BIOLOGY

Paper 9700/11
Multiple Choice

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

General comments

The paper differentiated well.

Comments on specific questions

Question 3

Many candidates found this difficult and could not manipulate the information correctly.

Question 4

The majority of candidates did not know what a typical eukaryotic cell contains.

Question 10

Weaker candidates did not understand the structures of amylose and cellulose. A common misconception was that cellulose contains α-glucose.

Question 11

Stronger candidates answered correctly but weaker candidates were confused about the distribution of peptide bonds and often selected answer **D**.

Question 14

Just over half of the candidates were able to evaluate which graphs correspond to high and low concentrations of a competitive inhibitor.

Question 16

Many stronger candidates processed the information correctly. Weaker candidates found this difficult both in terms of the direction of diffusion and respective directions of active transport.

Question 21

Just over a half of candidates knew that tRNA contains single stranded RNA which folds such that hydrogen bonding occurs between regions of complimentary bases.

Question 26

Weaker candidates did not know the functions of the labelled cells.

Question 27

Those candidates with a good understanding of oxygen dissociation curves and Bohr effect were able to process the information correctly.

Question 28

Nearly half of the candidates incorrectly selected option **D**. Carboxyhaemoglobin is formed when carbon monoxide binds to haemoglobin, not when carbon dioxide binds.

Question 29

Stronger candidates showed understanding of the concepts involved in the reactions involving carbonic anhydrase.

Question 32

Some stronger candidates and few weaker candidates answered this correctly.

Question 33

Stronger candidates answered well but weaker candidates found this challenging with all answers seen equally.

Question 37

Many weaker candidates believed incorrectly that only B-lymphocytes produce memory cells.

BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

The paper differentiated well.

Comments on specific questions

Question 2

The majority of candidates realised that the magnification is unaltered but many did not realise that the resolution is decreased.

Question 6

Over half of candidates were able to correctly process the information.

Question 10

A significant number of weaker candidates believed incorrectly that ionic bonds hold together the structure of cellulose.

Question 12

A significant number of candidates did not appreciate that the second test would increase the concentration of reducing sugars and so gave an answer which included option 2.

Question 13

Weaker candidates found this difficult and each option was chosen equally.

Question 14

Weaker candidates thought all three statements were correct.

Question 17

The majority of stronger candidates answered correctly but weaker candidates found this very challenging.

Question 19

Weaker candidates found this difficult.

Question 20

Most weaker candidates answered incorrectly.

Question 25

The majority of weaker candidates answered incorrectly.

Question 30

The vast majority of candidates found this question very difficult. The strongest candidates chose correctly with weaker candidates choosing each incorrect option equally.

Question 33

Many candidates correctly identified disease 1 and many of these also correctly identified disease 2.

Question 34

A significant number of weaker candidates answered incorrectly with many choosing one of the options which included factor 3.

Question 35

The majority of candidates answered correctly but a significant number of weaker candidates thought cholera to be non-infectious.

BIOLOGY

Paper 9700/13
Multiple Choice

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

General comments

The paper differentiated well.

Comments on specific questions

Question 1

The majority of weaker candidates answered incorrectly.

Question 3

Many weaker candidates believed incorrectly that all companion cells contain chloroplasts.

Question 4

The majority of candidates answered incorrectly.

Question 6

Some candidates found standard form difficult.

Question 10

The majority of weaker candidates found this challenging.

Question 11

The majority of stronger candidates answered correctly but weaker candidates found it difficult to relate the diagram to the correct description.

Question 13

A minority of candidates were able to evaluate the information correctly.

Question 16

The majority of stronger candidates processed the information correctly.

Question 21

Almost half of the weaker candidates didn't appreciate that base T (thymine) is replaced by base U (uracil) and so selected incorrectly option **A** or **B**.

Question 25

Weaker candidates found this very difficult.

Question 27

The majority of strong candidates had a good understanding of the transport of carbon dioxide by blood.

Question 34

The majority of weaker candidates thought incorrectly that both measles and tuberculosis are bacterial in nature.

Question 35

The majority of candidates were able to process the information correctly.

Question 36

The majority of candidates answered correctly.

BIOLOGY

Paper 9700/21
AS Structured Questions

Key Messages

- Candidates should have a clear understanding of the different types of bonds associated with protein structure and the different levels of organisation. Some candidates referred to peptide bonds when describing secondary and tertiary structure. They should also understand that denaturation of a protein involves breaking bonds that are a result of interactions between R-groups (side chains) of amino acids. The weakest bonds, hydrogen bonds, are broken first. Some candidates named both the strong covalent disulfide bridges and peptide bonds as those that break during denaturation.

- Memory cells should not be described as cells that 'remember' the foreign antigens of pathogens. They can be described as long-lived cells of the immune system that are produced from both specific B- and T-lymphocytes during a primary immune response to the presence of non-self antigens, whether they have entered the body during an infection or in a vaccine. Candidates should understand that they are present in higher numbers than the original specific lymphocytes from which they originate. Memory cell production is a feature of active immunity. Memory cells can respond rapidly if exposed to the original non-self antigen and account for the faster response of a secondary immune response compared to a primary immune response.

- The two command words 'explain' and 'describe' are frequently used in examination papers and some candidates are not clear as to the difference between the two. Some guidance is given in the syllabus (8.5 Glossary of terms) as to the meaning of these terms. Additionally, candidates should have experience of a variety of questions using these two terms, set in different contexts, so that they can tackle examination questions with more confidence.

General Comments

There was a good range of marks on this paper. Candidates found **Question 3(b)** on phloem transport relatively straightforward and were fluent at describing the process of flow down a pressure gradient in phloem sieve tubes, even though some started their description too early with loading of sucrose into companion cells rather than loading into sieve tubes. Similarly, good descriptions of secretion of protease from pancreatic cells in **Question 5(b)** were given, but these often began with protein synthesis on the rough endoplasmic reticulum rather than packaging into vesicles in the Golgi body, as required by the question. It is likely that provision of unnecessary information by candidates occasionally led to omission of relevant details. It is important that candidates focus their responses on the actual requirements of the question. They would benefit from looking at a range of similar questions to identify where a response should start and where it should end, and how this makes sequencing the answer easier.

Candidates were sometimes less confident in questions asking about 'roles'. These types of question require answers that go beyond just providing a sequence of events or description of a process. Some idea of the significance or contribution at a wider level is also expected. For example, in **Question 1(d)(i)** about the role of nitrogen fixation, candidates were good at describing the process but often did not consider its significance in contributing to soil fertility and replacing fixed nitrogen lost by denitrification. Similarly, in **Question 6(b)** about the role of mRNA, good descriptions of translation were given, but consideration of the importance of mRNA as a copy of a gene that codes for a polypeptide or the significance of travelling from the nucleus to a ribosome in the cytoplasm was often lacking. Candidates therefore often provided description of roles that were incomplete. Compared to these examples, candidates found it much easier to gain marks for describing the role of carbonic anhydrase in **Question 4(b)(ii)**.

Candidates should make use of information provided in questions, including diagrams. For example, in **Question 4(a)** making reference to the examples of enzymes **A** and **B** in **Fig. 4.1** aided explanations of the differences between the two ways in which enzymes interact with their substrates. Similarly, in **Question**

4(b)(i), discussion of secondary structure was improved by reference to structures **P** and **Q** – the α helix and β pleated sheet – in the image of carbonic anhydrase, **Fig. 4.2**.

Comments on Specific Questions

Question 1

Parts **(a)**, **(b)** and **(c)** assessed knowledge of mitosis from ***Section E*** of the syllabus. There were many good answers to part **(a)**, which was based on a photomicrograph of mitosis in *Vicia faba*.

The remainder of the question assessed knowledge and understanding from ***Section K***. Answers to **(d)(i)** tended to concentrate on what happens during nitrogen fixation rather than its role within the nitrogen cycle. Some confusion between nitrogen fixation and nitrification was evident in the responses of a number of candidates. There were many excellent answers to **(d)(ii)**.

(a) A very high proportion of candidates gave the correct sequence of stages of mitosis and chose suitable examples from the labelled cells from **Fig. 1.1**. Some candidates confused telophase with cytokinesis and some gave the stages in the wrong sequence. A small number of candidates did not follow the rubric and wrote their answers in the wrong columns. Some added detailed descriptions of the stages using the right hand column for this. This was unnecessary. Candidates should be reminded of the need to address the requirements of the question. A common error was the inclusion of interphase (cell **D**) as one of the stages in mitosis.

(b) Many candidates gave good descriptions of the role of the spindle in mitosis. Some candidates did not make it clear that the spindle is attached to centromeres of the chromosomes and many omitted the term 'pole' from their answers; instead, they stated that the spindle microtubules pull chromosomes to the 'ends' or 'sides' of the cell. During anaphase, sister chromatids are pulled to opposite poles. These are also known as daughter chromosomes. Some candidates referred to the centre of the cell rather than to the equator and some did not make it clear that the spindle was responsible for their alignment at the equator. The role of the spindle fibres in ensuring that an equal number of chromosomes pass to each daughter cell was not often mentioned.

(c) Most candidates gave two suitable roles of mitosis. Among the most common correct answers were asexual reproduction, repair of tissues and replacement of cells. There were some that gained credit with regeneration of lost structures, such as legs and tails, and clonal expansion of lymphocytes; both were very acceptable responses. A common incorrect response was 'repair of cells'. Few candidates took a wider view by considering maintenance of the number of chromosomes or genetic stability.

(d) (i) Not all candidates were sure of the products of nitrogen fixation. Whilst ammonia is the product of biological fixation and the Haber-Bosch process, nitrate is the product of fixation by lightning. Some candidates referred to the triple bond in dinitrogen (N_2), but did not explain that the bond has to be broken or that the molecule is reduced. Some went on to describe the process of nitrogen fixation involving nitrogenase in some detail, which was not required. Many thought that when bacteria fix nitrogen, it is immediately available to plants as nitrate ions or that the ammonia produced is immediately changed to nitrate by nitrification in the soil. Very few candidates took wider views that nitrogen fixation improves soil fertility or balances the loss of fixed nitrogen from the biosphere by denitrification and ocean deposition.

(ii) Effective responses recognised as the starting point that nitrogen becomes available to the cereal crop as a result of the decomposition of the legumes. They then went on to describe part of the sequence in which organic nitrogen in proteins is made available first as ammonium ions and then as nitrate ions. Often very full and detailed descriptions of the stages involved were given.

Very few candidates mentioned detritivores as the first step in the breakdown process, the hydrolysis of protein into amino acids by proteases, or the process of deamination.

Question 2

This question, about defence against pathogens in the context of the gas exchange and immune systems, assessed knowledge and understanding from ***Sections H*** and ***J*** mainly. The three questions in part **(d)** prompted candidates to apply their knowledge of the immune system.

(a) (i) Many candidates identified the ciliated epithelium in **Fig. 2.1**. Some used the term endothelium instead and others gave cilia without any further information. Far fewer identified the red blood cells. Incorrect answers were goblet cell, cartilage and mucous gland. Candidates tended to identify what they knew to be present in the lining of a bronchiole rather than using the evidence from **Fig. 2.1**.

(ii) Most candidates gave suitable descriptions of the roles of cilia and mucus in the defence of the gas exchange system from pathogens. A number of candidates thought that cilia swept bacteria, rather than mucus and some were not clear that the mucus was being removed from the lungs. As few candidates had identified **Y** as a red blood cell, there were few references to the role of the capillary in delivering phagocytic cells, neutrophils or macrophages to the epithelium. The role of phagocytic cells in protecting against the entry of bacterial pathogens was not a valid response since none are visible in the electron micrograph.

(b) (i) Many correctly identified cell **J** as carrying out phagocytosis or endocytosis. Many of those that did not use either of these terms described the process in terms of the cell engulfing the bacteria and this was acceptable.

(ii) There were some very good answers about antigen presentation, but far fewer about the digestion or breakdown of bacteria.

(c) Candidates provided many good explanations of the differences between the secondary and primary immune responses, although these were presented in a wide variety of ways. Some started their answers by stating that the secondary response would be faster and then proceeded to explain the role of memory cells. Others started with the memory cells and finished their answer by stating that the whole process would be faster. Candidates often did not explain that the memory cells that respond are specific to the pathogen or that the response is faster as there is a much larger population of them than before the first response. Some candidates seemed to confuse a secondary infection with a secondary immune response.

(d) (i) There were many answers that stated that a certain function of T-lymphocytes would occur slowly or not at all. For example, the deficiency of T cells would result in much slower immune responses, reduced cytokine secretion to stimulate B-lymphocytes and increased susceptibility to infectious diseases.

(ii) Some candidates used the appropriate term from the syllabus, non-self, when answering part **(ii)**. However, many just stated that the pathogen would not be recognised, but were not clear why.

(iii) Many candidates stated that there would be no immune response. This was not a correct answer since T-lymphocytes are still able to respond even if there are no B-lymphocytes to stimulate.

Question 3

Candidates struggled to apply knowledge of plasmodesmata from ***Section A*** to explain the advantages of plants having complex plasmodesmata, but were more successful at describing translocation in part **(b)**, from ***Section G*****,** which also included an understanding of water potential from ***Section C***.

(a) The complex plasmodesmata shown in **Fig. 3.1** provide more pathways between cells. Some candidates did not realise that these pathways are symplastic and do not involve crossing cell membranes or passing through cell walls. These pathways allow faster or increased movement between cells. Sucrose and water were the most commonly mentioned named examples of substances that move from cell to cell via plasmodesmata, but amino acids, assimilates and ions were also seen and accepted. Candidates did not gain credit for referring to osmosis or stating that movement was simply ‘easier’ or ‘more efficient’. Stating generally that carbohydrates, substances or materials are transferred through plasmodesmata did not gain credit.

(b) There were some good and well sequenced responses to this question, but descriptions of translocation often started with quite lengthy accounts of movement of sucrose into companion cells. This was not necessary in the context of this question. Answers should have started with the accumulation of sucrose in sieve tubes, which lowers the water potential. Some candidates did not make it clear that the resulting pressure was hydrostatic pressure and that mass flow occurs down a hydrostatic pressure gradient. Instead, many referred to movement down a water potential gradient or concentration gradient. A few referred to sieve tube elements as 'phloem'.

Question 4

This question, based on ***Sections B***, ***C*** and ***G*** of the syllabus, began with enzyme activity, comparing the 'lock and key' and induced fit mechanisms, and then covered protein structure before progressing to the specific example of carbonic anhydrase. As mentioned in **General Comments**, answers would have benefited from referencing the labels **A**, **B**, **P** and **Q** that were given in the diagrams.

(a) There were many good answers that used the diagram to compare the 'lock and key' method with the induced fit method. To gain credit, answers had to describe the shape of the active site in both **A** and **B**. Many candidates did not do this but just wrote about 'the enzyme' rather than its active site. Some candidates incorrectly stated that the active site in **A** has the same shape as the substrate rather than that they have complementary shapes. Some candidates confused this question with inhibition and stated that **A** showed competitive inhibition and **B** showed non-competitive inhibition.

(b) (i) Descriptions of the secondary structure of proteins in part **(i)** were often short on appropriate detail. For example, a common error was to describe hydrogen bonding between R groups rather than between the carbonyl and amine groups either side of the peptide bond. Many identified the two forms as an α helix and a β pleated sheet, but did not identify **Q** and **P** from the image of the enzyme in **Fig. 4.1**.

