bacteria and viruses do not have cell walls. Some high quality answers showed evidence of background reading and explained how viruses do not have other structures targeted by other antibiotics. Some candidates would have benefited by checking their answer to spot that they were using the term antibody instead of antibiotic. Some candidates needed a better understanding of the difference between antibiotics and antibodies as they answered the question solely from an immune response angle, describing viruses lacking antigens that antibodies can ‘attack’ or writing about the mutation rates of viruses and the inability to be detected.

(c) (i) Candidates were instructed to refer to the information to help them answer this question. Some candidates spotted that the viral envelope was formed from the cell surface membrane of the infected cell, and using this information were able to state the general structure of membranes, the phospholipid bilayer, and then add the information about the viral (glyco)proteins embedded in the envelope. Others used the information about proteins and described the envelope as only consisting of proteins. These candidates needed to also mention the phospholipid bilayer. Where no credit could be given, it was generally for confusing the envelope with the protein coat and describing either a protein coat made of capsomeres or describing a ‘hybrid’ structure that was a mixture of the two.

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(ii) Better performing candidates used appropriate information to help them answer this question: the specificity for *Morbillivirus* to infect cells with SLAM glycoproteins; the virus had projecting surface (glyco)proteins; cell infection required both **H** and **F**; the viral envelope was to the outside of the nucleoprotein; binding of the virus to the host cell occurred; the envelope was largely the same composition as the host cell. From this, candidates who performed well were able to suggest SLAM as a receptor for binding to viral glycoprotein **H** (as **H** acts first) and action of viral glycoprotein **F** to allow fusion of the envelope to the host cell surface membrane. Some described the follow-on event as similar to exocytosis, with only the release of the nucleoprotein into the host cell, which was acceptable. Some candidates suggested one or two of these ideas, with others simply stating that the virus bound to the host cell. Some did not provide the initial correct details to lead to the correct method of entry of the nucleoprotein, but were able to suggest a method of entry that was an acceptable suggestion, such as passage through membrane transport proteins or endocytosis by the host cell. Some weaker responses gave descriptions of what happened in the cell after the entry of nucleoprotein.

(iii) Many spotted the term 'polymerase' and were able to think about their knowledge of the roles of RNA and DNA polymerases to give correct suggestions for the role of viral polymerase. Some responses needed to be less vague and provide more detail than 'for replication of the virus' or 'for replication of the nucleoprotein'. Weaker responses suggested that the enzyme was used for the initial infection of the cell or to breakdown cell components.

(d) (i) Most candidates gave protein or glycoprotein for **(d)(i)**. Two common incorrect responses were 'pathogen' and 'virus'.

(ii) High quality responses were sequential in nature and gave the main steps in the production of monoclonal antibody. Each main step had sufficient detail to show understanding of the concepts involved. These candidates understood that an immune response in the small mammal injected with antigen p24 would bring about an immune response and that it was specific immune response cells, B-lymphocytes/plasma cells, rather than antibody, that needed to be obtained from the mammal and then fused with myeloma cells. Some candidates stated that hybridoma cells were formed: preceding this there were descriptions of antibody being produced in the mammal, antibody harvested from the mammal and antibody fused with cancer cells, with no reference to the actual cells producing the antibody. Some described mixing B-lymphocytes with myeloma or cancer cells and could have improved this by stating that they were fused together to form the hybridoma cells. There were a number who appeared to understand what was meant by monoclonal antibody as they described correctly an immune response to antigen p24, but did not realise that they should have given steps in the procedure for the production of the antibody. These candidates did not demonstrate knowledge of the immune response.

Question 5

Candidate knowledge with understanding of syllabus ***Topics 3, 6*** and ***7*** was assessed in this question. Part **(a)** was left blank by some candidates, presumably because they did not know the structure of ATP. However, others who did not know the details used their knowledge of general nucleotide structure and made an attempt to answer the question.

