BIOLOGY

Paper 9700/11
Multiple Choice

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

General comments

There was a very good spread of scores. Nine questions were answered correctly by more than 75%, **Questions 2**, **3**, **5**, **11**, **12**, **14**, **18**, **25** and **38**. **Questions 9**, **29**, **31**, **35** and **39** proved to be more difficult, with fewer than half of the candidates answering them correctly.

Comments on specific questions

Question 1

More than half of the candidates answered this correctly, although a significant number of less able candidates thought that starch grains were not visible in a suitable stained plant cell. Candidates who had carried out practical microscopy were more likely to answer correctly.

Question 2

Almost all of the more able and more than half of the less able candidates answered this correctly.

Question 3

Many of the less able candidates did not realise that the endoplasmic reticulum or lysosomes have only a single membrane.

Question 4

The majority of candidates could identify the nucleolus and calculate its size.

Question 5

Almost all of more able and more than half of the less able candidates realised that ribosomes were so small that they would not be seen using a microscope with a resolution of 200 nm.

Question 6

Almost all of the candidates knew that iodine in potassium iodide solution turns black in the presence of starch, but just over half were unable to link the biuret test for protein to the presence of the enzyme amylase.

Question 7

A significant number of less able candidates incorrectly thought both amylopectin and cellulose are polymers of α-glucose and almost half thought that adjacent glucose molecules are rotated by 180° in both amylopectin and cellulose.

Question 8

Many of the less able candidates thought that sucrose is a reducing sugar. Candidates who have carried out tests on biological molecules should know this is incorrect.

Question 9

Candidates who carefully read the question were able to eliminate any answer containing glycerol, which clearly does not contain C=O bonds, and therefore, could deduce that **A** was the only possible answer. The basic structural formula of glucose does contain a C=O bond.

Question 10

It was encouraging that many of the less able candidates knew the role of the tertiary protein structure in maintaining the globular shape of enzymes.

Question 11

Most of the candidates knew amylopectin is a carbohydrate and therefore does not contain nitrogen.

Question 12

This was well answered by most candidates.

Question 13

Those candidates who had carried out the suggested practical work in the syllabus to investigate and explain the effects of temperature, pH, enzyme concentration and substrate were able to answer this correctly.

Question 14

Less able candidates continue to have difficulty in understanding the roles of the components of the cell surface membrane.

Question 15

The majority of candidates realised that depending on concentrations and the presence of membrane proteins all four processes can allow transport into or out of the cell.

Question 16

Many candidates realised that only the uptake of 6-carbon sugars was stopped by the absence of oxygen, which meant that they were taken up by active transport.

Question 17

Less that half of the candidates incorrectly thought that a reduction division reduces the chance of mutation.

Question 18

This was well answered by most candidates.

Question 19

The relationship between the number of molecules of DNA and number of chromatids during prophase was not understood by the vast majority of less able candidates.

Question 20

Of less able candidates, very few were able to identify the correct statement.

Question 21

It was encouraging that the majority of candidates were able to correctly answer this. However, less able candidates found this concept difficult.

Question 22

This was well answered by very nearly all of the more able candidates. Candidates who carefully read the question realised that there would be 60 nucleotides to code for the polypeptide.

Question 23

Many less able candidates did not fully understand the concept of transpiration and more than half incorrectly thought that water evaporates from the stomata.

Question 24

Whilst almost all of more able candidates identified the correct answer, many less able candidates were unable to use the information in the diagram to answer the question.

Question 25

This was well answered by most candidates.

Question 26

Less able candidates continue to find it difficult to understand the process of transpiration and its effects.

Question 27

Whilst the vast majority of candidates realised that the water potential would be decreased, a minority incorrectly thought that this was due to diffusion of sucrose into sieve tube elements.

Question 28

Many were able to process the information correctly to identify the correct part of the heart.

Question 29

Those candidates who carefully studied the information provided and linked this to their knowledge of the blood vessels were able to select **D** as the correct answer.

Question 30

The biochemistry of the Bohr effect is poorly understood by less able candidates.

Question 31

Whilst the majority of candidates knew that haemoglobin has the highest affinity for carbon monoxide, fewer than half knew that it had the least affinity for carbon dioxide.

Question 32

Most of the less able candidates did not understand that a partial blockage of an artery can only cause cardiovascular disease.

Question 33

This was well answered by the majority of more able candidates. However, many of the less able candidates did not realise that exocytotic vesicles would be visible in goblet cells.

Question 34

Less able candidates frequently find questions about the immune response challenging.

Question 35

A minority of candidates correctly realised that only eating shellfish which have fed on raw sewage would increase the risk of contracting cholera.

Question 36

This was well answered by nearly all of the more able candidates.

Question 37

Many of the less able candidates do not understand the action of antibodies.

Question 38

It was pleasing that the majority of candidates knew the definition of community.

Question 39

Most of the candidates found it difficult to process the information, in order to answer the question, but almost half were able to work out that the first species should be U.

Question 40

This was well answered by the more able candidates and it was pleasing that almost half of the less able candidates were also able to process the information.

BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

There was a very good spread of scores. Fifteen questions were answered correctly by 75% or more of candidates – **Questions 4**, **6**, **7**, **11**, **12**, **13**, **14**, **16**, **23**, **29**, **31**, **36**, **37**, **39** and **40**. **Questions 21**, **22**, **27**, **30** and **33** proved to be more difficult, with fewer than half of the candidates answering them correctly.

Comments on specific questions

Question 1

Those candidates who had undertaken microscopic examination of cells were most able to identify the range of sizes of most eukaryotic cells.

Question 2

Those candidates who had experience of drawing plan diagrams and annotating observable features were able to eliminate those statements containing non-observable features.

Question 3

This was well answered by the more able candidates.

Question 4

The vast majority of candidates answered this correctly.

Question 5

Most of the less able candidates found this calculation difficult. However, almost all of the more able candidates were able to obtain the correct answer.

Question 6

This was well answered by the majority candidates.

Question 7

Less able candidates continue to find basic biochemistry difficult, with fewer than half answering correctly.

Question 8

Fewer than half of the less able candidates knew that all three molecules contain C=O bonds.

Question 9

Almost half of the less able candidates incorrectly thought both amylose and amylopectin contain 1,6 glycosidic bonds.

Question 10

A minority of less able candidates were able to identify the reducing sugar, with many incorrectly identifying it as sucrose. Candidates who have carried out tests on biological molecules should know that this is incorrect.

Question 11

This was well answered by the more able candidates. However, more than half of the less able candidates continue to have difficulty understanding the formation of glycogen.

Question 12

This was correctly answered by most candidates.

Question 13

This was correctly answered by many candidates, although a significant number of less able candidates did not make the link to specificity.

Question 14

This was answered correctly by almost all of the candidates.

Question 15

A significant number of candidates did not realise that both osmosis and facilitated diffusion are passive processes.

Question 16

Whilst almost all of the more able candidates answered correctly, almost a half of the less able candidates found the concept of water potential difficult.

Question 17

Almost all were able to place the events 5, 3, 1 and 2 in the correct order, with just over a half knowing that these four events were followed by the chromosomes uncoiling.

Question 18

Less able candidates find it difficult to relate synthesis of DNA to the cell cycle.

Question 19

The majority of less able candidates and a significant number of more able candidates were unclear as to the requirements for transcription to occur.

Question 20

Almost half of the less able and almost all of the more able candidates correctly processed the information.

Question 21

Whilst the majority of candidates realised that statement 3 was incorrect, since some anticodons would contain uracil instead of thymine, only a minority knew that statement 2 was correct, since some portions of tRNA are double stranded.

Question 22

Only a minority of candidates answered this correctly. Statements 2 and 3 are not relevant to the need for large animals to evolve a transport system.

Question 23

This was correctly answered by the majority of candidates.

Question 24

Most of the more able and almost half of the less able candidates answered this correctly.

Question 25

Less able candidates continue to find it difficult to understand the processes of transpiration and translocation and their effects.

Question 26

Whilst the majority of candidates correctly identified the sink and source, fewer knew where the hydrostatic pressure was highest.

Question 27

Only a minority of candidates knew that all four substances could be found in blood vessels, lymph and tissue fluid.

Question 28

Many less able candidates continue to find the Bohr effect difficult to understand.

Question 29

This was well answered by the majority of candidates.

Question 30

More than half of the candidates were able to interpret the data in order to realise that as one volume increases, so does the other. However, the relationship cannot be linear since some blood is never expelled from the ventricle.

Question 31

This was correctly answered by almost all candidates.

Question 32

Just over half of the candidates incorrectly thought that chronic obstructive pulmonary disease can be reversed by treatment.

Question 33

Over half of the candidates incorrectly thought that an epidermis would be seen in a photomicrograph of the wall of the trachea.

Question 34

Whilst the vast majority of candidates knew that this was artificial immunity, fewer knew that it was active.

Question 35

Many of the less able candidates found this question about the immune response challenging.

Question 36

This was well answered by the majority of candidates. Less able candidates continue to find it difficult to link the causative agent to the disease.

Question 37

This was well answered by almost all candidates.

Question 38

Many candidates could identify the five different trophic levels in the food web.

Question 39

This was well answered by most candidates.

Question 40

Many of the less able candidates did not read the question carefully, and answered in terms of energy transfer from producers to consumers.

BIOLOGY

Paper 9700/13
Multiple Choice

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

General comments

There was a very good spread of scores. Four questions were answered correctly by 75% or more of candidates – **Questions 1**, **4**, **21** and **28**. **Questions 2**, **16**, **20**, **22**, **23**, **31**, **32** and **36** proved to be more difficult, with fewer than half of the candidates answering them correctly.

Comments on specific questions

Question 1

The majority of candidates knew the definition of the term *community*.

Question 2

Many candidates found it difficult to process the information in order to answer the question. Only a minority were able to work out that the first species should be U.

Question 3

This was well answered by the more able candidates and almost half of the less able candidates were also able to process the information.

Question 4

The majority of candidates answered this correctly.

Question 5

The majority of less able candidates did not realise that the endoplasmic reticulum or lysosomes have only a single membrane.

Question 6

The majority of candidates answered this correctly. However, a significant number of less able candidates thought that starch grains were not visible in a suitably stained plant cell. Those candidates who had carried out practical microscopy were more likely to answer correctly.

Question 7

It was encouraging that almost all of the more able candidates and almost a half of the less able candidates realised that ribosomes were so small that they would not be seen using a microscope with a resolution of 200 nm.

Question 8

It was encouraging that over half of the candidates could identify the nucleolus and calculate its size.

Question 9

Less able candidates continue to have difficulty in understanding the roles of the components of the cell surface membrane.

Question 10

Many candidates realised that depending on concentrations and the presence of membrane proteins, all four processes can allow transport into or out of the cell.

Question 11

More than half of the candidates realised that only the uptake of 6-carbon sugars was stopped by the absence of oxygen, which meant that they were taken up by active transport.

Question 12

The majority of less able candidates thought that sucrose is a reducing sugar. Candidates who have carried out tests on biological molecules should know this is incorrect.

Question 13

Whilst almost all candidates knew that iodine in potassium iodide solution turns black in the presence of starch, many were unable to link the biuret test for protein to the presence of the enzyme amylase.

Question 14

Many of the less able candidates incorrectly thought both amylopectin and cellulose are polymers of α-glucose and almost half thought that adjacent glucose molecules are rotated by 180° in both amylopectin and cellulose.

Question 15

Almost all of the more able candidates and a significant minority of less able candidates knew amylopectin is a carbohydrate and therefore does not contain nitrogen.

Question 16

Candidates who carefully read the question were able to eliminate any answer containing glycerol, which clearly does not contain C=O bonds. Therefore the only possible answer was **A**. The basic structural formula of glucose does contain a C=O bond.

Question 17

Many of the less able candidates knew the role of the tertiary protein structure in maintaining the globular shape of enzymes.

Question 18

Those candidates who had carried out the suggested practical work in the syllabus to investigate and explain the effects of temperature, pH, enzyme concentration and substrate were able to answer correctly.

Question 19

This was correctly answered by the more able candidates, whilst more than half of the less able candidates incorrectly selected the activation energy in the absence of the enzyme.

Question 20

Over half the candidates incorrectly thought that a reduction division reduces the chance of mutation.

Question 21

This was well answered by most candidates.

Question 22

The relationship between the number of molecules of DNA and number of chromatids during prophase was not understood by the majority of less able candidates.

Question 23

This was correctly answered by the majority of more able candidates. Candidates who read the question carefully realised that there would be 60 nucleotides to code for the polypeptide.

Question 24

Only a minority of less able candidates were able to identify the correct statement.

Question 25

It was encouraging that most candidates were able to answer this correctly. However, less able candidates found this concept difficult.

Question 26

Many less able candidates do not fully understand the concept of transpiration, and many incorrectly thought that water evaporates from the stomata.

Question 27

Less able candidates continue to find it difficult to understand the process of transpiration and its effects.

Question 28

This was well answered by the majority of candidates.

Question 29

Whilst the majority of candidates realised that the water potential would be decreased, there were some who incorrectly thought that this was due to diffusion of sucrose into sieve tube elements.

Question 30

Whilst the majority of more able candidates identified the correct answer, many less able candidates were unable to use the information in the diagram to answer the question.

Question 31

Only a minority of candidates correctly realised that only eating shellfish which have fed on raw sewage would increase the risk of contracting cholera.

Question 32

Most of the less able and many of the more able candidates found this question about the immune response challenging.

Question 33

This was well answered by over almost all of the more able candidates.

Question 34

Many less able candidates do not understand the action of antibodies.

Question 35

It was pleasing that the majority of candidates were able to process the information correctly to identify the correct part of the heart.

Question 36

Those candidates who carefully studied the information provided and linked this to their knowledge of the blood vessels were able to select **D** as the correct answer.

Question 37

Whilst the majority of candidates knew that haemoglobin has the highest affinity for carbon monoxide, fewer than half knew that it had the least affinity for carbon dioxide.

Question 38

The biochemistry of the Bohr effect is poorly understood by less able candidates.

Question 39

This was well answered by almost all the more able candidates. However, a significant number of less able candidates did not realise that exocytotic vesicles would be visible in goblet cells.

Question 40

The majority of less able candidates did not understand that a partial blockage of an artery can only cause cardiovascular disease.

BIOLOGY

Paper 9700/21
AS Structured Questions

Key messages

- Candidates should always include units when they give data quotes and copy them correctly from graphs and tables
- Comparative words should be included where appropriate. For example, 'the electron microscope has a higher resolution than the light microscope' is preferable to writing 'the electron microscope has a high resolution'.
- Candidates should read through the entire question before beginning their written response. There may be occasions when the general overview is beneficial to the candidate, or where later part questions provide a stimulus for thought for the first part of the question.

General comments

It was encouraging to see that many candidates had been well prepared for this paper, scoring well on all questions. However, some found **Questions 3(b)** and **(c)** difficult to answer. Answers to **Question 3** tended to be Centre dependent, although there were some excellent answers displaying good understanding of this topic.

Candidate performance across the complete paper was very Centre dependent. Most candidates completed the paper and there was no indication that they had insufficient time. The best candidates were very good at sequencing answers and presenting their information in a logical order. Almost all candidates attempted all the questions.

Comments on specific questions

Question 1

This straightforward question proved a good start for almost all candidates. A significant number did not identify the pulmonary artery correctly in **(a)**; the most common incorrect suggestions were the aorta and the pulmonary vein. 'White blood cell' was seen frequently as a response for parts **(b)** and **(c)**. The most common error in **(e)** was not identifying cartilage as the tissue that prevents the collapse of the trachea; elastin or collagen was given instead.

Question 2

Most candidates showed good knowledge of microscopy and cell structure. A significant number of candidates identified structure **F** in Fig. 2.1 as the cell wall and **G** as the cell membrane. It is clear that candidates need to look at many more electron micrographs and drawings made from them. Candidates' knowledge of the permeability of cell membranes and cell walls was often good. Although candidates were not required to name structures **F** and **G**, it was clear that some did not know what they were and spoke generally about the permeability as if they were one layer. Many said that **F** and **G** together formed the phospholipid bilayer, **F** being the hydrophilic part and **G** the hydrophobic part or vice versa.

(a) Many candidates explained why the details of chloroplasts and mitochondria can be seen in the electron microscope (EM) but not in the light microscope (LM). They referred to the higher resolution of the EM and explained what this means in terms of seeing detail, but rarely referred to the membranes within the two organelles. The mark points most often given were 1 and 4; it was also pleasing to see many candidates giving the correct resolutions for the two microscopes which often gave them further credit. However, few candidates referred to the width of the membranes within the two organelles, even if they had given the different resolving power of the two microscopes. Many candidates lost credit by failing to make it clear that it is electrons themselves, rather than electron microscopes, that have the shorter wavelength. Some discussed magnification without any reference to resolution so did not gain any credit.

(b) Most candidates identified the three structures labelled in the drawing of the cell. A common error was to identify **E** as a Golgi body rather than smooth endoplasmic reticulum. Candidates were expected to write out the full names of the rough endoplasmic reticulum and the smooth endoplasmic reticulum rather than giving RER and SER, which were not credited. The word reticulum was misspelt quite often, but credit was given for phonetic spellings. Candidates from one Centre named **E** the 'soft' endoplasmic reticulum.

(c) Candidates gave a range of roles of vacuoles in plant cells. Credit was lost by candidates who gave very general answers such as 'for storage' rather than storage of a specific substance or substances, such as water, pigments and ions. Many gave answers involving osmotic properties or osmoregulation, which did not gain credit. Many thought that the vacuole stored starch.

(d) There was no credit available for identifying structures **F** and **G** from Fig. 2.1 and credit was given for features associated correctly with cell membranes and cell walls. If the structures were misidentified, only partial credit could be awarded for this part question. Candidates were more confident about the permeability properties of cell membranes, but struggled to say more than that cell walls are composed of cellulose. Credit was awarded for contrasting the partial permeability of cell membranes with the fully permeable nature of the cell walls of the mesophyll cells shown in the drawing. Candidates who only referred to the permeability of these structures to water were not awarded credit. Many explained that the phospholipid bilayer makes cell membranes permeable to non-polar molecules but impermeable to polar molecules and ions. Some went on to explain that proteins permit the movement of polar molecules and ions across cell membranes. Few explained that proteins known as aquaporins permit the movement of water. A number of candidates thought that **F** and **G** together were the phospholipid bilayer. They wrote, for example, that **F** was the heads of the phospholipids and **G** the tails. Others discussed the differences between the cell wall and cell surface membrane, but did not refer to **F** or **G** at all.