(ii) There were many thorough answers detailing the role of carbonic anhydrase. Most stated that it is in red blood cells and catalyses the reaction of carbon dioxide and water to form carbonic acid. Some candidates were unsure about the dissociation to form hydrogen ions and hydrogencarbonate ions. Others were uncertain of the roles of these two ions in the release of oxygen from haemoglobin and the transport of carbon dioxide in the plasma. While quite a number described the role of hydrogen ions in the release of oxygen from oxyhaemoglobin, fewer stated that carbon dioxide is transported as hydrogencarbonate ions. Many did not make it clear that hydrogen ions promote the oxyhaemoglobin dissociation. Some candidates gave relevant information that was additional knowledge, such as the role of hydrogencarbonate ions as the buffering system in the plasma, and this was credited. However, many answers included additional information that was not relevant to the question, such as the role of haemoglobin as a buffer.

Question 5

This question assessed knowledge from ***Sections A***, ***B*** and ***D*** of the syllabus. There were many good answers to parts **(a)** and **(b)**. Many candidates were less confident with matching the properties of water to the roles given in **Table 5.2**.

(a) Many candidates completed **Table 5.1**, very effectively, correctly identifying two suitable features of the lipids in **Fig. 5.1**. Common answers were presence and absence of phosphate groups and the number of fatty acids. There were some rather complex ideas given that were often incorrect.

(b) There were many excellent descriptions of secretion of the enzymes from pancreatic cells. As stated in the **General Comments**, some of these began earlier than necessary with protein synthesis, but most included the production of vesicles by the Golgi apparatus, movement of the vesicles through the cytoplasm, fusion of the vesicle with the cell surface membrane and exocytosis. Some excellent details were included in responses, such as the role of microtubules in vesicle transport and descriptions of the forming and maturing faces of Golgi bodies. Some candidates misinterpreted the diagram and described endocytosis.

(c) Many candidates correctly attributed the roles of water as a solvent and in decreasing body temperature in mammals to appropriate properties. Movement in the xylem was often attributed to cohesion and adhesion rather than to the underlying property that water molecules form hydrogen bonds.

Question 6

This question assessed knowledge from ***Section F*** of the syllabus. **Fig. 6.1** showed a small region of mRNA production from a template strand of DNA.

(a) The four bases labelled in **Fig. 6.1** were often identified correctly, although uracil was occasionally misidentified as thymine. Misspellings that were not allowed included thiamine and 'cystine'. Some candidates were not able to identify any of the bases correctly.

(b) Several key ideas were often missing from answers describing the role of mRNA. These included:

- mRNA is a copy of the DNA that codes for a particular polypeptide
- mRNA codes for the sequence or order of amino acids in the polypeptide
- the nucleotide or base sequence is read as a series of codons
- during translation there is base pairing between each codon and the appropriate anticodon on tRNA.

Most candidates tackled this question by describing the events that occur following the movement of mRNA from the nucleus to the ribosome, often making points that have been included in mark schemes for questions on translation in the past. As a result they missed the important points about the base sequence coding for the amino acid sequence of the polypeptide. This was a case where more careful reading of the question by the candidates would have resulted in better responses.

BIOLOGY

Paper 9700/22
AS Structured Questions

Key Messages

- Candidates should have a clear understanding of the different bond types associated with protein structure and protein level of organisation. Knowledge of this was required in **Question 4(b)(ii)**. Some candidates incorrectly referred to peptide bonds when describing secondary and tertiary structure. In addition, some candidates named both the strong covalent disulfide bridges and peptide bonds as those that break during denaturation, which would not be the case.

- Memory cells can be described as long-lived cells of the immune system that are produced from both specific B- lymphocytes and T-lymphocytes as a result of a primary immune response to the presence of non-self antigens (for example, from an infection or, as in **Question 5(a),** in a vaccine). Candidates should understand that they are present in higher numbers than the original specific lymphocytes from which they originate. The term 'memory cells' is difficult for many candidates. Memory cells should not be described as cells that 'remember' the foreign antigens of pathogens.

- Candidates need to be clear about the different requirements for the command words, 'explain' and 'describe'. For example, in **Question 2(e)**, signs and symptoms of COPD were explained by a number of candidates, rather than described.

General comments

The performance of a number of candidates in this examination was of the highest quality. For these a very good knowledge of the syllabus learning outcomes was evident so that the candidates were able to recognise relevant syllabus learning outcomes, such as in **Question 5(c)(i)**. They were also able to confidently apply knowledge and understanding to new situations, such as in **Question 4(b)(ii)**. Many others gave solid responses and demonstrated a good grasp of the syllabus.

Some candidates could have improved their overall performance by having a better understanding of scientific terminology. For example, in **Question 2(d)(i)**, some candidates thought that 'transcription' was the process of polypeptide chain synthesis at the ribosome and described translation, which was a costly error. In part **(e)** of the same question, some did not understand what was meant by 'signs and symptoms'. In **Question 4**, the importance of re-reading the question was highlighted in **(b)(i)**, where some candidates gave similarities in the results in **Fig. 4.1**, which was not required. Similarly in **Question 6(b)(i)**, not all noted that the focus was on light reaching leaves, and these candidates gave reasons that included light energy missing leaves. **Question 6** proved to be challenging for many candidates. Here, uncertainty in understanding the different definitions of the ecological terms was evident. In **(b)(iii)** there were a large number who did not understand the term 'organic' and gave inorganic nitrogen containing compounds, which could not gain credit. In the same question, candidates were asked to give a response in terms of plants, which many did not do.

Candidates had sufficient time to complete the paper. The majority attempted all parts of the questions and handwriting was usually legible. Most candidates showed their working in **Question 3(c)** and many wrote out the formula they used to obtain the magnification of the image in **Fig. 3.2**.

Comments on specific questions

Question 1

This question assessed knowledge of the mammalian heart from ***Section G***. A number of candidates drew labelled sketches of the heart to help them arrive at the correct answers.

Many candidates had few problems in identifying the structures of the heart being described and gained full credit. Of those gaining partial credit, structures described by statements **C** and **D** were the least well known. The structure described in statement **A** was generally well known. All but the weakest candidates deduced that the chamber being described was a ventricle and then most correctly noted that this was the right ventricle. **B** was usually known and only a small proportion named one of the other main blood vessels of the heart. Some only stated 'vein'. For statement **C**, many incorrectly gave Purkyne (or Purkinje) fibres as the answer. Septum and non-conducting fibres were also frequently seen. Coronary arteries described in statement **D** was commonly stated as either the aorta, cardiac arteries, arteries or capillaries. Most candidates noticed in statement **E** that the ventricle contained oxygenated blood so realised that they had to be precise in the location of the relevant valve. Bicuspid valve was the definitive answer, but for those who gave atrioventricular valve, this must state that was the left valve. Some incorrectly gave tricuspid or the right atrioventricular valve and a number incorrectly thought that the semi-lunar valve was being described. A few named the mitral valve.

Question 2

In this question, candidates were introduced to the infectious disease whooping cough and using this as a theme, were expected to apply knowledge and understanding from a number of syllabus areas, ***Sections A, F, H, I.***

(a) Many candidates correctly made direct reference to **Fig. 2.1** and the damage done by *Bordetella pertussis* before going on to explain the consequences of this. There were some clear descriptions given by these candidates, who generally focused on cilia rather than the ciliated epithelial cells. As cilia are cellular structures rather than complete cells, it was not appropriate to describe them as 'killed'. Candidates were also credited if they described the presence of scar tissue instead of, or in addition to, the absence of cilia in the damaged area **X**. Some candidates ignored the information that *B. pertussis* caused the damage and focused on excessive mucus production destroying cilia and there being so much mucus that this prevented their coordinated rhythm. The general idea of cilia being unable to waft mucus up the trachea was credited and a few candidates showed an understanding that areas of damaged or missing cilia would mean that overall the synchronous rhythm occurring to move the carpet of mucus to the top of the trachea for swallowing would be impaired. Some responses suggested some symptoms of whooping cough that would be caused by the damage, which was not required.

(b) This proved to be straightforward for many. There was a large range of incorrect responses, the most common of these were: cilia; goblet cells; epithelial cells; nose; thymus gland; bronchus; and alveoli. There were some who left this answer blank.

(c) In the main introduction to the question candidates had been informed that whooping cough was transmitted from person to person in a similar way to tuberculosis, a disease which was familiar to them. Some incorrectly described bovine transmission and others gave other incorrect modes of transmission, such as a faecal-oral route. The best responses gave descriptions in terms of transmission of the pathogen concerned from an infected to an uninfected person and were clear in how this occurred. Weaker responses just described the bacteria as being in the air or stated that a virus was transmitted.

(d) (i) There were some very full and fluent accounts of transcription seen, with many correct points given in a sequential flow. Where full credit was not gained, this tended to be a lack of clarity rather than a short response. In outlining the initial steps in transcription, good responses began with the unwinding of the section of the DNA double helix comprising *MUC5AC* and the breaking of hydrogen bonds between the strands. Many knew that helicase was an enzyme involved in this. Good responses noted that only one strand of DNA was used as the template strand. Some could have improved the quality of their response by being more precise and taking care to give correct details. Some were not clear that they understood that free RNA nucleotides were used in the synthesis of mRNA and many wrote about mRNA copying DNA or stating that the information on DNA was copied onto mRNA, rather than outlining a sequential build-up of a polynucleotide chain from the nucleotides. There was sometimes confusion between nucleotides and amino acids, and between polynucleotides and polypeptides. Some weak responses gave statements that were a mixture of outline events of DNA replication and transcription. There were a number who went on to describe translation and a few who only described translation.

(ii) The majority realised that the Golgi body was the most likely cell structure for glycosylation, although the nucleus, cytoplasm, ribosomes and cell surface membrane was also given by candidates. Some repeated the information given, that mucin was packaged ready for exocytosis, while others stated that the mucin was protected from the rest of the cell, neither of which gained credit. Of the acceptable explanations, the most common idea given was the need to secrete the mucin extracellularly.

(e) There were some excellent responses for part **(e)**, with some describing all the main signs and symptoms of COPD. Some candidates named emphysema and chronic bronchitis and separately described the symptoms of each, which was not required. Lung cancer is not grouped within COPD but some candidates gave symptoms for this disease. Coughing alone is not enough to relate it to COPD: the best descriptive terms were 'chronic' and 'persistent' to indicate understanding of the difference between this and the cough that results from acute infections. Deep or heavy breathing was not credited as people with COPD (emphysema) have shallow breathing owing to the loss of alveoli. Chest tightness, the feeling caused by the accumulated mucus in the lung or from lung infections associated with chronic bronchitis, was interpreted incorrectly by some candidates as angina pectoris and some of these wrote about heart attacks. A proportion of candidates did not describe signs and symptoms: either a description of events occurring leading up to COPD was given, or more commonly, explanations were given of why there is a chronic, persistent cough, why there is overproduction of mucus and why a person would have problems breathing. In these cases many of the points correctly stated in part **(a)** were repeated here. The weakest responses gave symptoms indicative of colds and influenza.

Question 3

This question required candidates to consider topics from ***Section G***, such as the structure and function of capillaries, as well as movement across membranes from ***Section D***.

(a) High quality responses were clear and used correct terminology. They also explained that this meant that there was no net movement of water. Partial credit was gained for stating that there was no movement of water. Stronger candidates understood that the saline solution provides the equal water potential that is required to avoid changes to the red blood cell, whereas a number thought the composition of the cytoplasm of red blood cells was the same as the composition of saline solution, or that saline solution was the same as blood plasma. Others explained why red blood cells need to remain intact and so did not directly answer the question. Some candidates thought that the saline solution provided the red blood cells with required salts or provided the correct pH, whilst others thought that the saline solution helped the exchange and carriage of respiratory gases. Weak responses mentioned features of red blood cells such as a lack of a nucleus and the presence of haemoglobin, which did not have any relationship to the question.

(b) The majority of candidates chose one of the two respiratory gases, oxygen or carbon dioxide, to enter red blood cells. A few were correct in naming (passive) diffusion as a transport mechanism and even fewer gave further detail in explaining that the molecules (being small) would be able to cross the hydrophobic core of the phospholipid bilayer. There were a number that stated that these were polar molecules and incorrectly went on to state that entry would be by facilitated diffusion through transport proteins.

Some candidates chose mineral ions, or named mineral ions and frequently these went on to gain full credit with details of the transport mechanism. However, no credit was given for relating channel proteins to active transport as these are involved in facilitated diffusion only. Glucose, and sometimes amino acids, were also named and generally the additional information accompanying these was correct. Weak responses named components of plasma or plasma itself as entering red blood cells. Plasma proteins, including antibodies were suggested, as were white blood cells and platelets. A number of candidates gave lengthy accounts of events occurring inside the red blood cell which were not relevant to the question and others missed out the details of crossing the membrane.

(c) The majority of candidates answered this question correctly. Partial credit was gained where there was an error in converting the measurement to micrometres, where the answer was given to too many decimal places, or rounding to two significant figures (i.e. 950 instead of 947) without stating that this had been done. Candidates who had calculated correctly and who then stated that their final answer was to significant figures gained full credit.

(d) Most candidates noted the thin capillary wall as a feature and gained full credit for their explanation. Partial credit was awarded for stating that this meant it was 'easier' or 'faster' for diffusion to occur or for imprecise answers. There were some good explanations referring to the red blood cells within the capillary.

(e) Candidates found this question to be challenging. Some were able to make valid suggestions, such as realising that the capillaries still needed to function to deliver materials and take away waste, so impermeable cell membranes and thick or multi-layered capillary walls would not allow this to occur. Most of the responses that gained credit suggested that there would be no or fewer fenestrations (endothelial pores). A small number made other suggestions such as tight junctions and a relatively impermeable basement membrane.

Question 4

This question presented candidates with unfamiliar material and some showed a high level of skill in handling information and giving reasoned explanations. Part **(a)** of this question assessed candidate knowledge of the structure of β-glucose from ***Section B***. Part **(b)** required candidates to apply their knowledge of protein structure, also from ***Section B***, and of enzymes (from ***Section C***) as well as to use graphical information to complete their responses.

(a) The quality of responses here was variable. Some candidates produced some very clear drawings of the ring structure of β-glucose, although others drew correct complete structures but forgot to include the hydrogen bonded to carbon 5. A few candidates drew a disaccharide.

(b) (i) The best responses were clear and concise and stayed focused on the question. Clear sentences comparing the results for enzyme **A** and enzyme **T** for each main feature evident on **Fig. 4.1** were given by these candidates. Data were accurately extracted from **Fig. 4.1** with units given. Comparative terminology was used and, by using the terms 'optimum temperature' 'the lowest/highest temperature for detection of activity' and 'temperature range', it was clear which feature was being compared. Other responses had less clarity and frequently gave a general comparison of the results. Many candidates thought that denaturation started after the highest temperature at which activity was detected, rather than that it was a progressive process throughout the temperature increase from the optimum. Better responses stated that complete denaturation occurred at these points. Accurate use of comparative language would have helped many candidates in this question.