(a) The general structure of a nucleotide was very well known by many candidates, with a proportion giving details of ATP. Of these, the majority named the phosphate group(s); together with ribose as the pentose sugar and adenine as the nitrogenous base. A few gave adenosine as a label and correctly positioned a bracket to show understanding that this encompassed the base and the sugar. Some knew adenine as the base and labelled a phosphate but gave 'sugar' or 'pentose' as a label for ribose. Others labelled this sugar glucose or deoxyribose. Phosphate was sometimes seen spelled as 'phospate'.

(b) (i) Most of the better performing candidates knew the answer to **(b)(i)**. Statement **C** was the most common incorrect answer. Some candidates chose statement **B** and with some careful thought could have discounted this by noticing that sucrose was diffusing via plasmodesmata, which is a passive movement.

(ii) Well-prepared candidates were able to work out the correct sequence from their knowledge of this process. There were a few candidates that did not use all the statements given to provide a sequence.

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(iii) Some candidates would have benefited from re-reading the question, which asked for 'any area... where sucrose is loaded...'. These candidates gave 'leaf' as their answer, rather than stating 'source'. Candidates who performed less well stated 'sink' or 'phloem'.

(c) (i) Candidates who performed well not only understood the role of tRNA in translation, but also realised how this linked to the sequence of mRNA codons and the amino acid sequence of the polypeptide. Others either thought about translation or explained the importance of the amino acid sequence. Good responses were clear in their detail, describing tRNA anticodon binding to a complementary mRNA codon at the ribosome and explaining that an incorrect amino acid added to a growing polypeptide chain would alter the primary structure of the protein. This type of response highlighted a good understanding, which contrasts with other answers where detail was lacking. Examples of this were stating a codon but not mentioning mRNA, writing about an aspect of the process but not mentioning the ribosome, or stating that an incorrect amino acid would produce a non-functioning protein but not explaining that this was because there would be an altered primary structure. Some candidates needed to have a greater understanding of the flow of information from DNA to polypeptide. These candidates described how a failure for a particular amino acid to link with its specific tRNA molecule would lead to a mutation of the DNA. Others misread the question and explained how an amino acid attached to its specific tRNA, more or less re-writing the information provided at the start of **(c)(i)**, or explaining what was meant by specificity of aminoacyl synthetase.

(ii) A thorough response to this question detailed the effect of the increase in hydrogen ions on the correctly named bonds in the enzyme structure and went on to explain how this would result in an altered shape of an enzyme and its active site. A good answer did not need to include the effect on the functioning of the enzyme, as was seen in other responses. Only hydrogen and/or ionic bonds should have been described as being broken; other named bonds such as peptide and disulfide bridges were incorrect. Some candidates re-stated the information provided and explained that broken bonds would denature the enzyme or would change the structure of the enzyme. In these cases, there needed to be further qualification explaining that the shape or tertiary structure of the enzyme changed, or detailing changes at the active site.

(iii) There were some excellent explanations of the induced fit mechanism, some of which were accompanied by diagrams. Some answers were vaguer in explaining how the slight change in active site allowed a better fit for the substrate, beginning by stating that the substrate was complementary to the active site – some good responses explained that the shape of the substrate was not quite complementary to the shape of the active site. A number thought that induced fit described the enzyme-substrate complex formed as a result of the lock and key mechanism, and weak responses only described the lock and key mechanism.

Question 6

This final short question to complete the paper assessed subject knowledge of syllabus ***Topic 9***.

(a) There were many candidates that knew the four main structures of the gas exchange system that were missing from Fig. 6.1, and most of these were able to get the sequence correct. Some had greater difficulty in remembering one of the four and instead added 'lungs' or 'alveolar sac', or named different bronchiole types (respiratory and terminal). A few added 'blood' in the bottom box.

(b) Most candidates knew one or both of the diseases to be named. Some should have added 'chronic' to their answer of 'bronchitis'. A number thought that lung cancer and/or asthma was a condition in COPD, with some weaker responses incorrectly naming the infectious disease tuberculosis.

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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.

Candidates should be able to assess the risk of a procedure.

Candidates should be given the opportunity to estimate unknown concentrations from results for known concentrations. If the value for the unknown concentration is between two known concentrations the answer should state this, e.g. between 0.6% and 0.4%. It would not be correct to state a concentration that has not been made e.g. 0.5%.