(e) There were many competent descriptions of the roles of plasmodesmata. Most of these concentrated on the movement of water via the symplast pathway across roots and the movement of sucrose from companion cells into phloem sieve tube elements. Few candidates pointed out that plasmodesmata provide a pathway from cell to cell that avoids passage through cell membranes and cell walls – something that is evident from the drawing. Some candidates were confused between the movement of sucrose *into* and *out of* companion cells. In most cases, sucrose enters companion cells from the apoplast through a co-transporter *in the membrane*. This mechanism was described very fully by some candidates but did not gain any credit. Others described the movement of sucrose from companion cell to sieve tube element as 'going through a co-transporter in the plasmodesmata' which is not the case. It is worth noting that in some species sucrose passes from mesophyll cell to companion cell through plasmodesmata although the pathway via the apoplast and co-transporters is likely to be the more common pathway. Very few wrote about plasmodesmata providing easy routes of communication between cells; however, many did correctly discuss movement of water through the symplast.

Question 3

This question on the oxygen haemoglobin dissociation curve provided the greatest challenge for candidates. Some candidates assumed from Fig. 3.1 that the transport of carbon dioxide and the Bohr shift were involved when there was no information about this at all in the information provided. Candidates rarely gave a good explanation of the ways in which humans become adapted to moving to high altitude in part **(c)**, but often gave excellent answers to part **(d)** explaining why vaccination cannot be used to control sickle cell anaemia.

(a) Many careless answers to part **(i)** were seen. There was leeway with the figure quoted for sample **M** – anything between 4.45 and 4.55 kPa was allowed. However, 4.4 kPa is not a correct reading from the graph. Some candidates omitted the units and were not credited. Answers to part **(ii)** were often supported by data quotes from the graph, with candidates choosing figures from right across the range from 1 to 12 kPa in Fig. 3.1. Error carried forward was allowed for the data quote if an incorrect answer to part **(i)** was used in support. Very few candidates stated that the difference between the two curves exists between 0.5 kPa and 13 kPa and/or is greatest in the middle part of the range. The interpretation of the graph in some cases showed a lack of understanding; an example of this was the statement that 'saturation of haemoglobin influences the partial pressure of oxygen'.

(b) Superficially this question appears to be similar to questions on the Bohr effect, but here there was no mention of the effect of carbon dioxide on the dissociation of oxyhaemoglobin. Instead, this is about the effect of the partial pressure of oxygen on the dissociation. Many candidates noticed that at low partial pressures, the haemoglobin of people with sickle cell anaemia is less saturated with oxygen than normal so favouring dissociation and the *unloading* of oxygen to tissues. This compensates for the reduction in oxygen supply because of the loss of red blood cells in people with sickle cell anaemia. Answers that did not gain credit tended to wander away from the evidence in the graph which was the clue offered by both parts of **(a)**. They did this by referring to carbon dioxide or by discussing the advantage of protection against malaria which was not relevant here. Some candidates wrote about the blood unloading rather than referring to oxyhaemoglobin or haemoglobin unloading oxygen. This was the one part where it was clear that many candidates did not really understand the dissociation curve. This was the part of the paper that candidates appeared to find most difficult.

(c) Well argued answers to this question explained that at high altitude the low partial pressure of oxygen leads to a low percentage saturation of haemoglobin with oxygen, as can be shown from the graph where it decreases from nearly 100% to about 90%. The changes that occur in response compensate for this decrease in percentage saturation by attempting to maintain the total volume of oxygen transported, not by increasing it. This is done by a number of means, such as increasing the production of red blood cells which leads to an increase in the haemoglobin in the blood. These two changes were given by most candidates. Others included an increase in breathing rate and heart rate. References to erythropoietin (EPO) were encouraging. A very effective change is the rightward shift in the dissociation curve which is prompted by the increased production in red blood cells of 2,3-bisphosphoglycerate (BPG) also known as DPG (diphosphoglycerate). Few candidates realised that the inclusion of the figure of 7.5 kPa in the introduction was a cue to quote the percentage saturation of sample **L** from Fig. 3.1 in the answer.

(d) Almost all candidates gained full credit for explaining that sickle cell anaemia is an inherited disease, not an infectious disease, and so vaccination is useless in controlling it. Future candidates for this paper might like to discuss the problems involved in vaccinating against an intracellular protein, such as haemoglobin. The consequences bear thinking about. Also they could discuss the methods that have been introduced in many countries, such as Saudi Arabia, to reduce the prevalence of this inherited disease. Some candidates were confused between antibiotics, antigens and antibodies. Some candidates thought this was a vaccination question, talking about 'herd immunity' and suggesting that all of a population should be given the vaccine at the same time. Spotting the word *vaccination* in the question seemed to prompt this response.

Question 4

This question provided several opportunities for candidates to show what they had learnt about protein structure, enzyme action and antibiotics. There were many high scoring answers.

(a) There were many well written explanations of the importance of the shape of the active site. A significant number of candidates stated that, in order to fit, the substrate had to be the same shape as the active site. Most wrote about the complementary shapes of active site and substrate that allow the two to 'fit' together. The lock and key model was mentioned far more often than induced fit, and the term *specificity* was used in the correct sense in most answers. Incorrect answers only dealt with one idea showing no development. Some candidates incorrectly wrote about 'complementary base pairing' and a few thought that they had to write about penicillinase, its inhibition by a competitor inhibitor so freeing penicillin to act on bacteria.

(b) Most candidates gained full credit here by listing aspects of protein structure that are shown in the ribbon model of penicillinase and those that are not. The easiest way to gain full credit was to state that secondary and tertiary structures are shown and primary and quaternary structures are not. Many candidates mentioned the absence of bonding, including peptide bonds, in the figure. Some candidates gave incorrect answers, for example stating that primary, secondary and tertiary structures are shown. In this case, some credit was awarded for secondary and tertiary, but not for primary if also given in the 'not shown' section.

(c) The curves drawn on Fig. 4.2 to show the changes in energy during the progress of a reaction catalysed by an enzyme were often very precise, starting at the upper dashed line, ending at the lower dashed line and having a peak below the curve for the uncatalysed reaction. Common errors included:

- starting and ending the curve at the same place
- starting the curve below the upper dashed line and ending on the *x*-axis
- taking the curve above that for the uncatalysed reaction
- having a curve with several peaks
- having a fluctuating curve rather than a smooth one.

Candidates who started and/or ended in the wrong place could gain some credit if the peak that they had drawn was less/smaller than that for the uncatalysed reaction. Almost all candidates identified the term in part **(ii)** as activation energy.

(d) There were many encouraging answers to this question considering the global problem of antibiotic resistance. Candidates often applied their knowledge of the treatment for tuberculosis to this question, explaining that antibiotics can be used in combination and that patients should always complete the course of treatment and not stop when they feel better. Many seemed to consider that taking a long course was an effective way of using an antibiotic and some got confused and wrote about antibiotics as if they were vaccines. Some candidates thought this was a vaccination question, and talked about 'herd immunity', suggesting that all of a population should be given the antibiotics at the same time.

Question 5

This question tested knowledge of the roles of nuclear division in life cycles, nitrification and the role of transporter proteins in cell surface membranes all linked together by the biology of the slime mould, *Dictyostelium discoideum*.

(a) Candidates who stated mitosis as the answer to stage **X** were credited here. Although post-zygotic meiosis occurs in *D. discoideum*, **Y** could be correctly interpreted as either meiosis or mitosis.

(b) Most candidates realised that *reduction division* referred to meiosis, explaining that the chromosome number is halved. They also stated that this ensures that the diploid number is restored at fertilisation and that the chromosome number does not double with each generation. There were also many references to the role of meiosis in generating variation. Candidates who did not interpret the term correctly thought that the division reduces the number of cells by killing some off, or reduces the size of the cells produced.

(c) Many scripts showed evidence of a good knowledge of nitrification. The conversion of ammonium ions to nitrite ions and then to nitrate ions was given very often and the named bacteria were usually given in the correct sequence. Many candidates stated that ammonium and/or nitrate ions are absorbed by plants. No credit was given for 'denitrification' since that does not start from ammonium ions, and was considered too far removed from the immediate fate of ammonium ions excreted by *D. discoideum*. A common error was to involve *Rhizobium* and root nodules in the uptake of ammonium ions.

(d) There were many confident answers to this question about the removal of the ammonium ions. Many stated that the ions are charged and cannot pass through the phospholipid bilayer which is hydrophobic. There were references to the solvation of ammonium ions so that they are surrounded by a cluster of water molecules making it even less likely that they will pass through the bilayer but have to go through a protein. Some candidates considered the removal by active transport against a concentration gradient and a few wrote about facilitated diffusion with the concentration gradient. All these approaches gained credit. Ammonium ions are not large polar molecules.

Question 6

Almost all candidates gained credit in part **(b)**. It was encouraging to find well worded answers that used Chargaff's data given in Table 6.1 to confirm the base pairing shown in Fig. 6.1. Part **(c)** proved to be the most difficult. Many gave the correct observation in part **(i)**, but did not make the right conclusion in part **(ii)**.

(a) Dashed lines were most commonly drawn for the hydrogen bonds in part **(i)** and these were often correct for the C-G base pair. The A-T base pair proved to be more difficult as many candidates drew lines between –H and H_3C– rather than between –H and –O. Some candidates missed this question, others just drew lines right across the figure rather than in the precise places required. Many knew that there were two H bonds between A and T and three between C and G but did not know where they were joined and so drew random lines. The importance of hydrogen bonding in DNA in part **(ii)** was often explained in terms of holding the two polynucleotides together and the stability of the molecule. The maintenance of the double helix shape was also found. Incorrect answers referred to the strength of DNA, an answer more appropriate to cellulose and fibrous proteins. Candidates also stated that the bonds are weak enough to break during replication and transcription. Weaker candidates discussed protein structure.

(b) Most candidates identified the similarity between the percentages for A and T, and for C and G. They supported their observations by using figures taken from the table. Incorrect answers tended to dwell on the *differences* between the percentages in different species and the fact that in each case they add up to 100%. Differences between species is an interesting observation and one that future candidates might like to discuss, but was not relevant to this question.

(c) Almost all candidates realised that the percentages for A and T, and for C and G in the viral DNA are not as close as they are in Table 6.1. Many quoted the difference of 7.2% between A and T. This shows that the bases are not paired, since viral DNA is single stranded. Some candidates got very close to this answer, but referred to RNA instead which would have uracil not thymine. Some stated that DNA and RNA are present in viruses. Credit was awarded for this in the few cases where it was given. The idea that DNA is circular was not accepted.

BIOLOGY

Paper 9700/22
AS Structured Questions

Key Messages

- Candidates should read through the entire question before beginning their written response. There may be occasions when the general overview is beneficial to the candidate or where later part-questions provide a stimulus for thought for the first part of the question. **Question 2** is a good example of this.

- Comparative words should be included where appropriate. For example in **Question 3** 'lower transpiration rate' demonstrates that a candidate has considered the various comparative rates for the tree species or type of day, rather than 'low transpiration rate', which does not have a reference against which to compare.

- Candidates should always include units when they give data quotes and must copy them correctly from graphs and tables. For example, using Table 3.1, it would not be acceptable to state '0.25', '0.25 cm^3', or even 'transpiration rate of 0.25'. It is not always necessary to write out the full information from row and column headings from tables or from the *x*-axis and the *y*-axis of graphs. For example, it would be sufficient to state '…whereas the transpiration rate for sour cherry on the warm rainy day is only 0.25 $cm^3 h^{-1}$' instead of '…whereas the transpiration rate for sour cherry on the warm rainy day is only 0.25 mean transpiration rate $cm^3 h^{-1}$'.

General comments

There was high proportion of candidates who did very well on each question in the examination. The highest scoring candidates addressed each question directly and gave clear, unambiguous responses that included correct scientific terminology. They had clearly revised very well and demonstrated a good grasp of what was required for individual learning outcomes in the syllabus, for example in **Question 2(b)(ii)** and **Question 4(c)**. To improve on the overall score some could have provided sufficient points in their response to match the credit allocation for each part, while others could have focused their attention more on the actual requirements of the question. Other areas for improvement are discussed in the comments on specific questions. Most candidates were prepared for this examination, with weaker candidates gaining the available credit in each question that assessed knowledge acquired throughout the course. **Questions 1** and **4** were most accessible to candidates.

Many candidates gained maximum credit in **Question 1**. This question also demonstrated the need to settle in quickly to an examination, as some biologically able candidates did not read the question in part **(b)** carefully enough. The varied quality of response in **Question 2** meant that this question differentiated well. In addition, the importance of analysing the requirements of a question was highlighted in all sections of **Question 2**. In **Question 3**, which also differentiated well, generally only the stronger candidates achieved a high score. Part **(c)**, which included some interesting data, required candidates to apply knowledge and understanding from various sections of the syllabus. This question is a good example to use in class discussion or to give as an assessment exercise when encouraging candidates to improve skills in this area. **Question 4** was another question where many candidates gained full credit, although, as discussed later, some able candidates misinterpreted the requirements of part **(c)** and repeated information that they had already given in **(b)**. They should have been aware that it would be highly unlikely for an examination question to have successive part-questions that overlap to this extent. **Question 5** was well attempted by many, with only the calculation in **(c)(i)** proving to be a challenge for a number of the candidates. There was a high quality of response for the extended answers in **(b)** and **(c)(ii)**. **Question 6** produced a range of responses, with many candidates gaining credit only in part **(a)**, and generally only the more able candidates showed an understanding of what was required in **(b)**.

There were two question parts, **Question 2(b)(ii)** and **Question 4(c)**, where blank space was provided for candidates to use as part of the explanation of the answer. Both written work and labelled diagrams were checked in order to award credit and in many instances, especially in **Question 4(c)**, full credit could be awarded for information appearing in the completed space. The quality of the diagrams produced by a number of candidates was excellent. The more careful candidates ensured that they did not give a written response containing points that contradicted with their diagrams. Only a very few candidates left sections blank and almost all candidates had legible handwriting. Spellings were generally good, including scientific terms, although there were quite a number who should have learned more carefully the spelling of *Vibrio cholerae* for **Question 5(a)**. Candidates appear to have had sufficient time to complete all questions and generally candidates wrote an appropriate amount for the question posed, with only a minority of candidates unnecessarily continuing into nearby spaces.

Comments on specific questions

Question 1

A large proportion of candidates found this question, based on cell membranes and transport (***section D***), to be relatively straightforward, and many gained full credit. Other candidates would have benefited from reading the whole question before attempting to answer. This may have prevented a number of candidates from misreading part **(b)** and providing a set of incorrect responses.

(a) The majority of candidates knew both transport mechanisms. To gain credit candidates needed to name either phagocytosis or endocytosis for the transport of bacteria across the membrane, rather than bulk transport, which a small proportion of candidates gave. Almost all correctly identified water as an example of osmosis, and the majority also gave a relevant example of a material transported via facilitated diffusion. The most common incorrect example was 'proteins'. Only one example was required for this; where candidates gave two or more examples, all needed to be correct for credit to be awarded.

(b) Most candidates were able to follow each pathway successfully and correctly named a transport mechanism to match each set of features. Where credit was lost, this was generally for naming active transport twice, once in the correct pathway and again incorrectly in the last pathway. A number of candidates did not know that endocytosis and exocytosis were active processes. Some candidates were unsure as to whether to name a substance or a transport mechanism, possibly as they had focused on the word 'example' in the question rather than 'example of a transport mechanism'. In many of these cases, boxes were completed with statements such as 'glucose by facilitated diffusion' or 'active uptake of nitrate ions'. Where the example was correct, credit was given for the correct mechanism. Instead of 'active transport' or 'active uptake', 'sodium-potassium pump' was accepted in recognition of the fact that this is sometimes named as a mechanism in addition to the membrane transport protein. Generally, weaker candidates completed the boxes with only examples of substances. In addition, a number confused facilitated diffusion with active transport, despite having the prompt term of 'active' provided. A few of the weakest candidates did not attempt this part.

Question 2

Many Centres teach plasma cells as additional knowledge when covering ***Section J***, Immunity. However, these cells are not named in the learning outcomes and so specific information about the cells was provided in the introduction to **Question 2** so that no candidates were disadvantaged. Attentive candidates recalled, when answering **(a)** and **(b)(i)**, that in the introduction they had been told that plasma cells had been produced from B-lymphocytes and that their role was the production of antibodies. Learning outcomes from Cell structure (***Section A***) were also assessed in **(a)** and learning outcomes from Cell and nuclear division (***Section E***) were assessed in **(b)(ii)**.

(a) A small proportion of candidates gained full credit for this part, which was a good achievement as some boxes in the table were more challenging to complete than others. Most candidates correctly identified structure **A** as the nucleus, which was also spelled correctly by the majority. A number stated that the structure was a chromosome. This was not accepted, as only chromatin, and not chromosomes, was visible. The internal membranes of structure **B** were just visible, which enabled some to correctly identify the mitochondrion. For candidates who could not discern this feature, additional clues were provided by the shape and relative size of the structure. Almost all candidates recognised structure **C** as endoplasmic reticulum, and the majority of these wrote out in full 'rough endoplasmic reticulum' to gain credit. Others did not make the choice between rough and smooth so only stated 'endoplasmic reticulum' or incorrectly gave 'smooth endoplasmic reticulum'. Plausible incorrect identifications in column one were allowed to carry forward. Hence, credit was given either for the correct answer or for the function of the incorrectly named structure. In the second column of Table 2.1 many good answers were seen from the stronger candidates. There were some excellent outlines of the contribution of each structure in the *production of antibody* by the plasma cell. Hence, for the nucleus, an appropriate response would be to state that the nucleus contains the genetic material that codes for the production of antibody, rather than a general reference to control of cell activities or a reference to mitosis, which does not actually occur in mature plasma cells. It was not acceptable for candidates to state that the mitochondrion produced 'energy', 'ATP energy' or 'energy as ATP'. Responses such as 'synthesis of ATP, which supplies the energy required for antibody production' were credited.