(ii) There were a number of points to consider in **(b)(ii)** and there were also ideas to retrieve from information given. These ideas needed to be linked to similarities and differences in primary structure. Candidates who did very well on this question produced well organised responses that made reference to the differences shown in **Fig. 4.1**. Others were confused between the bonds formed between R-groups and peptide bonds. Many candidates did not appreciate that the main similarity was the active site of the enzymes, as they both are involved in the hydrolysis of cellobiose. Some simply re-stated that there were differences and similarities in the primary structure and went on to summarise the results in **Fig. 4.1**, frequently repeating much of what was written for **(b)(i).** A number of weak responses included reference to codons and base sequences.

Question 5

This question mainly assessed subject matter from ***Section I***, with a link to ***Section E***.

(a) Many gained full credit for this question. Where partial credit only was gained, this was generally for not stating both aspects of the immunity acquired, for example, artificial active immunity or artificial passive immunity. There were some who did not have a good grasp of this topic and gave answers such as 'natural artificial immunity'.

(b) Most candidates answered correctly. The most common incorrect response was neutrophil.

(c) (i) Candidates who performed well made a clear statement that healthy body cells are considered 'self' and/or have self-antigens and that cancerous tumour cells are non-self cells with non-self, or foreign, antigens. Some included the terminology but did not go on to link the idea of self to healthy cells and non-self to tumour cells and so did not gain credit. There were a number who knew that the recognition was based on antigens but this was not sufficient to be credited. Confused responses wrote about receptors on the different types of cells, recognition of pathogens, and

named antigens as antibodies. Some stated that phagocytes released antibody, while others explained that phagocytes were attracted to histamine released by immune system cells, which is not recognition.

(ii) Most candidates gained full credit for this question, although a high proportion also included points about mutagens and carcinogens, which was not required. The quality of expression of the responses seen was very varied.

Question 6

Parts **(a)(i)** and **(ii)** and parts **(b)(i)** and **(ii)** assessed learning outcomes in ***Section K***. In **(b)(ii)**, candidates were free to draw from many sections of the syllabus to name two organic compounds containing nitrogen.

(a) (i) Candidates who had learned what was meant by a habitat had few problems working out which terms from the list were required to complete the definition. The final missing term proved to be the most challenging for the majority of candidates, with many opting for 'trophic level' or 'consumers'.

(ii) Many answered this correctly, although a number gave the first term as 'ecosystem' and then chose one of 'a niche', 'a population', 'a community' or 'trophic level' to complete the response.

(b) (i) Although the information in the question prompted candidates to focus on the light energy striking the leaves, a good number gave one or more ways that light energy could miss leaves. The clearest responses gave a reasoned account, beginning with light reflection from the cuticle and then considering the various losses of light energy that could occur if light entered the leaf. A small proportion of candidates wrote about energy losses in a food chain.

(ii) High quality responses used comparative terminology to suggest the advantages of growing crops with high PE compared to growing crops with a lower PE. Most could gain partial credit with an understanding that there would be comparatively more stored energy that could be put to use. Fewer showed an understanding that there would be more biomass per unit area to harvest. One very common misunderstanding was that the crop would be used for fuel rather than being used for the production of biofuel.

(iii) Candidates were expected to understand that nitrates were absorbed by plants for assimilation. Stronger candidates gained full credit by making sure that their example was an organic compound containing nitrogen and giving a direct function of that compound. No credit was given for stating 'for growth'. Many others could name a compound but were vague in their statement of function and so no credit could be given. Some gave organic compounds such as glucose, sucrose, cellulose and lipids that did not contain nitrogen. Other responses that were not credited were those that gave inorganic compounds containing nitrogen. There were many of these, and it may be that some candidates did not know what was meant by the term 'organic'. Some named bacteria from the nitrogen cycle, such as *Nitrobacter or Rhizobium*.

BIOLOGY

Paper 9700/23
As Structured Questions

Key Messages

- Candidates should have a clear understanding of the different bond types associated with protein structure and protein level of organisation. Knowledge of this was required in **Question 1(d)**. Some candidates incorrectly refer to peptide bonds when describing secondary and tertiary structure. In addition, some candidates named both the strong covalent disulfide bridges and peptide bonds as those that break during denaturation, which would not be the case.

- Memory cells should not be described as cells that 'remember' the foreign antigens of pathogens, as a number of candidates did in **Question 3(d)**. Memory cells can be described as long-lived cells of the immune system that are produced from both specific B-lymphocytes and T-lymphocytes as a result of a primary immune response to the presence of non-self antigens (for example, from an infection or in a vaccine). Candidates should understand that they are present in higher numbers than the original specific lymphocytes from which they originate. Memory cell production is a feature of active immunity.

- Candidates need to be clear about the different requirements for the command words 'explain' and 'describe' as in, for example, **Question 4(a)(i)**.

General comments

The performance of a number of candidates in this examination was outstanding. For these, a very good knowledge of the syllabus learning outcomes was evident and candidates were able to confidently apply knowledge and understanding to new situations. Many others gave clear unambiguous answers for many questions. In some cases performance could have been improved by giving further supporting detail for some answers.

In **Question 1(a)**, the strongest candidates understood that they needed to describe the term 'fluid mosaic' rather than describe the fluid mosaic model of membrane structure. In **Question 1(d)** many wrote about denaturation of enzymes in general, rather than about denaturation of proteins of cell membranes. In **Question 2(c)(ii)**, many described tumour formation rather than compare the cell cycle of cancer cell with a normal dividing cell. In **Question 4**, many candidates gave biologically correct explanations of the changes occurring in **Fig. 4.1** which could not be credited as the question asked them to describe the changes in the graph. **Question 5** proved to be the most challenging question overall for the majority of candidates. Although **Question 6** presented few problems to many candidates, this question proved to be the most challenging for weaker candidates, who tended to do well only on **(b)(iii)**.

Candidates had sufficient time to complete the paper. The majority attempted to answer all questions and handwriting was usually legible. Most candidates showed their working in **Question 3(b)** and many wrote out the formula they used to obtain the magnification of the image in **Fig. 3.1**.

Comments on specific questions

Question 1

This question assessed knowledge of the fluid mosaic model of membrane structure and transport across membranes from ***Section D*** and also gave candidates the opportunity to make links between protein structure (***Section B***) and the role of proteins in membranes.

(a) The clearest responses for the term 'fluid' described how phospholipid molecules move within the bilayer, with some indicating that mainly the molecules move freely within their own monolayer. It was also noted by a number that some of the membrane proteins also move within the bilayer. Other responses were less precise, stating that the bilayer moved or that the structures or components within the membrane moved, without naming these components. Some wrote about cholesterol and its role in fluidity, which was not required, while others wrote about how substances were able to move across the membrane. A greater proportion was able to successfully explain the scattered proteins forming the 'mosaic'. Explanations that were not creditworthy included the idea that there were many different components in the membrane or that there were many different ways to transport substances across the membrane.

(b) A high proportion of candidates gained full credit, with a smaller number providing clear, concise answers that made it obvious to which model of membrane structure they were referring. Some candidates gave a number of points rather than only one similarity and one difference.

(c) Almost all candidates could give one or more correct features of active transport and there were many who gave excellent accounts of the mechanism to gain full credit. Partial credit was awarded where candidates forgot to write about the membrane protein involved or described it as a channel protein, which is used in facilitated diffusion. Weaker responses incorrectly described movement from a low concentration gradient to a high concentration gradient. The best responses included detail of the conformational shape change of the membrane protein and stated that the mechanism was specific for the substance being transported. There were a number who incorrectly included detail of endocytosis and exocytosis.

(d) Generally the stronger candidates considered both the idea of denaturation of proteins as well as their involvement in cell membranes. Some saw the term 'denaturation' and gave an account of enzyme denaturation, with only some of these explaining how this would lead to membrane damage. Descriptions of protein denaturation were varied, with some giving much detail about increase in kinetic energy and vibration of molecules but not going on to give the precise details of which bond types would break and how this would affect secondary and tertiary protein structure. A common error was to state that peptide bonds would break, rather than to explain that the weaker hydrogen and ionic bonds between R-groups would break. There were many who were too general in their description. Most correct ideas about how the membrane would be damaged focused on the inability of the membrane to transport substances across, although a few realised that cell signalling and cell recognition would be affected. Weaker responses suggested that the proteins would disappear from the membrane or wrote about the fluidity of the phospholipid bilayer.

Question 2

Candidates used knowledge and understanding from ***Sections E*** *and* ***F*** in this question.

(a) It was generally well known that DNA replication occurs during interphase, although there was a proportion who thought that DNA replication occurred during mitosis or in specific stages of mitosis, and a few thought that DNA replication would occur at the same time as transcription. More able candidates were precise in their response and correctly gave the S phase of interphase.

(b) (i) As with part **(a)** a high proportion of candidates recognised that the pairing between bases was due to hydrogen bonding. Weaker responses stated covalent bond or glycosidic bond.

(ii) Although many correctly identified base **Y** as the pyrimidine, there were fewer who went on to state how **Y** had only one ring as part of its structure compared to the two rings of purines. Of these, not all gained credit as they went on to give an incorrect explanation of the ring as being a pentose sugar. Candidates are not expected to know details of the structure of the bases, but should be able to recognise that purines have a double ring structure and pyrimidines have a single ring structure. A stated difference in size of between **Y** and **X** was also credited.

(c) (i) Candidates were expected to be able to give a concise definition of a gene mutation and then further qualify this definition. There were some very full responses that went beyond the question requirements. Some wrote about changes to the DNA sequence or gene sequence rather than the sequence of nucleotides or sequence of bases in the DNA. Many did not explain exactly what was meant by a gene mutation. Weaker responses stated that a gene mutation is an altered sequence of amino acids or that a gene mutation was a change in the number of chromosomes. Some weak responses used incorrect terminology or phrases, such as 'changed DNA code', 'mutated protein',

'gene codes for a different amino acid', 'wrong amino acid is made', change in DNA base sequence of an amino acid' and 'change in the coding of a gene'. A few incorrectly described tumour formation.

(ii) Some candidates realised that their response should be based on the cell cycle and they answered accordingly to gain full credit. Others did not give comparative information or described tumour formation.

Question 3

This question, on immune system cells and vaccination, from ***Section J***, contained links to ***Sections A*** and ***I***, and included a magnification calculation.

(a) This presented few problems to most candidates. Some gained full credit by giving detail of RER structure and noting the presence of ribosomes as the site of protein synthesis. Far fewer suggested that RER may be required for modification or for protein transport (to the Golgi body). Some did not use the information provided, so did not highlight the link between plasma cells and antibodies. However, these still gained credit for knowing the function of RER and making the link with ribosomes.

(b) Most candidates measured the length of **A**-**B** correctly and knew the formula to use to determine the magnification of **Fig. 3.1**. Loss of credit was commonly because the candidate was not able to convert the measurement correctly to μm and so obtained a calculated value that was frequently a factor of 10 out. Measuring in cm often proves to be a mistake for some candidates as they forget to multiply by 10 to convert to mm before multiplying by 1000 to get to μm.

(c) The majority of candidates who performed well knew the name of the causative organism of smallpox. Incorrect responses seen were virus, bacteria, *Vibrio*, *Morbillivirus* and *Plasmodium*.

(d) There were some comprehensive and well-expressed responses given for this question. The best showed an understanding that memory cells for both B- lymphocytes and T-lymphocytes would be present for a secondary response and gave good explanations as to how this would provide immunity. Not all remembered to state that these would remain in the circulation and there were many who mistakenly thought that plasma cells turned into memory cells. Common errors were to suggest that there would be a continually high level of antibodies or that plasma cells were still remaining. A few thought that the vaccine contained plasma cells or antibodies.

(e) The best responses focused on the features of the vaccination programme for eradicating smallpox, rather than on features of the disease, and also used correct scientific terminology to gain credit. The term 'strand' was fairly frequently seen, presumably intended to mean 'strain'. Others referred to the unchanging virus but then went on to state that it meant that it was non-resistant to the vaccine or that it meant the pathogen could not adapt to the vaccine. In the best answers, reference to the ease of identifying people with smallpox was carefully related to the fact that individuals who had been in contact with those with smallpox could then be vaccinated, or the term 'ring vaccination' was used. Others incorrectly stated that these individuals could be treated with the smallpox vaccine and the vaccine was sometimes described as 'frozen' rather than 'freeze-dried'.

(f) The precise type of immunity provided by the smallpox vaccine was required, hence only those noting that if was both artificial and active gained credit. Weaker responses stated that the immunity was temporary or gave descriptions explaining that antibodies and white blood cells were present.

Question 4

Question 4 was on a theme of blood pressure, with knowledge and understanding from ***Section G*** and ***Section C*** assessed.

(a) (i) Many candidates gave precise descriptions and accompanied these with numerical data extracted from the graph. Some responses could have been improved by stating exactly where the changes were occurring. Partial credit was awarded for a statement that included a description of the decrease in blood pressure with distance.

(ii) Many realised that, because the blood in the veins is at such a low hydrostatic pressure, the valves are the main structural feature of veins in returning blood back to the heart. These candidates gained full credit. Some responses gave detail of the lower quantity, compared to arteries, of smooth muscle and elastic fibre in the tunica media. As this is a consequence of not having to cope with the high pressure blood leaving the heart, it was not relevant for this question.

(b) Some candidates found this a straightforward question and gained full credit. Many responses gave a detailed description of enzyme action which was not required and so gained no credit. There were a number of weaker responses that gave long descriptions of translation.

(c) This question was generally well answered and the details of competitive inhibition were well known. Some candidates gave confused descriptions of ACE as the substrate and competing with the drug for the active site on the enzyme. Weak responses did not refer to enzyme inhibition and wrote about the possible effect in the body of a decrease in angiotensin.

Question 5

Parts **(c)** and **(d)** of this question required extended responses. There was considerable variety in the quality of these responses and some candidates appeared to have little knowledge of the main ideas. ***Sections A***, ***B*** and ***G*** were assessed in **Question 5**.

(a) Many candidates understood the main advantage of using the light microscope to view movement in *Chlamydomonas* was the ability to view living, and hence moving, organisms. Not all differences between the light and electron microscope, such as details about magnification and resolution, were relevant in answering this question.

(b) (i) The most common correct answer was the link to chlorophyll. Stating that magnesium was needed for chloroplasts or for photosynthesis was not adequate to gain credit.

(ii) Good answers to this question used the information supplied about *Chlamydomonas* and applied knowledge and understanding of the properties of water to the organism. Hence, they realised that the property of hydrogen bonding to provide high surface tension for organisms to 'walk' on water was not appropriate to *Chlamydomonas* as an organism that moves through water. Noting that the organism was photosynthetic enabled some candidates to explain that the transparent nature of water would allow light through for photosynthesis. Other good answers related properties of water to *Chlamydomonas* (and other such organisms).

(c) Some candidates realised that this was a question related to the decreasing surface area to volume ratio that occurs when organisms get larger. Those who gained full credit explained the benefits of the transport system in reducing the time taken to supply cells or in being involved in mass flow. Some responses gave examples of substances that are transported and of these, many of the best responses were careful to only refer to the transport of respiratory gases by animals rather than by plants. Although there were some very well-expressed responses that considered both multicellular and unicellular organisms, there were a number that were vague and only concentrated on unicellular organisms. Some of those who did not gain credit stated that transport systems were not required when there was only one cell, while many stated that unicellular organisms were less active but did not go on to explain the idea of bulk transport for multicellular organisms.