When carrying out practical work, candidates should be encouraged to gain experience in deciding which variables have been standardised and how to standardise other variables to provide accurate results. If key variables are allowed to change during an investigation the results may change.

General comments

Better performing candidates had used materials and apparatus during practical work as part of the course. Candidates who have had the opportunity to follow instructions carefully in a variety of practical situations are likely to find it easier to organise and complete unfamiliar activities.

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

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully and answer the specific questions accurately.

Comments on specific questions

Question 1

(a) Many candidates correctly stated that the hazard of one of the solutions was corrosive and the level of risk was medium or high.

(b) (i) Many candidates were able to carry out a simple dilution, showing at least four correct concentrations in the table in addition to the two concentrations stated. Many candidates correctly stated at least four percentage concentrations of **P** with the correct volumes of **P** and **W**, making 5 cm^3 to use in the investigation.

(ii) Some candidates correctly stated that the volume of the sample and the volume of the reagents (**K** and **C**) needed to be standardised when testing the other protein solutions and **U**.

(iii) The majority of candidates organised their results clearly by presenting a ruled table. The better candidates included an appropriately detailed heading for the independent variable (percentage concentration of protein solution) and the dependent variable (colour and number).
The majority of candidates recorded results for at least four concentrations of protein solution.
The better performing candidates showed the result for 1 % concentration of protein solution first and showed the correct trend for the results.

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(iv) Many candidates correctly estimated the concentration of protein solution in sample **U**. The better performing candidates stated that the concentration was between two known concentrations rather than estimating a value between the known concentrations.

(v) Most candidates correctly identified one significant source of error as the difficulty of judging the colour of the solution.

(c) (i) Some candidates correctly stated that two variables which needed to be standardised were the volume of urine, the volumes of **K** and **C** and the amount of shaking of the solutions when mixing. The better performing candidates then described the use of syringes to deliver the necessary volumes or an appropriate method for standardising the mixing of the solutions.

(ii) The majority of candidates drew the graph, using the headings given in the table, with protein concentration / $\mu g\ cm^{-3}$ on the *x*-axis and absorbance on the *y*-axis. The better performing candidates used scales of 200 to 2 cm, labelled at least each 2 cm for the *x*-axis and 0.2 to 2 cm, labelled at least each 2 cm for the *y*-axis, plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear ruled line accurately connecting each of the points or using a line of best fit.

(iii) Most candidates drew a circle on the graph to show that the anomalous result was the plot at 200 $\mu m\ cm^{-3}$ (protein concentration) / 0.36 (absorbance).

(iv) Many candidates correctly estimated the concentration of protein with an absorbance of 0.49 according to their results. The better performing candidates stated the units as $\mu g\ cm^{-3}$.

Question 2

(a) (i) Those candidates who had experience of producing large drawings as part of their course performed well. Some candidates produced drawings using a sharp pencil which did not include any shading and used most of the space provided. Many candidates were able to draw two cells that touched each other for the slides **S1** and **S2**. The better performing candidates drew the cells of **S1** with the membrane pulled away from the cell wall. The most common error was to draw lines that did not meet up precisely or were too thick. Most candidates used one label line and label to identify the cell wall of one cell.

(ii) Many candidates correctly stated that the solution **S1** had a more negative water potential than the onion cells and correctly explained that the difference in water potential between the external solution and the onion cell resulted in water moving out of the cells.

(b) (i) Many candidates were able to draw cells **D** and **Z** with sharp outlines and show that cell **D** had a wavy outline that included the correct number of folds and draw cell **Z** with a smooth outline.

(ii) Many candidates correctly annotated their drawings to describe the observable difference between cell **D** and cell **Z**. The better candidates stated that cell **D** had an irregular outline or that cell **Z** had a smooth outline.

(iii) Some candidates were able to suggest that the reason for the observed difference between cells **D** and **Z** was due to the different water potentials between the cells and the external solutions.