(b) It was important in **(i)** for candidates to note the mark allocation and provide three or more explanations for the statement. Some candidates were thorough and detailed in their approach and gave explanations for 'many antibodies' in addition to 'identical antibodies' to gain full credit. The best responses displayed an understanding of the difference between antigen and pathogen, so were able to express clearly how antibodies act against antigens, and how high concentrations of antibody enabled a successful defence against invading pathogens. It was rare for a candidate to note that identical plasma cells would mean that the relevant gene coding for the specific antibody would be switched on. A number of weaker candidates forgot that, in the introduction to **Question 2**, they had been told that plasma cells secrete antibody. These candidates made no reference to antibody and described plasma cells as having a function akin to T killer cells.

In **(ii)** excellent written answers coupled with high quality diagrams were produced by many good candidates. These responses avoided details of mitosis that were not relevant to the answer, and gave sequential accounts that included correct naming of stages and demonstrated comprehensive knowledge of the role of centrioles and the spindle. The most common misconceptions were that centriole pairs replicate during prophase, and that spindle formation occurs only in metaphase. Centriole pairs are visible at the beginning of prophase, having replicated in late interphase, and organisation of the spindle by the centriolar area occurs during prophase, completing prior to the onset of metaphase when the nuclear envelope has completely disassembled. Weaker candidates were generally very confused when attempting to link a named stage to an event involving the centriole or spindle. Although candidates were not required to link every event with a named stage, biologically incorrect statements were not credited. The response provided by a number of candidates could have been improved by more precise use of the terms 'chromatid' and 'chromosome'. On occasion, a rather vague sentence in a written response could be credited if checked against clear, annotated diagrams, where stages were named correctly. Part **(ii)** is a good example of the need to check through responses. Had they done so, some candidates may then have noticed that they had described the attachment of chromosomes to spindle fibres before they described the formation of the spindle, or the positioning of the chromosomes at the spindle equator before centrioles had organised the spindle formation.

Question 3

Two syllabus sections were assessed in this question, Transport (***Section G***) and Gas Exchange and Smoking (***Section H***). Stronger candidates coped well with the unfamiliar material introduced in this question and many were awarded full or almost full credit. Weaker candidates attempted all sections, writing copious amounts that enabled them to gain some credit in each section.

(a) The more able candidates gave some very clear, precise explanations of the differences between evaporation and transpiration, many covering all the available creditworthy points. At the other end of the spectrum, there were some responses that suggested that considerable guesswork had been employed. The best responses began with an explanation of evaporation so that they could give a sequential account and did not get involved in descriptions of movement of water into the roots, up the xylem and to the mesophyll cells, as these were not relevant and are not an explanation of transpiration. Precision was important, and hence evaporation of water from the cell walls of the spongy mesophyll cells was a correct statement, compared to the more vague idea of water evaporating from the air space. Similarly, 'air spaces' or 'intercellular spaces' were acceptable, but 'empty spaces' was not. A high proportion of candidates assumed that evaporation only occurred from the outer surface of the leaf, or that evaporation was one process that occurred in transpiration, stating that transpiration was the evaporation of water out of the stomata. The less able candidates tended to write about water rather than water vapour and so did not gain credit for the definition of transpiration unless they had made it very obvious in previous sentences that evaporation had occurred. Descriptions such as water loss 'from the stomata' are vague and do not indicate an understanding that water vapour leaves the leaf via the stomata. Responses that gave the impression of water beginning its pathway out of the leaf from the stomata were rejected. A sizeable minority of candidates thought that transpiration was used by plants to get rid of 'excess' water, or for cooling. Many candidates used the terms 'water potential' and 'diffusion' correctly and in context. Some candidates saw the term 'difference' and decided to construct a comparison table. The term 'explain', in addition to the subject matter, should have suggested to candidates that this was not a suitable approach. Candidates would benefit from discussing when a comparison table could be used. For example, a table constructed as a response for 'state the difference between the structure of DNA and RNA' would work better than one for which the question is 'explain the difference between a community and an ecosystem'.

(b) The standard of responses in part **(i)** was very varied. Stronger candidates realised that they had not been asked to 'suggest' explanations, and had not been provided with sufficient information to explain all the results. Hence, they took the correct approach and described data for which they could give a valid explanation by applying syllabus knowledge and understanding. Some of the best answers began with an explanation that the data showed the effects of factors affecting transpiration. They continued to compare hot dry days with warm dry days and discuss the effects of temperature on transpiration rate, and then proceeded to compare warm dry and warm rainy days in a similar manner. These candidates confidently and accurately made use of relevant comparative data and remembered to include the correct units. They knew to compare data for one species of tree or to look for the overall trends rather than make irrelevant comparisons such as 'apple has the highest rate on hot dry days but sour cherry has the highest rate on warm rainy days'. Good candidates realised that there was a marked difference in the transpiration rate for peach compared to the other fruit trees, for which the stomatal counts were similar, and so were careful to state that the lower count for peach meant that less water would be lost by transpiration, rather than providing the reverse argument of 'increasing the number of stomata increases the transpiration rate', which was not confirmed by the data. Some candidates wrote out all the results that appeared in the table instead of reducing the volume of data and organising their response so that explanations could be given. Marking some responses proved to be very difficult, as the points given were unrelated and, in some cases, contradictory. Many explanations used basic terminology and ignored the factors affecting transpiration, temperature and humidity. Following on from the previous parts of the question, the more able candidates gained full credit in **(b)(ii)** with clear, concise explanations. Less able candidates were confused about the processes going on during the day and night, often stating that there would be more transpiration at night time, with stomata being open as there was more water to lose. Some responses gave explanations correlating differing transpiration rates with changes in temperature and humidity and did not mention at all the open or closed state of the stomata and links to light intensity, photosynthesis and gas exchange.

(c) The change in topic allowed many candidates, who had found the previous sections challenging, to gain full credit in this part. Knowledge of the effect of smoking on the gas exchange system was generally very sound for the majority of candidates and those who actually answered the question scored well. Good responses were those that named the diseases linked to smoking and were written in terms of prevention, how symptoms would be less likely to appear and risk reduced. Part **(c)(i)** was frequently answered to a higher standard than **(ii)**, with most gaining at least some credit for the idea of preventing cancer. In **(ii)** candidates who simply described symptoms of inflammation, or repeated information provided, gained no credit. Some candidates gave correct biological points but in the wrong sections and so lost credit. Some weaker candidates thought that a diet containing the appropriate fruit would be a cure or would reverse events such as scarring, alveolar wall breakdown and cilia destruction. There were only a few candidates who strayed into descriptions of thrombosis and cardiovascular disease.

Question 4

This question assessed two sections of the syllabus, Genetic control (***Section F***) and Biological molecules (***Section B***). Most candidates were awarded at least half of the available credit. Many candidates realised that there was a switch to a different section of the syllabus in part **(c)** and a large proportion of these gained full credit. Some of the many candidates who incorrectly continued to describe translation in **(c)** were those who gained good total scores overall.

(a) Almost all answered **(i)** correctly, with most correctly copying the spelling of 'thymine'. A very large proportion of the weaker candidates in **(ii)** were possibly thinking about complementary base pairing and incorrectly named the covalent bond as 'hydrogen bond', while a small number gave 'peptide' or 'disulfide'. Most of the remaining candidates gave phosphodiester as the answer and incorrect spellings of this were marked to the candidate's benefit, although 'ester bond' was rejected. In **(iii)**, having been told that Fig. 4.1 represented part of a DNA molecule, it was extremely clear to many candidates that component **X** was deoxyribose, and that an answer of 'pentose sugar' or, incorrectly, 'ribose', would not gain credit.

(b) Most candidates gained minimal credit, generally for noting peptide bond formation between adjacent amino acids. The best responses began by outlining the collection of a *specific* amino acid by a tRNA molecule and did not waste time describing events occurring with mRNA following transcription. Good responses gaining full credit completed their answer well within the lines provided. A common error avoided by better candidates was to describe a single tRNA as having a set of three anticodons, or to write about a single tRNA and continue to state that 'anticodons bind with codons on the mRNA'.

(c) Many candidates correctly interpreted the question and were well prepared to give a thorough answer. Some of the diagrams were of excellent quality. A condensation reaction with the reactive groups highlighted in some way was sufficient to gain full credit. Where the OH of the COOH of the first amino acid and the H of the NH_2 of the second amino were not marked by a box or other means, credit was often awarded if the relevant groups were stated in the written response. A number of biologically artistic candidates produced these diagrams as part of a larger diagram showing the two tRNA molecules attached to the mRNA on the ribosome. Some drew the diagram of translation to show the adjacent amino acids and then magnified this portion with the structural formulae of the amino acids drawn out and the condensation reaction shown. Others described this in the text. Those candidates who misinterpreted the question and repeated much of what was written in **(b)** were sometimes able to score some credit for mentioning a condensation reaction or the peptide bond forming between the carboxyl and amine groups. Less able candidates who gained no credit, tended to repeat what they had written in part **(b)**, also often accompanied by good diagrams to illustrate translation. A minority missed the opportunity to gain credit in **(i)** by describing mRNA attachment to the ribosome in this section and then giving information relevant to **(i)** in **(ii)**, thus illustrating the importance of re-reading a question and checking if a response actually answers a question.

Question 5

In this question candidates were given the opportunity to demonstrate knowledge and understanding of enzyme inhibition (***Section D***, Enzymes) and cholera (***Section I***, Infectious disease). Some weaker candidates gave good answers to this question, which gave many their proportionately highest scoring question of the examination.

(a) More than half of the candidates gave the correct spelling of the species name of the causative organism of cholera, in addition to writing out in full the species name. The most common incorrect spellings seen were as 'Vibreo' or *'Vibro'* instead of 'Vibrio', or the 'e' missed off the species name '*cholerae*'. Many Centres appear to be teaching the correct convention to candidates of using a capital for the first letter of the generic name and lower case for the first letter of the specific epithet.

(b) The majority of candidates had sufficient knowledge and understanding to gain some credit for **(b)**, with many gaining full credit. There were some faultless responses that included information about reversible and irreversible inhibition, which is beyond the requirements of the syllabus. This contrasted with weaker responses where candidates used low level terminology or wrote about the enzyme as a whole rather than refer to the active site. Some candidates did not seem to realise that the enzyme was actually on the bacterium, while others wrote in terms of the bacterium being the enzyme, or the substrate being NQR. 'Active site' was quite frequently written as 'active side'.

(c) Most candidates attempted **(i)** and the majority correctly calculated the total cholera fatality rate. For almost all incorrectly calculated values, the method employed was to add up the final column of Table 5.1 to get 3.77%, rather than using the values for total number of deaths and total number of cases. In **(ii)**, nearly all candidates demonstrated an understanding of the problems involved in controlling the spread of cholera and the majority attempted to link points with the regions in Table 5.1 or gave comparisons using terms such as 'LEDC' and 'MEDC', 'developing' and 'developed'. Identifying features such as the difference in the provision of uncontaminated, treated water or in the quality of sewage treatment plants indicated that candidates had an understanding of the mode of transmission of the disease. All valid suggestions were considered and many seen, with only a handful stating that there may be problems in reporting cases or that there may be differences in the distribution of antibiotic resistant strains of the bacterium. The quality of response for **(ii)** was very varied. The weakest responses focused on only one explanation or only quoted numerical data from Table 5.1. This contrasted with the best responses, which were well expressed, using concise sentences and covering at least four different points to ensure the maximum available credit. Descriptions were accurate and unambiguous, referring to, for example:

- 'contaminated water' rather than 'dirty water' or 'polluted water'
- 'sewage treatment plants' rather than 'drainage systems'
- 'effective vaccines' rather than 'proper vaccines'
- 'education about the prevention of transmission of the disease', rather than 'awareness of the disease'
- 'treated with the correct antibiotics' rather than 'given drugs'

Question 6

Candidates found **(a)**, assessing ***section K*** of the syllabus, Ecology, to be more accessible than **(b)**, which was aimed at the higher-level candidates. This part expected candidates to apply knowledge from various different strands of the syllabus, a task accomplished well by the more able candidates.

(a) Many candidates had a good attempt at this, correctly interpreting the information in Fig. 6.1 to gain full credit. Almost all knew that stage **G** referred to *Nitrosomonas europaea.* The weakest response was for stage **F**, *Streptomyces coelicor,* which many suggested was stage **E**. Candidates who were less familiar with the features of the nitrogen cycle appeared to guess the answers and it was sometimes difficult to see why a particular letter had been chosen.

(b) To gain full credit for this question, candidates not only needed to correctly identify structures or molecules that had phosphorus as a component, but also to relate this to plant growth. Good candidates stated that phosphates were required for nucleotides, and then accompanied this with an explanation that this would enable the synthesis of DNA or RNA. Similarly, knowing that phosphates were required for phospholipids was only part-way to scoring; stating that the phospholipids could be used for the production of new membranes finalised the idea. Candidates who were scoring highly overall tackled this question with ease and gave fluent accounts. At the other extreme, many wrote about the role of nitrate ions or were thinking about magnesium ions in describing the structure of chlorophyll. A minority had not read the question and attempted explanations involving increasing fungal growth or suggested that the uptake of potassium ions would allow osmotic entry of water. The very weakest candidates did not attempt to answer this part.

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Paper 9700/23
AS Structured Questions

Key Messages

- Candidates should read through the entire question before beginning their written response. There may be occasions when the general overview is beneficial to the candidate, or where later part questions provide a stimulus for thought for the first part of the question. This was particularly important in **Question 1** and **Question 5**.

- Comparative words should be included where appropriate. For example in **Question 3** 'there is a higher transpiration rate when temperature increases...' instead of 'there is a high transpiration rate when temperature increases...' shows that the candidate understands that transpiration rate will increase when the temperature is raised by 5 °C.

General comments

A minority of candidates addressed each question directly, providing unambiguous responses and using correct scientific terminology. Responses to the questions requiring extended answers were logical in their approach and, where relevant, sequential in their organisation. These candidates scored highly. Other candidates had clearly revised well and were familiar with the syllabus topics. For these candidates, one way to improve on the overall score would have been to provide sufficient points in their response to match the credit allocation for each section. A significant number of candidates appeared not to be ready, or prepared, for an examination at this level.

Many candidates would have benefited in **Question 1** from reading the whole question before attempting to answer. The calculated value in part **(c)** may have provided an indication to candidates as to which type of blood vessel was shown in Fig. 1.1. The question required candidates to use a range of skills and was not an easy start to the examination for those who rushed through without considering if their initial ideas could be supported by the written and visual information that accompanied the question. Very good scores were achieved by the stronger candidates only. Differences seen in the quality of response in **Question 2** may correlate with experience of carrying out, or seeing, practical work involving the potometer. **Question 3** differentiated well. Here, stronger candidates were confident in digesting new information and then applying syllabus knowledge and understanding to respond to each part-question. **Question 4** required thought and consideration before formulating responses for each part question, especially in **(a)**, which required an extended answer. Part **(c)** was one of the most challenging sections of the examination and a few candidates were able to produce a high quality response. **Question 5** was composed of three sections, each of which required longer responses. Although part **(a)** was less accessible than **(b)** and **(c)**, good attempts at these sections allowed many candidates to score well. This question is a good example to use with candidates when discussing the biology behind developments in science. As weaker candidates showed considerable confusion throughout the question, this may also be a good example to use in class group work, where those candidates who have grasped the concepts could discuss their train of thought with others in the group. **Question 6** was generally the highest scoring question for most candidates. A good understanding of the ecological definitions helped many to score well before tackling the sections on energy losses.

In extended writing it is often helpful for candidates to set out a response by beginning with some fundamental points. Stating in **Question 5 (a)** that proteins are antigens or that vaccines contain antigens, and in **Question 5 (c)** that antibody production is part of the primary response, are examples of this. A number of candidates clearly understood the topics concerned and could have improved their overall score by including some of the more basic points that are often credited. Many were careful to use correct scientific terminology while others provided responses that were more suited to a non-scientific audience. Hence, 'pathogens' instead of 'germs', 'function' instead of 'job', 'contaminated water' instead of 'dirty water', were all examples of good versus poor terminology used in responses. A number of candidates left blank

spaces; as these were spread throughout the paper it appears that this was through a lack of knowledge or understanding, rather than through a lack of time. Candidates who scored well were able to complete every section and write the appropriate amount for each question. Handwriting was usually legible and spellings of scientific terms were generally correct.

Comments on specific questions

Question 1

This question, based on Transport in mammals (***Section G***) and Cell structure (***Section A***), was best tackled by taking a problem-solving approach. It was a challenging question for many candidates. Candidates who carefully considered the information provided were able to score maximum credit.

(a) Candidates are more used to interpreting a diagram of an electron micrograph of a section through a capillary, whereas Fig. 1.1 was a false-coloured electron micrograph. Hence, details were less obvious. A number of candidates realised that the central shape, conveniently coloured red, was an unusual view of a red blood cell and so were able to deduce that the blood vessel was a capillary and could then state a correct characteristic feature. Candidates should understand the difference between 'thin wall (of capillary)', which was acceptable, and 'thin cell walls', for which no credit was awarded. 'Artery' was the most common incorrect identification, which was coupled with either 'narrow lumen' or 'thick wall'. Some candidates who gave an incorrect answer gained further 'clues' for part **(a)** when tackling the rest of the question and returned to rectify their mistake.

(b) In **(i)**, approximately half of the responses correctly identified structure **A** as a red blood cell and so interpreted substance **B** in **(ii)** as either blood plasma, which was the more precise identification, or as blood. For this reason the mark scheme accommodated both and accepted 'water' or 'plasma'. For structure **A**, 'lumen' was the most common incorrect answer from the candidates who had identified the vessel in Fig. 1.1 as an artery or vein, although 'blood clot' and 'blood' were also seen. Many then struggled for the identification of substance **B**; some left this blank, while others thought that it was part of the artery or vein wall and gave smooth muscle or elastic tissue as their answer. A few thought that it was an atheroma and so wrote 'fatty deposits'. For **(iii)**, stronger candidates named structure **D** as the nucleolus, although the mark scheme allowed 'nucleus' as an alternative identification. The reason for this was the confusion some candidates had with the label line **C**, which extended into the endothelial cell and finished at the nucleus (coloured red). These candidates did not realise that the surrounding blue area was the cytoplasm of the endothelial cell. Weaker candidates were distracted by the non-spherical appearance of the nucleus and gave other cell structures such as 'vacuole' or 'mitochondrion'. 'Haemoglobin', 'cytoplasm' and 'lymph' were other incorrect responses seen. Having been told that **C** was an endothelial cell, candidates were provided with an additional clue to name 'capillary' in part **(a)**.