(d) Generally only the candidates who did well overall were confident enough to begin their response with the presence of sucrose in the phloem sieve tube. The majority decided to give the whole account of movement of sucrose from the photosynthesising mesophyll cells adjacent to the companion cell. This means that there were often long accounts of the events occurring in the companion cells leading up to the arrival of sucrose in the phloem sieve tubethat were not relevant for this question. Some candidates were still able to gain credit for describing the events leading to mass flow. There were a few answers that were too general. Common misconceptions included stating that the hydrostatic pressure would increase as a result of water entering the sieve tube from the companion cells rather than from the xylem and that the flow was as a result of a water potential gradient rather than a hydrostatic pressure gradient. Some contradicted themselves by stating that the influx of sucrose decreased water potential and increased solute potential. Some candidates knew that a pressure gradient existed but were not clear that it was at the source where the hydrostatic pressure was higher. A number wrote about a hydrostatic pressure being created at the source rather than an increase in hydrostatic pressure resulting from an inflow of water.

Question 6

This question assessed learning outcomes in ***Section K***. In part **(b)**, only some candidates were able to gain full credit on the ecology definitions.

(a) (i) Although many correctly identified nitrification as the stage shown, many others thought that this was nitrogen fixation.

(ii) Candidates who did well overall gave a correct, concise answer to gain full credit. Others, who correctly wrote about denitrification, then went on to contradict themselves by describing decomposition. Weak responses only described decomposition.

(b) (i) There were only a few that began their definition of an ecosystem as 'a unit…..'. Most described an ecosystem in terms of a region or community. Where candidates realised that ecosystems involved both biotic and abiotic factors and that interactions occurred, credit was awarded. Some candidates gained credit for the idea of a self-sustaining unit. There were a number who wrote about abiotic organisms or non-living organisms. Generally, weaker responses gave the definition of a community or stated that organisms interacted.

(ii) There were some detailed definitions given. Many candidates vaguely described a producer as an organism that makes its own food and some incorrectly described a producer as an organism that makes its own energy.

(iii) Many knew the definition of a habitat, although quite a number did not actually state 'a place…' or equivalent, simply beginning their answer with 'where an organism lives', which did not gain credit.

BIOLOGY

Paper 9700/31
Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination.

Candidates should be able to assess the risk of a procedure. The heating of water-baths or use of chemicals such as Benedict's solution or hydrochloric acid would be judged as a medium risk. A high risk would be the use of high concentrations of acids and alkalis.

Candidates should be familiar with recording quantitative results and qualitative observations in a table. Tables should have ruled headings with no units in the body of the table. The heading for the independent variable should be in the left column or top row with the appropriate units.

Candidates should be able to use a serial dilution to obtain required concentrations of solutions and specified volumes of solutions. In this case, candidates were required to dilute a 1.00% starch solution to start their serial dilution and to prepare 10 cm^3 to use of each successive dilution. Candidates were required to show a four step serial dilution of starch solution using a constant dilution factor at each step. The initial step combines 10 cm^3 of the 1.00% starch solution with 10 cm^3 of water to produce a 1:2 dilution. In the second step, 10 cm^3 of the 1:2 dilution is combined with 10 cm^3 of water producing a dilution of 1:4. Candidates were required to show how to make four concentrations of starch solution by this method, e.g. 0.50%, 0.25%, 0.125% and 0.063 (0.0625)%.

When carrying out practical work candidates should be encouraged to consider how they could improve their investigations to increase the confidence in their results, e.g. by repeating the procedure.

Candidates should be given the opportunity to draw both graphs and charts. In this case, a bar chart was required. The bars should be plotted accurately and drawn exactly along the horizontal lines with a fine ruled line. All lines, both vertical and horizontal should be clear, sharp and unbroken.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

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

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and 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.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) Many of the candidates organised their results clearly by presenting in a table, with appropriate column headings. The majority of candidates gained credit for recording the colours observed for both the starch and the starch and enzyme when tested with iodine solution. The better candidates included repeats in their table.

(ii) The majority of candidates answered correctly recording the time in seconds.

(iii) The majority of candidates answered correctly.

(iv) Many candidates answered correctly.

(v) Many candidates correctly stated the hazard with the greatest level of risk and rated it as medium or high.

(b) (i) Many candidates were able to carry out a serial dilution, showing this correctly in **Fig. 1.1**.

(ii) 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 starch) and the dependent variable (time / seconds). Many candidates gained credit for recording times in whole seconds for the five concentrations of starch. The most common error was to include units in the body of the table.

(iii) Many candidates correctly calculated the rate at which the product was produced. A common error was to add incorrect units.

(iv) The majority of candidates correctly either supported or rejected the hypothesis depending on their results. A valid explanation was also given by many of the candidates. The most common error was for candidates not to use their results to support their answer to this question.

(c) (i) Some candidates correctly identified the significant source of error being the difficulty in judging the colour change. The most common error was to state timing issues or errors with measuring volume.

(ii) Many candidates correctly stated that the error was a systematic error as the same syringe had been used throughout the experiment. The most common error was to state human errors in their reasoning.

(iii) Many candidates identified that, in order to standardise the independent variable used in the previous procedure, the concentration of starch would have to remain constant in the new investigation. The better candidates identified that **X** would need to be diluted by either simple or serial dilution and at least five concentrations would be required. The better candidates also recognised that the Benedict's test would need to be carried with these concentrations at (at least) 80 °C and the time taken to observe the colour change should have been noted. Common errors were to omit the detail required for this answer, e.g. by simply stating that a dilution of **X** needed to be made and then the Benedict's test carried out.

Question 2

(a) (i) Credit was awarded to candidates whose drawings did not include any shading and used most of the space provided. The better candidates gained credit for carefully following the instructions, only drawing the quarter of the stem as shown in **Fig. 2.1** and for showing at least three layers of tissue. Many candidates gained credit for drawing the epidermis as double lines and for drawing a well-proportioned diagram. Most candidates used one label line to identify **T** (the xylem).

(ii) Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly and used most of the space provided. The better 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 four adjacent cells from the cortex 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. Most candidates used one label line to show the position of one cell wall.

(b) The majority of candidates correctly stated the correct number of eyepiece graticule units for **Y** within an acceptable range and showed this number multiplied by 11. The majority of candidates gave the correct answer along with the correct units. The most common errors were to measure line **Y** with a ruler or not showing all the steps in the calculation.

(c) (i) Most candidates correctly used the headings given in the table to correctly label the *x*-axis (biological molecule found in the fruit) and the *y*-axis (mass of biological molecule in the 35 g fruit / g). Some candidates incorrectly labelled the axes or omitted part of the label. Many candidates plotted the bars accurately with bars of equal width. The most common error was drawing lines that were too thick or not ruled. Candidates should be reminded of the need to use a sharp pencil. Another common error was the drawing of a line graph instead of a bar chart.

(ii) Many candidates answered correctly. The most common errors were to not show all the steps in the calculation and incorrect units being given.

BIOLOGY

Paper 9700/32
Advanced Practical Skills 2

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 different procedures. A risk assessment would include judging that heating chemicals might be harmful or that some chemicals are irritants. For example, heating Benedict's solution or hydrochloric acid would be assessed as medium risk. A high risk would be the use of high concentrations of acids or alkalis.

Candidates should be familiar with recording quantitative results and qualitative observations in a table. Tables should have ruled headings and no units in the body of the table. The heading for the independent variable should be in the left column or the top row with the appropriate units.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

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

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and 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.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates gained credit for describing how to carry out the test for starch using iodine solution.

(ii) Most candidates correctly completed the table.

(iii) Many candidates correctly described how to carry out tests for reducing and non-reducing sugars.

For the reducing sugar test the most common error was not stating that the temperature required to heat the Benedict's solution was in the range of 80ºC to 100 ºC. For the non-reducing sugar test the most common error was not neutralising the acid.

(iv) Many candidates correctly stated a hazard with the greatest level of risk and rated it as medium or high.

(v) 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 (drinks) and the dependent variable (time / seconds). The most common errors were to omit the headings for the reducing sugar tests and the non-reducing sugar tests or to include units in the body of the table. The better candidates recorded times for **D2** showing that the time taken for the non-reducing sugar test was less than that for the reducing sugar test.

(vi) Many candidates correctly suggested that **D3** would provide the greatest quantity of glucose as it took the least time to show a colour change for the reducing sugar test. Credit was also given for **D1** and **D2** if it was explained that the greatest quantity of glucose was produced by the breakdown of starch or sucrose.

(vii) Many candidates suggested appropriate modifications to investigate the concentration of reducing sugar in another drink, **D5**. Stronger answers suggested preparing at least five glucose concentrations by serial or simple dilution and carrying out the Benedict's test on these known concentrations and on **D5**, then comparing the times to estimate the concentration of reducing sugar in **D5**. The most common error was carrying out the Benedict's test on **D5** and comparing the time with the drinks **D1**, **D2**, **D3** and **D4**.

(b) (i) The majority of candidates drew the graph using the headings given in the table, with $\log_{10}$ distance / m on the *x*-axis and average speed / ms^{-1} on the *y*-axis. The better candidates used scales of 0.5 to 2 cm for the *x*-axis with 2 at the origin and 1 to 2 cm for the *y*-axis, with 5 at the origin. They also plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear ruled line that accurately connected each of the points.

(ii) The majority of candidates correctly estimated the average speed for a race of distance $\log_{10}$ 3.5m by reading off the graph. The most common error was omitting the units, ms^{-1}.

(iii) The majority of candidates correctly described the trend.

(iv) The majority of candidates answered correctly.

Question 2

(a) (i) The better candidates produced drawings using a sharp pencil and did not include any shading. Many candidates were able to draw at least two layers of tissue and showed subdivision of the vascular bundles. The most common error was not showing the epidermis as two lines drawn close together. Most candidates used one label line and label to show a vascular bundle.

(ii) Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, thin lines. The majority of candidates gained credit for drawing four touching cells, with a space between the cells and by drawing the cell walls as double lines. Most candidates used one label line and label to show a cell wall. The most common error was to draw lines that did not meet up precisely or were too thick.

(b) The majority of candidates were able to gain credit for recording appropriate differences for the vascular tissue and one other tissue.

(c) (i) The majority of candidates showed the measurement for **Y** within an acceptable range and showed division by 250 and multiplication by 1000. The most common errors were not showing units for the measurement of **Y** and not showing multiplication by 1000.

(ii) The majority of candidates stated either that there were no cell contents in cells **Q** and **R** so that transport could occur or that the presence of a wall would provide strength and support.

(iii) Many candidates correctly determined the simplest ratio.

BIOLOGY

Paper 9700/33
Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination.

Candidates should be able to assess the risk of different procedures. A risk assessment would include judging that heating chemicals might be harmful or that some chemicals are irritants. For example, heating Benedict's solution or hydrochloric acid, would be assessed as medium risk. A high risk would be the use of high concentrations of acids or alkalis.

Candidates should be familiar with recording quantitative results and qualitative observations in a table. Tables should have ruled headings with no units in the body of the table. The heading for the independent variable should be in the left column or top row with the appropriate units.

When carrying out practical work candidates should be encouraged to consider how they could improve their investigations to increase the confidence in their results, e.g. by repeating the procedure.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

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

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and 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.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates were able to describe the test for starch using iodine solution.

(ii) Many candidates were able to describe the test for reducing sugars using Benedict's solution. The most common error was not stating that the temperature of the water-bath needed to be between the temperatures of 80 °C and 100 °C.

(iii) The majority of candidates organised their results clearly by presenting a ruled table. The better candidates included headings for the solutions (**S1**, **S2** and **S3**), the starch test and the reducing sugar test. Acceptable headings for the dependent variable included observation and colour. The majority of candidates gained credit for recording the correct colour changes for both tests for **S1**, **S2** and **S3**.

(iv) The majority of candidates correctly identified **S1**, **S2** and **S3**.

(v) Many candidates correctly stated a hazard with the greatest level of risk and rated it as medium or high.

(b) (i) The majority of candidates were able to complete the sentence correctly.

(ii) 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 (solutions or samples) and the dependent variable (number of plasmolysed cells). The majority of candidates gained credit for recording the number of plasmolysed cells. The better candidates included repeats in their table.

(iii) The majority of candidates correctly identified the difficulty of judging the degree of plasmolysis of the cells as the significant source of error when measuring the dependent variable.

(iv) Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly and used most of the space provided. Many candidates were able to draw a cell from the epidermis in **W** and **S1** with double lines representing the cell walls. The most common errors were to draw lines that did not meet up precisely or were too thick. Many candidates correctly showed the cell membrane in **S1** coming away from the cell wall.

Most candidates used a label line to identify the cytoplasm in **W** and **S1**.

(v) Many candidates correctly explained that **S1** had a lower water potential and that water, moved, by osmosis, from the cells to the solution outside. Many candidates correctly stated that there was no net movement of water for cells in **S3**.

Question 2

(a) (i) The majority of candidates gained credit for correctly describing how to measure the volumes $\mathbf{V_0}$ and $\mathbf{V_9}$.

(ii) 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 (tube) and the dependent variable (volume / cm^3). The majority of candidates gained credit for recording the volumes for $\mathbf{V_0}$ and $\mathbf{V_9}$, for each of the four tubes and including the processed results by stating the volume of water lost by evaporation in each tube. The most common errors were stating the incorrect heading for the dependent variable and for including units in the body of the table.

(iii) The majority of candidates gained credit for correctly completing the table.

(iv) The majority of candidates gained credit for correctly describing a suitable control for the investigation.

(v) Most candidates correctly described using a thermostatically-controlled water-bath to increase the temperature as a way to increase the rate of evaporation from the tubes. Credit was also given to the use of fans to increase wind speed and to lower humidity. The most common error was describing the use of lamps without any reference to temperature.

(b) Most candidates correctly used the headings given in the table to correctly label the *x*-axis (total circumference of holes / mm) and the *y*-axis (rate of evaporation of water / $cm^3\ day^{-1}$). Some

candidates, however, labelled the incorrect axis or gave incomplete headings. The *x*-axis must be the dependant variable.

Most candidates used scales of 5.0 to 2 cm for total circumference of holes and 0.2 to 2 cm for the rate of evaporation of water. Many candidates plotted the points exactly with a small cross or dot in a circle, and some drew a sharp, clear, ruled line, as a line of best fit or accurately connecting the points. The most common error was drawing lines which were too thick or not ruled to the centre of the point. Candidates should be reminded of the need to use a sharp pencil.

(c) Credit was awarded to candidates whose drawings did not include any shading and used most of the space provided. The better candidates gained credit for carefully following the instructions, drawing the quarter of the stem as shown in **Fig. 2.4** and for showing at least three layers of tissue. Many candidates gained credit for drawing a well-proportioned diagram.

(d) (i) The majority of candidates stated that the micrometre is the most appropriate unit for use with the light microscope and showed 0.024 multiplied by 1000.

(ii) Many candidates stated the correct number of eyepiece graticule units for line **Y** within a range and showed this number multiplied by the answer for **(d) (i)**. The most common errors were to measure line **Y** with a ruler or not showing all the steps in the calculation.