(c) (i) Many candidates correctly measured the diameter of the cells labelled **D**, **E**, **F**, **G** and **H** to the correct degree of accuracy, showed the conversion from millimetres to micrometres (multiplying by 1000) and showed division by the magnification (1430).
The better performing candidates showed their working.

(ii) Many candidates showed the addition of the measurements from **(c)(i)**, showed the division by 5 and included the correct units (μm).

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Paper 9700/42
A Level Structured Questions

Key messages

Candidates should be prepared to apply their knowledge in novel situations, such as **Questions 2**, **4** and **6**.

Candidates should be aware that precise answers are particularly important in the shorter questions, such as **Questions 5** and **6**.

General comments

Candidates found **Questions 2** and **4** to be the most challenging. **Questions 1**, **7** and **9** were on the whole well answered.

Comments on specific questions

Section A

Question 1

(a) (i) The graph showed the effect of light intensity on the rate of photosynthesis. A large minority were unable to identify light intensity as the limiting factor during the early part of the graph, stating carbon dioxide concentration or temperature. A common error was to state light alone.

(ii) Many candidates had an understanding of limiting factors; some had difficulty in expressing themselves clearly. Few mentioned that a process needs to be affected by more than one factor in this situation. Better performing candidates were able to say that the rate of reaction would be limited by the factor nearest its minimum value.

(iii) Many were able to say that temperature or carbon dioxide concentration were now acting as limiting factors. Some candidates omitted concentration when referring to carbon dioxide.

(b) This question was answered quite well. Many candidates were able to show that enzymes could be denatured by a rise in temperature and that this would affect the light-dependent stage and the Calvin cycle. Some noted that the stomata would have to close to limit transpiration but that this would affect carbon dioxide uptake. Better performing candidates mentioned the problem of photorespiration but few talked about loss of turgor or wilting.

Question 2

(a) Candidates were given information on the American badgers and the black-footed ferrets and most were able to show that the ferrets were endangered because they had only one source of food and many predators, whereas the badgers had many sources of food and no predators.

(b) This question was well done with many able to state that local government could raise awareness about the situation of the ferrets and also ban hunting. Some candidates stated that universities could carry out research and zoos could be involved in captive breeding programmes with a view to eventual release into the wild. Other candidates said that Native Americans could provide a suitable safe habitat for the animals.

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(c) (i) Most candidates clearly described the three graphs, though occasionally not reading the figures accurately.

(ii) Better performing candidates were able to show that the gene pool and leg size had decreased in Wyoming but that the gene pool had increased in Arizona. Some needlessly wrote about the figures for South Dakota.

(iii) This question proved to be challenging for most candidates. Few were able to provide reasons for the changes in gene pool and leg size.

(d) Very few candidates were able to explain the benefits of using frozen sperm in captive breeding programmes. Better performing candidates stated this would increase the gene pool and that sperm could be sent to other zoos.

Question 3

(a) Some candidates had a good understanding of the mechanism of sarcomere contraction. Several candidates did not answer this question.

(b) Many candidates were prepared to use their knowledge of neuromuscular junctions to attempt to answer this question. Many were able to suggest interference by the toxin at the presynaptic neurone or the sarcolemma. The most common correct answers mentioned the non-release of acetyl choline, the blocking of receptors on the sarcolemma or the inhibition of acetylcholinesterase.

Question 4

(a) This question required candidates to compare gametogenesis in males and females. Many wrote about spermatogenesis and oogenesis. Better performing candidates made comparative statements or linked statements in different parts of their answer. These candidates were able to show that in females the process begins before birth whereas it starts at puberty in males. Many mentioned that in the female, one gamete would be produced at the end of the process but that there would be four in males.

(b) (i) Many were able to identify locus **R** but fewer accurately gave mutation as the cause.

(ii) Many candidates were able to show that parents **A**, **B** and **C** and offspring **5** were all heterozygous; some did not give reasons, using the gene loci.

(iii) This question required candidates to give explanations using specific loci. Better performing candidates were able to show that offspring **1** and **2** differed at loci **P**, **Q** and **R** or that offspring **3** and **4** differed at loci **P** and **S**. The same references were also needed for the second question about asexual reproduction.