(c) Many candidates scored full credit in this part, although often this was the only part of the question for which they were awarded credit. Most candidates were aware of the correct formula to use to arrive at the actual diameter of the lumen. Line **X-X** was very clearly 39 mm long, and most were able to use their correct measurement and the formula to arrive at an answer of 6.5 μm. Thorough candidates then remembered to round up to 7 μm. Fewer candidates than in previous sessions used an incorrect conversion factor or multiplied their measurement by the magnification. Some candidates appeared not to have a calculator at their disposal for the calculation, and stopped after they had written out the sum that needed calculating. As most candidates did calculate the lumen size correctly, this should have served as another piece of evidence to identify the blood vessel in Fig. 1.1 as a capillary.

Question 2

Well-prepared candidates used their knowledge of Transport in plants (***Section G***) to score the majority of credit for this question. Progress towards full credit was made by those candidates who used additional thought processes to arrive at a more complete answer. Candidates who had seen a potometer in action, either as a laboratory demonstration or on-line, or who had set up their own simple potometer, may have had more confidence in tackling this question.

(a) Apart from the less well-prepared candidates, knowledge of the name of the apparatus in Fig. 2.1, the potometer (transpirometer), frequently proved to be Centre specific. A number of candidates did not attempt this part. Incorrect responses included 'spirometer', 'respirometer', 'photometer' and 'capillary tubing'.

(b) Credit was available for those candidates who showed an understanding that transpiration meant water loss from the leafy part of the plant. Candidates needed to consider reasons for a difference in rates of uptake versus loss. Although weaker responses re-stated the wording of the question, for which no credit could be awarded, more thoughtful candidates described one or more uses of the water taken up to gain full credit. The most common use given was as a reactant in photosynthesis. Some incorrectly thought that water was used in respiration. Others gave reasonable suggestions linked to how external conditions, such as higher temperatures, could lead to a higher rate of transpiration than water uptake rate, and this was also credited.

(c) Candidates were reminded to consider the apparatus in Fig. 2.1 for part **(c)**. A number forgot to do this in **(i)** and wrote about the plant's roots in their answer. Others did not digest all the information provided and thought that the transpiration rate at the higher temperature would lead to a lower rate of water uptake and hence tried to provide explanations based on stomata closing. The best responses not only linked the increased uptake rate to an increased rate of transpiration, but also went on to break this down into the effect of higher temperature on the evaporation of water from the walls of the mesophyll cells and its effect on the rate of diffusion of the water vapour out of the plant. Other ways to gain credit were to consider the effect this would have on the transpiration pull and hence the water uptake. The involvement of enzymes in photosynthesis is not covered at AS Level. However, credit was awarded for the suggestion from some candidates that the increased temperature would lead to an increased rate of photosynthesis and hence more of a demand for water. Approximately half of the candidates gave two correct factors in **(ii)** and this generally came from humidity and wind; many gave 'light' as a factor and did not gain credit as 'light intensity' was required.

(d) This question was based on the wording of a syllabus learning outcome in ***section G*** (Transport). Many candidates were clearly familiar with the syllabus and had no problems gaining most or all of the available credit without writing beyond the lines provided. Stronger candidates who were not familiar with the learning outcome often tended to use the blank space below and give more elaborate answers in an attempt to gain maximum credit, a strategy that generally was successful but would have cost them time. Weaker candidates re-wrote the statement in their own words, not realising that they were being asked to show an understanding of how gas exchange and the process of transpiration in plants were linked. This question is a good example of how, for candidates who understand the topic, attention to detail will lead to additional credit. An example of a response that would gain full credit would be:

'Stomata are open for gas exchange to occur. For example, carbon dioxide diffuses in and is needed for photosynthesis. It is inevitable that transpiration will occur as water vapour diffuses out through the stomata'.

A candidate who did not include the second sentence or who used the term 'water' instead of 'water vapour' would not gain full credit. 'Stomata are open for gas exchange to occur so it is inevitable that transpiration occurs' would only be awarded minimal credit.

Question 3

This question, based on cholera as a theme, required knowledge and understanding from three areas of the syllabus: Biological molecules (***section B***), Cell membranes and transport (***Section D***) and Infectious disease (***section I***). In addition, the majority of the question required candidates to digest information provided and apply knowledge appropriately, a task which some carried out very well to gain most, or all, of the available credit. At the other extreme, many of the weaker candidates found this style of question very challenging and ended up with only minimal credit.

(a) Candidates were provided with written information about the cholera toxin, in addition to Fig. 3.1, the ribbon diagram of the protein. In **(i)** the majority of candidates correctly named the level of structure shown as *quaternary*, with the bulk of the remainder stating either *secondary* or *tertiary*. Some candidates had not read the question sufficiently carefully and gave as their response 'subunit **B**'. Fewer did well in **(ii)**, which required a precise name of alpha (or α) helix. As β-pleated sheets are also included in secondary structure, those candidates who only wrote this needed to qualify correctly before the credit was awarded. Similarly, 'alpha-chain' and 'helix' gained no credit. Others were confused by the ribbon diagram and thought that **S** depicted a bond; of these some were misled by the letter **S** and stated 'disulfide bond', while others named **S** as 'peptide bond' or 'hydrogen bond'.

(b) In **(i)**, stronger candidates applied their knowledge of cell membrane structure and the various transport mechanisms to deduce that the movement of ions through the membrane channels must be by facilitated diffusion. As the question concerned transport across membranes, diffusion was not an acceptable answer as ions would not be able to cross the hydrophobic core of the phospholipid bilayer. The majority realised in **(ii)** that the movement of water across the membrane would be by osmosis, and there were some excellent sequential accounts explaining the consequences of an outflow of ions into the lumen. Candidates who gained full credit noted the credit allocation and realised that their response required more than two ideas. Hence the best answers explained how increasing ion concentration would mean that the water potential in the lumen would lower, so that the movement of water was down the water potential gradient from the higher water potential of the epithelial cell.

(c) The best responses in **(i)** demonstrated clear understanding of the term 'transmission' in the context of infectious diseases. These described how the pathogen was transferred from the infected person to the uninfected person. In order to gain maximum credit candidates were also required to show an understanding that a disease-causing organism was involved. This should have been relatively straightforward considering that the introduction to **Question 3** informed candidates that the disease was caused by the bacterium *Vibrio cholera*e, so vague statements such as 'the disease is in the faeces passed out…', or 'cholera is passed out…' were avoided by stronger candidates. These candidates also understood how a statement such as 'food and water are contaminated by the bacterium' would not gain credit, whereas 'a person becomes infected when he or she ingests food or water contaminated with the bacterium', would. A number of candidates who had misunderstood what was required for **(i)** repeated information for **(ii)** that could gain credit. This should have prompted a return to **(i)** to re-think the appropriate response. Again, attention to the credit allocation for **(ii)** enabled organised candidates to explain in detail two correct features that are associated with cholera transmission. Some gave more than two features; this often proved to be a good strategy as this generally assured them of maximum credit if one idea was not worded sufficiently correctly to be credited.

Question 4

The more able candidates who had a sound grasp of DNA and RNA structure and function, and who thought carefully about ensuring that their response was tailored to the question, were able to gain most or all of the available credit. Less confident, but well-revised, candidates wrote more elaborately and less succinctly in part **(a)**. Credit was gained in this way, and together with a correct answer for **(b)**, scores of up to half the available credit were achieved. Others were able to gain some credit in **(a)** and possibly also in **(b)**.

(a) The majority of candidates described hydrogen bonding as part of the structure of DNA, firstly stating that there were two hydrogen bonds between A and T and three hydrogen bonds between C and G and continuing to describe how complementary base pairing occurred in DNA replication or in transcription. These points did not answer the question of the *importance* of hydrogen bonding. The best responses avoided the contradiction given by many others of incorrectly stating that hydrogen bonds were strong bonds or covalent bonds and then continuing to state that the bonds were weak enough to be easily broken. Stronger candidates showed an understanding of how the weak hydrogen bonds enabled separation of the strands to allow replication and transcription. Some of these went on to explain that the stability of the molecule came from the strength provided by *many* hydrogen bonds.

(b) Over half of all responses correctly deduced the processes **P** and **Q**. In order to gain credit, both processes had to be named correctly. It was fairly common for candidates to name the processes the wrong way round. Another common incorrect response was to suggest that process **P** was 'replication'.

(c) This required high-level responses and candidates who fully qualified their suggestions were more likely to gain credit. For example, in **(i)**, noting that maintaining DNA allowed functioning proteins to be produced was a valid suggestion that was credited, but stating that DNA coded for proteins did not score. In **(ii)** the most common valid response was for the suggestion that mRNA could be broken down and the nucleotides re-used. A few candidates realised that mRNA breakdown would serve as a control mechanism, as protein synthesis would then stop. This was in contrast to the majority who thought that protein synthesis would stop and this meant that mRNA was no longer needed.

Question 5

Although details of the life cycle of *Plasmodium* is not required learning for the AS Level syllabus, many Centres may cover this as extension material when studying malaria in ***Section I***, Infectious disease. Inclusion of the material at the start of the question ensured that no candidates were disadvantaged. This information was a useful stimulus to answer all parts of the question. Focused candidates noted both the diagram and all the written information so were also prompted to consider the Immunity section of the syllabus (***Section J***).

(a) For those candidates who understood the approach used for the malarial vaccine trials and the difference between a parasite and an antigen, there were some excellent explanations as to the benefits of using radioactivity to obtain dead organisms for vaccine production. These candidates realised that radioactivity would preserve the structural integrity of the antigens possessed by *Plasmodium* so allow the development of an immune response in the volunteers. At the other extreme, a high proportion of candidates misunderstood what was required, and from their responses it appears that there were a number of interpretations of the question:

- some focused their thoughts on the disease and thought that the reason for killing the parasites was as a control method;
- some misread the question and thought that high temperatures did not kill the organism;
- some thought that the approach was to try and kill the organisms when they were inside the volunteer's body.

Hence, some suggested that *Plasmodium* was resistant to high temperatures as it is found in hot regions, while others stated that high temperatures would denature enzymes, harming the volunteer.

(b) When providing explanations for the choice of parasite form used, the best responses referred directly to the two distinct forms. Statements such as 'because it is inside cells so it is difficult for antibodies to reach' should have been avoided as it is not clear which form the candidate is referring to. Although most candidates understood that the injected parasite had been killed, a very sizeable minority thought that live parasites were being injected and answered in the context of how the immune system would respond to this situation. Weaker candidates misunderstood the question and chose the first form of the parasite for incorrect reasons, stating that it was easier to inject into the bloodstream rather than directly into the liver.

(c) Most candidates were able to attempt this question and there were some excellent accounts of the primary immune response. The question did not require candidates to describe the production of memory cells or the secondary immune response as the focus was on the production of antibodies following injection of the parasites. Many gave correct information, most of the available credit, and a number gained full credit for remembering the role of macrophages in antigen presentation and the beneficial action of T helper lymphocytes on the humoral response. Responses that lost credit confused the roles of B- and T-lymphocytes or focused on explaining how immunity would be gained.

Question 6

Generally, this proved to be a very accessible question and many achieved most or all of the available credit.

(a) In **(i)**, the definition of a habitat was well known and almost all candidates gained some credit. Some referred to an organism or a population rather than a species or community and made a statement such as 'the place where an organism lives', rather than 'where an organism lives'. The complete definition of a community was provided by those candidates who obtained a high score overall; these remembered to include a reference to all organisms and time. Only those who combined their excellent definitions with reference to the examples in the passage, as instructed, gained full credit. The inclusion of examples had an additional benefit; where candidates had given more vague general definitions, Examiners could check that correct examples had been provided. Almost all gained credit in **(ii)**, and many continued in **(iii)** to give three acceptable features of producers. Terminology was important here, for example, noting that they provided the input of energy to the ecosystem was creditworthy; stating that they provided food for the ecosystem was not.

(b) To gain full credit for this question, candidates needed to pay careful attention to the information provided, which gave percent values of the energy *taken in* by the catfish population. For **(i)** candidates had to consider uses and loss of energy within the body of the catfish that were not linked to increasing biomass. Candidates who listed energy losses in general were in danger of losing some credit, as explanations such as inedible parts or available food decomposing rather than being eaten were not relevant to the question. One fairly common error was to state that energy was used in respiration, rather than stating that heat energy from respiration was lost. Candidates answered from two points of view; losses by, for example, egestion and heat from respiration and ways that energy could be used by the catfish, such as in movement or digestion. In **(i)**, most candidates gave sensible, creditworthy suggestions, such as increased movement to find food or escape predators.

BIOLOGY

Paper 9700/31
Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to understand the terms used in questions. For example, if they are asked for 'quantitative results' they are required to obtain numerical data; the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, the onion cells changed when left in water. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

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. They also need to be familiar with the practical investigations in the syllabus (PA), for example recording the state of plasmolysis of a number of individual cells which have been placed into different concentrations to show the movement of water by osmosis.

Candidates should be familiar with how to use the microscope provided in the examination and how to make slides in order to study cells. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus and in the Confidential Instructions.

General Comments

The majority of Centres returned the Supervisor's report 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 similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is 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 when completing the question paper.

Centres are reminded that they should contact Cambridge if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with Cambridge. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important these solutions and materials are labelled only as specified in the Confidential Instructions.

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. These candidates could then assess whether they had time to attempt repeats or replicates. For

example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements. In this question paper, it was expected that the candidates would record the state of plasmolysis of a number of individual cells.

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) Those candidates who had experience of drawing cells as part of their course gained most credit.

Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question.

The majority of candidates gained credit by carefully following the instructions and drawing only two touching plasmolysed cells, with the cell membrane labelled.

The most common error was to draw the plant cell wall incorrectly – this should be shown with a double line and a line for the middle lamella where adjacent.

(ii) The majority of candidates gained credit for correctly stating that to obtain quantitative results a sample of cells should be observed and the number of plasmolysed cells recorded.

(b) (i) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variable (solution) and the dependent variable (number of plasmolysed cells). In addition, many candidates also gained credit for the collection and recording of results for the three solutions.

The better candidates recorded that cells soaked in **S1** had the highest number or all of cells plasmolysed, whilst those in **S2** and **S3** had fewer cells that were plasmolysed.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were giving an incomplete table heading for the concentration, positioning columns incorrectly, or using qualitative data such as descriptions.

(ii) Many candidates correctly completed the table using their results.

(iii) Most candidates gained credit for describing how they identified the concentrations.

(c) (i) The majority of candidates gained credit by carefully following the instructions and drawing only two touching cells.

The most common errors were to draw the plant cell wall with no double line and not recording the cell as being turgid.

(ii) The majority of candidates knew that the water was moving by osmosis, and the better candidates were able to link this to the higher water potential outside the cells.

(d) The candidates who considered the question carefully were able to suggest modifications to determine the water potential of the onion. Many candidates suggested that more concentrations of the sodium chloride solution would be needed; the better candidates suggested concentrations of less than 1.0 mol dm^{-3}. Few candidates were able to suggest that they would plot the results on a graph and find the concentration at which 50% plasmolysis occurs and then use a conversion of concentration to water potential.

Question 2

(a) (i) Those candidates who had experience of drawing plans as part of their course gained most credit.

Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question.

The majority of candidates gained credit for clearly showing the skin and a recognisable feature in the centre; this varied according to the source and age of the material.

(ii) Those candidates who read and followed the instructions carefully gained full credit. The candidates were required to annotate the drawing to show the effect of staining by using a label line to any change and describing their observations.

(iii) The candidates were required to describe the pattern of staining using their observations. Credit was not awarded for attempts to explain what was happening.

(b) (i) The better candidates showed the measurements for at least three total widths and an equal number of skin widths, with the appropriate unit (mm or cm). The better candidates were able to show the ratio as a larger whole number to a smaller whole number, such as 5:1 or 33:7.

(ii) The better candidates correctly stated the degree of uncertainty as +/–1 mm, as they recognised that there would be uncertainty at each end of the width of skin or section being measured, and so the error of half the smallest division on the ruler (+/–0.5 mm) had to be doubled, giving an answer of +/–1 mm. Common errors included the omission of units, the omission of +/–, or to state the answer as +/–0.5.

(c) The majority of candidates drew the chart, using the headings given in the table, with 'component' on the *x*-axis and 'percentage mass' on the *y*-axis.

The better candidates ensured that all eight bars were the same width (commonly 1 cm) and used a scale of 2 cm to 5 for the percentage mass. Many candidates plotted the horizontal line at the top of each bar exactly. The better candidates correctly arranged the bars in pairs for each component with a gap between each pair.

The most common errors were omitting the label for the *x*-axis, not including a value for the scale on each 2 cm of the *y*-axis, plotting the tops of the bars using lines that were too thick (greater than 2 mm), incorrectly arranging the bars, shading the bars so that the horizontal or vertical lines became unclear or using lines which were too thick or not ruled.

(d) The majority of candidates correctly used one of three ways to calculate the correct answer of 8%.

The most common error was to not show how values of 32 or 68 and 24 or 76 were obtained for plantain and sweet banana respectively.

BIOLOGY

Paper 9700/32
Advanced Practical Skills 2

Key Messages

Candidates should be encouraged to understand the terms used in questions. For example, if asked for an 'observation' the candidate should record what they can see; the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, a graph has a particular trend. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

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. They should also be given opportunities to reflect on this work by identifying significant errors specific to experiments they have carried out and by suggesting improvements linked to these errors.

Candidates should be familiar with how to use the microscope provided in the examination and how to make slides in order to study cells. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus and in the Confidential Instructions.

General Comments

The majority of Centres returned the Supervisor's report 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 similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is 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 when completing the question paper.

Centres are reminded that they should contact Cambridge if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with Cambridge. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

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. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements. In this question paper, it was

expected that the candidates would repeat the experiment and obtain two sets of results for the time taken to reach the end point.

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 candidates identified the need to prepare the same volume of solution for each concentration.

The better candidates correctly selected five concentrations which had even intervals between them, and showed the correct use of the 1% solution provided (**E**) in either

- a simple dilution where **E** was used in the preparation of each concentration,
  or
- a serial dilution where **E** was used only for the first dilution.