BIOLOGY

Paper 9700/34

Advanced Practical Skills 2

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. The heating of water-baths or use of chemicals such as Benedict's solution or hydrochloric acid would be judged as a medium risk. A high risk would be the use of high concentrations of acids and alkalis.

Candidates should be familiar with recording quantitative results and qualitative observations in a table. Tables should have ruled headings with no units in the body of the table. The heading for the independent variable should be in the left column or top row with the appropriate units.

Candidates should be able to use a serial dilution to obtain required concentrations of solutions and specified volumes of solutions. In this case, candidates were required to dilute a 0.3% solution of **X** to start their serial dilution and to prepare 10 cm^3 to use of each successive dilution. Candidates were required to show a three step serial dilution of solution **X** using a constant dilution factor at each step. The initial step combines 1 cm^3 of the 0.3% starch solution with 9 cm^3 of water to produce a 0.03% solution. In the second step, 1 cm^3 of the 0.03% dilution is combined with 9 cm^3 of water. Candidates were required to show how to make three concentrations of solution **X** by this method, e.g. 0.03%, 0.003% and 0.0003%.

When carrying out practical work candidates should be encouraged to consider how they could improve their investigations to increase the confidence in their results, e.g. by repeating the procedure.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

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

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and 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.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) Many candidates correctly stated the hazard with the greatest level of risk and rated it as medium or high.

(b) (i) Many candidates were able to carry out a serial dilution, showing showing this correctly in **Fig. 1.1**. The most common error was to use incorrect concentrations below each beaker.

(ii) 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 **X**) and the dependent variable (number of bubbles). Many candidates gained credit for recording the number of bubbles for the four concentrations of solution **X** and **W**. The most common errors included putting units in the body of the table or not repeating the experiment.

(iii) Many candidates correctly recorded the time and used this to correctly calculate the rate of activity of the catalase.

(iv) The majority of candidates stated correctly that solution **X** was an inhibitor. The better candidates were able to suggest that **X** prevents the substrate from binding with the active site of the enzyme.

(v) The majority of candidates identified the significant source of error when counting the bubbles, the better candidates also identified the source of error regarding the displacement of water. Common errors included candidates referring to air escaping from the top of the syringe, difficulties in measuring or counting and being unable to start the stopwatch at the same time.

(vi) Many candidates gained credit for indentifying that the concentration of **X** would need to remain constant. Many candidates identified that temperature would be changed, however only the better candidates stated five different temperatures would be required. Some candidates stated that a thermostatically-controlled water-bath could be used to maintain these temperatures.

Question 2

(a) (i) Most candidates correctly used the headings given in the table to label the *x*-axis (length of neck / cm) and the *y*-axis (thickness of the muscle wall in left ventricle / mm). Some candidates labelled the axes incorrectly or gave incomplete headings. The *x*-axis must be the dependant variable. Many candidates used scales of 10.0 to 2 cm for the length of neck and 5.0 to 2 cm for the thickness of the muscle wall in left ventricle. Many candidates plotted the points exactly with a small cross or dot in a circle, and some drew a sharp, clear, ruled line as a line of best fit or accurately connecting the points. The most common errors were drawing lines which were too thick or not ruled precisely, or using an inappropriate scale. Candidates should be reminded of the need to use a sharp pencil.

(ii) The majority of candidates answered correctly.

(iii) The better candidates were able to suggest a reason for the relationship shown in the graph. The most common error was to simply describe the relationship rather than giving a reason.

(b) (i) Credit was awarded to candidates whose drawings did not include any shading and used most of the space provided. The majority of candidates gained credit for carefully following the instructions and selecting either vessel **Q** or **T**. Many candidates gained credit for drawing at least two layers and for drawing a well-proportioned diagram.

(ii) The majority of candidates were able to show on blood vessel **S** where they took their measurements. Many candidates recorded measurements with correct units for both the thickness and the diameter of the blood vessel. Most candidates were able to determine the simplest ratio. Common errors included using fewer than five measurements of each, not using whole numbers in the ratio and displaying the smaller number to the largest number.

(c) (i) Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly and used most of the space provided. The better 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 four xylem vessel elements 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. Most candidates used one label line to show the position of one lumen.

(ii) The majority of candidates answered correctly. The most common error was comparing the shape of the lumen.

(iii) The majority of candidates recognised that the lumen was the observable feature. The better candidates stated that this lumen had no contents thus enables it to transport materials.

BIOLOGY

Paper 9700/35

Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination.

Candidates should be able to assess the risk of different procedures. A risk assessment would include judging that heating chemicals might be harmful or that some chemicals are irritants, such as 5% urea solution and enzyme solution. Heating Benedict's solution or hydrochloric acid would be assessed as medium risk. A high risk would be the use of high concentrations of acids or alkalis.

Candidates should be familiar with recording quantitative results and qualitative observations in a table. Tables should have ruled headings with no units in the body of the table. The heading for the independent variable should be in the left column or top row with the appropriate units.

Candidates should be able to use a serial dilution to obtain required concentrations of solutions and specified volumes of solutions. In this case, candidates were required to dilute a 5% urea solution to start their serial dilution and to prepare 20 cm^3 to use for each successive dilution. Candidates were required to show a three step serial dilution of urea solution using a constant dilution factor at each step. The initial step combines 20 cm^3 of the 5.00% urea solution with 20 cm^3 of water to produce a 1:2 dilution. In the second step, 20 cm^3 of the 1:2 dilution is combined with 20 cm^3 of water producing a dilution of 1:4. Candidates were required to show how to make three concentrations of urea solution by this method e.g. 5.00%, 2.50%, 1.25% and 0.625%.

When carrying out practical work candidates should be encouraged to consider how they could improve their investigations to increase the confidence in their results, e.g. by repeating the procedure.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

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

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and 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.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) Many candidates correctly stated a hazard with the greatest level of risk and rated it as medium or high.

(b) (i) Many candidates were able to carry out a serial dilution, showing this correctly in **Fig. 1.1**.

(ii) 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 urea) and the dependent variable (time / seconds). The majority of candidates gained credit for recording times in whole seconds for the four concentrations of urea. The better candidates included repeats in their table.

(iii) The majority of candidates correctly identified the difficulty in judging the colour change of the whole piece of red litmus as the significant source of error when measuring the dependent variable. Many candidates also correctly identified the inconsistency of mixing the urea and the enzyme as a source of error. Credit was also given for the area of the piece of litmus paper not being an exact size.

(iv) Some candidates correctly identified that the use of a mechanical stirrer would make the mixing of urea and enzyme the same for each concentration of urea or that a ruler could be used to standardise the area of red litmus paper.

(v) Many candidates correctly stated that the syringe used in the investigation may have a systematic error.

(vi) Many candidates correctly described how to increase the time taken to reach the end-point by lowering the temperature with a thermostatically-controlled water-bath, or by decreasing the concentration of enzyme by serial dilution or by decreasing the volume of enzyme.

(c) (i) Most candidates correctly used the headings given in the table to correctly label the *x*-axis (time of sampling / minutes) and the *y*-axis ($^{13}CO_2$ in the breath / arbitrary units). Some candidates, however, labelled the incorrect axis or gave incorrect units for time. The *x*-axis must be the dependant variable.

Most candidates used scales of 20 to 2 cm for time of sampling with 30 at the origin and 2 to 2 cm for $^{13}CO_2$ in the breath with 10 at the origin. Many candidates plotted the points exactly with a small cross or dot in a circle, and some drew a sharp, clear, ruled line, accurately connecting the points. The most common error was drawing lines which were too thick or not ruled to the centre of the point. Candidates should be reminded of the need to use a sharp pencil.

(ii) Many candidates gained credit for the idea that for sampling times of 60 minutes, 75 minutes and 110 minutes there was a decrease in substrate concentration. Less urea resulted in fewer enzyme substrate complexes being formed. The most common error was not mentioning the formation of enzyme substrate complexes.

Question 2

(a) (i) Credit was awarded to candidates whose drawings did not include any shading and used most of the space provided. The better candidates gained credit for carefully following the instructions, only drawing the half of the stem as shown in **Fig. 2.1** and for showing at least two layers of tissue. Many candidates gained credit for drawing the epidermis as double lines and for drawing a well-proportioned diagram. Most candidates used one label line to identify the pith.

(ii) Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly and used most of the space provided. The better 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 adjacent cells from the epidermis and two adjacent cells from the cortex 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. Most candidates used one label line to show the position of one cell wall.

(b) (i) The majority of candidates stated that the micrometre is the most appropriate unit for use with the light microscope and showed 0.028 multiplied by 1000.

(ii) Many candidates correctly stated the correct number of eyepiece graticule units for **X** within a range and showed this number multiplied by the answer for **(b) (i)**. The most common errors were to measure line **X** with a ruler or not showing all the steps in the calculation.

(iii) Some candidates correctly stated that the presence of air spaces helped the stem to float in the pond.

(c) Many candidates recorded observable differences appropriately, with the majority able to gain full credit.

BIOLOGY

Paper 9700/41
A2 Structured Questions

Key messages

- Candidates need to read questions carefully, interpret related stimulus material and focus on what the question is asking before composing their answer. Data questions such as **4(e)(i)** and **5(b)** provide examples of questions where candidates often wrote in general terms without fully analysing the question and its context.
- Some questions require candidates to make a reasoned judgement about a hypothesis or a recommendation for action, e.g. **4(e)(ii)** and **5(c)**. Candidates should state their decision clearly and explain whether each line of reasoning supports or opposes the hypothesis or decision.
- Candidates should use A Level biology terminology in their answers in order to access maximum credit.

General comments

Candidates who scored highly were able to combine a breadth and depth of knowledge with an ability to interpret the question and to understand and use new information from the question context.

Generally candidates were most successful on **Questions 1** (photosynthesis recall), **4(a)** (conservation recall), **7(a)** and **7(b)** (respiration recall) and the two biotechnology essays. Questions that involved data handling, skills of analysis and the making and substantiating of judgements (**Questions 2**, **4 and 5**) tended to be lower-scoring. Genetic terminology in **Question 3** proved difficult for some candidates.

Comments on specific questions

Question 1

(a) The majority of candidates labelled the tissues correctly but often did not use the labels requested. Some candidates confused phloem with xylem.

(b) Generally candidates answered well, but incomplete answers were seen quite often, such as omitting the term diffusion or not naming the substanced that diffused. A common incorrect response related thinness to penetration of light. Some candidates described features of xylem and palisade mesophyll tissues.

(c) (i) Most correct responses made a comparative reference to the difference in the thickness of the cell wall. Some candidates thought incorrectly that chloroplasts are present in lower epidermal cells and not in guard cells. Non-technical descriptions of shape, such as ‘sausage-shaped’ and ‘bean-shaped’, were not creditworthy.

(ii) Many candidates gained full credit. Incorrect responses included those which focused on the cells outside rather on the events inside the guard cell or to misname the guard cell as a stoma.

Question 2

(a) The definition was well known but some candidates gave an answer specific to haemoglobin rather than a general definition. There was some confusion between the different polypeptides, α and β, described in the question and the secondary structural motifs α-helices and β-pleated sheets.

(b) Few candidates gained full credit. Partial credit was often gained by describing the manufacture of monoclonal antibodies or for adding appropriate monoclonal antibodies to urine and explaining that they would bind to u-FSH. Those answers which mentioned immobilisation usually focused incorrectly on dipsticks. Some candidates discussed hCG instead of u-FSH.

(c) Few candidates gained full credit. The need for the Golgi apparatus to glycosylate the protein was the most common creditworthy response. Candidates tended to think incorrectly that the mammalian cells will already have the 'right promoters'. Common incorrect responses included reference to an immune response to bacterial cells or bacterially-produced recombinant protein, the human patient being used as an incubator for monoclonal antibodies, and raising antibodies to remove, 'attack' or 'kill' all of the substances in urine.

(d) Some candidates gained full credit but generally the standard of drawing and recall was limited. Common incorrect responses included the zona pellucida being much too thick or outside of the corona radiata and terms such as theca were frequently misspelt.

(e) (i) Many candidates gained credit for the comparisons but the explanations proved to be very difficult. Some candidates did not appreciate that the figures were a mean and attempted to calculate a percentage.

(ii) Candidates found this very difficult. Many thought that the test compared using FSH with not using FSH rather than comparing the use of the two types of FSH. The term 'critical value' was used rarely.

Question 3

(a) Many candidates gained full or almost full credit. Common incorrect responses included self-pollination described as asexual and offspring of self-pollination showing no genetic variation.

(b) Whilst some candidates appreciated that the distance travelled by the pollen would be less, few named the anther and stigma or discussed the comparative distance between them.

(c) Many candidates gave a prehearsed answer with no reference to the new context of the question. A common misconception equated smaller flowers with shorter plants.

Question 4

(a) (i) Most candidates understood habitat loss due to urbanisation but then frequently incorrectly linked this to deforestation. Some candidates appreciated the human causes and some the lack of pollinating insects.

(ii) Most candidates gave a comprehensive list.

(b) Most candidates understood the role of gibberellins, although few knew that gibberellin moves to the aleurone layer. The role of amylase was less well known. Although references were seen to transcription and mRNA, this was rarely linked to the gene being switched on. Most candidates gained credit for the sugar produced being used for respiration or as an energy source.

(c) (i) Stronger candidates could distinguish between the two statements and describe the effect of each variable but many candidates could not distinguish between the two variables.
In the second part candidates often approximated the value rather than reading the value from the graph to the nearest grid line.

(ii) Whilst many candidates understood the principle of scraping many did not discuss the pros and cons of scraping and did not make a judgement on whether to recommend the procedure or not.

Question 5

(a) Many candidates gained partial credit but few gained full credit.

(b) Many candidates gave a summarised rewording of the question rather than grouping the data into categories showing a preference and not showing a preference to the calls of their own males.

(c) Whilst the criteria for determining whether organisms belong to the same species or not were well-known, some candidates found it difficult to apply them appropriately within the context of the question and data provided. Candidates who made and then clearly communicated their decision usually gained credit.

Question 6

(a) Candidates who gave several different modes of action for the toxin, or developed an idea in step-by-step detail with correct references to the key molecular players gained most credit. Common incorrect responses included misuse of the terms synapse and synaptic cleft, binding to the sodium ion channel without mentioning the specific receptor protein, referring to sodium or calcium rather than the relevant ions, using enzyme-substrate terminology inappropriately, receptor proteins having an active site and neurotoxin not being a 'competitive inhibitor' of acetylcholine or its receptor proteins. The terminal of a pre-synaptic neurone can be referred to as a synaptic knob, but there is no such structure as a 'post-synaptic knob'.

(b) Most candidates gained full credit. Common incorrect responses included that calcium ions enter the pre-synaptic membrane rather than the pre-synaptic neurone, and to describe exocytosis of whole vesicles leaving the neurone and entering the synaptic cleft.

(c) Common correct answers included a description of the role of synapses in learning and memory, and in unidirectional transmission of nerve impulses. Some candidates described an action potential incorrectly as being weak or under a threshold, whereas it is an all or nothing response.