(c) Many good answers were seen here. The fact that females could reproduce without a male to keep the population going was frequently given as an advantage. More commonly given were disadvantages such as a decrease in genetic diversity, decreased heterozygosity, inbreeding depression and the fact that the offspring may not be able to adapt to a changing environment.

Question 5

(a) (i) and **(ii)**
Most candidates were able to correctly identify negative feedback as the mechanism and glucagon as the hormone. Many candidates were able to correctly spell the term *glucagon*.

(b) Some candidates misunderstood the roles of the two enzymes. Better performing candidates showed that after a meal the glucose concentration in the blood would rise and this would trigger release of insulin from the pancreas. The insulin would stimulate an increased activity of glycogen synthetase leading to glycogenesis. As the glucose concentration in the blood was high the activity of glycogen phosphorylase would fall as less glycogenolysis would be needed.

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Question 6

(a) (i) Candidates were presented with a list of information about the movement of *Paramecium.* Many were able to suggest that the calcium ion channels would open and that calcium ions would move in. A reference to diffusion was also made by some candidates. Some then went on to state that the cilia would beat in the opposite direction for the *Paramecium* to move backwards.

(ii) Only a minority of candidates were able to state that active transport would ensure that calcium ions would be moved out against a concentration gradient and that would need energy or ATP.

(b) (i) Most candidates were able to state osmosis here.

(ii) Most candidates mistakenly thought that for the contractile vacuole to increase its rate of contraction, the exterior water potential would have to be lower when in fact the opposite is true.

(c) There were many good answers, referring to the linear nature of *Paramecium* DNA and that it is associated with histones and enclosed in a nucleus.

Question 7

(a) (i) Surprisingly only a minority of candidates was able to correctly identify the location of the Krebs cycle, oxidative phosphorylation and decarboxylation.

(ii) Many were able to state that proteins or enzymes were coded for but fewer related this to use in the mitochondrion itself.

(b) Many candidates were able to complete some of the table.

(c) Many good answers were seen here, with the most common correct answers including the failure of the ETC to work and the lack of ATP production. Only a minority of candidates then went on to identify which muscle would fail to contract resulting in death.

(d)(i) Most candidates calculated correctly the RQ value but some did not give their answer to two decimal places as requested in the question.

(ii) There were many good answers here referring to the fact that in aerobic respiration different substrates would be used and each would have a different RQ value. Few mentioned that different tissues may respire different substrates.

Question 8

(a) Most candidates were able to explain the terms *dominant* and *allele*.

(b) (i) (ii) (iii)
Many candidates used the symbols given in the question to identify the genotypes of the parents. This then enabled them to accurately complete parts **(ii)** and **(iii)**. Several candidates left this page blank.

(iv) Many gave the correct answer as 1/16, 0.0625 or 6.25%.

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Section B

Question 9

(a) Candidates who chose this question were usually able to show that organisms that contained the gene for fluorescence were able to be identified by glowing when UV light was shone on them. A common error was to imply that the gene itself emitted light rather than the substance it coded for. Many made comparisons with antibiotic resistance genes and noted that the use of fluorescent substances was far safer. Some were able to mention substances such as GFP from jellyfish.

(b) This question was very well answered. Good answers included the fact that there may be an increase in crop yield which would have a beneficial effect financially to the farmer. Also, crops may be tolerant to climate changes and be able to grow in poor quality soil. The fact that some crops may be pest resistant was also given but some candidates did not mention pesticide resistance. Many were able to give an example such as Golden Rice™ or By maize.

Question 10

(a) Candidates found this a challenging question. Better performing candidates referred to the use of vectors such as liposomes or viruses to deliver the normal gene or allele. Other facts such as the short term nature of this treatment and the need for repeat treatments were rarely given. Some candidates mistakenly talked about germ line therapy which was not requested.

(b) Candidate found it difficult to be precise when answering this question and often repeated their answers in different ways. The most common correct answers given were the identification of carriers, the ability to identify an unborn child with a genetic disease and make decisions regarding aftercare, treatment or even terminating the pregnancy.

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