This information was most clearly provided as a table when a simple dilution was suggested, or as a diagram showing a series of transfers of solutions between beakers for a serial dilution.

(ii) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variable (concentration of **E** / %) and the dependent variable (time / s). In addition, many candidates chose to investigate at least four different concentrations and recorded their results in whole seconds.

The better candidates recognised that there was time to repeat the experiment and recorded at least two readings for each concentration.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete heading for the concentration, to include method details in the table, such as volumes of solutions used, to write units next to each value of concentration or each recorded time and to record the results in minutes or fractions of seconds.

(iii) The better candidates correctly identified that water should be used instead of the enzyme. The most common errors were to suggest the use of boiled enzyme, which was not acceptable as candidates were not provided with the apparatus to do this, or to standardise variables, such as the volume of solutions used or the temperature.

Candidates should be encouraged to give only one control as multiple answers will not be awarded credit.

(iv) The better candidates correctly stated the degree of uncertainty, as they recognised that there would be uncertainty at each end of the depth of solution being measured, and so the error of half the value of the smallest division on the ruler, +/–0.5 mm, had to be doubled to give an answer of +/–1 mm. Common errors included the omission of units, the omission of +/– or to state the answer as +/–0.5.

(v) The candidates who considered the procedure carefully were able to suggest two significant sources of errors. Many candidates correctly identified that judging the colour change to identify the end-point was a significant source of error. The better responses also identified that both the intensity of the iodine stain on the paper and the time the paper squares were soaked in iodine varied between individual pieces of paper.

Two common incorrect answers were to identify inaccuracy in the measuring of the volumes of **E** and **W** when carrying out dilutions, or inaccuracy in the cutting out of the paper squares.

(vi) The better candidates suggested ways to improve the procedure that were linked to the sources of error identified in **(v)**. Many candidates suggested that there should be more concentrations of **E** for the independent variable. The better candidates suggested using a fresh solution of iodine for each square of paper tested. They were also able to identify the need to standardise variables such as the mixing of **E** while the stained paper was in it, and the length of time the pieces of paper were left in the iodine.

Candidates should be encouraged to read the questions carefully; only two improvements were required here and any additional improvements did not gain any credit.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with 'bead diameter / mm' on the *x*-axis and 'mass of product / mg min^{-1}' on the *y*-axis.

The better candidates used scales of 2 cm to 1.0 mm for bead diameter and 2 cm to 10 mg min^{-1} for mass of product, plotted the points exactly and drew a sharp, clear line accurately connecting each pair of points.

The most common errors were not including the units for both the *x*-axis and *y*-axis, omitting to label the origin when it had a value other than zero, plotting points which were just blobs or too large (greater than 2 mm) or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled.

As a general rule, lines should not be extrapolated.

(ii) Many candidates were able to read a correct value from the graph. Candidates should be encouraged to give their answers to the value of half a square, rounding up or down if the line crosses between a vertical and half a square and include the complete unit as shown in the table and used to label their graph axis.

(iii) The better candidates correctly explained that the increase in mass of product formed was due to the greater number of enzymes on the beads with larger diameter, which meant that more active sites would be available to form a greater number of enzyme substrate complexes. In addition they identified that the plateau on the graph was due to substrate concentration becoming a limiting factor.

Many candidates wrote only a detailed description of the trend; this could not be awarded any credit because an explanation was required.

Question 2

(a) (i) The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Many were able to draw two complete alveoli with different irregular shapes. The better candidates drew nuclei within the alveoli walls and used a label line to correctly identify one nucleus.

The most common errors were shading on the drawing, drawn lines that did not meet up precisely or were too thick, no nuclei drawn within the alveoli walls and including cells which would not be observable using the microscope.

(b) (i) A high proportion of candidates correctly stated that they should count the squares on the grid in order to find the area of the lumen.

(ii) Many candidates were able to use the grid to give a correct whole number of squares for both the total area of the lumen and the blocked area. The better candidates included appropriate units with these figures. Candidates gained credit for showing clearly how they used these values to calculate the percentage change in the lumen and expressing their final answer as a whole number.

The most common errors were to calculate the percentage of the lumen which was unblocked and to express the final percentage as a decimal rather than a whole number.

(iii) Those candidates who had experience of drawing cells as part of their course gained most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Most candidates gained credit for carefully following the instructions, drawing only two red blood cells from each species and carefully drawing a label line which touched but did not cross the cell membrane. The better candidates considered size, and drew the cells at appropriate sizes relative to each other.

(iv) The better candidates recorded observations using the most appropriate organisation, which included one column for listing the features and two additional columns, one headed for fish red blood cells and one for frog red blood cells. They also correctly decided that observational differences were only those features which they could see in the Fig. 2.2 and 2.3.

The majority of candidates were able to gain full credit for recording appropriate differences.

The most common errors were to include similarities or reference to haemoglobin.

BIOLOGY

Paper 9700/33

Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to understand the terms used in questions. For example, if they are asked for 'accurate results' it means that they should obtain results as close as possible to the true value; if asked for an 'observation' the candidate should record what they can see; the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, the graph has a particular trend. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

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. They also need to be familiar with the practical investigations in the syllabus (PA), for example recording the state of plasmolysis of a number of individual cells which have been placed into different concentrations to show the movement of water by osmosis.

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It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

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. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements. In this question paper, it was expected that the candidates would record the state of plasmolysis of a number of individual cells.

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 correctly stating that to obtain accurate results, as close as possible to a true value, a sample of a number of cells, (preferably at least five), should be observed and the state of plasmolysis of each cell recorded, or more than one slide or field of view should be observed.

(ii) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variable, (concentration of sodium chloride / mol dm^{-3}), and the dependent variable, (state of plasmolysis). In addition, many candidates also gained credit for the collection and recording of results for the three concentrations and **S4**.

The better candidates showed the state of plasmolysis of a number of individual cells and also recorded that for the highest concentration, 0.8 mol dm^{-3}, the cells were showing complete or more plasmolysis, whilst for the lowest concentration, 0.2 mol dm^{-3}, the cells were showing slight or no plasmolysis.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete table heading for the concentration or to position the columns incorrectly.

(iii) Many candidates correctly completed the statement using their results.

(iv) Most candidates gained credit for giving the **one** most significant error as the difficulty of identifying the state of plasmolysis using only the four diagrams in Fig. 1.1.

(v) Candidates who considered the procedure carefully were able to suggest three improvements. The majority of candidates suggested that there should be more concentrations of the sodium chloride solution for the independent variable. The better candidates suggested that the dependent variable could be modified by the addition of more diagrams to show the intermediate states of plasmolysis, and other variables could be standardised such as using tissue from the same onion or leaving the tissues for the same time in each solution.

Candidates should be encouraged to read the questions carefully; in this question only three improvements were required and any additional improvements were not awarded any credit.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with 'concentration of sodium chloride / $\times 10^{-2}$ mol dm^{-3}' on the *x*-axis and 'percentage of red blood cells destroyed' on the *y*-axis.

The better candidates used scales of 2 cm to 0.5×10^{-2} mol dm^{-3} for concentration and 2 cm to 20 for the percentage of red blood cells, plotted the points exactly and drew a sharp, clear line accurately connecting each pair of points.

The most common errors were omitting the units for both the *x*-axis and *y*-axis, not including a value for the scale on each 2 cm of the axis, plotting points which were just blobs or too large (greater than 2 mm) or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled. As a general rule, lines should not be extrapolated.

(ii) The majority of candidates showed the reading at 50% by drawing horizontal and vertical lines, and then read off the value correctly. Candidates should be encouraged to give their answers to the value of half a square, rounding up or down if the line crosses between a vertical and half a square and to include the complete unit as shown in the table and used in their graph axis label.

(iii) The better candidates correctly explained that at 0% there was no net movement of water and at 100% water had entered the cells. Fewer candidates stated that the water was moving by osmosis.

Question 2

(a) Candidates gained full credit by reading and following the instructions carefully. Each part of the question required candidates to label the contents and annotate, using a label line to any change, and describe their observations. Candidates were not awarded any credit for trying to explain what was happening.

(i) The majority of candidates only shook test-tube **P** and observed bubbles in the upper oil layer.

(ii) The majority of candidates labelled the oil and water. In addition, many candidates drew the drop of egg as a drop resting at the bottom of the oil layer, then labelled the egg and described it as having moved down to rest above the water.

(iii) Many candidates gained credit for labelling and describing the effect of shaking both test-tubes, for example forming a cloudy layer or, in **Q**, describing foam on the surface.

(b) (i) Those candidates who had experience of drawing cells as part of their course gained the most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. The majority of candidates gained credit for carefully following the instructions, indicating on Fig. 2.6 one red blood cell and each of the two different white blood cells, drawing each cell at the correct sizes relative to each other and drawing the two nuclei with the correct shapes and relative proportions.

The most common errors were to shade the nuclei or stipple the cytoplasm, draw lines that did not join up or draw the neutrophil too small.

(ii) The better candidates recorded observations using the most appropriate organisation which included one column for listing the features and two additional columns, one headed for red blood cells and one for white blood cells. They also correctly decided that observational differences were only those features which they could see in the Fig. 2.6.

The majority of candidates were able to gain full credit recording the differences.

The most common error was to include functions of blood cells.

(iii) The better candidates showed the measurements for each of the individual cells **J**, **K**, **L**, **M** and **N**. The majority of candidates correctly recorded the measurements in mm and showed the addition of these measurements and the division by the number of measurements. The better candidates gained credit for a correct conversion of mm to μm by showing a multiplication by 1000. They also showed a division by the magnification 1430, most clearly shown as, for example:

$$\frac{11 \times 1000}{1430}$$

The better candidates drew the cell **J** carefully with clear sharp lines that joined up. They also drew a neat line which touched, but did not cross, the outline of the cell to gain credit for showing where the cell had been measured.

The most common errors were to show measurements which were not linked to each cell, to not show the ×1000 conversion and to not join up the outline of cell **J** carefully.

BIOLOGY

Paper 9700/34

Advanced Practical Skills 2

Key Messages

Candidates should be encouraged to understand the terms used in questions. For example, if they are asked for 'accurate results' it means that they should obtain results as close as possible to the true value; if asked for an 'observation' the candidate should record what they can see; the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, a graph has a particular trend. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

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. They also need to be familiar with the practical investigations specified in the syllabus (PA), for example investigating and explaining the effects of temperature, pH, enzyme concentration and substrate concentration on the rate of enzyme-catalysed reactions.

Candidates should be familiar with how to show their working in calculations, and the key steps in their reasoning.

Candidates should be familiar with how to use the microscope provided in the examination and how to make slides in order to study cells. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus and in the Confidential Instructions.

General Comments

The majority of Centres returned the Supervisor's report 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 similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the actual procedures used in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is 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 when completing the question paper.

Centres are reminded that they should contact Cambridge if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with Cambridge. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

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. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it was possible to complete the question and do a set of repeat measurements. In this question paper, it was expected that the candidates would carry out at least two readings per concentration for at least four concentrations of plant extract.

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

Comments on Specific Questions

Question 1

(a) (i) Many candidates identified the need to prepare 10 cm^3 of each concentration.

The better candidates correctly selected 100% and four additional concentrations which had even intervals between them, or a reduction by half between each concentration, or a reduction by a tenth between each concentration, and showed the correct use of 100% plant extract in either

- a simple dilution where 100% **P** was used in the preparation of each concentration,
  or
- a serial dilution where 100% **P** was used only once for the first dilution.

This information was most clearly provided as a table when a simple dilution was suggested, or as a diagram showing a series of transfers of solutions between beakers for a serial dilution.

(ii) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary, and appropriately detailed headings for the independent variable (percentage concentration of plant extract) and the dependent variable (time / seconds for filter paper to reach the surface). Many candidates also gained credit for the collection and recording of results for at least six concentrations and repeating the experiment to calculate a mean.

The better candidates showed that, for the highest concentration of plant extract the time taken to reach the surface was shorter than for the lowest concentration.

Those candidates who were familiar with carrying out investigations presented their results most clearly and gained most credit. The most common error was not giving results in whole seconds.

(iii) Many candidates gained credit for suggesting three most significant errors such as the hydrogen peroxide was not the same concentration for each of the squares of paper, each square of filter paper contained different volumes of plant extract, or the squares of paper occasionally stuck to the side of the test-tube.

(iv) The candidates who considered the procedure carefully were able to suggest three improvements. The majority suggested that the independent variable needed more concentrations of the plant extract. The better candidates suggested that the hydrogen peroxide should be renewed for each of the squares of filter paper, each square of paper should be submerged in the plant extract for the same time period, or a larger container should be used to reduce the chances of the paper touching the sides.

Candidates should be encouraged to read the questions carefully; only three improvements were required here and any additional improvements did not gain any credit.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with 'percentage concentration of hydrogen peroxide' on the *x*-axis and 'time to collect 25 cm^3 oxygen / seconds' on the *y*-axis.

The better candidates used scales of 2 cm to 5 for percentage concentration and 2 cm to 10 seconds for the time to collect 25 cm^3 oxygen, plotted the points exactly, and drew a sharp, clear line between each pair of points.

The most common errors were omitting the units for both the *x*-axis and *y*-axis, not including a value for the scale on each 2 cm of the axis, plotting points which were just blobs or too large (greater than 2 mm) or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled. As a general rule, lines should not be extrapolated.

(ii) The better candidates correctly explained that as the percentage concentration of hydrogen peroxide increased more substrate was available to bind with the enzyme (catalase), forming more enzyme-substrate complexes, and at high concentrations of hydrogen peroxide there were fewer active sites available.

Some candidates wrote only a detailed description of the trend; this could not be awarded any credit because an explanation was required.

Question 2

(a) (i) Those candidates who had experience of drawing large plan diagrams as part of their course gained most credit.

Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question.

Many candidates gained credit for carefully following the instructions and showing on the diagram the location of the muscle layer in the artery.

The most common errors were to omit the corrugated inner lining of the artery and not include all the layers that were observable.

(ii) Those candidates who had experience of drawing as part of their course gained most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Many candidates gained credit for carefully following the instructions and showing on the diagram the location of the gas exchange membrane.

The most common errors were to omit the shared adjacent wall between the alveoli and not include the nuclei that were observable.

(iii) The better candidates showed the measurements for each of the individual lines **C**, **D**, **E**, **F** and **G**. The majority of candidates correctly recorded the measurements in mm and showed the addition of these measurements and division by five. The better candidates showed the multiplication by 1000 and division by the magnification, 95, most clearly shown as, for example,

$$\frac{22 \times 1000}{95}$$

The most common errors were not showing the measurements specifically linked to each line and not showing the ×1000 conversion.

(iv) The better candidates recorded observations using the most appropriate organisation which included one column for listing the features and two additional columns one headed for Fig. 2.2 and one for Fig. 2.3. They also correctly decided that observational differences were only those features which they could see in the Fig. 2.2 and 2.3.

Many candidates were able to gain full credit for recording appropriate differences.

The most common error was to include functions of the alveoli.

BIOLOGY

Paper 9700/35
Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to understand the terms used in questions. For example, if they are asked for 'accurate results' it means that they should obtain results as close as possible to the true value; the term 'explain' should be understood to mean that scientific reasons are required to explain, for example, the effect of putting plant tissue into water. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

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. They also need to be familiar with the practical investigations in the syllabus (PA), for example investigating the effects on plant cells of immersion in solutions of different water potential.

Candidates should be familiar with how to use the microscope provided in the examination and how to make slides in order to study cells. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus and in the Confidential Instructions.

General Comments

The majority of Centres returned the Supervisor's report 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 similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is 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 when completing the question paper.

Centres are reminded that they should contact Cambridge if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with Cambridge. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

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. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is

possible to complete the question and do a set of repeat measurements. In this question paper, it was expected that the candidates would record the state of plasmolysis of a number of individual cells.

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 correctly completed the sentence using their knowledge of osmosis.

(ii) Most candidates correctly decided to use plant tissue of a minimum length of 5 cm, which was the radius of the protractor and would allow the angle to be easily read from the protractor.

(iii) Many candidates identified the need to take repeat readings. The better candidates realised that an equal pressure would be required.

(iv) Those candidates who had carefully planned their practical work decided to measure the angle of bend at least three times at equally spaced intervals within the 10 minute period, e.g. 0 minutes, 5 minutes and 10 minutes.

The most common errors were to select intervals less than 2 minutes apart, which would make it difficult to collect results in an organised manner, to choose intervals which were irregularly spaced or to omit the unit, minutes.

(b) (i) Most candidates recorded their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variable (the sample) and the dependent variable (angle of bend/degrees). Many candidates also gained credit for the collection and recording of results for the plant tissue samples before being placed in water, as well as recording all measurements to whole degrees.

The better candidates showed that plant tissue from **P1** had the highest angle of bend at the start and that the angle of bend decreased over time.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete heading for the angle of bend, to not record the initial results, or to record angles of bend greater than 90° which was not possible using the apparatus and method supplied.

(ii) Those candidates who used their results from measuring the angle of bend before the tissues were placed in water were often able to identify **P1** as 1.00 mol dm^{-3}, **P3** as 0.50 mol dm^{-3} and **P2** as 0.25 mol dm^{-3}. **P4** should then have been positioned to the left of **P2**.

The most common errors were to show **P4** with the highest concentration, or to assign a value for the concentration of **P4**.

(iii) The best candidates correctly explained that when plant tissue from **P1** was placed in water, the water moved from the higher water potential (in the water), into the tissue by osmosis.

(iv) Most candidates gained credit for identifying the variability in the widths of the plant tissues as a significant source of error in the investigation. The better candidates were able to identify the variability of pressure or the difficulty in holding the tissue as errors.

Candidates should be encouraged to read the questions carefully; only two errors were required here and any additional errors did not gain any credit.

(v) The better candidates correctly stated the degree of uncertainty as they recognised that there would be uncertainty at each end of the protractor when the bend was being measured, and so the error of half the smallest division on the protractor (+/–0.5°) had to be doubled giving an answer of +/–1°. Common errors included the omission of units, the omission of +/–, or to state the answer as +/–0.5.

(vi) The candidates who considered the procedure carefully were able to suggest three improvements in order to have results as reliable as possible. The majority of candidates suggested that standardised variables could be controlled, such as using tissue from the same plant, cutting each piece of tissue to the same width, testing each solution separately or controlling the applied pressure.