Question 7

(a) The process of glycolysis was outlined well by most candidates, although some lost credit by not including the number of molecules of each substance produced. Some candidates confused photosynthesis and respiration and referred incorrectly to reduced NADP. Incorrect responses included incorrect use of 'substrate level phosphorylation', NAD being involved in reduction rather than oxidation of the glycolysis intermediate and that NAD causes the step to happen whereas it acts as a co-enzyme.

(b) The processes producing ATP were generally well known. Most candidates used ticks and crosses in all the boxes as instructed, but a few candidates left some boxes blank and so could not gain credit for these.

(c) Some candidates showed good understanding and gained full credit. Weaker candidates usually described the relative amounts of oxygen and carbon dioxide involved in producing the RQ value and did not consider the underlying processes taking place in the seeds or seedlings to produce these values. Few candidates appreciated that anaerobic respiration results in a high RQ value in excess of 1.

Question 8

(a) Most candidates gave mutation rather than gene mutation as their answer. Responses not creditworthy included change to the DNA sequence and change to the genetic code, as these are too imprecise.

(b) Most candidates gained some credit and many candidates only missed full credit by not including the offspring phenotypes and not relating these to the genotypes in the Punnett square. Some candidates attempted to answer without using a Punnett square which made the the task much more difficult. A number of candidates misinterpreted their symbols such as c^h as chinchilla rather than Himalayan.

Question 9

(a) Most candidates showed good knowledge and answers mostly showed logical sequencing of events. However, a few went beyond the scope of the question to transforming bacteria which was required in part **(b).**

(b) Some candidates described only the first stage in the process but stronger candidates described both stages although most candidates found it challenging to include sufficient detail in their

descriptions. Common incorrect responses included omitting the nutrient medium in the petri dish, confusing antibiotic with antibody and the plasmid being given the antibiotic resistance genes along with the new insulin gene.

Question 10

(a) Most candidates showed good understanding and organised their responses well, keeping batch and continuous culture separate and in the question order. A common error was to discuss the production of a secondary metabolite in static low nutrient conditions or high stress conditions rather than as a dynamic process.

(b) Stronger candidates gained high credit by using the correct biological terms in the correct context and order. Incorrect responses included omitting the detail of extraction from the spleen, confusing lymphocyte cells or plasma cells with antibody proteins, mixing the plasma cells with myeloma cells rather than fusing them together, and trying to test the antibody product as opposed to the hybridoma cell in order to select the correct cell for large scale cloning.

BIOLOGY

Paper 9700/42
A2 Structured Questions

Key message

Candidates need to read questions carefully, this should enable them to use this information coupled with their own biological knowledge in the unfamiliar context of the question. The command word for these types of questions is 'suggest'.

General comments

The paper differentiated well.

Comments on specific questions

Section A

Question 1

(a) Most candidates labelled both **L** and **R** correctly. A significant number omitted this question. Common incorrect responses included the reversal of **R** and **L**, **R** on the intermembrane lamellae and **L** on the granal stack.

(b) Most candidates were awarded partial credit and many full credit. A large minority of candidates discussed the loss of water with excess light which was not creditworthy.

(c) The majority of candidates gained full credit. Many candidates gave reduced NAD instead of reduced NADP. Other incorrect responses included oxaloacetate and glucose.

Question 2

(a) Many candidates gained credit. A number concentrated on problems such as deformed sperm or the fact that the sperm might nor fertilise the oocyte, both of which were not creditworthy.

(b) The majority of candidates gave a clear understanding of the role of the promoter being there to switch on the gene but the second marking point was rarely seen

(c) Few candidates gained full credit. Many answers concentrated on stages of oogenesis rather than explaining the differences between metaphases I and II of meiosis. Diagrams were often not well enough annotated to be creditworthy.

(d) The majority of candidates gave a correct comparison often with correct paired figures. The explanation proved to be very difficult and was omitted by some. A common incorrect response was to state that r-hFSH was more effective.

(e) (i) The highest concentration was the most common correct response although some candidates gave units of mol dm^{-3} instead of nmol dm^{-3}. Some candidates commented on where the results were the same but very few commented on the day of greatest dfference.

(ii) Most candidiates gained partial credit. Common incorrect responses included discussion of the uterus wall, oestrogen maintaining the lining and FSH being inhibited rather than its production being inhibited. Candidates tended to discuss many hormones and often referred to oestrogen stimulating progesterone and then discussing the effects of that hormone

Question 3

(a) Most candidates gained high credit but few gained full credit. Common non-creditworthy responses included the relative positioning of the stamens and stigma and factors such as height of the plant. Weaker candidates confused pollen and pollination and also seeds and seed dispersal.

(b) Candidates found this very difficult and few gained credit. The idea of maintaining the gene pool was the most common correct response.

(c) Most candidates had the idea that the hybrid is not reproductively isolated but many did not gain credit as they did not appreciate that it is the parent species with which they can still breed.

Question 4

This question caused the candidates the most difficulty. It required candidates to analyse data, interpret results and know Darwinian theory.

(a) Most candidates gained partial credit**.** Many omitted to describe the recessive alleles as harmful or described the current environment rather than a changed one.

(b) (i) Many candidates appreciated that the frog's body temperature is dependent on ambient temperature and could state the effect on metabolic rate but could not give explain these.

(ii) Most candidates gained partial credit, mainly for the data. However, some candidates gave lists of figures from the graph rather than describing the trends.

(iii) Few candidates realised that the frogs had been kept in identical laboratory conditions.

(iv) Some candidates gained partial credit but few achieved full credit.

(c) Most candidates realised that the lowland frogs would die but few could then give another creditworthy point. A common incorrect response considered the fate of the hybrid frogs.

Question 5

(a) Most candidates identified the direction of impulse propagation along the axon but some placed it incorrectly. A significant number omitted this.

(b) (i) Many candidates gained full credit. Often the direction of sodium and potassium ions pumping across the membrane was reversed. Some discussed sodium and potassium without reference to them being ions.

(ii) Most candidates gained full credit. Incorrect responses included calcium ions ‘entering the presynaptic membrane’ rather than ‘knob’ or ‘neurone’, incorrect references to calcium ions crossing the pre-synaptic cleft with the vesicle/neurotransmitter to initiate the transmission.

(iii) Few candidates gained any credit here. There was generally little specific reference to dendrites or axons.

Question 6

(a) The role of humans and interbreeding was known by most candidates but some thought that the offspring were interbred without any further selection. Few discussed directional selection.

(b) Most candidates gained full credit. Unusual answers included eye colour, length of ears and coupling a good meat output with cattle requiring minimum food.

(c) Stronger candidates were fully aware of the consequences of inbreeding over a period of time and appreciated the larger picture. Weaker candidates tended to use terms incorrectly and a number thought incorrectly that there was no genetic variation.

Question 7

(a) Most candidates gained full credit. Common incorrect responses included adenosine in **(i)** and pentose in **(ii).**

(b) Many candidates gained full credit. Some thought energy was produced rather then released. A common incorrect response had ATP transported round the body rather than around the cell. Some gave a list of uses of ATP which was not creditworthy.

(c) This was generally answered well. Incorrect responses included NADP or ATP and some candidates incorrectly thought that oxygen is a product of oxidative phosphorylation.

(d) Most candidates gained partial credit with stronger candidates gaining full credit.

(e) (i) Most candidates knew how RQ is calculated, but many didn't include time or volume or moles. A few candidates inverted the equation.

(ii) Most candidates knew the typical RQ values, although a few quoted the figures given in **Table 7.1**.

(iii) Many candidates answered in terms of RQ becoming greater without giving a value. A number incorrectly gave infinity.

Question 8

(a) (i) The majority of candidates gained credit. A few gave allele or genotype incorrectly.

(ii) Most candidates showed a good understanding of the term homozygous. Weaker candidates often confused homozygous with recessive.

(b) Some candidates scored full credit. Some confused their annotations $\mathbf{C^{CH}}$ and $\mathbf{C^{CM}}$ while others used incorrect annotations, such as $\mathbf{C^{H}}$ or $\mathbf{C^{M}}$. Occasionally, candidates who did not use a Punnett square obtained incorrect **F2** genotypes and some didn't link the **F2** genotypes to their respective phenotypes.

Section B

Question 9

(a) There were some excellent accounts of how electrophoresis is used in genetic fingerprinting. Often credit was not achieved because points were missing rather than the answer being incorrect. Few included references to the enzyme cutting at the VTNR regions, the fragments needing to be heated to separate the DNA strands so that the single stranded probes could hybridise with them, or that a banding pattern would be seen as the end product. Stronger candidates appreciated that the fragments would be negatively charged due to the phosphate groups. Some candidates gave uses of genetic fingerprinting but these were not required by the question.

(b) Most candidates gained some credit but full credit was often not achieved because points were missing rather than the answer being incorrect. A few stronger candidates gained full credit. Few included references to the response being rapid, the reduced risk of transmitting disease or infection or that it would be usefult to treat diabetics who had developed tolerance to animal insulin.

Question 10

(a) The majority of candidates described accurately the method of obtaining the alginate beads with immobilised enzyme. Some candidates didn't know which solution to mix with the enzyme and mixed all the ingredients together. Few knew that the beads and enzyme would need to be separated from the mixture. Most candidates appreciated the advantages of immobilised enzymes although some suggested incorrectly that very wide ranges of temperatures might be possible in industrial processes.

(b) Few candidates realised that the enzyme is immobilised. The pads on the sticks were often omitted and the enzyme was often referred to as being stuck to the stick with a substance which changed colour. The method of use was described well by all candidates and many discussed the oxidation involved. Stronger candidates linked the action of the enzyme to the colour change and to the concentration of glucose. A minority of candidates suggested that monoclonal antibodies were attached to the dip stick, confusing pregnancy testing with this glucose test.

BIOLOGY

Paper 9700/43
A2 Structured Questions

Key messages

- Candidates need to read questions carefully, interpret related stimulus material and focus on what the question is asking before composing their answer. Data questions such as **4(e)(i)** and **5(b)** provide examples of questions where candidates often wrote in general terms without fully analysing the question and its context.
- Some questions require candidates to make a reasoned judgement about a hypothesis or a recommendation for action, e.g. **4(e)(ii)** and **5(c)**. Candidates should state their decision clearly and explain whether each line of reasoning supports or opposes the hypothesis or decision.
- Candidates should use A Level biology terminology in their answers in order to access maximum credit.

General comments

Candidates who scored highly were able to combine a breadth and depth of knowledge with an ability to interpret the question and to understand and use new information from the question context.

Generally candidates were most successful on **Questions 1** (photosynthesis recall), **4(a)** (conservation recall), **7(a)** and **7(b)** (respiration recall) and the two biotechnology essays. Questions that involved data handling, skills of analysis and the making and substantiating of judgements (**Questions 2**, **4 and 5**) tended to be lower-scoring. Genetic terminology in **Question 3** proved difficult for some candidates.

Comments on specific questions

Question 1

(a) The majority of candidates labelled the tissues correctly but often did not use the labels requested. Some candidates confused phloem with xylem.

(b) Generally candidates answered well, but incomplete answers were seen quite often, such as omitting the term diffusion or not naming the substanced that diffused. A common incorrect response related thinness to penetration of light. Some candidates described features of xylem and palisade mesophyll tissues.

(c) (i) Most correct responses made a comparative reference to the difference in the thickness of the cell wall. Some candidates thought incorrectly that chloroplasts are present in lower epidermal cells and not in guard cells. Non-technical descriptions of shape, such as ‘sausage-shaped’ and ‘bean-shaped’, were not creditworthy.

(ii) Many candidates gained full credit. Incorrect responses included those which focused on the cells outside rather on the events inside the guard cell or to misname the guard cell as a stoma.

Question 2

(a) The definition was well known but some candidates gave an answer specific to haemoglobin rather than a general definition. There was some confusion between the different polypeptides, α and β, described in the question and the secondary structural motifs α-helices and β-pleated sheets.

(b) Few candidates gained full credit. Partial credit was often gained by describing the manufacture of monoclonal antibodies or for adding appropriate monoclonal antibodies to urine and explaining that they would bind to u-FSH. Those answers which mentioned immobilisation usually focused incorrectly on dipsticks. Some candidates discussed hCG instead of u-FSH.

(c) Few candidates gained full credit. The need for the Golgi apparatus to glycosylate the protein was the most common creditworthy response. Candidates tended to think incorrectly that the mammalian cells will already have the 'right promoters'. Common incorrect responses included reference to an immune response to bacterial cells or bacterially-produced recombinant protein, the human patient being used as an incubator for monoclonal antibodies, and raising antibodies to remove, 'attack' or 'kill' all of the substances in urine.

(d) Some candidates gained full credit but generally the standard of drawing and recall was limited. Common incorrect responses included the zona pellucida being much too thick or outside of the corona radiata and terms such as theca were frequently misspelt.

(e) (i) Many candidates gained credit for the comparisons but the explanations proved to be very difficult. Some candidates did not appreciate that the figures were a mean and attempted to calculate a percentage.

(ii) Candidates found this very difficult. Many thought that the test compared using FSH with not using FSH rather than comparing the use of the two types of FSH. The term 'critical value' was used rarely.

Question 3

(a) Many candidates gained full or almost full credit. Common incorrect responses included self-pollination described as asexual and offspring of self-pollination showing no genetic variation.

(b) Whilst some candidates appreciated that the distance travelled by the pollen would be less, few named the anther and stigma or discussed the comparative distance between them.

(c) Many candidates gave a prehearsed answer with no reference to the new context of the question. A common misconception equated smaller flowers with shorter plants.

Question 4

(a) (i) Most candidates understood habitat loss due to urbanisation but then frequently incorrectly linked this to deforestation. Some candidates appreciated the human causes and some the lack of pollinating insects.

(ii) Most candidates gave a comprehensive list.

(b) Most candidates understood the role of gibberellins, although few knew that gibberellin moves to the aleurone layer. The role of amylase was less well known. Although references were seen to transcription and mRNA, this was rarely linked to the gene being switched on. Most candidates gained credit for the sugar produced being used for respiration or as an energy source.

(c) (i) Stronger candidates could distinguish between the two statements and describe the effect of each variable but many candidates could not distinguish between the two variables.
In the second part candidates often approximated the value rather than reading the value from the graph to the nearest grid line.

(ii) Whilst many candidates understood the principle of scraping many did not discuss the pros and cons of scraping and did not make a judgement on whether to recommend the procedure or not.

Question 5

(a) Many candidates gained partial credit but few gained full credit.

(b) Many candidates gave a summarised rewording of the question rather than grouping the data into categories showing a preference and not showing a preference to the calls of their own males.

(c) Whilst the criteria for determining whether organisms belong to the same species or not were well-known, some candidates found it difficult to apply them appropriately within the context of the question and data provided. Candidates who made and then clearly communicated their decision usually gained credit.

Question 6

(a) Candidates who gave several different modes of action for the toxin, or developed an idea in step-by-step detail with correct references to the key molecular players gained most credit. Common incorrect responses included misuse of the terms synapse and synaptic cleft, binding to the sodium ion channel without mentioning the specific receptor protein, referring to sodium or calcium rather than the relevant ions, using enzyme-substrate terminology inappropriately, receptor proteins having an active site and neurotoxin not being a 'competitive inhibitor' of acetylcholine or its receptor proteins. The terminal of a pre-synaptic neurone can be referred to as a synaptic knob, but there is no such structure as a 'post-synaptic knob'.

(b) Most candidates gained full credit. Common incorrect responses included that calcium ions enter the pre-synaptic membrane rather than the pre-synaptic neurone, and to describe exocytosis of whole vesicles leaving the neurone and entering the synaptic cleft.

(c) Common correct answers included a description of the role of synapses in learning and memory, and in unidirectional transmission of nerve impulses. Some candidates described an action potential incorrectly as being weak or under a threshold, whereas it is an all or nothing response.

Question 7

(a) The process of glycolysis was outlined well by most candidates, although some lost credit by not including the number of molecules of each substance produced. Some candidates confused photosynthesis and respiration and referred incorrectly to reduced NADP. Incorrect responses included incorrect use of 'substrate level phosphorylation', NAD being involved in reduction rather than oxidation of the glycolysis intermediate and that NAD causes the step to happen whereas it acts as a co-enzyme.

(b) The processes producing ATP were generally well known. Most candidates used ticks and crosses in all the boxes as instructed, but a few candidates left some boxes blank and so could not gain credit for these.

(c) Some candidates showed good understanding and gained full credit. Weaker candidates usually described the relative amounts of oxygen and carbon dioxide involved in producing the RQ value and did not consider the underlying processes taking place in the seeds or seedlings to produce these values. Few candidates appreciated that anaerobic respiration results in a high RQ value in excess of 1.

Question 8

(a) Most candidates gave mutation rather than gene mutation as their answer. Responses not creditworthy included change to the DNA sequence and change to the genetic code, as these are too imprecise.

(b) Most candidates gained some credit and many candidates only missed full credit by not including the offspring phenotypes and not relating these to the genotypes in the Punnett square. Some candidates attempted to answer without using a Punnett square which made the the task much more difficult. A number of candidates misinterpreted their symbols such as c^h as chinchilla rather than Himalayan.

Question 9

(a) Most candidates showed good knowledge and answers mostly showed logical sequencing of events. However, a few went beyond the scope of the question to transforming bacteria which was required in part **(b).**

(b) Some candidates described only the first stage in the process but stronger candidates described both stages although most candidates found it challenging to include sufficient detail in their

descriptions. Common incorrect responses included omitting the nutrient medium in the petri dish, confusing antibiotic with antibody and the plasmid being given the antibiotic resistance genes along with the new insulin gene.

Question 10

(a) Most candidates showed good understanding and organised their responses well, keeping batch and continuous culture separate and in the question order. A common error was to discuss the production of a secondary metabolite in static low nutrient conditions or high stress conditions rather than as a dynamic process.

(b) Stronger candidates gained high credit by using the correct biological terms in the correct context and order. Incorrect responses included omitting the detail of extraction from the spleen, confusing lymphocyte cells or plasma cells with antibody proteins, mixing the plasma cells with myeloma cells rather than fusing them together, and trying to test the antibody product as opposed to the hybridoma cell in order to select the correct cell for large scale cloning.

BIOLOGY

Paper 9700/51
Planning, Analysis and Evaluation

Key Messages

It was essential for candidates to read and take note of the information provided in both **Question 1** and **2** in order to be able to answer the questions fully. Candidates also need experience of practical work in order to be familiar with techniques mentioned even when these techniques are in unfamiliar contexts. This was particularly applicable in **Question 1**. Candidates should be comfortable with the purpose of a control experiment and the techniques involved in dilution of standard solutions.

There will generally be data handling questions involving statistical methods. Some responses showed good understanding but many seemed unclear about what standard deviation is and the proper construction of a null hypothesis. These are areas that would benefit from careful practice as would drawing conclusions from sets of data.

General Comments

Candidates did not seem to be short of time and most candidates were able to confine their answers to the space provided.

Comments on Specific Questions

Question 1

This question introduced candidates to an enzyme practical and, based on the information provided, asked questions on the dilution of a stock solution, the planning of a similar experiment and the inference of the expected results. Although the exact investigation was a novel context, background practical experience in the general area was of great value here. Careful reading of the information provided was essential.

(a) The stem of the question provided information about how to answer this question. The majority of candidates conveyed the idea that the end point of the reaction would be difficult to pin-point exactly. Fewer candidates went on to explain why this would be, but most who did, realised that the cleaning solution would become cloudy or coloured during the digestion process. Others were aware that the process of gelatine removal would be gradual, thus making it difficult to decide when to stop the stopwatch. A few candidates suggested that it might be necessary to lift the lens out of the cleaning solution to observe if the gelatin or colour had gone and that this would add another potential difficulty to exact timing. A number of candidates suggested areas of candidate error with regard to use of the stopwatch which was not a valid response.

(b) (i) Candidates are be expected to have performed a dilution of a stock solution to prepare a range of known concentrations as part of their practical training. The vast majority were able to name either proportional or serial dilution as appropriate methods or give a valid description. Fewer candidates suggested an appropriate range and number of dilutions to be prepared, despite the information on range being provided in the stem of the question. Relatively few responses indicated that the candidates realised that a conversion is required from mg cm^{-3} to μg cm^{-3}. Even fewer candidates realised that it is good practice when performing a dilution to use the same diluting medium (in this case buffered saline) as present in the original solution you are trying to emulate (here the lens cleaning solution). Most merely described diluting with water to achieve 50 cm^3 of the new solution.

(ii) Candidates found this question difficult. The control for an enzyme-based practical should be familiar to candidates, but a majority put only water as their control solution. A few of the best responses conveyed the impression that the purpose of a control experiment is to prove that no factor other than the independent variable causes the dependent variable to change. This idea had

to be made specific to the context provided, which is that the other components of the cleaning solution do not break down the gelatin layer. Thus an appropriate control is either boiled cleaning solution or the buffered saline (plus EDT). This then allows the experimenter to show that it is the enzyme not the other constituents of the cleaning solution that is responsible for the breakdown of the protein (gelatin). Common incorrect answers stated that the control solution is just 'buffer', with the reason given as 'to control pH' or suggestions that the mid range of the enzyme concentrations was the control.

(c) (i) The majority of candidates were able to identify the variables which were provided in the stem of the question. Some responses were too general to gain credit. These included just 'time' or 'concentration of solution' rather than time to remove gelatin or concentration of subtilisin A. A few responses had the variables the wrong way round.

(ii) Many of the best responses provided a detailed method based on the information provided. Despite the instruction not to repeat the description of the dilution method used a number did so. Candidates should aim at producing a logical set of instructions such that someone else could follow them.
Although most candidates realised that the volume of each enzyme solution should be kept constant, fewer stated a valid volume at which it should be kept constant (10 cm^3) and which would fit the apparatus they were using. Volumes significantly more or less than this would require an alteration of the apparatus away from that provided. Only some candidates suggested an accurate piece of apparatus to allow the volumes to be measured. The vast majority of candidates suggested that a timer/stopwatch should be used to record the end-point of the reaction. Colourimetry is not an appropriate technique in this investigation. The key variables to keep constant were well covered by most candidates and made good use of the information provided, however a significant proportion missed that the temperature required by this investigation was 35^0C not the 60^0C optimum. Credit was awarded for mentioning the need to bring the enzyme solution to temperature before putting in the simulated lenses. This point was not seen very often, but the best responses gave a logical sequence of steps for carrying out the investigation and making clear at what point equilibration should occur. In others there was some mention of 'equilibrating to temperature' with no indication as to when this should occur - or even saying it was after the lens was put in, which would really invalidate the whole experiment. In some cases candidates put in a vast range of possible things to standardise. It is important to be selective about what variables are important factors in the particular investigation. Candidates should be aware that it is best practice to repeat each experiment at least twice (to give 3 results) and that it is the identification and removal of anomalous results from the mean that improves reliability.
Whilst as a practical experiment the investigation is low risk, it it does have some risk. Where hazards are mentioned the nature of the hazard needs to be clear and specific and the precaution linked to the particular hazard. General statements about 'danger' and 'care' are not sufficient.

(d) (i) Many candidates were able to orientate the axes correctly and write sufficiently detailed axes titles. Either time or rate was acceptable on the *y*-axis but the labelling did need to indicate full detail in terms of removal of gelatin. Some candidates provided appropriate units but there was some confusion over the correct units for a reaction rate. Many candidates were able to sketch an appropriate line for their axes. The commonest error was to sketch a rate graph when it was time on the *x*-axis and thus showed the plot rising, whereas the time for gelatin to be removed will drop with higher enzyme concentrations. Some candidates drew rate of enzyme activity against temperature graphs showing a decrease at the end.

(ii) Determining an unknown concentration from a graph of known concentration was a technique that was not familiar to all candidates. A significant number made reference to the peak of the graph or to the maximum/minimum plateau region or to the gradient of the graph. Others made a general statement about comparing to the graph or to the data, without explaining what they meant. Good responses either repeated the experiment with cleaning solution of unknown concentration (or took the mean value from Table 1.1) and then made it clear they would read across from this time to see where it hit the plot which indicating the actual concentration. Thumbnail sketches helped make this clear in a number of cases.

Question 2

This question was about the effect of pre-natal alcohol exposure on the rate of median nerve conduction. The tables of data and experimental design had to be carefully studied in order that the results were understood. Familiarity with the *t*-test was also examined. There were some good responses to the statistical sections, but also a lot of misconceptions.

(a) Many responses gained credit here. Weaker responses did not make reference to the pre-natal aspect of the alcohol exposure. Others incorrectly stated volume, concentration or amount of alcohol. There were some who thought the independent variable was the speed of conduction.

(b) (i) Candidates were able to suggest a number of key conclusions. There was some confusion when candidates did not appreciate that the values in the table were rates of nerve conduction and thus drew the incorrect conclusions on comparative velocity between pre-natal alcohol exposure and no pre-natal alcohol exposure. Some candidates were not specific enough in their choice of data to compare and did not refer to specific days at which they made their comparison. Some responses gave only raw speed figures. Some candidates correctly processed the data to compare the change in conduction speed over the time period for the two groups.

(b) (ii) Here the focus was on the whole median nerve. Many candidates continued to compare the non-alcohol exposed babies with the alcohol exposed babies. Some conclusions could be focused on comparison between motor and sensory neurones at a given time and with a given alcohol exposure. There were some responses in this category, but the majority of candidates who obtained credit here made reference to the fact that the conduction velocity increased as the baby got older.

(c) To identify any one particular result within the table of data, the group, type of neurone and number of days should be stated. Most candidates realised that the most reliable result could be identified by the smallest standard deviation. There was some confusion between standard error and standard deviation. No credit was given for references to standard error. Some candidates gave several results which they thought most reliable. These responses showed a lack of understanding of the descriptive side of statistics as they included statements like 'those at 20 days because they had less time with or without alcohol', with no reference to the actual data and standard deviation.

(d) (i) There were a lot of confused responses here. Many candidates incorrectly discussed significance in terms of how different speeds of nerve conduction might have an effect on the development of the baby. Only a few candidates correctly identified that there was no overlap in the standard deviations of the two numbers being compared. There seemed to be some confusion about what a standard deviation shows and some uncertainty about this type of descriptive statistics. Again standard error and error bars were quite often mentioned and were inappropriate responses.

(ii) Many candidates gained credit here for either saying that the data was continuous or that means were being compared. A few responses suggested that the test allowed you to find the mean or to find out if the data had normal distributions. It was also important to give a positive characteristic of the data that allows a *t*-test to be performed. Some candidates digressed into what the *t*-test might show about the data with comments on chance and probability.

(iii) There is a standard format in which a null hypothesis should be framed. Thus it should state that there is no significant difference between the conduction speed in the sensory neurone of babies from group 1 and babies from group 2. The most common omissions were to not make reference to the sensory neurone or to omit the word significant to qualify 'different'.

(e) Candidates needed to read the stem of the question carefully in order to answer this question. The expected responses were not just critiques of the experiment in terms of things like 'no repeats'. Certain faults in design were valid when trying to apply these results to all babies. These included small sample size, gender imbalance, differing sample size and restricted age range of the mothers. Suggestions that the alcohol consumed by the mothers was 'not constant' was not creditworthy. The two groups who are not represented are those mothers who drink some alcohol but less than 32 mg per day and those who drink occasionally rather than daily as in the sample. There were also rather general suggestions on the difference in alcohol transference across the placenta or in the way different mothers metabolised it in the liver which did not address the question.

BIOLOGY

Paper 9700/52

Planning, Analysis and Evaluation

Key messages

- Candidates should carry out as much practical work as possible and become familiar with different types of apparatus, how it is used and any limitations of its use.
- When describing an experimental method, candidates should organise it into a logical sequence and include sufficient practical detail for another person to carry out the experiment without any additional information.
- Candidates should use scientific terminology when referring to quantities, such as volume, concentration, and mass. Answers that use 'amount' are not credited.
- Candidates should read and assimilate the information given in questions and apply it to their biological knowledge to answering questions.

General comments

Candidates had sufficient time to complete the examination paper. Most candidates were able to confine their answers to the space provided. There was a good range of marks, with many candidates giving clearly presented answers. Where candidates made errors in calculation and changed the numbers by over-writing the original, such as in **Questions 1(d) (iii)** and **2(b)**, candidates must ensure the intended answer is clear. While many candidates showed a good understanding of experimental method there were also candidates with limited practical experience who could not always identify variables, describe how to obtain reliable results or use appropriate methods. Weaker responses reflected uncertainty about units for volume and concentration and how to sequence the method for an investigation. There was also evidence that candidates did not always use the information given to answer questions. For example, in **Question 1(c)** it was common for candidates to copy the information given about the mode of action of the two types of amylase, without explaining how this allowed the different enzymes to be identified. This was also true of many answers to **Question 1(d) (iv)**.

Comments on specific questions

Question 1

This question was about using standard solutions of amylase to find the concentration of this enzyme in an extract from a fungus. Candidates were expected to use the information given to devise a method by which the concentration of amylase in an extract could be determined by the hydrolysis of starch. Data interpretation and calculation of standard deviation were also tested.

(a) Most candidates correctly identified both the independent variable and the dependent variable. The only common error was giving the concentration of the fungal extract as the independent variable. Poorer answers reversed the independent variable and the dependent variable.

(b) There were some good answers that gained maximum credit. There were also very many poorer answers where candidates had not read the question carefully and so made a range of concentrations of the fungal extract. While most candidates could give an example of a method of dilution, only the best answers stated that a minimum of five was needed and were able to give a suitable range that matched the stated method. It was very common for candidates to give serial dilution as a method but then give concentrations that would be achieved by proportional dilution. Better answers also referred to a suitable control, commonly water. Most candidates gained credit for a method of measuring the dependent variable, although candidates should be aware that a metre ruler is not appropriate for accurate measurement. Poorer answers either measured the area with a ruler or 'found the area', without describing any method.

The majority of candidates were able to describe at least one method of standardising a variable, commonly temperature using a water-bath or incubator, although some weaker answers 'incubated at the same temperature', without saying what apparatus would be used. Better answers usually gave a number of correct variables, the most common being a reference to using the same volume of amylase solution and the time for incubation. Candidates who referred to using a buffer to standardise pH rarely gained credit as their answers were too vague. To gain credit candidates needed to state that the starch agar should be buffered as this is where the enzyme is going to be active. Candidates who specified times and volumes often showed a limited understanding of the apparatus and the method being used. A common statement was 'add 10 cm^3 of each amylase solution to the well', suggesting a lack of familiarity with the capacity of a standard Petri dish. Incubation times were often too short, commonly 10 minutes or 20 minutes, which is not sufficient time for amylase to spread far enough by diffusion and give a measurable result. Weaker answers often stated that buffer would be poured over the starch agar, again suggesting a lack of familiarity with practical work.