The majority of candidates showed the reading at 50% by drawing horizontal and vertical lines, and then read off the value correctly. Candidates should be encouraged to give their answers to the value of half a square, rounding up or down if the line crosses between a vertical and half a square and to include the complete unit as shown in the table and used in their graph axis label.

The better candidates correctly explained that at 0% there was no net movement of water and at 100% water had entered the cells. Fewer candidates stated that the water was moving by osmosis.

Question 2

(a) Candidates gained full credit by reading and following the instructions carefully. The question required candidates to annotate the drawing to describe one observable difference between **S1** and **S2**. Those candidates who had experience of making slides and drawing cells as part of their course gained the most credit.

Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question.

The majority of candidates gained credit by carefully following the instructions and only drawing and clearly identifying two touching cells from each of **S1** and **S2**.

Only the better candidates were able to identify the obvious starch grains, which stained black with iodine solution and were normally clear when methylene blue was used.

The most common error was not drawing the plant cell wall with a double line.

(b) (i) Those candidates who had experience of drawing plans as part of their course gained the most credit.

Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question.

The majority of candidates gained credit for clearly showing the outer layer of cells as one tissue with at least three other enclosed areas which contained similar cells forming tissues. The better candidates drew a distinct triangular area to the right of the centre of the section and an enclosed area in the centre of the section.

The most common errors were to draw individual cells and to label the clear area in the centre of the section as the xylem.

Candidates should be encouraged to use a sharp pencil for drawing.

(ii) Many candidates showed the addition of their measurements for at least three cell lengths and an equal number of cell widths, which were divided by the number of measurements, along with the appropriate unit for measurement (mm or cm).

The better candidates measured all 20 cells and were able to show the ratio as a larger whole number to a smaller whole number, such as 3:1 or 33:7.

(c) (i) The majority of candidates drew the graph, using the headings given in the table, with 'time / hours' on the *x*-axis and 'concentration of sugars / μmol' on the *y*-axis.

The better candidates used scales of 2 cm to 5 hours for time and 2 cm to 0.10 μmol for the concentration of sugars, plotted the points exactly and drew a sharp, clear line accurately connecting each pair of points.

The most common errors were not including the units for both the *x*-axis and *y*-axis, not including a value for the scale on each 2 cm of the axis, plotting points which were just blobs or too large (greater than 2 mm) or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled.

As a general rule, lines should not be extrapolated.

(ii) The better candidates answered only in terms of what was happening to the concentration of sugars in the phloem and then correctly explained the decrease due to sugars being used up at night and the increase due to sugars being made.

The most common errors were trying to compare the leaf and phloem data, or only explaining the decrease or the increase in concentration.

BIOLOGY

Paper 9700/41
A2 Structured Questions

Key Messages

- Accurate supporting figures, with the correct units, should be used when answering a question accompanied by a table or graph.
- Candidates should be encouraged to look for an overall trend in figures or graphs and to be aware that this is often more important than individual figures that may be showing minor fluctuations.
- In genetics, candidates should be given opportunities to carry out basic crosses so that they are confident in the use of keys and use suitable symbols for genotypes.

General Comments

Many candidates had clearly used or referred to past papers when preparing for this exam. It is always useful to practise past papers as some candidates have a good knowledge of biology but are unsure how to express themselves clearly.

Command words such as 'describe', 'explain', 'suggest' and 'compare' require different responses from candidates. If a description is required, including a reference to a graph or table, then it will be expected that data will be used in the answer. Many candidates are able to do this effectively. An explanation requires more than just a description and candidates should be encouraged to practise the difference between 'explain' and 'describe'. A 'suggest' question encourages the candidate to display biological knowledge linked to the learning outcome being tested. It is always worthwhile for a candidate to attempt an answer to this sort of question as the mark scheme here will be fairly flexible

Finally, if a question requires a comparison then a candidate must refer to all of the variables being tested. This was shown in **Question 2(c)** when it was not sufficient to simply state that diagnosis was fast. A better approach is to refer to both in the same sentence or use 'faster' which shows a comparison. Words such as 'whereas' or 'however' can be used to link two parts of a sentence and therefore create a comparison.

Section B is an opportunity for candidates to display their knowledge of a learning outcome in a less structured way. Much credit is available for answers in ***Section B*** and it is worth noting the credit allocations for parts **(a)** and **(b)** whilst writing.

Comments on Specific Questions

Section A

Question 1

(a) Candidates were able to identify key definitions of a species, such as individuals breeding together to produce fertile offspring, but many candidates lost credit because they did not give any detail of the features, i.e. they did not state morphological, physiological, etc.

(b) The most common problem here was giving allopatric speciation as an answer; 'allopatric speciation' is a term which implies geographical isolation, but does not explain how separation has been physically caused.

(c) Most candidates were awarded some credit here. It was obvious when candidates had learnt by rote the answer to this question, and perhaps had looked at past exam questions in order to identify key marking points for this style of question. Allopatric speciation was used in responses and described clearly. There were very few candidates who discussed the idea of the mating song not being recognised by the females, but good coverage of all other marking points. Mutations are not caused by environmental/selection pressures – they are random. Geographical isolation preventing gene flow was commonly confused with reproductive isolation should the two species meet.

Question 2

(a) (i) Some problems with describing the immune response were seen. T cells and B cells were frequently confused. Very few responses included the correct detail of how B cells bind the antigen; even fewer made reference to antigen-presenting cells. Credit was mostly awarded for references to plasma cells and antibodies.

(ii) Candidates knew that a hybridoma cell is a plasma cell fused with a myeloma. 'Mixing the cells' was not enough; they needed to join together.

(iii) Candidates struggled here; many seemed to understand the concept and knew that plasma cells cannot divide or grow in culture. They stated that myeloma cells will divide but did not specify indefinitely or continuously.

(iv) Some candidates talked about markers, but did not qualify properly what the marker could have been attached to. Simply adding antigens to the solution would not identify hybridoma cells. Very few candidates suggested the use of labelled antigens or gave valid methods of marking or identifying the antigen. A small number gave other valid methods of identifying the hybridoma cells.

(b) (i) This was a difficult question, not least because the graph required a lot of interpretation. Candidates would be well advised to make sure in descriptions of data that they clearly identify the trend. A common reason for not scoring marks here was incorrect reading of the results from the graph; group **P** is quite clearly 30.5% and not, for example, 30%. Many candidates stated that results in groups **S** and **T** were different; a 0.5% difference should not be considered meaningfully different. A proportion of the candidates simply wrote out the data in the graph but did not interpret in any way.

(ii) Very few candidates were awarded credit for this question. Perhaps most candidates do not consider 71 people to be a small number, but in the context of this kind of investigation it is a small group.

(c) A commonly given response was that monoclonal antibodies give a faster diagnosis, but many other points given referred to treatment, despite diagnosis being emphasised in the question.

Question 3

(a) Many candidates were unclear about this topic. They knew the movement of DNA to the anode, but failed to say that it was the phosphate group of the DNA that was negatively charged. Those who attempted to describe that lower mass moved faster were awarded, but candidates who wrote about the distance moved needed to include 'per unit time'.

(b) Candidates generally drew a band in the same place as the band for the HbA HbA individual, but did not correctly draw the second band above it.

(c) Many candidates referred to checking family histories but did not give enough detail. A few mentioned genetic counselling. Many incorrect answers gave information concerning paternity testing and use in criminal investigations.

Question 4

(a) Relatively few candidates answered this well. Some confused male and female parts of the flower, and pollen with seeds, while others did not use Fig. 4.1 and concentrate on the male parts of the flower. Even those who did focus on stamens frequently failed to relate their descriptions to increasing the likelihood of wind dislodging pollen. Most did not refer to anthers and those who did, only referred to half the answer, e.g. anthers outside of flower but no mention of pollen or long filament. Some thought that the anthers collected pollen. Many candidates referred to stigmas or stamens.

(b) Most candidates scored well, identifying mutations, survival and reproduction for full credit. Candidates followed a well-rehearsed sequence of steps in describing an evolutionary change. However, some confused maize with corn borers, and the idea of resistant alleles was missed. Candidates used the term gene rather than alleles.

(c) The homozygous recessive genotype **rr** was mostly given correctly.

(d) The candidates appeared to have an understanding of the ideas, but their responses were not always detailed and concise enough score credit. Breeding non-resistant and resistant corn borers gave the heterozygote but they did not go on to say that these organisms would not be resistant or die.

(e) (i) Many candidates were confused by the data and a fair number did not provide an answer at all. Mixing was identified but this was sometimes confused by also talking about mating.

Some picked up on the variation in the results, and some noticed the discrepancy between males and females. Candidates tended to interpret the data in terms of missing (non-recaptured) borers having moved to other fields, rather than new (unmarked) borers having come from other fields.

(ii) Candidates did not understand the impact of the strategy and what would be needed for it to be effective. Figures were quoted, but these did not relate to points being made and inbreeding occurring. The credit was mostly awarded for marked females mating with marked males or marked females mating with unmarked males.

Question 5

(a) Candidates knew the role of progesterone and answers were detailed. Common errors were to references to the uterus wall instead of the lining, and to implantation of the egg or ovum.

(b) (i) Many candidates did not read to the smallest square of the graph and rounded their answer up to 33. Many missed the unit (days) and a few gave an incorrect unit, e.g. years.

(ii) This was a difficult graph to interpret, but as with other questions, candidates should be encouraged to identify trends; many simply described each curve without using the data to answer the question. Many candidates stated that the different diets caused the rats to reach puberty, without giving any time span; they all reached puberty, so time was needed to make a comparison.

As with any graph, there were a number of candidates who describe the *y*-axis variable affecting the *x*-axis variable, instead of the correct way around.

Question 6

This question was one of the best answered on the paper.

(a) Candidates identified the reasons covering a range of marking points for species becoming endangered. They were also able to make links between pollination and a removal of flies.

(b) (i) There was a lot of variation in the answers about the definition of the term biodiversity, but most candidates had learnt the definition and so gained credit here.

(ii) Candidates had seen this type of question before and their answers showed the benefit of practising past papers.

Question 7

(a) Many candidates wrote that the allele symbols were R and r, and then went on to carry out the cross perfectly, using the X and Y chromosome symbols in all genotypes in addition to the colour alleles. Common candidate errors included a number who did not include X and Y at all and scored no credit, or put superscripts on the Y chromosome. Most candidates were quite successful on this question.

(b) (i) Candidates who were not awarded credit here pointed out that the son could only inherit the allele from the mother, but this was not really answering the question. Therefore, although they had scientific knowledge, they were not applying it tightly enough within the given context.

(ii) Many candidates spoiled their answer of 'heterozygous' by adding dominant or recessive, however, many were awarded credit.

(iii) There were many candidates whose answer 'mutation' did not score because more detail was required; they had not specified gene or allele mutation.

Question 8

(a) (i) Most candidates realised that the enzymes would denature. Some candidates were awarded some credit for discussing optimum temperature, (although some did not specify the enzyme), stomata, and reduction in Calvin cycle or increased photorespiration. It is important to note that less carbon dioxide (not no CO_2) and a reduction in the Calvin Cycle (not cycle stops) are important points.

(ii) Most candidates were credited for correctly drawing the likely curve. They were not as successful at explaining the curve. It was necessary to state that sorghum or C4 enzymes have a higher optimum temperature and give some structural feature which enabled the plant to avoid photorespiration. Some said it was adapted to an arid rather than a hot climate.

(b) (i) Most candidates completed the table correctly.

(ii) The graph was successfully completed by a majority of candidates. Those who did not score full credit made the usual mistakes. These included the axes being the wrong way around, the scales being incorrect, the units missing, points plotted incorrectly and a poorly drawn line.

(iii) The definition of a limiting factor is always something candidates find difficult to explain. When a process is affected by more than one factor, the rate of the reaction is restricted by the factor that is nearest its lowest value.

Section B

Question 9

Candidates answered this question very well and the majority chose this question rather than **Question 10** on the kidney.

(a) The question asked the candidates to describe how ATP is synthesised by oxidative phosphorylation. There was some confusion between NADH and NADPH and many missed out the hydrogen being released from the reduced NAD. Electrons accepted by ETC were mentioned, but no mention was made of carriers/cytochromes. Some candidates thought that it was hydrogen that moved rather than the hydrogen ion. Many candidates scored full credit here.

(b) Another well answered question. The need for energy in living organisms was well known and examples were also given. Some missed the reference to light energy in photosynthesis and detail of the light dependent and light independent stages. All other energy requiring processes were well documented.

Question 10

(a) Candidates were mostly well-prepared and in a few sentences or on a diagram were able to list at least six parts of the kidney. The only thing they were not used to doing was specifying which parts of the nephron were in the cortex and which in the medulla. Where diagrams were used they were used well, with correct labels and the position of nephron identified. Few candidates referred to the afferent and efferent arterioles or the capillary network.

(b) Responses here were very varied from candidates who had shown a thorough knowledge of the functioning of the nephron. Many candidates gave a full account of ultrafiltration and then went on to reabsorption. There was confusion over where the sodium ions were moving from and to. Many gave a muddled account of the facilitated diffusion and cotransporters. Few mentioned osmosis. In the adaptations it was rare to see anything more than microvilli and many mitochondria.

BIOLOGY

Paper 9700/42
A2 Structured Questions

Key messages

- Accurate supporting figures, with the correct units, should be used when answering a question accompanied by a table or graph.
- Candidates should be encouraged to look for an overall trend in figures or graphs and to be aware that this is often more important than individual figures that may be showing minor fluctuations.
- In calculations candidates should always show their working, so that credit can be given for a suitable method, even if the final answer is incorrect.

General comments

The paper discriminated well between candidates. The overall performance was similar to previous years, with most candidates attempting all parts of the questions. Candidates' work was usually clearly set out and legible.

The paper included a variety of topics and question styles, involving both recall and data interpretation, which allowed candidates to demonstrate their knowledge and their ability to apply this to unfamiliar data. Many candidates demonstrated a sound understanding of the concepts involved and expressed their ideas clearly, using the information provided. Comparative figures with units were not always precise enough to gain credit, e.g. in **Question 5(b)(iii)** where it was necessary to know which set of figures were being quoted. In **Question 8(c)(iii)** candidates found it difficult to gain credit due to their lack of observation of the trend in the figures. Of the two free response questions, **Question 10**, on the topics of homeostasis, endocrine and nervous systems, was the more popular choice, with candidates showing a sound knowledge base. **Question 9** proved to be more problematic, with the first section proving more difficult for candidates, although they were usually able to give a well informed account in part **(b)**.

Comments on specific question

Question 1

(a) (i) A majority of candidates correctly sketched a graph with two peaks for the extreme sizes joined together by a dip in the intermediate size range. There were a few instances where two overlapping curves were seen, but on the whole candidates appreciated that this would be a continuum.

(ii) Good explanations were given of how disruptive selection was maintained. Most candidates mentioned that similar sized animals were more likely to mate together, with the intermediates being selected against. In many responses this needed to be taken further to refer to alleles for extreme phenotypes being more likely to be passed on.

(iii) Most candidates realised that this was stabilising selection.

(b) Good responses were given, explaining how sympatric or allopatric speciation could have occurred. Most referred to different selection pressures resulting ultimately in reproductive isolation.

Question 2

(a) Many excellent accounts were given of the steps involved in producing a clone of hybridoma cells. Weaker candidates did not describe B lymphocytes maturing into plasma cells, although many referred to their extraction from the spleen. In most responses the fusion of plasma cells with myeloma cells was described, together with the resultant hybridoma cells being tested for antibody secretion. Extra details such as the culturing of the cells involved or the use of fusogen in the process were also known. Few candidates mentioned the need to wait for an immune response to occur before extracting the plasma cells.

(b) Good suggestions were made in this section, adding H9-1 and examining the material under a microscope for fluorescence that would indicate the presence of *T. pallidum.* Frequently reference was made to the use of UV light, but candidates seemed unaware of the need to give time for the binding of H9-1 to the treponemes before observation.

(c) Most candidates appreciated that there might be too few treponemes present, or that they would be too similar to other harmless ones, to detect. While some realised that there would be few antibodies in the blood, other possibilities could be the time needed to move from the point of entry to the bloodstream.

(d) (i) Most candidates correctly identified H9-1 as being the most accurate test, with the blood test being the least accurate. Clear comparative figures were not always given, as candidates needed to refer to numbers of incorrect diagnoses rather than just numbers of negative and positive results. A reference to the small number in the sample should also be recognised as a poor feature of these test results.

(ii) Good suggestions were given for why two positive results occurred in patients later found not to have the infection, such as the presence of antibodies left from previous infection. References to the presence of other treponemes causing the antibody production failed to explain that these may share an antigen with *T. pallidum.*

(e) The most common responses described the antibody recognising and delivering drugs to a specific antigen or cancer cell, with the potential to destroy the cell. A few good references to passive vaccines were also given.

Question 3

(a) Most candidates successfully described complementary base pairing of **A** with **T** and **C** with **G**. Those attempting to link the sequence to the original DNA strand did not always make it clear that it was the sequence of bases or nucleotides in the original that determined the order in the new strand.

(b) Few candidates gave a satisfactory suggestion that **C** was not included because of a low concentration, or that it would be random, or chance, that determined this.

(c) (i) A number of candidates did not simply list the letters as **ATCGAT**, but instead struggled to describe the order in terms of length of fragment.

(ii) The separation of the DNA fragments according to length or mass was well described by candidates. Good detail of the movement to the anode was provided, with shorter pieces moving faster, although some references lacked a time element and only referred to the distance moved. A few candidates also referred to the impedance of the gel.

Question 4

(a) Few responses referred to parts of the world where there is vitamin A deficiency, but the importance of rice as a staple food and its effect in preventing blindness were well known. Many references were made to increasing beta carotene but this needed to be related to increased vitamin A.

(b) It was rare to see a clear explanation of why the data showed that it was not the enzymes produced by the *crtI* gene that were limiting production of beta carotene. While candidates often noted the accumulation of GGDP or the lack of phytoene, this was not often correctly linked to the activity of the related enzymes.

(c) (i) Candidates were able to name the type of enzyme correctly. Just a few named a particular restriction enzyme instead of noting that it was the enzyme type that was required.