A number of candidates did not test a fungal extract, while others diluted the extract to make a range of concentrations. Candidates who did test the extract could not always explain clearly enough how to find the actual concentration. The best answers described how to use the known concentrations to produce a calibration curve on which the area of the fugal extract could be found and then used to find the concentration. Good answers referred to matching the area of the fungal extract to the areas of the known concentrations to find the closest match. Poorer answers simply stated that the areas would be compared.

Most candidates recognised that this was low risk investigation. Those who commented on specific hazards were not always accurate in their answers, for example iodine is an irritant, but is not considered to be an allergen.

Candidates who produce an answer modelled on previous mark schemes for this type of question will be limited in available credit as previous answers do not match the current question. Candidates are expected to describe a method that could be used as a procedure by another person, so practical details must follow a logical sequence that specifies what apparatus to use, how to standardise variables that may affect the results and how to measure the independent variable.

(c) Candidates found this question difficult. Hydrolysis of starch by β-amylase would give mainly maltose and a mixture of short chain sugars, which would not register with a glucose biosensor. Most of the candidates chose to use either iodine or Benedict's solution. Those choosing iodine showed a widespread misconception that starch hydrolysed by β-amylase would still remain blue, but that starch hydrolysed by γ-amylase would be brown. Another misconception was that the area of digested starch would be greater for γ-amylase than for β-amylase. Those candidates who used Benedict's solution gained credit if they stated that the products of hydrolysis from γ-amylase would change colour first. The majority however did not seem to be aware that maltose is a reducing sugar so that the colour of the precipitate from total hydrolysis of starch by both enzymes would be indistinguishable. Some candidates stated that a colorimeter could be used to measure the precipitate from Benedict's test, which suggests a misunderstanding of how a colorimeter works. A colorimeter can be used on the remaining blue solution as the intensity of the colour is a measure of the remaining unreduced copper.

(d) (i) Almost all candidates gave two correct answers.

(ii) The majority of candidates gave a correct answer, commonly to ignore or not use the anomalous results. The most common error was to state 'repeat the experiment' without saying that this is to obtain a consistent result.

(iii) Most candidates were able to complete the table to calculate standard deviation. Most errors were the result of inaccurate rounding up of figures so that the total for $(x - \bar{x})^2$ was incorrect. Error carried forward was allowed for a standard deviation calculated from this incorrect value. Some candidates did not gain credit for their use of the figure from Table 1.2 as they did not work out the square root.

(iv) To answer this question candidates needed to relate the area of the brown zone to the activity of amylase, then from this deduce the concentration of amylase in the saliva of the different people

tested and hence the relative number of genes present. The best answers showed the understanding that there was progressive decrease in the activity of amylase from person **A** to **F**, indicating that person **A** produced saliva with the highest concentration of amylase and had the greatest number of genes coding for amylase. Less good answers tended to miss out one of these stages of thinking, often the link between the area of the brown zone and the activity of amylase. Poorer answers often showed the necessary understanding, but used comparisons that were too vague, for example, person **F** has fewer genes than person **A** or extract **A** has more amylase than extract **F**. In some cases, the answers stated that the enzyme extracts contained genes for amylase production. Some candidates misinterpreted the question and answered in terms of anomalous results, standard deviation, confidence limits and reliability.

Question 2

This question was about an investigation into the speed of conduction in the ulnar nerve using a standard test and the statistical analysis of the results.

(a) The majority of the candidates gave answers related to the test set up, which is a standard test, rather than the subjects on which the test was carried out. These answers, for example, the distance between the electrode and the size of the electrodes, were not credited. Candidates should be aware that tests carried out on human subjects should attempt to standardise as much as possible about the people, in particular aspects of physiology or life style that could bias the test results. For this investigation, anything that might affect nerve conduction was relevant, such as drugs, body mass and the dominant hand. Candidates who did consider this aspect often gave answers that were too vague, for example diet and health. When groups are being compared, then other aspects of the investigation, such as the number of people in each of the groups and in this case the arm tested should also be considered. Some candidates incorrectly stated that all the women should be the same age.

(b) Almost all candidates gave a correct answer.

(c) (i) The majority of candidates chose two correct age groups, but only better answers were able to give a correct reason. Some candidates who understood the principle of the expected answer, often lost credit as they stated that the means did not overlap, rather than the confidence intervals. Candidates who chose the youngest and oldest age groups often gave the fact that one was younger as their reason. Other candidates quoted the mean values of their chosen age groups and stated that they had the greatest difference. References to error bars and ranges were also common. Candidates should be aware that a range is not the same as an error bar calculated from standard deviation and that error bars are only appropriate when considering data presented as a graph.

(ii) The majority of candidates gave a correct answer. Some poorer answers gave the rationale behind statistical tests in general terms, for example ‘to be sure there really is a difference’, rather than the reason why the *t*-test was suited to the data.

(iii) Whilst there were many candidates who could state an acceptable null hypothesis, there were others who simply copied the information in the question that mean conduction velocity varies with age. Candidates need to be familiar with the idea that a null hypothesis assumes there is no significant difference in the results of an investigation of two different groups. In this case, nerve conduction velocity in the age categories chosen in answer to **(c) (i)**. Credit was also given for a more general null hypothesis that there is no significant difference in nerve conduction velocity in different age groups.

(d) Many candidates gave a correct answer related to the large sample tested. A large number of candidates focused on specific age groups citing statistical data such as small standard error, which does not address the reliability of the whole investigation. Poorer answers were in terms of the number of repeats, rather than sample size.

BIOLOGY

Paper 9700/53
Planning, Analysis and Evaluation

Key Messages

It was essential for candidates to read and take note of the information provided in both **Question 1** and **2** in order to be able to answer the questions fully. Candidates also need experience of practical work in order to be familiar with techniques mentioned even when these techniques are in unfamiliar contexts. This was particularly applicable in **Question 1**. Candidates should be comfortable with the purpose of a control experiment and the techniques involved in dilution of standard solutions.

There will generally be data handling questions involving statistical methods. Some responses showed good understanding but many seemed unclear about what standard deviation is and the proper construction of a null hypothesis. These are areas that would benefit from careful practice as would drawing conclusions from sets of data.

General Comments

Candidates did not seem to be short of time and most candidates were able to confine their answers to the space provided.

Comments on Specific Questions

Question 1

This question introduced candidates to an enzyme practical and, based on the information provided, asked questions on the dilution of a stock solution, the planning of a similar experiment and the inference of the expected results. Although the exact investigation was a novel context, background practical experience in the general area was of great value here. Careful reading of the information provided was essential.

(a) The stem of the question provided information about how to answer this question. The majority of candidates conveyed the idea that the end point of the reaction would be difficult to pin-point exactly. Fewer candidates went on to explain why this would be, but most who did, realised that the cleaning solution would become cloudy or coloured during the digestion process. Others were aware that the process of gelatine removal would be gradual, thus making it difficult to decide when to stop the stopwatch. A few candidates suggested that it might be necessary to lift the lens out of the cleaning solution to observe if the gelatin or colour had gone and that this would add another potential difficulty to exact timing. A number of candidates suggested areas of candidate error with regard to use of the stopwatch which was not a valid response.

(b) (i) Candidates are be expected to have performed a dilution of a stock solution to prepare a range of known concentrations as part of their practical training. The vast majority were able to name either proportional or serial dilution as appropriate methods or give a valid description. Fewer candidates suggested an appropriate range and number of dilutions to be prepared, despite the information on range being provided in the stem of the question. Relatively few responses indicated that the candidates realised that a conversion is required from mg cm^{-3} to μg cm^{-3}. Even fewer candidates realised that it is good practice when performing a dilution to use the same diluting medium (in this case buffered saline) as present in the original solution you are trying to emulate (here the lens cleaning solution). Most merely described diluting with water to achieve 50 cm^3 of the new solution.

(ii) Candidates found this question difficult. The control for an enzyme-based practical should be familiar to candidates, but a majority put only water as their control solution. A few of the best responses conveyed the impression that the purpose of a control experiment is to prove that no factor other than the independent variable causes the dependent variable to change. This idea had

to be made specific to the context provided, which is that the other components of the cleaning solution do not break down the gelatin layer. Thus an appropriate control is either boiled cleaning solution or the buffered saline (plus EDT). This then allows the experimenter to show that it is the enzyme not the other constituents of the cleaning solution that is responsible for the breakdown of the protein (gelatin). Common incorrect answers stated that the control solution is just 'buffer', with the reason given as 'to control pH' or suggestions that the mid range of the enzyme concentrations was the control.

(c) (i) The majority of candidates were able to identify the variables which were provided in the stem of the question. Some responses were too general to gain credit. These included just 'time' or 'concentration of solution' rather than time to remove gelatin or concentration of subtilisin A. A few responses had the variables the wrong way round.

(ii) Many of the best responses provided a detailed method based on the information provided. Despite the instruction not to repeat the description of the dilution method used a number did so. Candidates should aim at producing a logical set of instructions such that someone else could follow them.
Although most candidates realised that the volume of each enzyme solution should be kept constant, fewer stated a valid volume at which it should be kept constant (10 cm^3) and which would fit the apparatus they were using. Volumes significantly more or less than this would require an alteration of the apparatus away from that provided. Only some candidates suggested an accurate piece of apparatus to allow the volumes to be measured. The vast majority of candidates suggested that a timer/stopwatch should be used to record the end-point of the reaction. Colourimetry is not an appropriate technique in this investigation. The key variables to keep constant were well covered by most candidates and made good use of the information provided, however a significant proportion missed that the temperature required by this investigation was 35^0C not the 60^0C optimum. Credit was awarded for mentioning the need to bring the enzyme solution to temperature before putting in the simulated lenses. This point was not seen very often, but the best responses gave a logical sequence of steps for carrying out the investigation and making clear at what point equilibration should occur. In others there was some mention of 'equilibrating to temperature' with no indication as to when this should occur - or even saying it was after the lens was put in, which would really invalidate the whole experiment. In some cases candidates put in a vast range of possible things to standardise. It is important to be selective about what variables are important factors in the particular investigation. Candidates should be aware that it is best practice to repeat each experiment at least twice (to give 3 results) and that it is the identification and removal of anomalous results from the mean that improves reliability.
Whilst as a practical experiment the investigation is low risk, it it does have some risk. Where hazards are mentioned the nature of the hazard needs to be clear and specific and the precaution linked to the particular hazard. General statements about 'danger' and 'care' are not sufficient.

(d) (i) Many candidates were able to orientate the axes correctly and write sufficiently detailed axes titles. Either time or rate was acceptable on the *y*-axis but the labelling did need to indicate full detail in terms of removal of gelatin. Some candidates provided appropriate units but there was some confusion over the correct units for a reaction rate. Many candidates were able to sketch an appropriate line for their axes. The commonest error was to sketch a rate graph when it was time on the *x*-axis and thus showed the plot rising, whereas the time for gelatin to be removed will drop with higher enzyme concentrations. Some candidates drew rate of enzyme activity against temperature graphs showing a decrease at the end.

(ii) Determining an unknown concentration from a graph of known concentration was a technique that was not familiar to all candidates. A significant number made reference to the peak of the graph or to the maximum/minimum plateau region or to the gradient of the graph. Others made a general statement about comparing to the graph or to the data, without explaining what they meant. Good responses either repeated the experiment with cleaning solution of unknown concentration (or took the mean value from Table 1.1) and then made it clear they would read across from this time to see where it hit the plot which indicating the actual concentration. Thumbnail sketches helped make this clear in a number of cases.

Question 2

This question was about the effect of pre-natal alcohol exposure on the rate of median nerve conduction. The tables of data and experimental design had to be carefully studied in order that the results were understood. Familiarity with the *t*-test was also examined. There were some good responses to the statistical sections, but also a lot of misconceptions.

(a) Many responses gained credit here. Weaker responses did not make reference to the pre-natal aspect of the alcohol exposure. Others incorrectly stated volume, concentration or amount of alcohol. There were some who thought the independent variable was the speed of conduction.

(b) (i) Candidates were able to suggest a number of key conclusions. There was some confusion when candidates did not appreciate that the values in the table were rates of nerve conduction and thus drew the incorrect conclusions on comparative velocity between pre-natal alcohol exposure and no pre-natal alcohol exposure. Some candidates were not specific enough in their choice of data to compare and did not refer to specific days at which they made their comparison. Some responses gave only raw speed figures. Some candidates correctly processed the data to compare the change in conduction speed over the time period for the two groups.

(b) (ii) Here the focus was on the whole median nerve. Many candidates continued to compare the non-alcohol exposed babies with the alcohol exposed babies. Some conclusions could be focused on comparison between motor and sensory neurones at a given time and with a given alcohol exposure. There were some responses in this category, but the majority of candidates who obtained credit here made reference to the fact that the conduction velocity increased as the baby got older.

(c) To identify any one particular result within the table of data, the group, type of neurone and number of days should be stated. Most candidates realised that the most reliable result could be identified by the smallest standard deviation. There was some confusion between standard error and standard deviation. No credit was given for references to standard error. Some candidates gave several results which they thought most reliable. These responses showed a lack of understanding of the descriptive side of statistics as they included statements like 'those at 20 days because they had less time with or without alcohol', with no reference to the actual data and standard deviation.

(d) (i) There were a lot of confused responses here. Many candidates incorrectly discussed significance in terms of how different speeds of nerve conduction might have an effect on the development of the baby. Only a few candidates correctly identified that there was no overlap in the standard deviations of the two numbers being compared. There seemed to be some confusion about what a standard deviation shows and some uncertainty about this type of descriptive statistics. Again standard error and error bars were quite often mentioned and were inappropriate responses.

(ii) Many candidates gained credit here for either saying that the data was continuous or that means were being compared. A few responses suggested that the test allowed you to find the mean or to find out if the data had normal distributions. It was also important to give a positive characteristic of the data that allows a *t*-test to be performed. Some candidates digressed into what the *t*-test might show about the data with comments on chance and probability.

(iii) There is a standard format in which a null hypothesis should be framed. Thus it should state that there is no significant difference between the conduction speed in the sensory neurone of babies from group 1 and babies from group 2. The most common omissions were to not make reference to the sensory neurone or to omit the word significant to qualify 'different'.

(e) Candidates needed to read the stem of the question carefully in order to answer this question. The expected responses were not just critiques of the experiment in terms of things like 'no repeats'. Certain faults in design were valid when trying to apply these results to all babies. These included small sample size, gender imbalance, differing sample size and restricted age range of the mothers. Suggestions that the alcohol consumed by the mothers was 'not constant' was not creditworthy. The two groups who are not represented are those mothers who drink some alcohol but less than 32 mg per day and those who drink occasionally rather than daily as in the sample. There were also rather general suggestions on the difference in alcohol transference across the placenta or in the way different mothers metabolised it in the liver which did not address the question.