(ii) Candidates usually knew that the promoter was needed to ensure expression of the gene. Few references were made to a suitable promoter not already being present in the rice cells or not in the correct position relative to the introduced genes.

(iii) This proved challenging for most candidates, with many failing to comment on all the rice cells having the same *crtI* gene, or that the only difference was the source of the *psy* gene.

(d) Few candidates were able to suggest reasons for the lower production of beta carotene, such as the different base sequences leading to different amino acid sequences in an enzyme. Reference could have been made to a change in tertiary structure, resulting in interaction with other components, and so leading to a reduced rate of activity.

(e) Candidates were able to describe some of the disadvantages of growing GM rice. Most struggled to find a third reason, e.g. the GM rice not necessarily growing well in all conditions, or farmers in developing countries having difficulty in obtaining the GM seed. A number of references were seen to the ethics of growing GM crops or customer resistance to eating them, which were not relevant here.

Question 5

(a) The majority of candidates gained full credit here, with the oestrogen and progesterone inhibiting FSH or LH and preventing fertilisation, ovulation or implantation. Details of the process, such as the thinning of the endometrium were also frequently included.

(b) (i) Many candidates successfully calculated the number of children born with HIV infection as 24813, although unsuccessful attempts could not always gain credit for the working as this was not always clearly set out.

(ii) A significant number of candidates misinterpreted the data, reading the figures in Table 5.1 as the number of pregnancies rather than the reduction in pregnancies. When interpreted correctly, most recognised that the ARVs have no effect on pregnancy numbers, but that numbers were reduced by contraception. Further explanation could include the idea that ARVs do not reduce the number of pregnancies in HIV infected women as they do not get rid of HIV.

(iii) Although many candidates understood that contraception reduces the number of pregnancies, few realised that this would mean less drugs needed for HIV infected pregnancies. Some responses did note the lower cost of contraception compared to the cost of ARVs and that contraception had a greater effect than ARVs on the number of births of HIV infected children. Most responses included acceptable comparative figures, but candidates must make clear what the figures refer to.

Question 6

(a) (i) Candidates had little difficulty in suggesting three benefits of conserving plant species.

(ii) Most correctly described the conditions needed for storing seeds in a seed bank as dry or low in temperature. A number of responses described conditions that would promote germination.

(b) (i) Many realised this was a positive correlation, with the number of plant genera increasing as the rainfall increased, but did not always give supporting figures. Candidates generally recognised China as not fitting the pattern, but often Malaysia was incorrectly thought to be anomalous as well.

(ii) Temperature, wind, carbon dioxide and humidity were all alternatives commonly correctly suggested as affecting plant biodiversity. Many candidates failed to adequately describe how light might be a significant factor, needing to be more precise in mentioning light intensity or day length.

Question 7

(a) Most candidates were able to clearly describe *heterozygous* as being two different alleles of a gene. The ability to produce gametes with different genotypes was an alternative way of explaining this term.

Few candidates appeared to have learnt a simple explanation of the term *genotype*, such as the alleles present in an organism or its genetic make-up.

(b) Many candidates were very familiar with this type of dihybrid cross and clearly stated the parental genotypes and gametes, producing a Punnett square with correct genotypes for the offspring. Although many responses then stated the correct probability of yellow offspring, credit was often lost for not linking the genotypes in the square to all the various phenotypes of the offspring.

Question 8

(a) The difference in thickness of the inner and outer wall of the guard cell or a difference in shape or size was usually stated well enough to be awarded credit.

(b) (i) ABA binding to the plasma or cell surface membrane was frequently stated correctly. Some candidates were unable to gain credit by not describing the membrane as being the cell surface membrane.

(ii) The ion diffusing from the guard cell was usually known to be the potassium ion.

(iii) Most candidates stated that the water potential of the guard cells was higher than in the epidermal cells.

(iv) Some candidates only described the guard cells as flaccid, but the majority correctly stated that the volume decreased.

(c) (i) A number of candidates did not know that the sodium hydrogen carbonate solution was used to supply carbon dioxide.

(ii) This calculation was straightforward for most candidates. A number of responses failed to give correct units.

(iii) While the rate of oxygen production for tube **B** was faster than for tube **A** during the first ten minutes, the rate changed after this point continuing to increase for **A** as the rate decreased for **B**. Candidates found difficulty in comparing rates on either section, although most were able to gain some credit for quoting suitable figures. Frequently no time references were given.

(iv) The majority of candidates were familiar with the fact that photosynthesis would not be taking place in tube **C** and that the oxygen would be used in respiration.

(v) Many candidates realised that temperature was not being controlled. Even when candidates knew in **(c)(i)** that the sodium hydrogen carbonate solution was supplying carbon dioxide, a number of responses suggested that carbon dioxide was the factor not taken into account.

(d) Naming substances **X** and **Y** was straightforward for most candidates, although **X** proved more difficult than **Y**, the most common fault being reference to reduced NAD instead of reduced NADP.

Question 9

(a) The general idea of ATP supplying energy for the processes of active transport and anabolic reactions was well described by the majority. Credit was gained in reference to active transport for movement against a concentration gradient, with a few references seen to the use of carrier proteins and their change of shape. In many cases the candidates seemed unable to describe anabolic reactions in general terms as synthesising complex substances from simple ones, or to name suitable anabolic reactions, such as the formation of glycosidic bonds between monosaccharides to form starch.

(b) Candidates were generally well prepared to outline the process of anaerobic respiration in mammal and yeast. The production of reduced NAD in glycolysis and the small amount of ATP produced were described by most. Only a few responses confused the process in mammals with the process in yeast. The remaining responses clearly described the use of the reduced NAD in the conversion of pyruvate to lactate or ethanol, supplying detail of the steps involved. Additional credit was often gained by describing whether the process was reversible, single step or by naming different enzymes involved.

Question 10

(a) The principles of homeostasis in mammals were well described both in general terms and in relation to the control of blood glucose concentration. The use of hormones and their effects bringing about the restoration of the norm were similarly well known. A few references to fluctuations around the norm were seen but the weakest area was in the reception of changes in a parameter. While some general references to a receptor detecting the change were seen, it was usually not clear in the case of the blood glucose concentration, that the receptors were the cells of the islets of Langerhans themselves.

(b) The majority of candidates were able to describe the role of the endocrine and nervous systems in control and coordination in detail, many gaining full credit. In addition to the structures involved, extra credit was often awarded for descriptions of how the system functioned in terms of speed of action, how long the effect lasted, or how widespread it was.

BIOLOGY

Paper 9700/43
A2 Structured Questions

Key Messages

- Accurate supporting figures, with the correct units, should be used when answering a question accompanied by a table or graph.
- Candidates should be encouraged to look for an overall trend in figures or graphs and to be aware that this is often more important than individual figures that may be showing minor fluctuations.
- In genetics, candidates should be given opportunities to carry out basic crosses so that they are confident in the use of keys and use suitable symbols for genotypes.

General Comments

Many candidates had clearly used or referred to past papers when preparing for this exam. It is always useful to practise past papers as some candidates have a good knowledge of biology but are unsure how to express themselves clearly.

Command words such as 'describe', 'explain', 'suggest' and 'compare' require different responses from candidates. If a description is required, including a reference to a graph or table, then it will be expected that data will be used in the answer. Many candidates are able to do this effectively. An explanation requires more than just a description and candidates should be encouraged to practise the difference between 'explain' and 'describe'. A 'suggest' question encourages the candidate to display biological knowledge linked to the learning outcome being tested. It is always worthwhile for a candidate to attempt an answer to this sort of question as the mark scheme here will be fairly flexible

Finally, if a question requires a comparison then a candidate must refer to all of the variables being tested. This was shown in **Question 2(c)** when it was not sufficient to simply state that diagnosis was fast. A better approach is to refer to both in the same sentence or use 'faster' which shows a comparison. Words such as 'whereas' or 'however' can be used to link two parts of a sentence and therefore create a comparison.

Section B is an opportunity for candidates to display their knowledge of a learning outcome in a less structured way. Much credit is available for answers in ***Section B*** and it is worth noting the credit allocations for parts **(a)** and **(b)** whilst writing.

Comments on Specific Questions

Section A

Question 1

(a) Candidates were able to identify key definitions of a species, such as individuals breeding together to produce fertile offspring, but many candidates lost credit because they did not give any detail of the features, i.e. they did not state morphological, physiological, etc.

(b) The most common problem here was giving allopatric speciation as an answer; 'allopatric speciation' is a term which implies geographical isolation, but does not explain how separation has been physically caused.

(c) Most candidates were awarded some credit here. It was obvious when candidates had learnt by rote the answer to this question, and perhaps had looked at past exam questions in order to identify key marking points for this style of question. Allopatric speciation was used in responses and described clearly. There were very few candidates who discussed the idea of the mating song not being recognised by the females, but good coverage of all other marking points. Mutations are not caused by environmental / selection pressures – they are random. Geographical isolation preventing gene flow was commonly confused with reproductive isolation should the two species meet.

Question 2

(a) (i) Some problems with describing the immune response were seen. T cells and B cells were frequently confused. Very few responses included the correct detail of how B cells bind the antigen; even fewer made reference to antigen-presenting cells. Credit was mostly awarded for references to plasma cells and antibodies.

(ii) Candidates knew that a hybridoma cell is a plasma cell fused with a myeloma. 'Mixing the cells' was not enough; they needed to join together.

(iii) Candidates struggled here; many seemed to understand the concept and knew that plasma cells cannot divide or grow in culture. They stated that myeloma cells will divide but did not specify indefinitely or continuously.

(iv) Some candidates talked about markers, but did not qualify properly what the marker could have been attached to. Simply adding antigens to the solution would not identify hybridoma cells. Very few candidates suggested the use of labelled antigens or gave valid methods of marking or identifying the antigen. A small number gave other valid methods of identifying the hybridoma cells.

(b) (i) This was a difficult question, not least because the graph required a lot of interpretation. Candidates would be well advised to make sure in descriptions of data that they clearly identify the trend. A common reason for not scoring marks here was incorrect reading of the results from the graph; group **P** is quite clearly 30.5% and not, for example, 30%. Many candidates stated that results in groups **S** and **T** were different; a 0.5% difference should not be considered meaningfully different. A proportion of the candidates simply wrote out the data in the graph but did not interpret in any way.

(ii) Very few candidates were awarded credit for this question. Perhaps most candidates do not consider 71 people to be a small number, but in the context of this kind of investigation it is a small group.

(c) A commonly given response was that monoclonal antibodies give a faster diagnosis, but many other points given referred to treatment, despite diagnosis being emphasised in the question.

Question 3

(a) Many candidates were unclear about this topic. They knew the movement of DNA to the anode, but failed to say that it was the phosphate group of the DNA that was negatively charged. Those who attempted to describe that lower mass moved faster were awarded, but candidates who wrote about the distance moved needed to include 'per unit time'.

(b) Candidates generally drew a band in the same place as the band for the HbA HbA individual, but did not correctly draw the second band above it.

(c) Many candidates referred to checking family histories but did not give enough detail. A few mentioned genetic counselling. Many incorrect answers gave information concerning paternity testing and use in criminal investigations.

Question 4

(a) Relatively few candidates answered this well. Some confused male and female parts of the flower, and pollen with seeds, while others did not use Fig. 4.1 and concentrate on the male parts of the flower. Even those who did focus on stamens frequently failed to relate their descriptions to increasing the likelihood of wind dislodging pollen. Most did not refer to anthers and those who did, only referred to half the answer, e.g. anthers outside of flower but no mention of pollen or long filament. Some thought that the anthers collected pollen. Many candidates referred to stigmas or stamens.

(b) Most candidates scored well, identifying mutations, survival and reproduction for full credit. Candidates followed a well-rehearsed sequence of steps in describing an evolutionary change. However, some confused maize with corn borers, and the idea of resistant alleles was missed. Candidates used the term gene rather than alleles.

(c) The homozygous recessive genotype **rr** was mostly given correctly.

(d) The candidates appeared to have an understanding of the ideas, but their responses were not always detailed and concise enough score credit. Breeding non-resistant and resistant corn borers gave the heterozygote but they did not go on to say that these organisms would not be resistant or die.

(e) (i) Many candidates were confused by the data and a fair number did not provide an answer at all. Mixing was identified but this was sometimes confused by also talking about mating.

Some picked up on the variation in the results, and some noticed the discrepancy between males and females. Candidates tended to interpret the data in terms of missing (non-recaptured) borers having moved to other fields, rather than new (unmarked) borers having come from other fields.

(ii) Candidates did not understand the impact of the strategy and what would be needed for it to be effective. Figures were quoted, but these did not relate to points being made and inbreeding occurring. The credit was mostly awarded for marked females mating with marked males or marked females mating with unmarked males.

Question 5

(a) Candidates knew the role of progesterone and answers were detailed. Common errors were to references to the uterus wall instead of the lining, and to implantation of the egg or ovum.

(b) (i) Many candidates did not read to the smallest square of the graph and rounded their answer up to 33. Many missed the unit (days) and a few gave an incorrect unit, e.g. years.

(ii) This was a difficult graph to interpret, but as with other questions, candidates should be encouraged to identify trends; many simply described each curve without using the data to answer the question. Many candidates stated that the different diets caused the rats to reach puberty, without giving any time span; they all reached puberty, so time was needed to make a comparison.

As with any graph, there were a number of candidates who describe the *y*-axis variable affecting the *x*-axis variable, instead of the correct way around.

Question 6

This question was one of the best answered on the paper.

(a) Candidates identified the reasons covering a range of marking points for species becoming endangered. They were also able to make links between pollination and a removal of flies.

(b) (i) There was a lot of variation in the answers about the definition of the term biodiversity, but most candidates had learnt the definition and so gained credit here.

(ii) Candidates had seen this type of question before and their answers showed the benefit of practising past papers.

Question 7

(a) Many candidates wrote that the allele symbols were R and r, and then went on to carry out the cross perfectly, using the X and Y chromosome symbols in all genotypes in addition to the colour alleles. Common candidate errors included a number who did not include X and Y at all and scored no credit, or put superscripts on the Y chromosome. Most candidates were quite successful on this question.

(b) (i) Candidates who were not awarded credit here pointed out that the son could only inherit the allele from the mother, but this was not really answering the question. Therefore, although they had scientific knowledge, they were not applying it tightly enough within the given context.

(ii) Many candidates spoiled their answer of 'heterozygous' by adding dominant or recessive, however, many were awarded credit.

(iii) There were many candidates whose answer 'mutation' did not score because more detail was required; they had not specified gene or allele mutation.

Question 8

(a) (i) Most candidates realised that the enzymes would denature. Some candidates were awarded some credit for discussing optimum temperature, (although some did not specify the enzyme), stomata, and reduction in Calvin cycle or increased photorespiration. It is important to note that less carbon dioxide (not no CO_2) and a reduction in the Calvin Cycle (not cycle stops) are important points.

(ii) Most candidates were credited for correctly drawing the likely curve. They were not as successful at explaining the curve. It was necessary to state that sorghum or C4 enzymes have a higher optimum temperature and give some structural feature which enabled the plant to avoid photorespiration. Some said it was adapted to an arid rather than a hot climate.

(b) (i) Most candidates completed the table correctly.

(ii) The graph was successfully completed by a majority of candidates. Those who did not score full credit made the usual mistakes. These included the axes being the wrong way around, the scales being incorrect, the units missing, points plotted incorrectly and a poorly drawn line.

(iii) The definition of a limiting factor is always something candidates find difficult to explain. When a process is affected by more than one factor, the rate of the reaction is restricted by the factor that is nearest its lowest value.

Section B

Question 9

Candidates answered this question very well and the majority chose this question rather than **Question 10** on the kidney.

(a) The question asked the candidates to describe how ATP is synthesised by oxidative phosphorylation. There was some confusion between NADH and NADPH and many missed out the hydrogen being released from the reduced NAD. Electrons accepted by ETC were mentioned, but no mention was made of carriers/cytochromes. Some candidates thought that it was hydrogen that moved rather than the hydrogen ion. Many candidates scored full credit here.

(b) Another well answered question. The need for energy in living organisms was well known and examples were also given. Some missed the reference to light energy in photosynthesis and detail of the light dependent and light independent stages. All other energy requiring processes were well documented.

Question 10

(a) Candidates were mostly well-prepared and in a few sentences or on a diagram were able to list at least six parts of the kidney. The only thing they were not used to doing was specifying which parts of the nephron were in the cortex and which in the medulla. Where diagrams were used they were used well, with correct labels and the position of nephron identified. Few candidates referred to the afferent and efferent arterioles or the capillary network.

(b) Responses here were very varied from candidates who had shown a thorough knowledge of the functioning of the nephron. Many candidates gave a full account of ultrafiltration and then went on to reabsorption. There was confusion over where the sodium ions were moving from and to. Many gave a muddled account of the facilitated diffusion and cotransporters. Few mentioned osmosis. In the adaptations it was rare to see anything more than microvilli and many mitochondria.

BIOLOGY

Paper 9700/51

Planning, Analysis and Evaluation

Key messages

- Candidates must have experience of practical work and be familiar with the use of a range of equipment that could be used for A Level studies. They should also be able to recognise the key stages in an investigation and be able to apply their knowledge to interpret complex data.
- Candidates should also have experience of processing data and making decisions about conclusions that can be made and if a hypothesis has been supported.
- Candidates should be familiar with different mathematical processes, in particular statistical tests and should be encouraged to practise the various statistical techniques as much as possible.

General comments

A wide range of answers were seen. Candidates who were well prepared were able to write concisely and to the point and the presentation of many scripts was good. There were some responses written in pencil or red pen and candidates should not follow this practice. There was no evidence that the candidates were short of time. Many of the questions presumed that the candidates had undertaken a range of experimental work. In some cases it seemed that practical experience was limited and it is important that Centres give as much time as possible to practical experience

Comments on specific questions

Question 1

(a) Most candidates identified the independent variable as the composition of the growth medium though a few thought it was time or temperature. Likewise the two dependent variables of percentage germination and growth of pollen tubes were usually given.

(b) (i) Few mentioned that the microscope would be used at a magnification suitable for observing pollen. This was a question where practical experience at calibrating an eyepiece graticule should have allowed the candidates to approach this question with confidence. Some answers were set out so that it was clear that the candidate appreciated that the eyepiece graticule was used to measure the pollen tubes and was calibrated using the stage micrometer not the reverse. This calibration would give a value in mm for the graticule units. To get the data in the table the measurements would then be converted to micrometers. There was some confusion evident here with some responses suggesting that the actual scale on the stage micrometer was in micrometers

(ii) The key idea expected here was that percentage germination allowed a comparison to be made between samples and the better responses made this point clearly

(c) (i) A majority of answers correctly identified that the mean and the standard deviation were the calculations that were needed. The commonest incorrect response was to cite standard error. Some responses had the chi square test in mind and mentioned expected and observed results. Variance was also sometimes mentioned

(ii) Good answers were able to explain the idea of one less degree of freedom than the number of categories and thus came up correctly with (10-1) + (10-1) = 18. In other cases there was a lack of understanding regarding how degrees of freedom were calculated and many thought that 3 categories could be compared at the same time in a *t*-test and thus came up with (7-1)+(7-1)+(7-1) =18, the seven being derived from the seven time intervals over which the experiment was conducted. Another common error was to state 19-1. It was also not enough just to give the formula (n–1) + (n-1) without explaining what n was. This underlines the importance of making it clear to candidates exactly what degrees of freedom are and how they are calculated.

(iii) Some Centres are now clearly teaching the statistical techniques successfully and there were some well set out answers. Biologists work at the 0.05 probability level and the first thing to mention here is that at this level and with 18 degrees of freedom, the critical value for *t* is 2.10. The first two calculated *t* values are higher than this critical value and thus these differences are significant (not due to chance) whilst the third calculated value is lower than the critical value and thus the difference is not significant (is due to chance). Some candidates had the ideas the wrong way round, thinking the values 2.50 and 3.56 were not significant. Some responses seemed to think that values can be 'more' or 'less' on the basis that 3.56 was a higher value than 2.50. It is important to realise that there are not degrees of significance in that sense. Values are either significant or not at a particular probability level. What is true is that the value $t = 3.56$ is significant at both the 0.05 and 0.01 probability levels.

A few candidates tried to turn the data into a chi-squared exercise.

(d) (i) There were some very long answers to this, often spreading beyond the allocated space. There was a lot of data to process but the key thing was to look at the overall pattern as shown at the end of the investigation. Data quotes alone do not answer the question as that is just describing the results. Three pieces of evidence for the conclusions are that tubes grow longer in media with calcium, germination is similar with or without calcium and that sucrose *alone* allows germination. This is not the same as saying it occurs in all three media all of which contain sucrose.

Ideas which do not support the conclusions are that all the media have sucrose so there is no way of knowing its effect, the presence of boric acid might be involved and in medium **C** so might magnesium, potassium or sulphate.

The question required that some time should be spent processing the data before writing down the concise ideas on which parts supported or otherwise the stated conclusions

(ii) The majority of candidates suggested doing a range of sucrose concentrations. The key was to carry out an experiment with no sucrose but this was credited as part of a range if that was the way that the candidates had approached the question. It was also important to indicate that the rest of the technique would be repeated as before

(iii) Most candidates scored here and full credit was not uncommon. They seemed able to make use of the stated conclusion 'sucrose is needed for pollen tube germination but has no effect on the growth rate of the pollen tube' much better here than they could in **(d)(i).** They did well at using the stated conclusion to predict results which were in line with their suggested investigation in **(d)(ii)**.

Question 2

(a) (i) In this question candidates needed to use their practical experience to a novel situation. The expected answer was that there needed to be a source of oxygen or method of getting it into the beaker. Thus something like an oxygen cylinder or an air pump would have been a valid way of gaining partial credit. Then there needed to be some way of ensuring even oxygen distribution such as a bubbler, a diffuser or by stirring. A lot of responses suggested adding something like photosynthesising plant material or hydrogen peroxide to the beaker. This did not gain credit. But it was acceptable to set up a chemical or biological source of oxygen separately and then use this as an oxygen supply to feed into the beaker. A few candidates suggested adding oxygenated haemoglobin to the beaker.

(ii) The majority of candidates correctly chose temperature with a few going for the acceptable alternatives of sampling time or sugar concentration. pH was not credited as the buffer mentioned in the diagram controlled that.

(b) (i) A lot of candidates tried to get too much information into this section. The question only asked them to outline how the rate of glucose absorption could be determined. Some answers tried to fit in full experimental detail for both sugars. The key ideas are that the starting concentration for glucose would need to be known. The uptake would then be allowed to proceed for a known time period. The concentration inside the bag or remaining in the beaker would then need to be measured. This would require a means of taking a sample, for example a syringe, and a means of quantitatively measuring the glucose. The most commonly mentioned way of doing this was by a Benedict's test. To make this quantitative it is necessary to compare the test result to a known series of standards and this was rarely mentioned. A few candidates mentioned biosensors which both identify and quantify the glucose. A number of candidates suggested methods involving change in mass of the intestines or even change in length. Neither method would be practical.

(ii) To answer this question, candidates needed to recognise that 'relative' means to compare to one another. Few considered that to obtain relative rates the two sugars would need to be investigated in the same way to make the two values obtained comparable. The closest most candidates got was to mention how to calculate the rate for glucose by dividing the change in the parameter measured in **(b)(i)** by the time taken.

(c) This was often well done with many candidates getting full credit. The most usual correct responses were to note that glucose uptake was reduced by respiratory inhibitors whilst fructose was not and that when an inhibitor was present the uptake of both was similar. Many also noted that glucose uptake had an active element. One common error was to suggest that respiratory inhibitors increased fructose uptake because the value changed from 30 to 31. Centres should ensure that candidates realise that small differences in values are not likely to be within experimental error and of little importance.

BIOLOGY

Paper 9700/52
Planning, Analysis and Evaluation

Key messages.

- Candidates must have experience of practical work and be familiar with the use of a range of equipment that could be used for A Level studies. They should also be able to recognise the key stages in an investigation and be able to apply their knowledge to interpret complex data.
- Candidates should also have experience of processing data and making decisions about conclusions that can be made and if a hypothesis has been supported.
- Candidates should be familiar with different mathematical processes, in particular statistical tests and should be encouraged to practise the various statistical techniques as much as possible.

General comments

There was a wide range of answers seen. Questions in the papers presume practical experience. Good answers showed evidence of this and sound understanding of biology, which was applied to the questions asked. Less good responses often seemed to be the result of less familiarity with practical techniques and the analysis of the results from using such techniques. The use of statistics showed a wide range of understanding and it is important that candidates are familiar with the expected definitions and know how to determine which statistical test to use.

Much information is provided in this paper that candidates need to address the questions. It is important that candidates read it carefully, but realise that credit will not be gained by restating this information as an answer to a question.

Comments on specific questions

Section A

Question 1

This question was about hybridisation in plants and how to identify hybrid cells by their chromosomes. Statistical analysis of the data in the latter part of the question required an understanding of mean, mode, median and the use of the *t*-test.

(a) (i) Relatively few candidates were able to identify the independent variable. The most common answer was 'the species of plant', which was too vague as some reference to pollen was expected. However the majority were able to identify the dependent variable.

(ii) Better answers made it clear that the bag was to prevent the entry of any type of pollen other than that being tested. Weaker answers however sometimes lost out as they just stated 'wind pollination' or in some cases 'insect pollination'. Other candidates referred to environmental factors such as humidity, carbon dioxide concentration and temperature.

(b) (i) A wide variety of answers were allowed which were expected to include a means of obtaining pollen and transferring it to a stigma. Suitable methods of obtaining pollen included using a brush, a cotton wool bud, a finger to rub an anther or cutting off a stamen or an anther. Some less likely methods were given credit, for example picking off individual pollen grains using forceps. Suitable methods of transfer included brushing or rubbing pollen onto the stigmas with the same implement used to collect pollen, shaking pollen from stamens directly onto the stigmas or indirectly from a container used to collect the pollen. The use of pollen traps, vacuum pumps or bees was not acceptable. Weaker answers re-stated the question 'obtain the pollen and transfer it to species **A**'.

(ii) Most candidates answered in terms of a pollen or plant allergy and gave a suitable precaution. The safety issue should have been related to the method used for pollen transfer, so electrical safety issues were not appropriate. Credit was allowed if the candidate chose an unsuitable method of pollen transfer, such as using bees, but described a suitable safety precaution for this method.

(c) Very few candidates gave a complete answer to this section. Candidates needed to apply their knowledge of maize fruit structure and their knowledge of the technique of staining cells to observe stages of mitosis to answer this question. Very few candidates realised that the maize should be germinated to have actively dividing cells. Credit was allowed for using embryo cells, although as these are relatively inactive, it is unlikely that mitotic cells would be visible. Candidates often seemed uncertain about maize structure and used sections of the fruit or endosperm. Many candidates crushed the whole fruit or embryo and thought they could use a centrifuge to obtain nuclei or chromosomes. Weaker answers also referred to counting all of the chromosomes rather than the number per cell. Better answers identified the regions of an embryo where cells in stages of mitosis could be found and in some cases stated a suitable stage of mitosis during which chromosomes could be counted. Most candidates described a way of obtaining cells that could be seen using a microscope. Better answers referred to cutting thin sections, rather than small sections. Weaker answers showed confusion with making epidermal strips of leaves. Almost all candidates referred to using a stain, but often identified an unsuitable chemical, for example iodine, DCPIP, ink and ninhydrin. DNA markers, such as ethidium bromide, fluorescent dyes and radioactive probes were common. Although candidates usually referred to using a microscope, often they were not credited since a suitable magnification was not given or, they used a high resolution microscope or an electron microscope. Weaker answers also described how to measure chromosomes using a graticule. Candidates commonly referred to 'doing repeats' but only better answers showed an understanding that several different embryos should be studied.

(d) Most candidates were able to gain partial credit by identifying the number of chromosomes contributed by each parent of hybrid species **A** x species **B**. Better answers showed a clear understanding of gamete formation and the role of meiosis. The explanations of the hybrid of species **A** and species **C** were less well explained. Better answers showed an understanding that the chromosome number of the hybrid was tetraploid, but explanations as to how this might occur were often confused. Acceptable explanations needed to show an understanding of non-disjunction during mitosis following fertilisation or non-disjunction during meiosis of gamete formation in the parent plants. Candidates often missed out here as they stated that the chromosome number became polyploid without any further explanation. Weaker answers showed a number of misunderstandings about the roles of meiosis and mitosis and the way in which polyploidy originates. For example, the embryo of **A** x **B** underwent meiosis to halve the chromosome number, the gametes of **A** and **C** are formed by mitosis and then fuse together, at fertilisation the zygote undergoes meiosis. The use of the terms haploid and diploid was often incorrect. For example, **A** x **B** have 16 chromosomes which is the haploid number, the haploid chromosomes undergo meiosis, hybrid **A** x **B** has the haploid number and hybrid **A** x **C** has the diploid number.

Other candidates did not address the question, either, because they explained about gamete formation in the hybrids and whether they could produce viable offspring, or they referred to the viability of the hybrid in terms of the number of chromosomes it possessed.

(e) (i) Almost all candidates gave a correct answer. Weaker answers gave an average of 7.5 for the hybrids of **A** x **B**. A few candidates appeared to have misread the question as they gave the number of fruits that germinated.

(ii) Better answers showed a good understanding of chromosome pairing and why the hybrids of **A** x **B** gave different chromosome numbers in the pollen grains. Some candidates only gave evidence for one of the hybrids and so did not gain full credit for this section.

(f) (i) Most candidates gained full credit. The only common error was giving a decimal answer for the mean, rather than rounding the answer.

(ii) The majority of candidates gave a correct answer. There were however some answers that were too imprecise, for example, comparing two sets of data rather than the mean of the data sets. Weaker answers tended to be a list, some of which were incorrect. As the question asked for 'a' reason, then only one was expected.

(iii) Well prepared candidates gave clear answers. Weaker answers tended to miss out the word 'significant', in effect stating 'there will be no difference'. Candidates should be encouraged to use the phrase 'not significant', rather than the word 'insignificant'.

(iv) Answers to this question were very varied. Candidates who used a formula that included the correct value for 'n' usually gained credit here, but candidates who tried to explain in words often lost their way. It was not enough just to give the formula (n–1) + (n-1) without explaining what n was. Weaker answers just said there were 22 samples so 20 was the nearest number of degrees of freedom. There were also some candidates who gave very vague answers, such as to improve reliability or accuracy.

Question 2

This question was about the permeability of cell membranes and how to estimate rate.

(a) (i) An important feature of this question was for candidates to identify how the variables had been standardised, either by saying 'the same' volume, same number or quoting the actual values given. Most candidates were able to identify three variables from the information given, commonly the same number of plant discs, the volume of deionised water and the time in the water bath. Candidates who simply wrote a list without any other qualification did not gain credit as they only identified the variables, not how they had been standardised. Some candidates gave three different aspects of the plant tissue, which is only one of the variables. It is important that candidates recognise that a biological component of an investigation is a single variable, but may need to be standardised in several ways, depending on the investigation. Weaker answers still tend to use 'amount' without identifying the nature of the amount, for example in this investigation, the deionised water has both an 'amount' of volume and an 'amount' of concentration of chloride.

(ii) Most candidates recognised that the investigation should be repeated. Many however did not gain full credit as they did not state the number of repeats, or did not refer to a mean or average value. It was not always clear what candidates meant by the word 'repeat' as they referred to 'repeat readings' or repeat measurements', which could be interpreted as taking several reading from the same tube, rather than readings from several tubes at the same temperature. Candidates should be encouraged to refer to replicate experiments or investigations, when the whole procedure is repeated a number of times. In principle, the more replicates the more reliable, but the usual minimum is three, the original and two more. Weaker answers referred to keeping the temperature constant. As the investigation already had a range of eight temperatures within the range most likely to affect the lipid and protein components of membranes, increasing the range of temperatures was not likely, in this case, to improve reliability of the results.

(b) (i) Many candidates gave a correct answer. Some candidates misinterpreted the graph and tried to calculate the rate from the slope. Others defined rate instead of stating how to do the calculation.

(ii) There were very few correct answers to this question. Most candidates were able to find the correct values, but then calculated the difference between them. Candidates did not seem to understand that 'relative' means to compare one to another, so they were expected to calculate how much faster the rate at 60˚C was in comparison to the rate at 50˚C. Common calculations were the difference between 56 and 14, the difference between 56 and 14 divided by 14 or the difference between 56 and 14 divided by 10. Some candidates misread the graph at 50˚C as 12.

(c) About half the candidates gave a correct answer. Many also gave a reason, which was not required. In better answers reasons were well explained, but in many cases they were incorrect and related to osmosis rather than membrane permeability.

BIOLOGY

Paper 9700/53

Planning, Analysis and Evaluation

Key messages

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- Candidates should be familiar with different mathematical processes, in particular statistical tests and should be encouraged to practise the various statistical techniques as much as possible.

General comments

A wide range of answers were seen. Candidates who were well prepared were able to write concisely and to the point and the presentation of many scripts was good. There were some responses written in pencil or red pen and candidates should not follow this practice. There was no evidence that the candidates were short of time. Many of the questions presumed that the candidates had undertaken a range of experimental work. In some cases it seemed that practical experience was limited and it is important that Centres give as much time as possible to practical experience

Comments on specific questions

Question 1

(a) Most candidates identified the independent variable as the composition of the growth medium though a few thought it was time or temperature. Likewise the two dependent variables of percentage germination and growth of pollen tubes were usually given.

(b) (i) Few mentioned that the microscope would be used at a magnification suitable for observing pollen. This was a question where practical experience at calibrating an eyepiece graticule should have allowed the candidates to approach this question with confidence. Some answers were set out so that it was clear that the candidate appreciated that the eyepiece graticule was used to measure the pollen tubes and was calibrated using the stage micrometer not the reverse. This calibration would give a value in mm for the graticule units. To get the data in the table the measurements would then be converted to micrometers. There was some confusion evident here with some responses suggesting that the actual scale on the stage micrometer was in micrometers

(ii) The key idea expected here was that percentage germination allowed a comparison to be made between samples and the better responses made this point clearly

(c) (i) A majority of answers correctly identified that the mean and the standard deviation were the calculations that were needed. The commonest incorrect response was to cite standard error. Some responses had the chi square test in mind and mentioned expected and observed results. Variance was also sometimes mentioned

(ii) Good answers were able to explain the idea of one less degree of freedom than the number of categories and thus came up correctly with (10-1) + (10-1) = 18. In other cases there was a lack of understanding regarding how degrees of freedom were calculated and many thought that 3 categories could be compared at the same time in a *t*-test and thus came up with (7-1)+(7-1)+(7-1) =18, the seven being derived from the seven time intervals over which the experiment was conducted. Another common error was to state 19-1. It was also not enough just to give the formula (n–1) + (n-1) without explaining what n was. This underlines the importance of making it clear to candidates exactly what degrees of freedom are and how they are calculated.

(iii) Some Centres are now clearly teaching the statistical techniques successfully and there were some well set out answers. Biologists work at the 0.05 probability level and the first thing to mention here is that at this level and with 18 degrees of freedom, the critical value for *t* is 2.10. The first two calculated *t* values are higher than this critical value and thus these differences are significant (not due to chance) whilst the third calculated value is lower than the critical value and thus the difference is not significant (is due to chance). Some candidates had the ideas the wrong way round, thinking the values 2.50 and 3.56 were not significant. Some responses seemed to think that values can be 'more' or 'less' on the basis that 3.56 was a higher value than 2.50. It is important to realise that there are not degrees of significance in that sense. Values are either significant or not at a particular probability level. What is true is that the value *t* = 3.56 is significant at both the 0.05 and 0.01 probability levels.

A few candidates tried to turn the data into a chi-squared exercise.

(d) (i) There were some very long answers to this, often spreading beyond the allocated space. There was a lot of data to process but the key thing was to look at the overall pattern as shown at the end of the investigation. Data quotes alone do not answer the question as that is just describing the results. Three pieces of evidence for the conclusions are that tubes grow longer in media with calcium, germination is similar with or without calcium and that sucrose *alone* allows germination. This is not the same as saying it occurs in all three media all of which contain sucrose.

Ideas which do not support the conclusions are that all the media have sucrose so there is no way of knowing its effect, the presence of boric acid might be involved and in medium **C** so might magnesium, potassium or sulphate.

The question required that some time should be spent processing the data before writing down the concise ideas on which parts supported or otherwise the stated conclusions

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